EDUCATION FOR RESEARCH

RESEACH FOR CREATIVITY

Edited by Jan Słyk and Lia Bezerra

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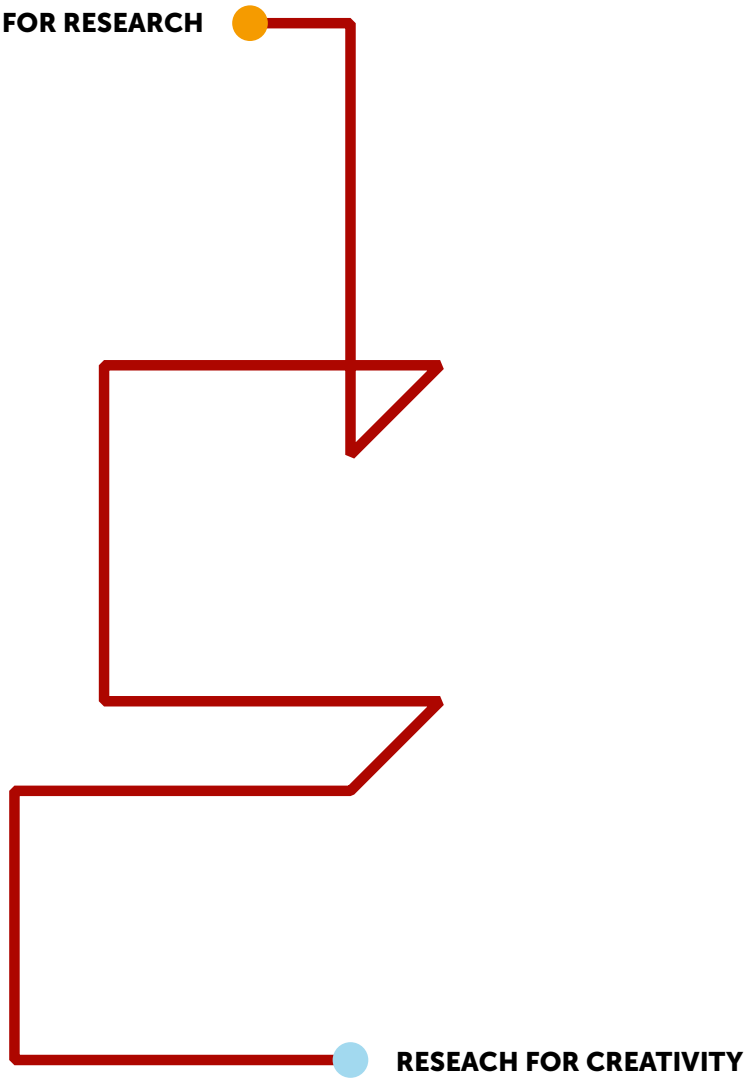**Edited by Jan Słyk and Lia Bezerra**

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Education for Research, Research for Creativity
Edited by Jan Słyk and Lia Bezerra

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CREATIVITY

Jan Słyk and Lia Bezerra

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FOREWORD

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The synergy of two processes created the idea of providing a space for architectural theorists, practitioners and educators to discuss research in information technology. The first of these processes, The Architecture for the Society of Knowledge program (ASK) has existed since 2008. The second began a little more than a year ago in the format of a new PhD studies pilot-project part of ASK at the Faculty of Architecture of the Warsaw University of Technology.

ASK was created as a new graduate program with a global perspective. In time, it has resulted in the creation of a center not only for educators, but also for researchers dedicated to the use of digital technology in the built space. The ASK program covers work in an array of fields: the theoretical basis of creativity, changes in culture (especially the digital revolution), architectural workshop tools used in the field of analysis and creation, interdisciplinary projects based on the use of BIM models, spatial experimentation, reactive, interactive and robotic installations, heritage protection and the analysis of historical objects based on digital tools implementation, simulation and optimization aimed at protecting environmentally sensitive sites.

A group of researchers within the ASK program have increasingly focused their attention on the understanding and application of experimental methods in architectural and spatial research. Due to the size, cost and timeframe of its works, architecture never undertook testing in line with the tenets of empiricism. Only recently with the use of different digital methods and representative digital models can architecture test its prototypes. The newly available methods for laboratory testing have become a basis for analytic architecture. These new experimental methods are becoming the basis for the doctoral studies at the ASK program. The PhD program is geared towards

the development of digital technology and enhancing environmental awareness as it relates to architecture and urban design.

Professor Wojciech Gasparski says "Human civilization has just faced a serious barrier". Currently, we see this as becoming more true: consumerism based on the exploitation of the environment inevitably leads to the destruction of both consumers and environment. This decay can be - partially - prevented through common approval for a design methodology. Societies that have accepted the need to foster positive and relevant changes, Gasparski's "designing societies", naturally seek sustainable development. Methods that could allow architecture to scientifically predict future consequences and influences on the environment are crucial to designing - these - societies.

Education for Research, Research for Creativity combines theory, applied science, academia and practice towards the creative transformation of the human space, while maintaining an environmental awareness. The works in this book cover a broad spectrum of issues related to research, practice, the digital environment, and architectural education.

We would like to express our immense gratitude to all the people involved in the publication of this book. We would also like to thank all the authors of the works for collaborating with us. This book is part of a project supported by the Norway Grants, Polish Funds and FSS, without this grant the project could not have been realized.

Education

"If we teach today's students as we taught yesterday's, we rob them of tomorrow."

- John Dewey, Schools of Tomorrow

In the first part of the book - education - we have selected works that contribute to the discussion of how architectural education can adapt to the new roles of the architectural profession. The opening work is a description of a new PhD curriculum currently at work in the ASK program at the Warsaw University of Technology and how it innovates in content and form. The subsequent works present a range of ideas within this common theme: from big data to games, environmental approach to traffic calming, prototyping to workshops.

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DEVELOPING A NEW PHD CURRICULUM FOR AN ENGLISH-SPEAKING DOCTORAL COURSE AT THE ARCHITECTURE FOR THE SOCIETY OF KNOWLEDGE PROGRAM, FACULTY OF ARCHITECTURE, WARSAW UNIVERSITY OF TECHNOLOGY

The ways research and studies in architecture are developed should be adjusted to the needs of modern society. This article covers the process of developing a new doctoral curriculum at the Faculty of Architecture, Warsaw University of Technology, aimed at addressing these evolving needs. We describe the steps leading to the program's concept, covering its context analysis and the continuous evaluation of the program's assumptions. The ASK PhD course is intended to continue the principles developed on the ASK Master program. We show how these experiences reflect on the PhD program. We present the program's concept and structure within a newly designed environment at the faculty. The model that we are adopting for this PhD study program will grow in significance in the nearest future.

The gradual changes in the architect's role in the building process require consequent reaction from the education system. The rapid evolution of digital technologies and society's demand for sustainable solutions opens yet other new opportunities to the faculties of architecture and necessitates the rethinking of their models of teaching. We believe that doctoral studies require a change of approach so that architecture can play a significant role in the Research & Development sector of the market. In order to realize this goal, we decided to restructure the PhD studies at the Faculty of Architecture of Warsaw University of Technology - WUT - and have applied for external funding. With a support granted by the Norway Grants, we were able to start a 1,5 year project of developing a new curriculum.

CURRICULUM DEVELOPMENT PROCESS

Project Goals

Designing a PhD curriculum is more complex than one would at first think. The project's aims are designed around four main tasks:

– Preparation of an English-speaking doctoral curriculum at the WUT's Faculty of Architecture;

- Development of the teaching resources, tools and methods necessary to start a new program at the Faculty of Architecture;
- Promotion of information technologies as flexible tools for enhancing environmental awareness and the sustainability of the built environment, as well as expanding the University's knowledge base in the field;
- Supporting a culture of quality through modification of the faculty's internal quality assurance system.

Three teams performed the aforementioned tasks:

- Curriculum development team: responsible for all activities related to setting up the new program at the Warsaw University of Technology;
- Quality assurance system modification team: works related to assessing and designing ways to raise the overall quality of education on the Faculty of Architecture;
- Social research team: focused on realizing a study of the Faculty's programs in a socio-economic context within the field of sustainable architecture and evaluating our efforts towards the completion of the project.

All teams coordinate their work towards the project's overall goal: increasing the awareness of environmental monitoring and improving the quality of education through the development of a doctoral program in English at WUT's Faculty of Architecture.

Defining the Needs

This section focuses specifically on the activities undertaken by the curriculum development team. Before producing the first draft of the curriculum, we went through an in-depth analysis in order to gauge the market and academic context of the designed program.

We explored over 150 existing PhD programs from all over the world, focusing on programs at European schools. We tried to get the widest possible cross-section of institutions so that almost every European country has been represented in the study. Additionally, we examined a number of universities from the United States and from chosen Asian countries. The analysis was divided into stages and included both quantitative and qualitative research, which allowed us to formulate the conclusions for shaping ASK PhD studies.

From the quantitative study, we were able to determine that structured PhD curriculums represent only about 40% of all examined programs. Structured PhD programs are those that have a clear schedule or scheme of courses that support the PhD candidate throughout the years of study. It is worth noting that most of these structured studies were relatively new initiatives. We assume that this ratio will change in favor of structured programs in the near future. We also explored other statistics, such as the PhD program's total duration or each program's fields of interest. Surprisingly, the intended focus areas of the ASK PhD program (i.e. digital tools in architectural and urban design) are rarely found at other institutions. Less than a third of the examined institutions place IT-related topics in their research area. The main emphasis in architectural and urban research is generally history and theory (about 60% of the examined institutions undertake research in that field) and a little less research fields related to sustainable development (around 45%). The digitally oriented programs were mostly new on the market, which helps affirm that this field will soon develop more. Therefore, it seems to be an ideal moment for the ASK PhD to appear in the academic scene and to secure WUT's Faculty of Architecture position as a research center, specializing in utilizing IT tools in design.

The next step of the analysis was selecting a number of programs for a further, more detailed study. The programs were then examined in terms of its structure, content and organization. For

each we created a chart compiling the collected data in a graphic form. The examined curriculums represented a wide variety of approaches, but there was at least one characteristic common for all of them: a narrow specialization. With this approach it is easier to offer common content to all program's participants but it also results in a smaller program with a fewer number of students.

It also appeared to be fairly common to have a partially defined curriculum consisting of a constant methodological block with other elected courses. The latter, usually to be chosen from a broader offer from the university, not only limited to the faculty. Larger PhD schools were often found to use this structure to be able to provide for students from different areas of interest.

After analyzing the PhD studies offers, it made sense for us that the ASK PhD should be of narrow specialization. The current PhD school at the WUT's Faculty of Architecture has almost 100 participants, which results in a substantial dispersion of fields of research. The students are distributed between different departments and their PhD topics are individual and often highly dependent on their advisor's interest. Therefore, it is hard to speak about a major identity for the PhD program, as candidates share only a couple of general classes. Creating a small program will allow the formation of an effective research unit, with the theoretical support of a specialized curriculum. At the same time, part of the curriculum – including classes in methods and other transferable subjects – can be offered outside of ASK, integrated with the broader PhD school.

Concept Evaluation

Simultaneously to developing the ASK PhD curriculum, we undertook actions to evaluate our tasks. We summarized each step of our work in a report, which documents our actions and helps monitor the project's progress. Our results are then presented and discussed with the project's Program Council, our advisory body, which meets every two months. The Council either approves our concepts or suggests alternative paths to issues we deal with.

To discuss our concepts and conclusions and to share experiences of establishing a PhD School, we went on a study trip to Norway, where we visited the Oslo School of Architecture and Design. Our hosts granted us the opportunity to see how their own PhD School is organized through participating in their PhD board meeting. During the two-day trip, we also had the occasion to talk with the School's research manager who explained further technical details and about their financial system to keep the program active. And finally, we were also able to get to know a student's perspective by meeting one of the AHO's PhD candidates.

An important observation for us was that AHO's PhD school found itself in a comparable situation to our school in Warsaw. Similarly to our faculty, they also suffer from an excessive dispersion of PhD candidates, which makes it hard to organize a coherent research unit. After talking about our common experiences, we concluded it would be beneficial for our new program to feature a collaborative environment for a multi-directional transfer of knowledge.

During the same trip we were also able to visit the Norwegian architectural studio Snøhetta, where we met one of the office's managing directors. We discussed possibilities and risks of the job market for architects that have finish a PhD program. We agreed that one of the possible career paths for ASK PhD alumni proficient in research and digital tools would be an expert position in institutions involved in the processes of shaping the built environment.

THE ASK MASTER PROGRAM

During our project, we were also able to benefit from the experience gained with the ASK Master (MSc) project, which we already host in our Faculty since 2010. The curriculum was created in 2008-2009 by a team from the Chair of Architectural Design led by Prof. Stefan Wrona. In the first year, 24 students enrolled. By April 2016, 95 students attended the course and 45 students have received their diplomas. Specialized study programs are the answer to a series of conditions brought forth by a study that analyzed the current situation of the architectural profession and the resulting needs in architectural education. The most important ones are:

– The increasing complexity and dynamics of conditions for working as an architect in the social, cultural, methodological and technological context;
– The design process becoming more professionalized and specialized, while its interdisciplinary nature is becoming broader, meaning changes in an architects' roles;
– Design seen as a process, which causes the need to reinforce its intellectual background;
– New tools and technologies becoming more available, bringing new capacity in architecture both in terms of designing and constructing;
– Weakness of critical evaluation in terms of new directions and ideas as well as tools, resulting in a need to develop a proper methodology;
– Challenges connected with the global socio-economic system based on knowledge, including the idea of design seen as an activity that is dispersed and networked, laid out in time and space;

The context of the modern architectural education is complex and dynamic. When undertaking the challenge of designing a program that would be suited to this context, it was agreed that the starting point would lie in the values gained from hundred-year tradition of teaching at the Warsaw Faculty of Architecture. The main features considered necessary to be continued are: the connection to the architectural practice, the engineering aspects found in architectural education and the importance of context in design.

The development of a modern curriculum tries to confront the dilemma of combining two contradictory tendencies in teaching[1]. There is an expectation (mainly from future employers, but also from students) of a vocational preparation that answers the current requirements of the market. Opposing it is a desire to form an architect's vision and to create architecture that is directed at future, when current students will undertake their own practices - this tendency belongs to the teachers. Connected to this forward looking tendency is the role of studies in forming life-long learning skills which allow students to face the challenges of ever-changing reality. Doctoral studies preparation becomes a part of that.

Another important aspect that influences the curriculum is the necessity to make the teaching program compatible with the regulations of the architectural profession and education, both at the national and the European level.

Considering these conditions and the necessity to provide prospective students with some added value through specific studies (and specific skills resulting from them), it was decided to focus on information aspects of architecture and the use of available IT tools in the process of design. The first aspect is connected with the conditions of the knowledge-based society, where all fields of human activity, including architecture, are based on a saturated and intensive processing of information. The second aspect results from the necessity to equip the architect with effective tools that allow one to control the aforementioned increasing complexity of the conditions of the design process.

1 - These are, among others: Directive of the European Parliament and Council No. 2013/55/UE of 20/11/2013 [3], describing in art. 46 knowledge, skills and competences to be achieved during architectural education and the Ordinance of the Polish Ministry of Science and Higher Education of 29/09/2011 [4] containing obligatory teaching standards in the field of architecture.

Jan Słyk, Krzysztof Koszewski, Karolina Ostrowska, Lia M. D. Bezerra_Developing a New PhD Curriculum ...

The master program includes three semesters of courses and one diploma-centered semester. It has been developed around three basic areas corresponding to three aspects of architectural activity:

- Theory and history of architecture (critique);
- Design (creation);
- Material aspects of architecture (innovation).

The first is a theoretical background for the design activity and focuses around interpretation, description and ordering of historical information, formalization of theoretical concepts, critical evaluation of contemporary architectural theories, tools and methodologies for identifying and describing formal qualities of historical structures. The second area, regarding the designing process itself, among others, covers the following issues: information processes in architectural and urban design, methodology of creative processes in design, algorithmization and parametric design, augmented and virtual reality environments, integration of IT tools in the design process, simulation and experimentation, and information exchange in multidisciplinary environments. The third area, introduced to connect the digital technologies with the raw physical material of architecture refers to the emerging building materials and structures, fabrication and prototyping, experimenting with prototypes, digital construction site, robotics and automation.
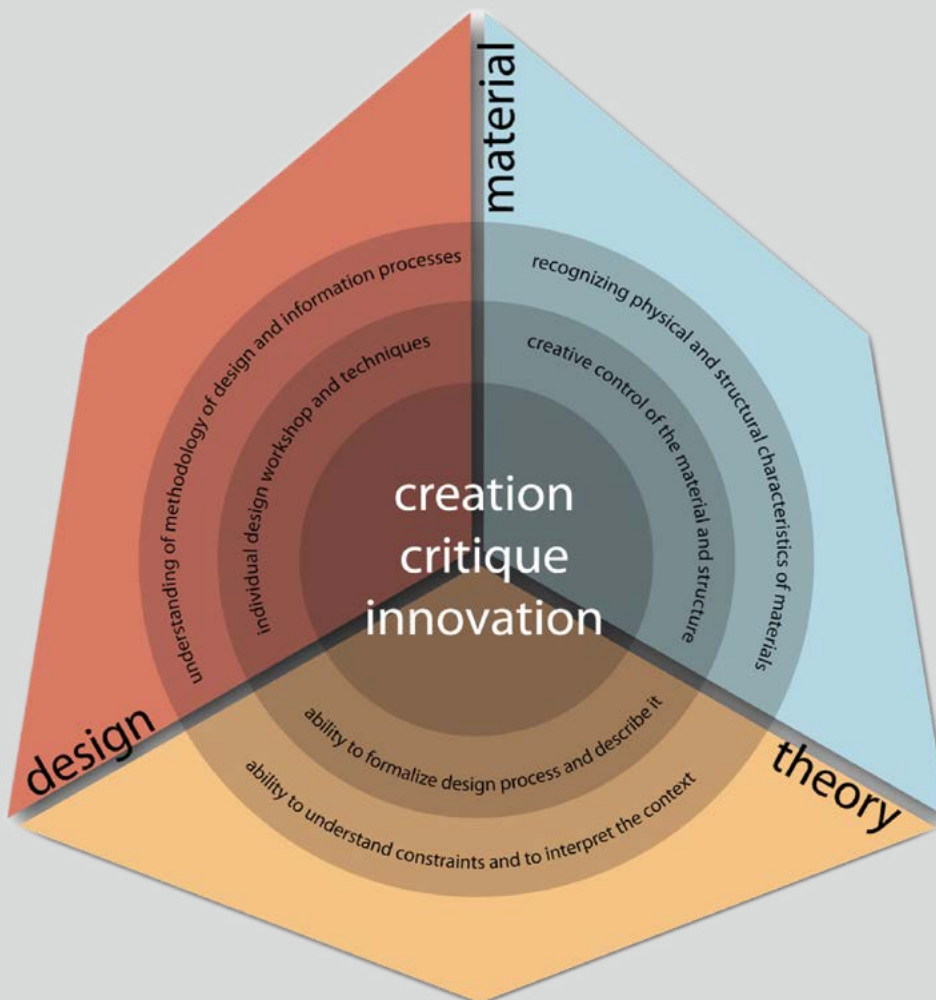
Fig. 1. Illustration showing the three program areas of ASK studies together with pin-pointed issues covered.

Source: ASK PhD materials

The curriculum was developed so that each of the three areas requires teamwork. The teams are often interdisciplinary and comprise students from other faculties (i.e. mechatronics in terms of classes on robotic aspects in architecture). This fulfills the demand of preparing students to work with a wide range of specialists in a spread-out network environment.

Among the problems covered in terms of theory, are also those that prepare the students to undertake doctoral studies. This is particularly important from the point of view of completing a project of PhD-level ASK studies conducted in English. Students focus on developing skills of critical evaluation of information in the design process, as well as the skill to clearly present the premises that are important the design process. The latter is facilitated by preparing the written part of the master's thesis, which takes a form of a dissertation written in accordance to the rules of scientific writing. Another aspect that introduces the topic of a possible future research is the importance of the experiment - understood as both a study tool and a method to be used during the process of design. Such a strategy is implemented during the Experimental Project classes that are held during each semester. Through the course of the classes, the assumptions made based on analyses are verified by going from experiments, through simulation up to verifying the assumptions by making prototypes, often in a 1:1 scale, which often takes a form of small pavilions or robotic structures [5]. This approach is also coherent with the PBL (project-based learning) methodology, where the whole teaching process is results in achieving a specific result and evaluating it.

The reinforcement of the role of the experiment in the design process is also stressed during the workshops that are complementary to the syllabus through a summer school. The idea of workshops is based on integrating a series of creative activities that follow the design-programming-constructing sequence and are conducted by the participants in full. The broad interdisciplinary nature of those projects is an additional aspect. A good example lies with the Modular Light Cloud installation (the result of a two-week students' workshop conducted in the summer of 2014), where a dancer's interaction with the constructed structure is an important element of the installation. Please refer to [6] for more about this installation.

2 - This area is of interest, among others, of Richard Foque, who says: „The designer indeed has no common, precise and consistent language to communicate about his activities and question them in logical discourse" [7]

Observations regarding the changing conditions of the architectural profession and role have resulted in introducing methodological elements into the program that concern the design process. A careful analysis of the actions, their sequences, premises and results is held during the design studies and seminars are aimed at raising the awareness of this process. It is an answer to the expected rationalization of project activities, which is ever more complex as it is accompanied by the paradoxically increasing flexibility of assessment criteria for the results, while there are no appropriate definitions to describe them[2].

In terms using IT in design, apart from the need to use advanced tools that results from the growing complexity of conditions and requirements, particular focus has been placed on their critical evaluation. It is important due to the commonly held conviction that these tools have a determining role in the design process, which is often understood solely in the formal aspect.

When constructing a modern curriculum in architectural design, one needs to constantly refer to dynamic changes in the conditions in which the profession is performed, while keeping in mind the basic and, to some extent unchanging, nature and purpose of our creative actions. From the praxeological point of view, design is defined as "conceptual preparation of change, which is relevant: simultaneously rational, desired, efficient, permissible and aesthetic" [8]. Considering modern conditions, one could modify this classic definition by Wojciech Gasparski into: "Design is a knowledge based activity, which aims at introduction of relevant (rational, desired, efficient, permissible and aesthetic) change. This activity consists of resolving non-standard problems in

dynamically changing circumstances". This definition carries the spirit of the ASK master studies by showing architectural design as a creative process based on a solid foundation of knowledge, and stressing its complicated nature and orientation towards the future. It also indicates the need for constant research efforts in order to ensure proper conceptual frameworks, definitions and methodologies that allow for a raise in awareness and efficiency of the design process, as well as to increase the importance of the cognitive processes that accompany it. This methodology may be continued within the ASK doctoral studies.

THE ASK PHD IDEA AND CURRICULUM

After 5 years of teaching the ASK Master program, we now enter a new phase of development. We benefit from new laboratories, the team's integration as well as reformatting the alumni profile. Our graduates have acquired basic research skills and expect the faculty to offer them further opportunities. The ASK PhD is intended to answer these needs, among others.

Taking into account the conclusions from the analyses completed in the earlier stage and considering the experience from the ASK Master program, we were able to initiate the process of creating a flexible environment for interdisciplinary research attractive for our ASK alumni as well as to foreign candidates.

Impact and Stakeholders

We expect that the graduates of the ASK PhD program will be capable of being experts in institutions involved in the processes of shaping of the built environment. Through the in-depth study of the role of information technology in architecture, knowledge built within the ASK PhD center could be useful for both pure scientific research and for applications associated with architecture, urban planning and spatial development. The basic impact areas of the program includes:

- Research and higher education: graduates of the program, doctors of technical sciences will participate in the education of students (at the undergraduate and graduate levels) and in research teams within universities; the content of doctorates and publications (reviewed by a broad, international audience) can be used to enrich the educational offer;
- Research and development: graduates proficient in the use of information technology for the analysis of spatial issues can join interdisciplinary teams, for which an experimental digital environment is a universal platform for exchange of information, knowledge, and experience;
- Spatial planning, including the rational use of resources and sustainable development: alumni would support local authorities and national institutions responsible for development; they will offer the ability to create tools in the field of simulation, optimization, and the interfaces that can help in a rational spatial policy;
- Design, construction, administration and building market: graduates from the program – their knowledge and the results of their research - can be useful for the implementation of innovative, unique methodology (projects, building materials, technology implementation, etc.), for which individual analytical tools are necessary.

In all these areas of impact, graduates will focus on the possibilities and limitations of predicting the future effects of contemporary spatial activities, which is a basic condition of sustainable design. Scientifically grounded analysis and intelligible presentation of research results can contribute to the growth of the environmental sensitivity and awareness of the society.

Limitations, Assumptions and Goals

The limitations and constraints we are able to recognize result from general, socio-economical changes in the age of digital revolution as well as from the local specificity. The most important barriers are:

– Enlarging the 3rd level studies:

In the case of our faculty, the number of PhD candidates has increased by five times in recent years. It started from about 20 participants, which is characteristic of a typical seminar group. Currently it contains almost a hundred students, which is equivalent to number of people on each year at the graduate level.

– Expanding the field of research:

As a consequence of the PhD school enlargement, a wide spectrum of candidates has been enrolled. It is hard to establish common ground for everyone, since we need to address various research interests (from history and theory, through practice up to interdisciplinary in engineering fields).

– Inability to integrate the program:

This is a consequence of the previous item. Furthermore, the traditional structure of PhD studies in Poland depends on the professor's tutoring and supervision. Numerous, small research groups accept different methods and different organizational structures.

– Loss of identity of the program:

As a result of all the previous barriers, the Faculty and its PhD offer lose consistency. It is difficult to improve infrastructure and communication strategy for a dispersed research program. It is also complex to establish strong external networks.

The analysis of internal problems as well as the desk research described helped us to form a set of objectives for the new curriculum development:

– Limited number of participants:

In order to react to real market needs, we decided to strictly limit the number of participants. One group of students (25 participants total) would deliver up to 6 alumni/experts each year. The school's size corresponds with its resources (laboratory, seminar room etc.).

– Clear and focused thematic ground:

A limited number of students and PhD topics will help to oversee areas of research. A limited scope of interests goes together with deepened research. As such, scientific centers gain better recognition.

– Compatibility with the system of faculty/university PhD procedures:

Cohesion of the educational system is a formal requirement. In the ASK PhD project, we tried not only to accept it as a constraint, but also to use its potential. By fulfilling requirements on the level of the faculty and university we try to structure our program as a flexible component of a larger whole.

– Project-based research organization:

Within the ASK PhD unit we intend to pursue research projects responding to the real needs of the market. With a project based methodology we aim to contribute both to theoretical knowledge and to applied science.

The Identity of the Program, Information Environment

The concept of the ASK PhD program is based around the idea of all participants' collaborative performance: using the experience of colleagues and learning through carrying out research tasks. The stationary part of the course is organized in the form of a vertical studio in which all participants work together in the same environment.

In order to maintain the clarity of goals and to facilitate the implementation of learning outcomes, subsequent stages of the program is marked with milestones and mandatory deliverables. After the first year, students are required to publish an article presented at a scientific conference. After the second year, the students are expected to publish an article in a peer-reviewed journal or in an international conference's proceedings. After the third year of studies, a PhD candidate shall develop the concept of his/hers individual research project, which can serve as a basis for a grant proposal. Classes in the curriculum are arranged in order to facilitate the achievement of these objectives.

ASK PhD studies will last four years. The program consists of four thematic blocks. The curriculum schedule illustrated below represents study semester (rows) and taught courses (columns).

ASK PhD
Architecture for Society of Knowledge

PHD STUDY PROGRAM

Year	Semester	Methodology	ECTS	ASK – Laboratory	ECTS	ASK – Theory	ECTS	Transferable / Interdisciplinary	ECTS	Didactic courses	ECTS	Deliverables	Milestones	ECTS
1st	1	SCIENTIFIC WRITING	2	ASK LAB I Assistantship tasks	4	CLASS I Information Architecture	1	ELECTIVE in Natural Sciences	1	Pedagogy	1			9
	2	SCIENTIFIC WRITING	2	ASK LAB I Assistantship tasks	4	CLASS II Digital Interface and Simulation	1	ELECTIVE in Socio-Economics	1	Public Presentation	1	Conference Paper Publication	Research Proposal: Topics + Methods	7
2nd	3	RESEACH METHODOLOGY	4	ASK LAB II Collaboration and simulation tasks	4	CLASS III Sustainable Development in the Digital Context	2	INTERDISCIPLINARITY in Collaboration in Design	1		1			11
	4	RESEACH METHODOLOGY	4	ASK LAB II Collaboration and simulation tasks	4	CLASS IV Knowledge Base of Research	2					Journal Paper Publication	Thesis Proposal: Prospectus + Bibliography	6
3rd	5	RESEARCH PROJECT MANAGMENT	4	ASK LAB III Team management tasks	4								Follow-up Presentation	8
	6	RESEARCH PROJECT MANAGMENT	4	ASK LAB III Team management tasks	4							Grant Proposal	Follow-up Presentation	4
4th	7												Follow-up Presentation	0
	8												Follow-up Presentation	0
	TOTAL ECTS		10		24		6		3		2			45

LEGEND:
- Standard Course unit
- time flexibility

eea grants FSS norway grants

Project supported by a grant from Norway through the Norway Grants and co-financed by the Polish funds.

Fig. 2 ASK PhD program schedule
Source: ASK PhD materials

The structure of the program is designed as follows:

– Classes on research methods [blue]:

The module consists of three stages, corresponding with a sequence of tasks in laboratory and yearly deliverables: in the first phase, classes relate to communication in science, with particular consideration of scientific writing; in the second stage, they are focused on the methods of reasoning, experimentation strategies, presenting arguments that are used in the description of student's own research; the third stage of the block brings up the project methodology in science and research (including recognition of stakeholders, methods of communication, cooperation, seeking partners for implementing the results, among others).

- ASK Theory [red column to the left];

  Supports research projects by delivering theoretical background according to the specificity of the developed themes. This includes four basic components: (1) a course on information architecture - discussing the issues of information society, digital aided engineering, civilization and cultural changes resulting from digitalization, to cite one; (2) a course on simulation and optimization - in terms of historical, theoretical and application contexts; (3) a course on environmental protection issues and sustainable development - in the context of actions taken by architects and urban planners; and (4) a course devoted to the theory of knowledge building in architectural studies - in the context of digital tools.

- ASK Lab [red column to the right]:

  Brings new (comparing with our experience) format of collaborative assessments. It is based on the assumption that students, regardless of their individual scientific interests, need to undertake experimental tasks in the environment of common tools and methods.

  The ASK Lab courses offer content depending on the currently running research projects.

  Students work together on joint projects introduced by the research center; roles change depending on the level of participants' preparation (from assistantship, through undertaking own research initiatives, up to team management tasks).

- Interdisciplinary classes [yellow]:

  Referring to interdisciplinary and transferable topics, such as: humanities, social sciences (sociology, psychology), the market economy, and interdisciplinary cooperation with engineering, environmental studies and beyond. This block will include the possibly of a flexible offer, implemented in cooperation with the WUT's Centre for Advanced Studies.

The ASK PhD program could be expensive in execution. It demands specific infrastructure and focuses on relatively narrow field of activities. To assure it's effectiveness we have designed it as a flexible element of a larger picture. The methodology block is universal and can be delivered to all focused programs – even outside the faculty. Thematic sections, however, should be the responsibility of different departments (i.e. ASK unit and others), as there is no other way to embrace different areas of research. At the same time, we are strongly convinced that the faculty needs to limit the number of thematic sections in order to obtain a position of a specialized research center. The last block (interdisciplinary classes) integrates the participants also on the university level.

All activities related to the implementation of the ASK PhD doctoral studies will run in the information environment created for this new unit. For this purpose, we will use both traditional media and digital tools (among the latter also customized tools).

The ASK PhD's small library will store books and publications purchased for the project in the development stage. Apart from these, all the publications produced by the program participants will be collected in printed form. The resources will remain under the ASK PhD director's care.

Implementation of individual courses will be supported by the Moodle platform, which was set as a part of pilot project. In the initial phase, it will create a platform to share teaching materials for students. In the future, it will begin to function as a resource for archiving student's achievements.

The infrastructure built during the studies preparation will be configured to archive lectures and seminars according to the concept implemented by the coordinators of each course. Collected in digital form, teaching materials will assist in the process of education including distance learning.
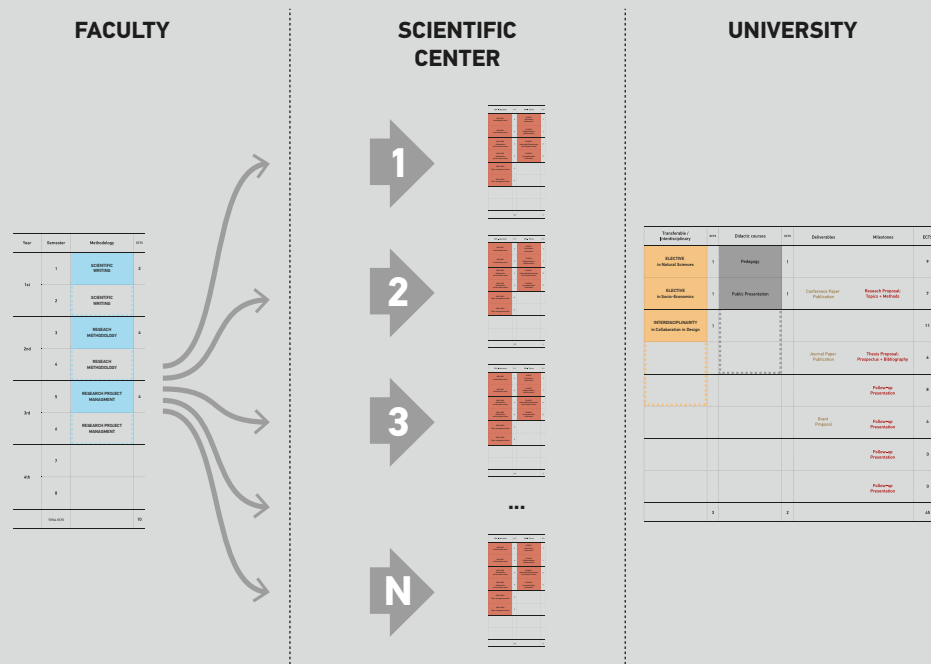
All components of the digital knowledge base will be sorted, archived and shared as needed. As the base hardware for handling the information, the ASK PhD program will use a dedicated server acquired with the support of the grant funds.

In the longer term, on the base of agreement and collaboration with other departments and after securing the content, we intend to publish all ASK PhD alumni outputs online. As a result, it would be possible to participate in the European and global networks of scientific information exchange in our field.

Terms of Realization, Location, Resources

The concept of the doctoral ASK PhD program is based on the assumption that in order to ensure the proper conduct of the educational process, cooperation and exchange of experience is needed. Most of architectural PhD studies in Poland are individual. Thematic studies, research, experimental work is done only in contact with the advisor.

The ASK PhD program offers the opportunity to collaborate on projects in a common research center. Its spatial environment is an annex to the WUT's Faculty of Architecture building, in connection with the existing ASK Master program laboratories. In the process of the ASK PhD program development, we expanded the existing premises by refurbishing a cluster of adjacent rooms. The idea was to form a larger ASK unit, integrating both cycles of ASK studies. Supported by the grant funding, we were able to equip the laboratories with new devices in order to facilitate future thematic studies.

The ASK PhD unit will address needs of the new study model. They specifically offer:

– Individual study room:

Equipped with computer stations and network devices (printing, communication) the room will be available for ASK PhD candidates to work at different times of the day, with the possibility of connecting their own computer and devices.

– Doctoral seminar room:

Supplied with conference equipment – table, traditional presentation features (magnetic wall, whiteboard) as well as technical features (remote communication equipment) – creates a collaborative environment for 12 -15 people.

– Doctoral Studies Director's office:

Dedicated to the professor in charge of the program who will also supervise the ASK PhD small library, portable electronic devices, archives, and others.

– The large seminar room:

The previous ASK Master's seminar room will now be used jointly by the participants of both cycle studies. With the project funding, we were able to reequip the room and increase its flexibility. The room can be used not only for lecture purposes, but also can also host dedicated workshops in connection with the adjacent laboratory.

The ASK PhD unit is clearly distinguished from at the faculty. At the same time it will remain open and transparent (also due to glass doors and walls) so that the activities taken within the unit can be visible to the wider public, students, faculty and staff. We hope that through these architectural solutions we'll be able to emphasize the special status of the project, and promote new ideas in the environment of the university.

Currently, we are entering the final stage of the curriculum's preparation. After formalizing the program and its acceptance by the university's executive bodies this summer (2016) we expect to enroll our first ASK PhD candidates in the winter semester of 2017.

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POST-OCCUPANCY EVALUATION METHODOLOGY AND ITS SIGNIFICANCE IN RELATION TO RESEARCH BY DESIGN

The qualitative methodology in architecture, called POE, was formulated almost 30 years ago by W. Preizer, H. Rabinowitz and E. White. Since then, it has become one the most basic investigative techniques in research by design and constitutes a fundamental methodology in Evidence Based Design (EBD). It also plays a significant role in the preparation of the brief/programming for architectonic projects.

INTRODUCTION

The entire 20th century was a period characterized by rapidly changing technical, social and environmental sciences, and modifications made to the built environment. One could also observe a correlation between human behaviors and the shaping of the built environment as well as the correlation between environmental conditions and the quality of human life. As a consequence, the user of the built environment was becoming increasingly important when it came to decisions connected with it, hence the development in research techniques based on participation, initially only quantitative, and at present mixed – quantitative and qualitative.

The second half of the 20th century marked the invention of a new tool aimed at facilitating scientific work, namely the computer which then simplified the analysis of a large number of data generated by quantitative research and qualitative research conducted in multi-scale urban research and in multiple case studies. Moreover, computer programs that facilitated design processes were developed which led to the creation of parametric and generative designing that was to facilitate the incorporation of research by design into architectonic designing.

A new concept of sustainable development came to being in the 1970s, seeking a balance between ecology, economics as well as social and cultural needs of societies. In this context, there was a need to create tools for checking that quality and to build its criteria in all fields of human activity, including architecture.

As a result, towards the end of the 1980s, a comprehensive method was devised concerning qualitative research in architecture called Post-Occupancy Evaluation (POE). In 1988, W. Preizer, H. Rabinowitz and E. White published the first book under that title, showing the full scope of its application as well as research techniques implemented in this method (E. Niezabitowska, 1998, 1999, 2005, 2008, 2014).

THE ESSENCE OF POE METHODOLOGY

Issues connected with POE are focused on three main problems, which concern:

– the environment in itself, seen as a place for people to live in - settings/places,
– the quality of the said place in a broader perspective, ranging from technical to behavioral quality,
– the users/occupants seen as an organization, group or the end user.

When it comes to such a broad approach, this method has enables one to assess the built environment within a large scope, ranging from a place within the building, through a fragment of a building, to the entire building in itself along with the urban area. By means of the POE, one could assess the level of technical, functional, behavioral, organizational and economic requirements and see the level of their completion, at three different levels: the walkthrough level, the investigative level and diagnostic level   (W. Preiser, H. Rabinowitz, E. White, 1988, p. 54).

The most important achievement of that method, however, was the fact that all needs of the user were addressed, both the end user as well as the users' group, along with the needs of organizations. The most important aspect concerning POE was the fact that it focuses on the needs of the user as the subject matter of all activities as regards the process of designing the built environment. What is most important at this point is the fact that one should pay close attention to behavioral needs of people   (J. Zeisel, 2006). These needs include, among others, the feelings of safety and security, privacy, territoriality and other feelings coming from Maslow's pyramid (A. Maslow, 1954). Such approach to the needs of occupants, resulted in the development of participatory research in architecture that includes techniques borrowed from sociology and environmental psychology, that is, surveying, interviews and "action research" (D. Duerk, 1994; G. Baird et al., 1996; D. Kernohan et al., 1996; L. Groat, D. Wang, 2002; T.M. de Jong, D.J.M. van der Voordt (eds.), 2005, J. Zeisel, 2006). As regards these last examinations, one was able to deal not only with occupants of a given object but also with a broader group of people, that is, the group of stakeholders who include designers, researchers coming from various associated disciplines, investors, facility managers, the owners or representatives of local authorities.

Walkthrough research should be performed prior to the commencement of research in order to specify the range of research at both the investigative and diagnostic level. The investigative level is mainly focused on specific criteria, agreed upon in advance. As a general rule, such investigation is characterized only by research by design so it facilitates the decision-making process when it comes to certain projects. This is mainly connected with situations where the building is waiting for its renovation or adaptation or when it comes to devising an improvement strategy for an existing object. This is performed in order to prepare a functional and spatial program for a newly-designed object (Duerk D., (1993), Blyth A., Worthington J. (2001), Baird G., Gray J., Isaacs N. et al., (1996) Kernohan D., et al., (1996), Pena W, Parshall S. (2001), Van der Voordt T., van Wegen H, (2005). Such pre-programmed research allows for an object in progress to be matched to the needs of future occupants.

Diagnostic research which is wholly scientific is usually focused on specific values and is performed in the form of multiple comparative case studies. Information coming from this type of research may serve to build model solutions, establishment of norms and rules or to create checklists for controlling the quality for a specific type of buildings, for example, hospitals. More on this type of research can be found in G. Baird et al., (1996), E. Niezabitowska (2014).

APPLICATION OF POE IN THE PROCESSES OF QUALITY ASSESSMENT AND DESIGNING.

As a general rule, POE research is used in order to perfect the processes of designing and, as a result, to solve current problems such as:

– functional and spatial programming for new objects (D. Duerk, 1993; A. Blyth, J. Worthington, 2001; T. van der Voordt, H. van Wegen, 2005),

– improvement on the quality of people's life environment through improving and modernizing standards,

– evaluation of existing objects (including their material value) prior to modernization and adaptation, purchase or sale,

– creating informative data bases concerning buildings,

– facility management in order to run the activities of a building at a higher level,

– checking whether the criteria specified in the qualitative program, by means of ready-made tools, such as checklists or questionnaires (e.g. AEDET, ASPECT) are met.

The POE method has many advantages such as universality and significant flexibility. POE research may be implemented when one wishes to design the interior, a fragment of a building or its entirety, or even a chain of buildings or an urban area. This research may be concentrated on only one group of issues, e.g. technical or economical quality. It may be characterized by either expert or participatory nature as well as mixed type. It could resemble strict scientific research or research used in designing.

Methods and research techniques which are being used in POE have already been elaborated on in E. D. Niezabitowska, Metody i techniki badawcze w architekturze (Methods and research techniques in architecture) (2014). When it comes to books worth mentioning in the scope of research problems in architecture, one should look into L. Groat and D. Wang's Architectural Research Methods (2002, 2013), which is the first to have described methodological issues in architectural research in full.

The principles concerning the construction of the built environment, created in the 1980s, have been developed by the same POE creator - Wolfgang Preizer as well as other architectural scientists, both at the diagnostic level which provides answers to the question of what a built environment is and what principles govern it, and at the research by design level which facilitates everyday decision-making concerning the design.

W. Preizer has been developing the qualitative approach to POE (W. Preiser et al., 1989; W. Preiser et al., 1993; W. Preiser, K. Smith (eds.), 2001; W. Preizer, J. Vischer (eds.), 2005; W. Preizer, U. Schramm, 2005), by presenting it in the context of a building's life cycle that includes the following phases: planning, programming, designing, realization, usage (including modernization, adaptation, redevelopment, expansions etc.) as well as demolition and recycling. Perception of the quality of the building in its whole life cycle as well as drawing conclusions from this process for the sake of future investments of the same function has been given a special name BPE - Building Performance Evaluation. Mallory-Hill, W. Preizer, Chr. Watson Ch. (eds.) 2012,).

The very wide scope of POE's activity along with the elasticity of that research method has led it to become the basis of the contemporary approach to architectonic designing, called EBD - Evidence Based Design (D.K. Hamilton, D.H. Watkins, 2009). Application of POE research enables one to devise checklists and to check, with their help, to what extent the ready-made project meets the demands set by the users (functional and behavioral aspects) along with the assumed technical, organizational and economic qualitative level.

Application of POE in research pertaining to the notion of energy saving based on LEED and BREAM system seem to be of utmost importance both on the technical level and when it comes to the use of materials as well as recycling (E. Niezabitowska, D. Masły, 2007). This proves to be especially important in designing and for energetic certification of the interiors in which the life cycle of the equipment is usually very short while the possibility of increasing the risk for the environment during its liquidation and replacement is greater than through buildings characterized by longer multi-year cycles of life (S. Brand, 1996).

The possibilities of the POE application in everyday design practice along with new design tools such as the computer and its software will soon change the approach to design processes connected with architecture and urban planning. It would seem that the implementation of parametric designing, generative above all, will completely change the future attitude not only regarding architectural and urban designing but also regarding the process of educating of architects. The current design process, apart from being based on designer's intuition within the functional scope, is more focused on aesthetic aspects than on qualitative criteria proven in research processes.

THE FUTURE OF THE ARCHITECTURAL DESIGNING PROCESS

Architectonic designing will, in the future, include three important phases in which the POE will play an integral role that will be key to specifying all qualitative priorities.

Phase I. (Brief Research) - will encompass pre-project research and will be focused on functional and spatial programing as well as specifying technical and material-based solutions. This phase, as an interdisciplinary one, will require integrated interdisciplinary teams to be created which will perform expert POE (concentrated above all on technical issues) and participatory POE with the help of specialists in social sciences (environmental sociologists and psychologists). This phase may also require the so-called "action research" to be performed in which not only scientists, designers and users, but also the decision making groups (project principals, local authorities that issue permission for the construction to be built, etc.) are present. Such stakeholders' team will be responsible for finding optimal solutions that will include the most significant technical and economic criteria and will maximally satisfy functional and behavioral needs of specific social groups as well as the end user.

Phase II. (Generative Design) - constitutes generative designing focused on testing solutions resulting from adopted qualitative criteria that emerged during phase I. and on the selection of the best optimal version that meets all the specified qualitative criteria. At this stage, the decisions are made by a panel of experts who determine the hierarchy of the criteria that are to be realized.

Phase III. (Aestheticization Design) will consist in the execution of aestheticization of the project concept chosen as part of generative designing process based on the model of systems applied in industrial design (e.g. in designing car bodies).

This new method of designing will require an introduction of new types of architects' education. The first group will include architects who are able to prepare functional and spatial programs in POE research by means of interdisciplinary cooperation and that will be able to conduct this type of activities from the organizational perspective. Another group will be comprised of architects who will be able to use computer programs to do generative designing. At this stage, a team of inter-disciplinary experts, able to make decisions concerning the best concepts generated by a computer and meeting high qualitative requirements (e.g. functionality, energy saving, costs) will also be necessary for the purposes of research by design. The third group of architects will include

	I PHASE BRIEF RESEARCH	II PHASE GENERATIVE DESIGN	III PHASE AESTHETIZATION DESIGN
RANGE OF PROBLEMS	scientific evidence stakeholder experience programming / briefing checklists of design performance	alternative versions of design measure baseline performance choice of the best solution	adjusting to urban surrounding baseline aesthetic problems solving (proportions, colours, materials and so on) interiors design
PARTAKERS	architects - POE professionals scientific, interdyscyplinary team stakeholders	architects computer professionalists interdyscyplinary professionals	architects / artists designers

Fig. 1 The Three Phases of the Future Design Process.

Source: Author's own work.

people who possess artistic skills focused solely on aestheticization of concepts generated by the computer. Their duties will consist in improving the profile and appearance of the building just like designers creating cars and other products on the market today.

A gradual, integrated and interdisciplinary design system of this type will allow one to improve the quality of the built environment and, as a result, it will lead to the improvement of the quality of life and natural environment protection, which currently, in its present life cycle, (from planning, through programming, designing, construction, occupancy and demolition) is generating 50% of energy losses as well as considerable environmental deterioration.

CONCLUSIONS

The POE is a basic methodology in quality research of architecture and built environment and can be used in scientific research and in research by design. It is used in every phase of the life cycle of the built environment, especially in programming phase. It can be used as either expert or participatory research, or as a combination of the two.

Universality, flexibility as well as interdisciplinarity constitute a significant value of POE. These characteristics led to the realization that after almost 30 years' worth of development they became the basis of the latest approach to designing, which is the EBD - Evidence Based Design based on program type research.   As a result, it seems that due to the new circumstances that architecture finds itself in, connected with generative designing which is making its way into practice, POE will be further developed as it constitutes the base programming methodology in architecture.

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EXTENDING THE LIMITS: USING BIG DATA AS INTEGRATED DESIGN TOOL WITHIN THE FIELD OF LARGE-SCAPE LANDSCAPE ARCHITECTURE

We are currently at a crossroads where conventional approaches to landscape architecture do not serve justice to the increasing complexity of environmental issues, which require solutions that are both visionary as they are sustainable. Landscape architects are forced to explore new design strategies that can accommodate the complex environmental issues facing us today. With the massive increase in scale that is often involved, traditional tools of design cannot take proper advantage of the wealth of information at our disposal. The introduction of information technologies to increase urban environmental quality, summarized in the concept of 'smart cities', already poses a first step within the rapid increasing role of technology in our daily lives. How can we handle the massive amount of data and databases as designers? What concrete implications do these resources have on our designs? A philosophy behind computational thinking is an essential part of this new strategy. The possibilities of these emerging tools need to be explored and developed to find expression both immediately in the university setting as well as subsequently in professional practice.

INTRODUCTION

Global urban tendencies such as urban sprawl and the rapid growth of cities require strategies that integrate datasets with geographical, ecological, sociological and infrastructural factors into planning. This exceeds the rather limited and simple integration for mainly analysis purposes of Geographic Information Systems (GIS) data into the field of landscape architecture.

In order to meet this complex challenge in a professional manner, an understanding for the potential of different software and hardware solutions is needed in addition to technical know-how so that the quality of the design is maintained. The designer has to be given the competency in order to be able to manage and guide the digital process step-by-step. The integration of site specific parameters within design requires, however, often training specifically aimed at honing the skills needed to be able to sift through the existing data overload and find the useful data within.

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The handling of and the integration of the different databases momentarily vary extremely among the different professions. In general, however, one can state that understanding and visualization still stand in the forefront (Huang et al. 2013).

In order to develop new approaches to solve these problems, the Chair of Professor Girot (ETH Zurich) has pinpointed application areas for the academic research and education of landscape architecture. In addition to the continued simplification of software products, the broad field of 'Big Data' currently offers a wide spectrum of innovative application areas for multifaceted data to be integrated into landscape architecture (Fricker et al. 2015).

In the international discourse on urban development, interest in landscape architecture is noticeably increasing. For example, this manifests itself in that the task profile of landscape designers is now extending to large-scale urban open space developments and their dynamic components in complex landscapes. In order that landscape architecture can assert itself in interdisciplinary cooperation with architects, engineers and spatial planners in an era that is marked by profound ecological change, the postgraduate "Master of Advanced Studies in Landscape Architecture" (MAS LA) was newly conceived under the leadership of Pia Fricker. This unique program is in a position to successfully distill the potential of a site by integrating the most modern of technologies and technical expertise into landscape architectural practice.

The central task of the MAS LA addresses the current trend in large-scale projects: which without the use of parametric technologies, can no longer be planned, realized nor managed. This trend presumes that the designer is able to work with a high level of expertise on a given design approach. In addition to specialized technical expertise, it also requires the ability to use design tools appropriately. The MAS LA program works within a range of technical and design inputs, theoretical issues and discussions, as well as feedback from international specialists, from landscape architecture and CAD-CAM to Landscape Design Simulation. The program will pick on current problems and investigate new workflows, which can be evaluated and applied experimentally to current site-specific issue.

The previous results of our research and teaching in this area strengthen our conviction that in the era of 'Data-Overload' special attention must be given towards how data is handled and specific information chosen in order to be able to make the decisive next step from mere "data mapping" and "datascapes" to the development of coherent and fully-functional data-driven design tools (Gray et al. 2013).

LOOKING BACK

Within the last 15 years, access to information technologies and their use in design has become radically simplified. In the frenzy of the making, little time has been taken to delve into deeper theoretical reflections on this rapid technological development and its consequences for cultural transformation in the area of landscape design. New concepts, such as parametrismus, smart materials, digital chain, biomimetic, datascapes, and geodesign are products of this powerful and influential development, and now is the time to carefully analyze what kind of impact these tools will have on the planning and design of our cities and landscapes. Do the aforementioned terms merely deal with the constant iterative development of professional practice? Programmed groundwork can either lead to a randomness in architectonic language – where designs are often very similar independent of program or site – or the opposite: where mathematically programmed solutions support a site-specific and program-relevant design. Currently in trend is a combination of different areas, 'algorithm aided architectural design', 'precision parametric modeling' (Hadid et al. 2003), and 'optimization and digital fabrication of complex geometries'. The different paradigms are

understood as mere tools and combined playfully in a somewhat arbitrary way. In addition to the continued simplification of software products, the broad field of 'big data' currently offers a wide spectrum of innovative application areas for multifaceted data to be integrated into landscape architecture (Kolarevic 2003).

The invention of statistical analysis of a scientific nature had its starting point over 250 years ago (William Playfair, 1759–1800). Historically, statistical charts have always aimed to communicate complex ideas in a clear, exact and efficient manner, however, today information visualization mainly serves to give meaning to a large amount of data in order to obtain a finding from it (Klanten, R. 2008, 2010).

The founding of the Laboratory for Computer Graphics at Harvard in 1965 is regarded as a catalyst in the advent of the digital map. A series of significant developments began with the entrance of Carl Steinitz into the Lab. Based on his work in overlay analysis (1967) he developed the method of map analysis (1970). Growing out from these techniques, the 'mapping of the scientific' or 'visualizing knowledge domains' developed as a relatively new field (Bertin, 1981). Its goal was to communicate the dynamic and changing structure of science and technology (Börner, 2010). If done successfully, visualizations can provide a very intuitive and efficient *"interface between two powerful information processing systems - the human mind and the modern computer."* (Gershom et al., 1998). Thus, the notion of interactive visualization was born (Tufte, 1990, 1997, 2001). A technical advancement of the spatial maps developed in the Laboratory for Computer Graphics at Harvard is the DataAppeal software by Nadia Amoroso (Amoroso, 2010, 2012, 2012). This software includes a GIS web-based application that allows impressive new presentation methods of environmental data (Hale 2009). This application could present hidden data in an understandable manner, in the form of animated maps, which could be used for participative processes.

Information Mapping is a research-based method used to analyze, organize and present information based on your audience's needs and the purpose of the information. The method is independent of technology, subject matter, as well as media. Critical voices gathered under the umbrella term 'critical cartography', such as that of the geographer Denis Cosgrove. He represented the view that the gap between technically oriented map generators and more theoretical sociological analysis should be closed.

FACING FUTURE CHALLENGES

Up to several years ago, GIS data in the area landscape architecture and spatial planning was almost exclusively used for scientific analyses, simulations of development plans, and the declaration of intent within different planning phases. In spatial planning, this process served to make decisions and be able to conduct participative processes with the involved groups. The inclusion of GIS data in design is currently understood as 'design-by-database'. Since GIS data comprises of historical data, current data, as well as future planning, territories can be understood as a dynamic system. This means that the analysis of patterns can be linked with the analysis of attributes, which leads to the fact that new patterns and possibilities can be continuously revealed (Oxman 2013).

Projects such as OpenStreetMap, or the commercial implementation of drones, show the increasing acceptance of the general collection of this data (Tierney 2007). Drones are used more and more for measuring purposes and scientific investigations and generate a plethora of environmental data regarding place-specific conditions in real-time through the simple technical access of sensor technology, for example in combination with Arduino. The technical development is momentarily ahead of users from professional practice as well as university curriculum. This more than anything has to do with the overwhelming nature of the mass of data and dealing with the complexity of its

interconnections (Hagan 2008). The discipline of landscape architecture has not yet been able to formulate the right questions in order to generate benefits from the 'data overload'.

Research by design - Developing new computational methodologies

The results of the MAS LA modules "Programming Landscape" und "Theoretical Programming" (teaching cooperation with Georg Munkel) serves as a basis for the theses and questions of the research (Greenberg, 2007). Their results allow for a comprehensive study of complex elements, grounded in founded results that can show solutions at different scales. An important component is the immediate linking of visionary technical questions and developments from the area of information technology with theoretical questions and the possibility of their practical implementation within design (Marble 2013). Especially the methical approaches used in the programming module show the possibility of programming tools, which are customized to the conceptual demands of the design and therefore able to be directly integrated into the planning. We are researching into workflows that thematically questioning the kind of data before the integration of datasets in order to determine which data is relevant and how it can be integrated into the design process.

The following questions subsequently arise:

How can site-specific data complement the conceptual ideas underlying the design and create new possibilities through their consolidation?

Which didactic and methical possibilities are available in order to train a consciousness for the interpretation of the data?
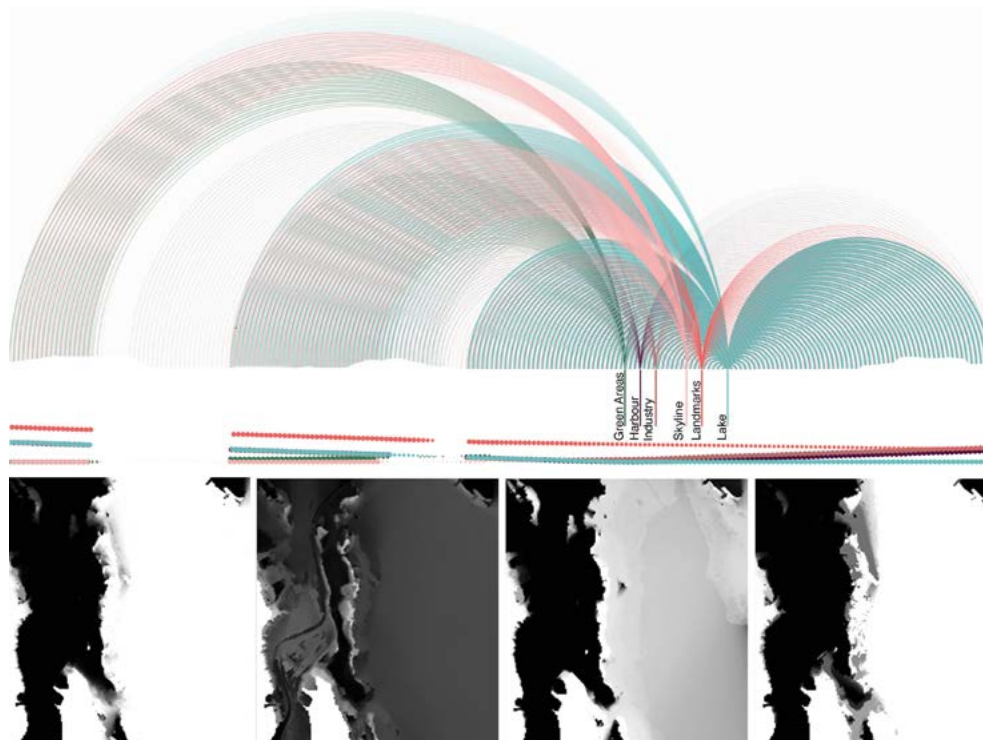
Fig. 1 The aim of the project by MAS LA student María del Camino Escosa García and Aikaterini Margarati is to explore the role and impact of certain landscape qualities in the surroundings of the shoreline of lake Zurich and it surrounded residential area. The script using the scripting language Processing (Reas, 2010), tests the visibility of those qualities by identifying potential lines of development and visual relations along the site. This project can be considered as a landscape perception tool that can be applied in different scales and topographies.

Source: Courtesy of Pia Fricker, MAS LA ETH Zurich (Switzerland), Prof. Christophe Girot

So far the results of our studios show a remarkable difference in the way students approach the task. Through the familiarization with site-specific data, the design reaches a different level in terms of quality, as well as sustainability.

Pilot Project – Insight into the Experimental Design Studio: Dynamic Landscapes at Aalto University, Finland

The overall goal of the pilot prototype studio is to investigate the potential of the integration of new information technology tools within the field of a complex large-scale landscape design. The studio concentrates on the achievement of a new reading of landscape systems by integration of emerging tools, like site-specific data capturing and data visualization in combination with traditional hands-on design tools. Students are encouraged to cross disciplines and theoretical boundaries and critically analyze the dataset information as a design tool.

A variety of media and experimental modes of representation and visualization tools will be developed to test and communicate the design proposal at a variety of scales and settings. An important component is the immediate linking of visionary technical questions and developments from the area of information technology with theoretical questions and the possibility of their practical implementation within design. The methodical approaches used in the programming module show the possibility of programming tools, which are customized to the conceptual demands of the design and therefore able to be directly integrated into the planning. We are researching into workflows that thematically questioning the kind of data before the integration of datasets in order to determine which data is relevant and how it can be integrated into the design process.

In order to be able to define approaches for highly complex large-scale problems, it is necessary to train people in the sensitive handling of a site. The students have to learn to understand the qualities of a place in order to subsequently be able to formulate the right questions. Without clear intent, accessible data is worthless, since no useful information can be generated from it.

CONCLUSION

The form language of the currently ongoing trend of parametric design is often symbolic and arbitrarily interchangeable. In order to counteract this general trend within landscape architecture, the increasing digitalization in design should not contribute to generating even greater complexity. Often data is integrated at the outset of the design process – in contrast, we would like to propose the thesis that an understanding of a site and the conceptual stance drawn from it influences the choice of data and not the contrary. The main goal is to examine which workflows are suitable for understanding a place with its given potentials as local data sets.

One of the goals of the research is to examine the creative handling of complex relationships relative to a design. First, an elementary understanding of data is required in order to subsequently investigate new strategies to visualize the data, which is needed in order to be able to derive design-relevant decisions in a next step. When one considers the commonly used software packages for visualizing data, for example ArcGIS or direct interventions in the design through Grasshopper, the process of reflection is often forgotten. Therefore, the overlapping between programmatic information (databases) and ideas (narratives) is also to be examined.

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GAMER LAB™: RETHINKING DESIGN EDUCATION

In this paper, we introduce GamerLab™ as an innovative way to train present and future generations of virtual architects by transforming architectural design education into an "affinity space" within higher education. We consider online, infinite game models to incentivize research, creativity, collaboration and achievement in architectural design. We show how within university level, design education, games and gamification offer an invaluable theoretical and practical solution to pedagogic problems entertained by architects and other design professionals. We support this claim by turning to cognitive science, which shows how our human brain actually learns and extrapolates for creative problem-solving.

INTRODUCTION

Today, whether one is engaged in entrepreneurial business development or evangelizing a new era of education, "online" games are at the forefront of cultural trends and economies. From *Fallout* to *Luminosity* we are witnessing the explosion of an online game industry offering the kind of mass embrace of entertainment unmatched by even film today. That pleasure translates into both intentional and unintentional skill building with scores totaled in hours and dollars spent online: According to a 2013 Pew research study, 15% of all teens spend more than 10 hours a day online playing games. The statistic accounts for both male and female players with averages increasing as one moves into the Asia-Pacific region. Researchers at the Entertainment Software Association claim social games count for 1/3 of games played reinforcing by social media behavior in their 2015 ESA report, they argue: "The most frequent gamer feels that computer and video games provide more value for their money (47%) compared to DVDs (28%), going to the movies (14%), AND music (12%)." The gender difference is significant: Female purchasers of games constitute 41% compared to the male purchasers amounting to 59% of the total composite number [1].

This might explain why 2015 American market research firms are interested to run statistics on a game entertainment economy estimated at $25 billion US a year; with the introduction of Virtual Reality headsets, another 4.6 billion is predicted to add to investor and stockholder pleasure by 2017. From an economic standpoint, there may be no better time for architects, content developers and programmers of future games and game environments [2].

Despite the parental scare around internet and game addiction — no thanks to Nick Carr's 2010 book *The Shallows* — neuroscience research offers a different read on game value. Games like our brains, operate off of incentive and reward and appreciate challenge or a "level up" in achievement. Daphne Bavelier's lab has targeted visual/spatial perception using *Call of Duty* and *SIMS* in a landmark 2010 study; others like UCSF researchers Michael Merzenich and Adam Gazzaley and Dane Clemenson in the UCI Stark Lab design and test games to activate visuomotor, attention and the speed and acuity of memory.

The cognitive neuroscience research is not lost on futurists, thought leaders and game developers in K-12 education, higher education and business training sectors. Both successful game design and neuroscience research have revealed an empirical, evolutionary fact: Rewards matter, especially to predict future outcome. Rich in reward dynamics, games engage viewers precisely because they offer immediate feedback. As futurist and game designer Jane McGonigal contends:

> *"When you strip away the genre differences and the technological complexities, all games share four defining traits: a goal, rules, a feedback system, and voluntary participation [3]."*

With new Massive Open Online Course (MOOC) systems on many minds, online games and gamification have earned the respect of curriculum designers and learning theorists like James Gee whose work we will turn to later on in this paper. For now, let us consider the directive given by futurist and game designer McGonigal who asks, 'How we can use games for real world problems recognizing our need for epic challenge and to be "super better?' Following McGonigal, we ask: First, how can we use gaming mechanics to improve architectural design pedagogy to improve the architect's learning experience cognitive development? Second, how can we use Virtual Reality (VR) interface game mechanics to train designers given triumphant architectural educational paradigms based on Graham Harman's Object Oriented Ontology (OOO) and Patrick Shumacher's theory of parametrics which we will claim, leave today's digital gaming natives ignorant of contextualizing cognitive neuroscience research, and force students to contend with a polarizing theoretical bind. By this we mean, as future stewards of the global architectural community, devotees of OOO and parametric approaches can pretend to ignore the privileged human dimension in object making, the fact remains it is networks of humans using their brains in design studios and bedrooms to game their way to crowdsource coding for robotic and genetic replication of architectural shapes, patterns and forms.

In order to tackle architectural philosophy in a relevant and timely manner, we propose a rethinking of architectural education from the standpoint of GamerLab™. In so doing, we propose a paradigmatic shift into new pedagogic and research questions regarding how we teach innovative courses to enhance collaboration skill sets, research skill sets and design skill sets; together, these skill sets constitute the new tools of trade for Transformations in Architectural and Urban Design Practice.

GAMER LAB™ METHODOLOGY: ALLIANCES AND CORPORATIONS

Inspired by the social contract practice within serious game culture and informed by behavioral /neuroeconomics, Gamer Lab™ creates an organizational hierarchy that allows each member to follow his or her own desires within an infrastructure that actually teaches skills necessary to collaborate and build professional relationships [4]. GamerLab™ borrows from two models often found in multiplayer online games — Alliances and Corporations. Alliances and Corporations are not equal in their studio function and each player (or in this case, student) has varying levels of commitment and responsibility afforded to them. What they do share is an agreed upon mission statement, bylaws, and power structure. There is a virtue of bringing in a social contract: Skills and responsibilities are spelled out within the context of the actual game. The rule based logic of gaming lends itself to the neuroeconomics of creating clarity and fair play. It also taps into the

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evolutionary network in our brains that processes the efficiency quotient of rule based experiences. Here we are speaking of *World of Warcraft* a prime example of an infinite, multiplayer game.

Alliances are formed around a specific research topic such as "educational models that will influence designing for the 21st century school." The purpose of the Alliances is to incentivize programmatic research prior to the introduction of the architectural project itself by forming research competition between various groups of students. The same is also true of the Corporations which are similarly tasked with unpacking specific site and contextual topics that will ultimately lead into the development of an initial concept for the project.

Within Corporations, information is exchanged both out of necessity and in response to the atmosphere of competition we have created. Why competition? Narrative gamification brings with it an algorithmic model of competition wherein competition operates according to rules of rivalry and collective survival. Insuring competition, GamerLab™ sets the noble goal of the entire studio to be working as a collective intelligence towards the complete understanding and spatial development of the design prompt.

In a bio-ecology, ritual, rhythm and consistency often follow calendars of the moon, the rain, the passing of seasons. In the ecology of architectural education rituals, final reviews follow rules of master-apprentice relations and play a central role in confirming one's status as a member of the architectural community. Within current beta tests of GamerLab™ methodology, there is no goal nor portal for the juried defense for how can one reconcile a master-apprentice model in a technocratic society that hosts game design and Rhino education on Lynda.com or the coordination of 7,548 players during the realtime space battle *BR5RB* in *EVE Online*. Today, we live, work and take classes on a Web that supports multiple *affinity spaces* for every topic (Rule 43: If you can imagine it, there is a website for it). As the Web becomes its own affinity space for Reddit users and social activists, prime rituals of architectural education are put in question. What proved profitable for guilds in late Middle Age, now loses social cache for digital natives which do not presume subjective connoisseurship nor the passing of power down to a mentee or protégé. For students today, GamerLab™ signals an end to architectural regimes and the disruption of rituals which *'consolidate power into a fossilized system of education and aesthetic'* to quote UCLA architect Natasha Bajc. The "virtual architect,"[1] masking through an avatar that explores 3D worlds, can now approach architectural education as an affinity space.

In his recent 2015 paper on affinity spaces, linguist and learning theorist James Gee points to the ways in which game spaces reveal greater possibilities for pedagogic incentive, skill and knowledge development along with the potential for new levels of social cohesion — features of traditional education deemed 'necessary and sufficient' goals by both behaviorists, humanists and economists alike. Following Gee's logic, we are charged with thinking differently about higher education environments to guarantee future GamerLab™ life cycles and student productivity [5].

As an affinity space, the GamerLab™ platform offers a place for connected and emergent learning made manifest by developing design ideas and products. At SCI-Arc and ASU, students post and comment online during an offline class studio. The beauty of GamerLab™ as an affinity space is that it is made for real time "blended learning." Our current beta tests reveal the degree to which GamerLab™ speaks to cross sector, collaborative and open source sharing of content be it in the form of ideas, images or objects. Weekly uploads and reports supplant a final review. By rethinking the architectural pedagogic canon, GamerLab™ provides students with a scenario wherein the final project is not simply a show of dazzling creative prowess, but an excuse to reach the ultimate goal of intellectual and personal development and finesse risk taking and social engagement with noble ends.

1 - The virtual architect follows eight principles derived from 40,000 years our bodies and minds moving, manipulating and interacting with our physical environment: Genesis, Exploration, Collaboration, Resilience, OpenSource, Networks, Placemaking and Stewardship.
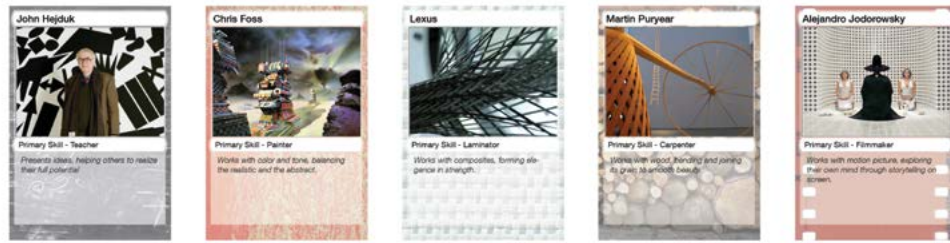
GAMERLAB™ METHODOLOGY: TRADING CARDS

To facilitate risk taking, each student within GamerLab™ is initially asked to form an Alliance and a Corporation, made up of different class members. These groups are designed to work much the same as a "raid party" in World of Warcraft. No raid would ever survive without a tank, a healer/buffer and a damage dealer. Similarly, each alliance and corporation are composed of the appropriate collection of personality types to raise the statistical probability of collaborative ideas made possible within a GamerLab™ context. Here we are not referring to brainstorming for innovation practices, which in recent times have fallen out of fashion due to contraindications born out of research. Instead, we are thinking of gamer practices that situate avatars into research alliances and corporations reinforced by the ritual of trading cards. We have chosen to apply a unified model of player styles based on Bartle's model to the creation of system of trading cards. These cards not only prove valuable to track a specific student's skill set, they also answer the request for tangible incentives in a form that helps promote collaboration and competition.

Less you think trading cards are a flagrant return to mere adolescent herd building and hero worship, trading cards (*Magic: The Gathering* comes to mind) are the stock and trade of famed gamer worlds, offering tangible AFK objects of reward and incentivize a *growth mindset* — a "take up the challenge" attitude proven out in cognitive and psychology of learning studies conducted by Stanford researcher Carol Dweck [6]. Trading cards also reinforce narratives generated to fuel game play. Adapted into GamerLab™, trading cards in the hands avatars make iconic gestures towards forming student identity and architecture as *storytelling*.

That is to say, architecture is not simply about designing objects. Rather, it is a system of embedded meaning, seeded with personal and cultural histories that lay and cement the foundation on which the gamer as "virtual architect" sets his or her research goals for an avatar's performance. Given the narrative basis of infinite game structures, we insist that all our students approach their projects from a storytelling perspective giving birth to what we like to call "the inside out rather than the outside in" perspective. In this way any formal characteristics are the direct result of the student as avatar interacting with the program as "a day in the life" of one of its future inhabitants.

Storytelling in a GamerLab™ curriculum as such departs from current rituals of architectural explanation enshrouded in "Post Kantian" OOO theory or attempting to reinforce parametric assumptions that straitjacket student thinking in only functionalist, metric terms. Recognizing the narrative power of games to incentive avatar skill building and imagination, we hold to the idea that stories speak of time /space experience tapping the listener's spatial memory and gamer logic. Projecting onto an avatar, students are encouraged to cultivate fresh ideas and points of view. The intellectual benefits of avatar projection should not be underestimated. As a theatrical masking device, students step into new identities, often bypassing attempts to make up pseudo architectural theory or worse, parrot of a mentor's point of view.

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By inserting strategies of storytelling and avatars as players of multi-dimension and varying moral intent, GamerLab™ thickens the personal and social dynamics of collaborative group design challenge. Where stories activate imagination and depart from academic nausea of poorly mounted rhetorical argument, the avatar character base optimizes the potential of each architectural student working to free themselves from a paralyzing, self-critical persona. Following Rene Girard's reading of ancient narratives and sibling rivalry, we recognize the inherent narrative element driving competition within gamer worlds just as we recognize the ways in which Second Life or other Virtual Reality worlds build self-confidence and compassion by taking up avatar identities [7]. GamerLab™, in other words, makes room for galvanizing the formation of an architect's identity and the need for social networks within learning as symbolic and deep passion play.

SPECULATION: TIME FOR A BREATH OF FRESH VIRTUAL AIR

Anticipating an age of ever increasingly sophisticated VR hardware and software, we present GamerLab™ as a platform for training virtual architects for twenty-first century design education and career opportunities. As we have claimed, educating virtual architects requires full recognition that we are training a measurable cognitive skill set that will alter their perceptual world and disrupt the space/time foundation of their 2D assumptions. Just as the microscope and the telescope redefined our understanding of scale and spatial relations at micro and macro levels, VR game environments are pushing us to reimagine spatial relations in buoyant, spherical landscapes [8].

Here then, we witness an unfolding future, a vast horizon of academic design inquiry constituting a technological response to critical theory laced, studio based education. Conceived in Los Angeles and tested in LA and in Phoenix, GamerLab™ hands the virtual architect a research based approach to design education wherein knowledge is farmed from a plethora of various sectors and combined within various teams: Alliances and Corporations often pitted against each other with the intention of increasing the rate of information transfer and consumption towards the positive development of one's divergent creativity. But is creative divergence the ultimate goal of GamerLab™?

As virtual architects, we pose that question to ourselves and our students: How do we inspire creative divergence at a time when information is easily at the fingertips of everyone and where robots and programmers are now working in tandem with concept artists and lead designers? Can Affinity Spaces offer something more than next trend, the next ideological method of studio practice? How will architects, as design thinkers and makers turn gamer, change the way new generations of learners imagine and design spaces to solve real problems for real spaces online and off?

We believe GamerLab™ to be a *procedural* learning system that emphasizes the student's role in their own education and prioritizes the experiences they gain while exploring elements of OOO and Parametricism. Our proposition is pedagogically radical precisely because it is learner and game centered. By aligning cognitive with aesthetic demands, we are calling for nothing less than an economic and intellectual shift in architectural education priorities starting with the architectural educational building itself. We imagine a global future where aspiring young architects will meet first online, in a game world and seek out GamerLab™ affinity spaces in their 'hoods to enter VR enhanced and technologically enchanted worlds. There they will strap on a Cardboard, Vive or a Gear, inhabit a new avatar, fly through strange new portals and join colleagues to test their spatial perception against the competitive, social creativity odds of civilization building.

We contend that if our brains need reward to reinforce actions for predictive decision making, and game design offers challenges and rewards using "level up" algorithms, then adapting game design to architectural design education makes perfectly good logical sense. It does more than that. Game

design with built in social media provides a platform for activating the herding instinct to reinforce socially useful behaviors and extinguish useless choice making in architectural design.

Now wouldn't that be grand?

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ENVIRONMENTAL APPROACH IN THE CREATION OF THE CONTEMPORARY CITY AT THE FACULTY OF ARCHITECTURE, WARSAW UNIVERSITY OF TECHNOLOGY

The paper presents results of research work concerning the environmental approach in the creation of spatial form of the contemporary cities. The main objectives of the research are: 1/Exploring the urban design solutions for the introduction of green environment in cities, on the example of student's works realized at The Faculty of Architecture, The Warsaw University of Technology, especially in The Chair of Urban Design and Rural Landscape, 2/Exploring how the theoretical basis in the field of spatial composition and urban design is applied in practice in various design projects, 3/Research by Design - how can the new possibilities of design simulation help to demonstrate environmental awareness.

INTRODUCTION

The need of research presented in the paper results from the necessity to apply postulates of the most recent ideas of development of contemporary cities. The most important principles and structural models of development of built environment are (among other things): minimum consumption of resources for maximum social effect, the correct solutions of the optimal integration of natural and artificial reality, creation of efficient spatial structure of every city (first of all by striving after efficient intensity of built up areas). High intensity of many areas in contemporary cities as well as integration of functions (especially within a single terrain and building), have become important factors in the process of saving space – an important non-renewable resource. However, dense and compact city structures require preservation or the introduction of green environment in order to assure proper living and working conditions. At the same time in the development of peripheral areas in cities, it is necessary to define links with natural systems, both inside urbanized territory as well as links with outer open landscape.

All guiding postulates and ideas in the didactic process at The Faculty of Architecture WUT, especially in The Chair of Urban Design and Rural Landscape are in agreement with the above mentioned principles, which are found in many planning documents as well (Agenda 21, The Habitat Agenda, Declaration from Istanbul: Ecopolises - Settlements for Sustainable Development 1996, The New Charter of Athens 2003). Following these global trends, we are trying to find and apply in the didactic process a new sustainable model for the development of human settlements.

In focusing on the environmental approach in the creation of the spatial form of cities, it is necessary to mention the most important postulated operations: 1/minimal consumption and protection of natural resources, 2/careful preservation, well maintained and increasing amount of various open spaces (significant landscapes, archaeological sites, monuments, traditional neighbourhoods, parks, squares, nature reserves, rural areas as well as water areas: lakes, rivers, wetlands and the sea shore [6]. The important aim is achieving high aesthetical quality of city environment, among other things by shaping attractive public spaces and proper system of green open spaces. One of the most important instruments of shaping spatial form of cities is urban design and urban composition.

At present, the introduction of green environment to contemporary cities has been carried out by three main activities: 1/introduction of green inside buildings (internal green floors and connected green spaces on different levels), 2/introduction of green outside buildings (external green walls and green roofs), 3/revitalization of existing public spaces, introduction of new public spaces into city structure (green public spaces or public spaces with high amount of green).

SUBJECT OF RESEARCH WORK: THE METHODOLOGY

The basic subject of the research work is green environment in cities. The process was concentrated on research of the design projects elaborated during the following courses: 1/"Elements of Urban Composition", 2/"Housing urban complex", 3/ "Multi-functional urban complex". In the research process, I have analyzed many types of public spaces: city squares, public courtyards, city parks, promenades and footpaths, main and local streets, green belts, green axles, etc.

The research work has been realized by taking into consideration existing state of knowledge and use of methods proper for morphological investigations of city space. I have used various research methods: method of analysis and critique of sources (planning documents, literature, case studies), observation method, comparative method, etc.

GREEN IN URBAN COMPOSITION – THE DESIGN PROJECTS ELABORATED DURING THE COURSE "ELEMENTS OF URBAN COMPOSITION"

Green areas are one of the main elements of spatial structure in a city. There are many functions of green areas: biological, social, protective, economic, etc. The results of research presented in the paper concern compositional functions of green, in particular the role of green in the spatial composition of public spaces and urban complexes. Theoretical bases in the field of urban composition given during the course "Elements of Urban Composition" are then applied in practice in the design project series elaborated during this course, and further in various design projects during whole studies.

The design projects elaborated during the course "Elements of Urban Composition" contain themes in four main subject groups: reproduction of remembered urban space, composition of simple and interconnected urban open space with regard to urban detail, particular problems in urban composition (light, colour, green, urban detail), design of small projects in concrete situations (housing, urban open spaces). For example, in the first subject group students had to show the character of public space such as squares, streets, and parks, situated in any existing city. In the second subject group, students had to design a simple urban interior, which had to be one of the following public spaces: city squares, market-places, exhibition grounds, courtyards, etc. The spatial form, scale and proportions of this urban interior had to be adequate for its function. In the third subject group, students had to design two simple green interiors interfaced indirectly. In the fourth subject group, for a given situation students had to design a spatial urban complex,

which consisted of one-family houses. In each design conception, students had to show eventual disparities of the terrain as well as the arrangement of green elements in public spaces. All design projects were elaborated as sketch designs with the use of freehand drawings techniques [5].

In the design projects, students used many types of basic green elements. One of the most important elements was a single individual tree, which had often monumental character and has a function of natural landscape sculpture or even spatial landmark. The next elements were two trees – a very characteristic motif, often in form of "gate" or a frame of fragment of landscape. The next element very often used in the design projects was a row of trees, which has functions of a lattice, partition, a line or a leading plane. The next important green element was the alley, formed by two or more rows of trees growing on both sides of a street or a footpath. There are many types of alleys used by students: single, double, manifold, homogeneous or mixed. The strong compositional element used in shaping urban interiors or as a background for architecture, was a green wall (simple or complex, consisting of rows of trees, shrubs and flowers). This element had various functions: a leading or a halting line, a leading plane. Urban interiors were often shaped with the help of green structure or various rhythms of trees. The next important green element is green floor, which was an element of composed urban floor or a plane of exposition for buildings. There were many types of green floor used: flat floor, undulating planes, sloping surfaces - geometrical and irregular and green terraces [2],[7].

THE ENVIRONMENTAL APPROACH IN THE CREATION OF CONTEMPORARY WARSAW

The Environmental Approach to Warsaw's Problems

The physical and functional structure of Warsaw was determined by its natural local environment - the Vistula valley with a high escarpment on its left bank, where magnificent buildings were located, built in harmony with nature. The Warsaw Escarpment has priceless value in town with its greenery and the landscape open till the horizon, because of its rarity - the single eminence in the city area [3]. The next most important speciality of Warsaw' townscape, which is giving the city its unique character, is greenery. Warsaw is often called a "green city" – as one of not numerous of such towns in the world. This character was developed by trials of introducing a system of green open spaces. The idea of such system was proposed before the war by Tadeusz Tołwiński in the regulation plan of Warsaw elaborated in 1916.

At present Warsaw - as the capital of Poland and the predominant urban structure within its own region is in a unique situation, because it is the centre of political life, as well as a crucial scientific, cultural and commercial centre. We can observe a lot of new modern investments, the process of revitalization of many parts of the city including public spaces, as well as changing patterns of leisure activity, etc. Unfortunately despite many positive phenomena we can also observe many negative changes, which influence mostly natural environment and cause deterioration of living conditions in the city: rapid development of motorization and increasing air pollution, increasing process of urban sprawl, process of decreasing and pollution of green open spaces, insufficient recreational development of the Vistula Valley and other open spaces, an insufficient amount of pedestrian and bicycle routes, etc. In the face of these changes preservation, well-maintained and introduction of green environment in contemporary Warsaw should be an operation of the great importance. The idea of Warsaw as a "green city" should be continued in the future.

The Courses "Housing Urban Complex" and "Multi-functional Urban Complex" – General Characteristics

The environmental approach to Warsaw's problems is visible in the program of studies at The Faculty of Architecture, WUT. Some of the student's works prepared in The Chair of Urban Design and Rural Landscape are presented here as the examples - they are prepared within the framework of basic student's projects as well as during International Urban Design Workshops.

In the design projects elaborated during the course "Housing Urban Complex" students had to design a complex of dwelling houses of different kinds with accompanied services in a chosen city in Poland. Students had to prepare: studies of existing conditions of the area (property of the land, transport system, existing buildings, existing green and natural systems, etc.), and studies of directions of development of the area. There were two main types of the design projects: revitalization of degraded inner city areas – the creation of new city structures on former industrial, railway, harbour areas as well as on various regained areas, development of peripheral city areas – the creation of new city structures of legible composition and distinct limits. New housing complexes had to establish the improvement of the image of existing city and had to contribute to the development of the city.

The aim of the design projects elaborated during the course "Multi-functional Urban Complex" was the improvement and revitalization of a fragment of city structures with the use of many types of buildings and various functions (with prevailing service functions), together with the shaping the system of public spaces. Students had to think about architectural forms, urban details, green areas, transport system, pedestrian movement, use of the newest technological solutions, etc. In the projects both formulation of a legible design idea and shaping elements of identity were very important. There were three main types of transformed areas: areas located in the city centre or in the district of large city, areas located on borders of city districts or city structures, areas located in extensive and not defined urban environments.

All design projects were elaborated with the use of the newest techniques of design simulation (including computer-based techniques, especially CAD technologies). Students had also used freehand perspective drawings in the process of creation of the projects.

The Design Projects – Case Studies.

The design projects are presented in groups, which reflects operations undertaken in the most characteristic city areas: in the centre of the town, in the district of Mokotów, on the outskirts -in Wola district.

The most important aim of the design projects located in the city' centre was introduction of green outside buildings (on walls, roofs, into public spaces, etc.) with simultaneous increasing intensity of built-up areas as well as preservation of the most important values of the site (a good example is project elaborated by K. Błaszkiewicz: revitalization of Mirów area near Chłodna street, shaping two types of inner courtyards in urban structure: green and service).

The design projects located in the district Mokotów concern the concept of transformation of direct surroundings of the main building of historic campus of Warsaw School of Economics into representative public space – The Mokotów Gate. The main aim of the project elaborated by M. Majewska, Z. Makaruk and M. Mutkowska was emphasizing the character of Warsaw as green European city by the penetration of green and existing buildings, the possibilities of perception of green areas from different levels thanks to a pedestrian platform in organic shape (determined by existing trees) proposed 3,5 m above the ground, the division of the park into various functional

areas, shaping representative public square in front of the main building (with urban floor directed towards the park and shaped in many fragments as a green floor). System of footpaths link area of the historic campus with the park Pole Mokotowskie and with other Warsaw universities [1].

The next example of the design projects located in the district Mokotów are solutions elaborated during German - Polish Design Workshop 2007 "Mokotów Meeting Point of Culture and Nature". The area is located near Puławska Street on the edge of the Warsaw Escarpment and is a meeting point of different uses and landscapes, including St Michael Church, historical "Dreszer Park", "Warszawianka" Sport Club with tennis centre, swimming pool and football stadium, various housing and services. The idea of protection of the identity of this place was introduced by students: B. Gajewski, W. Oehlkers, P. Piądłowski, D. Rudolph, M. Szambelan and J. Żmijewski. They created a continuous system of pedestrian paths, which connect all facilities and green terrains of the whole area. The important elements of this system are public spaces (some shaped near St Michael Church - the important spatial dominant). The main aim of this design was the opening the whole area to people, the creation or strengthening of view points on the edge of Warsaw Escarpment and the creation of a continuous system of green open spaces [4].

The next example is the design project „Returning to the City" elaborated by J. Galla and M. Gomółka on the outskirts of Warsaw - located west from the city center in the district Wola, on semi-abandoned railway area with some storehouses and industrial buildings. The authors had tried to achieve two seemingly opposite goals: to incorporate dense urban structure on the plot and to save the „green" spirit of the plot (by protection the wild greenery and introduction new greenery). Hybrid solutions developed in the project would blur the borders between „urban" and „natural"- the most important of them are: a garden of spatial forms of temporary use (movable settlement - an experimental approach of incorporating cheap, mobile accommodation into the city), a settlement of urban villas built by cooperatives, and an urban public park with various functions (creation of

Fig. 1. The design project "Returning to the city", Warsaw, district Wola, 2014, authors: Jakub Galla, Mikołaj Gomółka, supervisor: dr hab. inż. arch. Katarzyna Pluta, prof. nzw.

Source: Archival materials of The Chair of Urban Design and Rural Landscape, The Faculty of Architecture, WUT.

new landscape with the use of former railway elements). The whole design area could be arranged as an exhibition – an instrument for the promotion of and implementation of new ideas for the city. The bicycle „highway" was designed as a main transport axis (no collision with car traffic) and Ordona street was proposed as a main development axis (the service passage). The warehouse would be transformed into the multifunctional creative service center, connecting such functions as co-working, small craftsman workshops and sport facilities. (Fig.1)

CONCLUSIONS

Solutions presented in the paper are good examples of the conscious care of the green environment in contemporary cities, achieved by some important activities: the preservation of existing elements of natural environment, the introduction of new elements of natural environment, the development of inner city' areas with proper integration of built and natural environments. In the design projects there were planned systems of green areas in urban complexes as well as there were used green elements in spatial composition of urban complexes (especially in public spaces). Many design projects refer to the newest ideas of shaping townscape of contemporary cities: the idea of perception of townscape in move and from different levels, assurance of changeability of townscape, shaping flexible design solutions (which could be used variously both at present and in the future), conscious and unique spatial composition of public spaces, applying the newest material and technological solutions. New possibilities of design simulation of spatial forms could increase environmental awareness.

Results of these researches could be helpful in practice - in creation of contemporary cities, including Polish cities. At present environmental awareness and the environmental approach in creativity is indispensable. The transfer of this knowledge to the practice of architecture and planning can bring measurable economic effects.

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DESIGN AS METHOD

An innovative approach to architectural design was implemented in Warsaw in the 1930s. It has been proven to be equally effective nowadays and also effective in different fields, as I had tested its new possible applications. Given that its effectiveness stretches beyond the scope of architecture, it is well worth considering how the design approach can best be used today and in the context of future challenges, especially in the information age.

YESTERDAY

During conducting research on Polish architecture of the inter-war period, I came across a surprising event. In 1930, at the age of 54, Czesław Przybylski (distinguished Polish architect and professor in the Department of Architecture, Warsaw University of Technology, in charge of the prestigious Department of Monumental Forms) dropped his lectures on design principles. Intrigued, I was prompted to find out the reasons for his drastic decision. It turned out that he needed time to form his own position with respect to the avant-garde architectural changes which had occurred in the 1920s. On resuming the lectures in 1934, he expounded his position in these words:

"Above all, my lectures will be concerned with what could become an objective basis for research into new solutions; for paving our own way instead of imitating. Should we learn the principles of rational interior lighting with direct natural light, it will result in rational and perhaps even original - if the circumstances should allow it - designs of the building as a whole and in detail. If you understand the principles of acoustics then you will gain the real basis for shaping a theater, a cinema, etc. Essentially, only then you will be able to capture the wandering imagination into the framework of reality" [1].

Thus, the credo of the professional architect with extensive experience should comprise of three elements: the unchanging design data at the fundamental, nearly physiological level, which is beyond architecture; sciences such as acoustics, ergonomics, lighting etc, creation, understood as method as well as goal and the imagination of the architect, understood as a mechanism to evolve cultural values from fundamentally physiological level.

An analysis of inter-war projects adds to these two essential elements:

– The approach to architectural tasks, which can be summarised as an optimization of the "here and now". An example of this are three small adjacent buildings to be found in the magazine "Architecture and Construction" – "Architektura i Budownictwo" (1939). Three buildings, three functions and three different technologies, but each with a timeless form, which is not yet dated.

And this was the 1930s - a period divided between "high" and "low" culture, when national and regional trends contrasted with the emergence of CIAM, and the transition from craft to industrial technologies in construction was in full swing, as can be seen in Fig. 1. This approach may be evaluated on the Kukul shelter near Vorokhta, designed by Warsaw architect S. Marzyński (1939). Inspiration from *grażdy huculskie* is obvious, suggesting that it is an example of the regionalist trend. But is it really? Considering the plan (functionalist), and reading about the way it was built (oxen drag up stones and trunks of spruce from the valley to the moutain top through the bed of the stream), let's look at the photograph: it is the natives who were building a hostel for their first time contact with the intelligentsia of Warsaw. Putting yourself in Marzyński's situation, who had to rely on local materials and local contractors, it should be noted that this particular hostel is contextualist (the result of the optimization to the "here and now") rather than regionalist (implementation of a stylistic decision), as can be seen in Fig. 2.

– Individual, intuitive synthesis.
As an example, I chose the draft regulations for the Cathedral Square in Vilnius, made by R. Gutt (1938). The Cathedral Square, being in the historical heart of Vilnius, close to the buildings in the central hub, was to be organised for intimate celebrations and public gatherings.
After 8 months of analysis, Gutt elevated this space to the role of the *plateau*, intended to observe the elements of nature and culture most important for Vilnius: the Cathedral, the bell

From the left, vertically:
Fig. 1. Shelter for 2 persons, Toboggan track, Mountain lift.

Source: (1939) Architektura i Budownictwo: 62, 37, 37.

Fig. 2. Kukul shelter.

Source: (1939) Architektura i Budownictwo: 55. Plan, view of grażda huculska and family picture: Archive of Zakład Architektury Polskiej WAPW.

Fig. 3. Cathedral Square, Vilnus,by R. Gutt, 1938.

Source: (1938) Architektura i Budownictwo: 372, 371.

II. 1. three objects, 1939:
- schelter for 2 persons
- toboggan track
- mountain lift

II. 2. Kukul shelter, 1939 by S. Marzyński

II. 3. Cathedral Square, Vilnus, by R. Gutt, 1938

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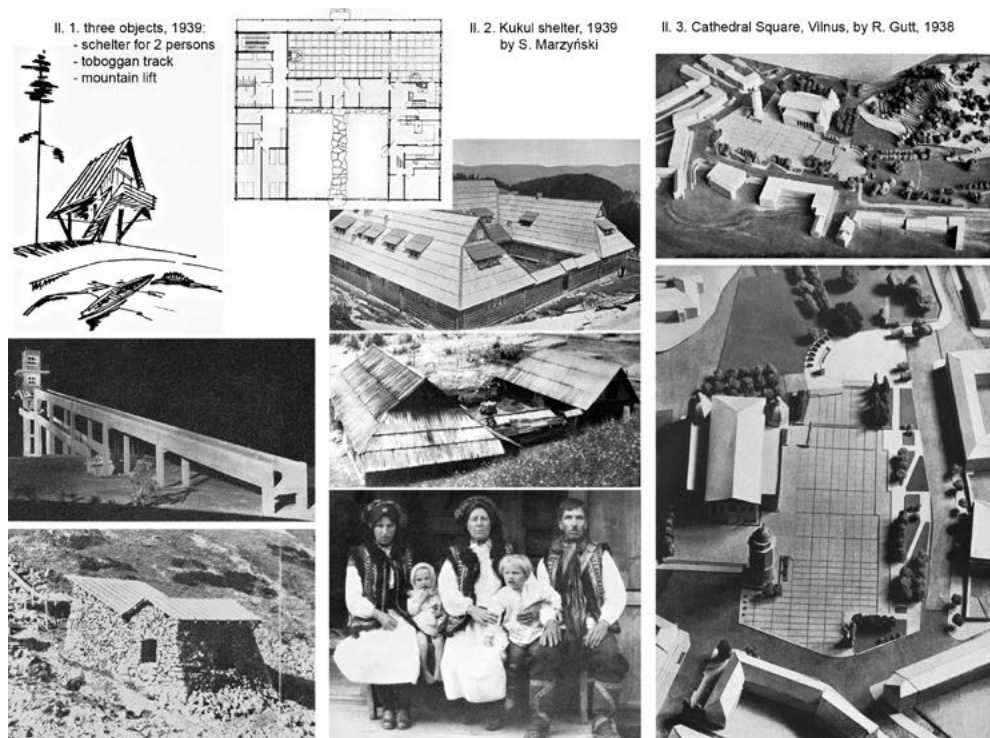
tower, the lower castle ruins, the higher castle ruins and the park which connects to the valley. Therefore, all transportation routes were moved to the rim and significant forms were avoided in the composition of the square, using rather a sequence of increasing levels of shutters and a rhythm of low walls. The isomorphic square shape allowed flexibility and could respond to the subtlest change in conditions. This was the value added by the architect's interpretation of the composition of historical forms, freely scattered in the landscape, along the lines of ancient Greece, as shown in Fig. 3.

TODAY

Today, we celebrate the centenary of the creation of WAPW, which developed the design and teaching model known as the "Warsaw school of architecture" – a model still in practice to this present day. Simply put, it combines a wide range of contrasting themes / subjects (history - modernity, urbanity - design, freehand drawing - parametric programming) with the highest-ranking design activities carried out under the direct supervision and individual guidance of a "master".

Using this model, I lead interdepartemental project classes called Tech+ at the Warsaw University of Technology. These classes made me realise the difference between an "architect", i.e. student from the department of architecture, and students from other departments of the university i.e. the "engineer":

– The architect does not have a specialty - versatility (and flexibility) is his/her forte.

– The architect controls the entire planning process - from the preliminary research stage, through to all phases of the project to be implemented in accordance with the client's expectations. The engineer does not want to participate in the construction phase, nor cares about for whom (and for what) he works. He prefers to tackle and answer specialised questions.

– The architects in the classroom Tech + found an application and determined the parameters for a 3D printer, (3 meter high prototype done in 30 minutes and for 30 PLN as a test form for industrial design) and invented an economical solution (of spot-welding the wire to create a polygonal net, instead of welding the whole thing). Engineers jointly invented the mechanism, material and welding technology. And at the end of the semester the architects simplified the project by replacing the wire with Styrofoam balls (which is important, because the balls did not have to be given a precise angle in 3D like wire which could simplify the mechanism).

– We treat students as authors and fulfil the required curriculum by forcing competition, i.e. "Gamification". This is a very effective motivator, because through competition strong emotions are brought into the creative process (though the level of emotion must constantly be kept under control). This method is in stark contrast to a social consensus style of motivation, which is, unfortunately, prevalent today.

– The engineers are taught a different kind of design than architects. The project engineer is imitative: he will implement a stock solution. The architect, on the contrary, having completed the same analytic tasks, will strive to find a new, unique solution.

– Working with engineers clarified the essence of our methods of design and the way it is learned. Creation takes place in a certain mental state. You must enter into this state and require results. And then repeat the process several times in order to build up the habit, which differs from the typical "know how" of other disciplines.

– Students of architecture are "thrown into the deep end and asked to swim." We provide a job description, do not pass on the full information, and then expect a solution. The tasks are quite varied - "from the furniture to the city." The teaching staff each have their different approach to design, so the student must form their own. In summary, this iterative style of training is focused on finding self-efficacy. After a few semesters, students are supposed to be able to work independently, and on any topic.

In summary: architectural design has proven itself in purely technical tasks, in which architects have a great advantage over the engineers by putting the problem into a social perspective.

The question is: How will our method work in the sphere of contracts and social agreements?

Test 1

It is often that clients of a single-family home project cannot verbalise what they want and settle for trite ideas, when their own home should be a reflection of their personality. Therefore, I constructed a simple test for customers based on psychological tests. It consisted of two parts: the aim of the first part was to precipitate a customer to think about the "nouns" (large kitchen, fireplace, garage for two cars etc.) and then to transfer him to a higher level of abstraction; the aim of the second part was to describe their dream house using 10 adjectives. The first 3 or 4 adjectives listed were usually standard, but later they were becoming more personal. Upon an analysis of the test, I was able to create an image of this space in my imagination, which was repeatedly checked in conversation with the vision of the client, until we finally reached an agreement. The success of the test depended on how well I was able to meet the clients' needs by empathizing with their "state" of mind. Among the 36 people tested, I was successful with about half - and with excellent results. Visions of their dream houses were so original, consistent with their personalities and stylistically varied, that no architect's imagination alone would have been up to the task.

– Examples:
High school maths teacher in the countryside: the house has to have a clear structure, because it reflects the platonic construction of the world. And the entire structure should be visible from any vantage point within the house, with views through the windows to the horizon. During the talks, I determined that this corresponds with the historical structure of the Polish country mansion (!).

– IT specialist with IBM in Warsaw: his space should oversee the house as does the captain's bridge of a ship. This entailed a small room, but with expansive views down to the entrance, living room and kitchen, the surroundings of the building, and all the control elements (electricity meters, gas, water, cameras, Internet, etc.).

– Housewife in the countryside: an incredible adventure, because the whole house was described to me only in the form of an acoustic stimulation (bare feet of children on the wooden stairs, the rain, the entrance to the building as a hard surface to strengthen reverberation, etc...).

Test 2
Lectures (3 x 1.5 hrs.) in the Faculty of Biology of the University of Warsaw.

I had to find out how much time and which methods are needed for 150 non-professionals to become partners in design. During the first lecture I spoke about shaped light closures and openings, the second lecture was about architecture as a coordinating function, location and form. During the third lecture, the participants / students had to propose the function and form of an object in the most difficult locations in Warsaw. The best solutions were not worse than those of students from the Warsaw Technical University. They might have even been better, because the focus was on the city rather than the perfect architectural form.

Examples:

– Site on Emilia Plater street only 13 meters wide, nineteenth-century buildings with shaded gables.
Solution: the proposed function: Museum Street Emilia Plater: glass envelope showing the current condition, including the surface of the brick gables. But interactive, as with the gable

walls showing the projection of the nineteenth-century interiors of neighbouring tenements and against the wall on the north (embassy of Morocco), an interactive map of the street. The compositions which were included: a monument executed in World War II, and a statue of the figure of Christ.

– Space under the viaduct route on Łazienkowska street, passing under the bridge over the Vistula River. Situation: high and steep slope opens up the beautiful panorama of the right bank of the Vistula and the lack of a built-in line of the slope creates a green belt along the city with bicycle paths.
Solution: proposed is an automatic cycle hire system in a space under every bridge, along the Warsaw left-bank. Form: each viaduct forms a roof, and it is enough to construct the side walls out of steel mesh for the automatic, vertical storage of bicycles.

– Grounds in the heart of Warsaw, round about Al. Jerozolimsky and Marszałkowska street. Located on every corner of the intersection is a different type of building.
Solution: a shell covering which would occupy 100% of the plot and be as high as the neighbouring hotel. The coating should be translucent (overshadowing traffic, but letting in light) and ecological, not because of plants, but through water that suppresses noise: proposed are aquariums with algae or fish.

In conclusion:

The subject of space has proven to be very engaging because of its direct concern to everyone. Thinking in the visual imagery of architecture is difficult for beginners – they must be taught - and our teaching methods have been proven to be effective. When only three meetings are sufficient to create an effective working partnership in the project, it is worth doing because the benefits far outweigh the effort involved.

Because the potential for the interpretation of space is so rich and diverse, it is worth collaborating with clients on projects rather than trying to go it alone. This involves shifting the role of architect from that of sole creator, towards that of co-founder and co-ordinator who formulates the design task. From the point of view of an architect, the technique is not much different than a psychoanalytic approach: both open up many opportunities for effective action beyond architecture.

The engineers in the Tech+ were drawn a simple diagram to illustrate they are not limited to just one stage of the design process. The diagram consisted of:

which (material), how (method), what (product), and for whom (goal)

The schema is straight forward, but is actually involved in many of our endeavours (writing a PhD, architectural design, the competition for Miss Polonia, cooking dinner, etc.). What is worth noting is mutual characteristics of the design process and its result (the finished work), as well as the paths of research and teaching.

Of course, in the Tech+ classroom, many issues associated with each element in the scheme were raised.

– **Which (material)**
Extreme diversity of the task (no specialization) means the freedom to choose the materials, thus,
freedom to pursue the creative process in both the real and virtual worlds. What is more, currently ongoing transformation of linear method of recording information (1D) into visual (2D) and our use of a spatial representation (3D) is changing with time.

- **How (method)**
  Architect uses himself/herself (whole personality - conscious and subconscious) as a tool, uses imagination rather than laboratories, material testing, etc. The design steps consist of a feedback and elimination process, which take place until the final decision is made.
  There is no fixed algorithm for the creative steps (methods depend on the goal). However, intuitive synthesis results in a higher efficiency than analytical thinking (and is faster) and since we have been operating in the same way since the days of Vitruvius, we have had an effective experience.

- **What (product)**
  For us, the building is both a concrete construction and an idea. Hence, our attitude towards the task is both physical and ideological and its effectiveness comes from the simple principle that architecture is what has been built. The rest is commentary. The justification of this premise stems from the banal fact that a building is an expensive investment, which is a necessary and sufficient test for the social requirement of an architectural structure.

- **For whom (goal)**
  It depends on ourselves, on our interpretation of the design task. Because it is worth reminding ourselves of the fact that we are working not only for the client, but also for ourselves: for experience, recognition or a sense of social duty.

To what extent is architecture art and how much is it communication? To what extent is it an "objective truth" as opposed to a subjective idea? A hundred years ago in Poland the architect was called "counsellor", because he gave advice. It is an illusion in society and the media that the development of science and technology solves social problems. Social problems are solved by social forces, which need a mediator - an expert on the issue. And controlling the built environment, we as architects have a direct physical impact on reality.

TOMORROW

Architectural design as a practical method has not yet been fully defined and thinking about the future is fundamental in deciding our course of action. The definitions of which I am familiar are too narrowly task-focused, or verly selective in their methodological aspects. I am also unable to provide a definition that clearly includes all of the elements, which would be necessary and sufficient

Therefore, I would like to point out two aspects resulting from treating the building as a material storage system of organised information.

The notion of "real" information is a simplification. Its "factuality" is associated with a probability. The value of information is fluid: it appreciates through its dynamic relationship with the source from which it is obtained, and is the end result of all those adjustments. As well as this source-information flux, architects add a third dynamic: interpretation of the information in a predetermined order. Only then does the source-information-goal system create a coherent entity, because the information is not the architect's goal in itself, but a means to an end. We assess its value relative to its usefulness.

This is the method for handling information: to take into account the entire process in which the act of designing architectural form is only one of several elements, and is done from a level of higher consciousness, inspiration, gamma brain waves, etc. It is an artistic approach: a level from which we can evaluate all of the new technology which can not be avoided in an age of computer generated images, virtually designed environments, and e-learning based on the data cloud available via the internet.

Anna Dybczyńska-Bułyszko_Design as Method

Do we understand the effectiveness of our method? Is it the freedom to handle information, to choose the methods, and to control over the entire process of setting the tasks to implementation? The architect is in a position to handle any task because he is able to manage both the environment of information and the human component, these constantly modify each other. Here I do not need to quote examples, as anyone experienced in co-ordinating industries while designing, or supervising construction, will understand. In the information age, the architect is responsible for the manipulation of information in order to add value to the social codex: he must translate the language of technology into a language which is accessible to society. In the information society, this activity has a cultural dimension.

Cultural values, which were obvious to Vitruvius and the pre-war "Warsaw school of architecture", have become increasingly blurred in a world dominated by ever faster changing fads. And, moreover, this blurring seeks to undermine the social role of the architect, who is increasingly forced between the role of media-star and the "hired help" of the developers. According to writer Umberto Eco, the architect is the "last humanist", and as such, is obliged to lead the discourse on social values.

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PLATEGLASS UNIVERSITIES: SPACES FOR A NEW HIGHER EDUCATION IN POST-WAR BRITAIN

In post-war Britain, the Plateglass Universities were further evidence of the trust in architects to act as professional links between government aims and social needs. These campuses gave the British middle classes easier access to higher education, and are here under study in a research that crosses architectural and urban design with pedagogical and social studies.

FRUITFUL HIGHER EDUCATION

Brian Eno was interviewed for a magazine in Madrid in December 2013. When asked about his first steps in music he answered he left university in 1972 and formed a music band:

"Nothing unusual in England at that time. Actually, faculties were institutions to secretly create rock bands".

So did John Lennon and David Bowie... What was happening at British universities and colleges? What made this ambiance so "special"? Looking for an answer, let us rewind...

London, October 1963: the Robbins Report is submitted to the British Parliament. Extensive statistical data showed the situation of higher education in post-war Britain and tried to correct a setting that had been cultivated for centuries. Restricted access for graduation turned out to be a social and economic problem. A new goal was created such that any talented person could reach university regardless of their socioeconomic conditions. Thus, Colleges of Advanced Technology was given the status of a university and a number of new institutions broke the existing near-monopoly of Oxbridge - Plateglass Universities were born, as Michael Beloff first named them in 1968 [1].

The massive influx of the middle-class to universities required important policies only comparable in optimism to those creating British New Towns from 1946. With the same energy, exceptional funding from the University Grants Committee (UGC) was already making possible the construction of new campuses for these universities, which were pioneers in their urban planning, their housing patterns, their curricula and their architecture, which was mostly built with prefabricated systems.

Compared to the urban setting, new universities were built in magnificent locations, country-clubs in the perimeter of cities that were rooted in an important historical legacy. The sites chosen not only responded to certain geographical and social needs, but also needed to meet three basic requirements of the UGC: to ensure financial security by the local government, to enable the use of the easily accessible existing housing and to have a minimum area of 200 acres, so that universities could grow freely. The third condition was closely linked to one of the objectives set by the UGC: to encourage the students' link with both nature of each place and the city hosting the university.

On the one hand, even though the new campuses were designed as urban campuses, they would promote university life in an independent and healthy atmosphere, as such they should contain extensive sports facilities. Furthermore, the new universities were to enrich the city they were part of, establishing relations with it by creating a cultural centre that could provide activities common to both hubs. In fact, some of the seven cities chosen had reached a stage of growth where the centre had been 'abandoned' and the busiest spotlights were being established in the periphery.

In any case, the fact of joining 'the new' to 'the existing' through the perimeter was obvious in the UK. British cities had quite compact densities and therefore it was not feasible to insert in their urban fabric new teaching spaces having short-term growth as one of their goals. For that reason wild places were selected, boundless and capable of allowing the necessary space for the existence of large open spaces with the potential for future growth.

The result was the creation of seven new campus –Sussex, York, East Anglia, Essex, Lancaster, Kent, Warwick – established in seven consolidated cities –Brighton, York, Norwich, Coventry, Lancaster, Canterbury and Colchester; seven universities sharing a common trait, despite the variety of their master plans and architectural styles, which also differentiated them from American universities. All seven reconciled compact and controlled scale outlines, so that the volumes, the relationship between buildings and even growth itself could be precisely defined. These features not only catered to urban and formal motives, but they encouraged the feeling of belonging and the easy communication between the different members of the university community. Both features are opposed again to American universities', the outlines of which induced anonymity. Thus, new British universities were designed as continuous structures, physically speaking, whose form preserved the dialogue between buildings and people and where the social activity hubs expanded rather than concentrated.

Having established the basic parameters of scale and compactness, and taking into account the particularities of each natural environment, only the academic program of each of them remained to be set [2].

Discussions in the field of architecture were immediate. Once the educational policies, the financing channels and the conditions of implementation were set, architects quickly asked how to transform revised syllabus in spaces (Casson, 1964) [3]. Richard P. Dober highlighted new universities emerging from the dialogue between ones that design academic degrees and others that imagine the architectural needs [4]. In this particular case, the functional character of modern architecture was even more dependent, since campuses were largely based on the philosophy of the curriculum of each university. No architectural design would be possible without considering prior academic structure. Therefore, vice-chancellors and architects shared the limelight. Both guilds had the desire (a) to innovate the traditional, educational and architectural scheme, (b) to promote equality, (c) to incorporate creative work spaces, such as theatres, concert halls or art spaces, (d) to promote sense of community (e) to prioritise quality over quantity, (f) to host building designs where the place would print personality on the whole and, finally, (g) to have spaces that were not specific or specialised but whose imprecision made its adaptation to different uses possible.

The first results of this research show different paths of design mechanisms apparently going in opposite senses. First, the way in which buildings were grouped and related to the landscape. Sussex chose a campus or district model, a central scheme growing to the periphery concentrically. This idea of growth taken from the first New Towns had nothing to do with the educational program. Actually this first planning, somewhat experimental, was essentially a direct response to the site, the landscape and the aesthetic concerns of the architect Sir Basil Spence. This did not happen in the other six universities, which took the syllabus as an organizing tool of their urban layouts. York and Kent opted for a scheme that could be labelled as molecular: a group of carefully communicated compact nodes where the movement favoured contact between people. The other universities -East Anglia, Essex, Lancaster and Warwick- intended to generate a global shape with a much more powerful intrinsic urban concept. Buildings, more or less continuous and open to the landscape, along with the transition spaces, formed an organism seeking the separation between the vehicle and the pedestrian, the concept of 5 minutes-walking and flexibility of use between schools.

Second, the permanence of some space approaches that transcend the institution type: inclusive interiors, embracing courtyards, self-observing buildings... are found in the 50s and 60s study cases. But when promoting the sense of belonging and community, not only the architectural and spatial design had a leading role. The decision as to whether the university would follow a 'college' or 'unitary basis' model – held by the rector and its respective Academic Planning Board– affected the organization of the planning and building typology of all buildings, either academic, residential or recreational. York, Kent and Lancaster opted for the 'collegiate' structure. This system established various colleges within which all uses were developed, so that each could function independently. Therefore, although the architecture itself could promote social and community uses, nothing prevented the interconnection with the other buildings on campus from happening. In contrast, Sussex, East Anglia, Essex and Warwick chose a 'non-collegiate' model - a model through which the teaching and leisure spaces were completely intermingled. There was no break between teaching and study, between teaching and researching, or in other words between studies and curriculum.

And third, an increasing indeterminacy in architectural form that was considering the works as systems in an open way: a gamble on flexibility typical of the 60s and 70s. Whether or not these buildings met the utopian ideas of the time, the construction techniques used reflected the technological development [5] and a design process that left behind the one-way relationship between form and function.

Half a century after this enriching experience, we can still learn from Plateglass Universities. Numerous sociological studies address the consequences of more collaborative and participative learning. Furthermore, architectural works of the most renowned architects (Stirling and Gowan, Lasdun, Spence...) have been extensively dissected within their context. However, little is known about the intended design strategies that helped (or not) to create this new college environment.

In order to carry out the verification on this collaborative work between various disciplines, original documents on education policies are considered, in parallel with collected published photographs and building drawings. Using a graphical reconstruction of the design process, the aim is to recall the stage in which certain attributes were incorporated into educational spaces. Sources are mainly contemporary specialised magazines and journals in both areas of knowledge (pedagogical-social and architectural), acting as reporters of the intense lived moments. The work to be done is enormous and research needs to be structured.

ABOUT THIS RESEARCH PROJECT

Research in architecture is as varied as the disciplines that come together in their practice. There are increasing contributions that refer to this plurality of areas of expertise involved in the advancement of architecture: from one end to another, the arc ranges from pure technological field to the characteristic qualitative analysis of social sciences. However, the study of architectural design does not fit into any of these points. Design is not a quantifiable process; nor is its understanding satisfied with the disclosure of historical or descriptive data. The architectural creative act walks its own path, but research cannot ignore established scientific methodologies. Since the object of this research is the one specific to our discipline –the architectural project considered a complete sequence from its design to its construction– the challenge is to produce new knowledge through systematic enquiry, which is to provide communicable and useful information. Thus, academic research becomes related to professional needs, two areas that are increasingly distant, unfortunately [6].

Professor Jeremy Till delves into this idea of specificity of research in architecture, while trying to dismantle three myths still in force [7]: that architecture is as unique as discipline that no standard research methodologies can be used, that architecture should reach out to other disciplines to consolidate a stable epistemological basis, and that designing a building is a form of research. The proposal is a research model resulting unaware to dualities science / arts and qualitative / quantitative, and integrating existing standard procedures with architectural contexts and fields. Only in this way, can the model be inclusive (open to scientists and historians, academics and practitioner profiles) and will enrich the knowledge of architecture.

This research supports the above discussion and therefore seeks to demonstrate the harmony between the educational policies of the post-war Britain and the architectural and urban production that fitted in them. The successes, but also the failures, could be useful for a contemporary

application, in terms of design process, collaboration between disciplines, and architectural results. Is there a link between a new academic structure and the physical form that supported it?

The question is answered with a methodology of case studies where the samples are the 7 new campuses identified as "Plateglass Universities". This common model of research applied in the field of architecture has been thoroughly analysed by Groat and Wang [8], who explained the advantages as a method that combines multiple strategies: the logical (argumentation), the interpretative-historical, the qualitative, the correlational, the experimental, and the simulation ones. From this point of view, the case study could be considered a meta-methodology that reduces the complexity of the empirical world, according to some specific variables, to a number of units of analysis (Johansson, 2003) [9]. Studying few or only one unit of analysis (a case), according to multiple variables, will produce explanatory research; in the opposite sense (as it happens in this project) many units of analysis (several cases) according to various variables will become a correlational research. In this study of Plateglass Universities, cases are fixed (there are 7), but the strategy involves designing the research perspectives: urban setting, metrics, scale, population, construction processes ... Each of the job prospects provides data for comparison and verification of the pros and cons. The research project has a predetermined structure, but must be able to be modified and specified according to the partial results.

Direct sources of the current study are twofold: Architectural (plans, drawings, photographs) and educational / social (written materials, videos and audio). The strategy involves looking across both areas of knowledge through tools specific to both disciplines. Quantitative and qualitative analysis methods are used, involving the urban and architectural design: Graphical tools help to uncover compositional and functional aspects of the study cases. The software used does not differ from that of other investigations (database of photographs and plans are used and stored in a reference manager software), but the look becomes specific when plans are redrawn, different settings are superimposed on the same scale or photographs of similar educational spaces are compared. Drawing and modelling are then disclosed as creation tools for architectural design, also useful for research itself.

This research is at a preliminary stage of development, in which sources are being localised, classified and analysed. Currently, the focus is on campus -architectural ensembles settled regarding social requirements- and in a future phase, the study will be addressed to particular buildings.

This paper addresses the Research in Architecture and Spatial Design through the architectural and the urban object itself, with the conviction that only an inclusive vision of architectural production which combines spatial, social, technological, constructive aspects will give applicable results in the area of design. At the same time, this Interdisciplinary Analysis in Design evidences the role of architecture as a social tool. Research in Architecture through cross readings and links between various areas of knowledge allows the discipline to update their values to modern times. The consequences enrich the subject of Redefining Building Typologies, which gives shelter to changing current needs.

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LEARNING DESIGN *THROUGH* DESIGNERLY THINKING. HOLISTIC DIGITAL MODELING IN A GRADUATE PROGRAM IN ARCHITECTURE

The paper presents the author's experiences in architectural design education as answers to questions that, for some years, have been hovering around Design as the Third Culture and its relationship with Science. More precisely, the paper proposes to address the following questions: Can Design itself be used as a tool for scientific research? If so, what are its characteristics and features? Can research through Design be used as an educational method? If so, with what results? In addition, and as a complementary aspect, the paper also focuses on Modeling as a core language of Design that, in its recent digital nature, can bring accuracy to the production process, and "makes Science visible" so that an holistic approach in learning can be reinforced and usefully adopted.

DESIGNERLY THINKING AS A RESEARCH AND LEARNING METHODOLOGY

"I do not believe that there is a single paradigm for research 'through design' but I am confident that we now have the means to conduct research that is appropriate to our profession and discipline, which makes a distinctive contribution to knowledge that complements that of other disciplines and, crucially, has the potential to inform professional [and educational] practice." (Rust, 2009: 6)

The relationship between science and design has a long and controversial story intimately connected with the beginning of design practice when the need for a scientific method, De Stijl, arose in the early Modern Movement and evolved within the cybernetic research of the 50's. The Conference on Design Methods, held in London in 1962 (Jonas and Thomley, 1963) is generally recognized as the climax of this debate and the point from where design starts to assume its own peculiar identity distinguished from science and the humanities. This question was revamped with the article *Research in Art and Design*, published in 1993 by Sir Christopher Frayling. The article renovated the question about the fundamental nature of design (Margolin, 1982), and the possibility for design to be a scientific research discipline: more specifically, if *Research through Design* can be considered a way of knowing but also a way of thinking to investigate and disseminate knowledge which are the main elements through which science is defined.

Addressing the above issues, this paper adopts the term *Designerly Thinking (Cross, 2001)* to designate the operational specific nature of design. It also identifies two questions as relevant

topics to evaluate the scientific nature of design, consequently assessing *Designerly Thinking* as a useful approach in learning design. These two questions are:

– Does *Designerly Thinking* employ a rigorous and, above all, transmissible methodology?
– Does the product of *Designerly Thinking* modify systems of knowledge?

Historically, many scholars and practitioners have defined diverse and fragmented methodologies for design, and as a result, we must therefore accept that *Designerly Thinking* does not seem to employ a rigorous and transmissible methodology. However, because science and the humanities have moved closer together, science has opened itself to qualitative domains and concerns itself with ill-defined problem solving which are viable through multiform methodologies, even unorthodox ones, if they are reasonable and consistent. Based in this approach, we can accept *Designerly Thinking* as a scientific practice with its own multiform methodology but on the condition that the process is explicit, coherent and communicable.

Concerning the second question, whether or not the product of *Designerly Thinking* modifies existing systems of knowledge we can start from the seminal distinction between science and design (Simon, 1969) where the former is seen as a transformation process of knowledge and the latter a transformation process of *utility*. From this we conclude that design cannot modify systems of knowledge. But this is not definitive. In fact according to Brown and Chandrasekaran (1985) and Gero (1990), design, when it is not addressed as a *routine* product but *innovative or creative*, can produce different kind of changes in knowledge. In addition for others including Archer (1995), design artifacts can produce knowledge facilitating – sometimes – major changes in people's perceptions and values. The hypothesis that design can be assimilated to science is therefore valid under the condition that the changed state of knowledge does not remain *tacit*, but conscious and transmissible. In addition, this hypothesis is more relevant and effective in education where knowledge transformation can be considered its primary output even if it is not related to the scientific community or the whole of humanity but limited to a specific group of students in a class. Therefore, in this specific and limited field, *Designerly Thinking* can be considered a cognitive and scientific activity as well, if methodologies and products of research are explicit, consistent, and formalized.

DIGITAL MODELING IN DESIGNERLY THINKING AS A MEDIUM OF LEARNING

From the above discussion it is clear that the questions "if *Designerly Thinking* can be based on a transmissible methodology and can produce a significant transformation on knowledge" are both related to the condition that all the activities, analysis, guessworks and outputs must be unambiguously expressed.

We believe that modeling, with pattern recognition and synthesis as the main and distinctive methods of Design, can be considered the answer. As we can see in the following examples, modeling represents the materialization of assumptions, methods and outputs: the medium through which students can objectify research, exchange experiences, and acquire knowledge.

Modeling has a long tradition based mainly on figuration: a personal sketching process (Laseau, 1989) developed by trials and errors, informed by *tacit* knowledge and controlled by *pondere et mensura* that, in the past, was typically analogical. In fact, with the exception of some drawings of Francesco di Giorgio Martini (see: School of Marco Varrone in Casinum) and the architectural firm of the San Gallo family, design modeling was mainly run through geometrical proportions. Famous examples are *Livre de Portraiture* designed by the Picard architect-engineer Villard de Honnecourt in the decade from 1225 to 1235, the beautiful mock-ups realized by renaissance hatchers, or lately the elegant buildings of Palladio modeled using musical harmonic proportions. Even Vitruvio

tells us of different measuring instruments but it is quite evident that the past reasoned and worked differently. It worked through the *analogical syllogism* of descriptive geometry and the ineffable knowledge of quality based on evidence.

Despite these historical antecedents, however, it was not until the Sixteenth century that The Number would start to accompany drawings in a more stable manner. While perspective in architecture was playing its baroque exaggerations, the *Scientia Mathematica* revolutioned design and architecture supporting Cartesian Space where objects and functions were describable with the elegance of numbers and mathematical formulas. From this moment onwards, Aristotelian geometry was threatened by a new approach which was no longer syllogism but numerical modeling. The forerunners of this new approach were the abstract ballistic calculations and crossfire lines that shaped urban fortifications.

The *Matema* paradigm-shift marked the passage, as stated by Fulvio Carmagnola, *"from a qualitative quality to a quantitative quality"* where also analogical representations and high fidelity models are derived from the quantitative logic of digital computation (Maldonado, 1992). As a result, nowadays, forms and behaviors of materials can be shaped and crafted to achieve particular design goals fitting exactly the visualization that designers are able to produce with their computer software. The standardization of elements is no longer a technique to build in an industrial way. Digital information has become the standard and designers, industry and craftsmen are using this standard to model, to share knowledge and, more than that, to formalize ideas: to give evidence of the design research process and *Designerly Thinking* as well.

Rooted in this theoretical basis, three teaching examples from a Graduate Program of the School of Architecture in Florence are presented. Common elements of these examples are the use of exploratory research and digital modeling able to produce a great number of tests and corrections especially if it is parametric or evolutionary and therefore more effective compared to the physical modeling. Furthermore, reflecting the same principle that distinguishes Research *through* Design from Research *for* Design, the examples share the criterion that the artifacts made by students are not evaluated for the quality of the product in itself but for the degree of knowledge enabled through the artifacts.

FORM MANUFACTURING

The first example comes from the «Architecture and Structure Design Lab», specifically the *Form Manufacturing Class*, where learning proceeds from a free intuitive activity towards a more formalized approach ending in the digital fabrication of prototypes. The course begins with Origami/ Kirigami manipulation inspired by the paper exercises of Josef Albers and his quote: *"All art starts with a material, and therefore we have first to investigate what our material can do".*

This introductory exercise *(Forming through Matter)*, is based on free exploration and intuitive perception about matter's behaviors in order to gain awareness of the relationships between the materia prima (in Latin definition or *materia rudis, corpora materia* in Lucrezio's acception: contents without form but factive) and the *form* through which materiality *(materia operata)* emerges.

Form Modeling is the second step, where students are first required to induce, from their experiments, forming regulatory diagrams such as *mountain & valley-fold*, or consistent methodologies such as tessellation to test, control and refine ideas. Eventually, this formalistic part ends with digitalization where experiments are run in a virtual way using 2D patterning, 3D and parametric modeling.

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After the exploratory phase, the class enters the conclusive stage with the final assignment *(Form Fabrication)* where students are required to produce a mock-up in rapid prototyping for a structural or envelope system. The mock-up and its evaluation are not related to its capacity to represent qualitative aspects and the morphology of the real building system (the form in *itself*). Instead, the goal is to model, to let emerge, the materiality of the constructability: relationships, procedures, and criteria that must be observed in the designing activity finalized for fabrication. To reinforce this goal some constraints were deliberately imposed: the exclusive use of flat elements obtained from laser cutting and the assembly process could not using glue, nails or screws.

HOLISTIC LEARNING THROUGH HI-FI MODELING

Modeling, as operational research and learning tool, is also the main concentration of the second teaching example. In this class, from the «Environmental Design Lab», modeling entirely refers to the digital prototyping. Explorations are carried out inside the virtual dimension simulating and testing performative *matter* of materiality. In this case, the model is used, not as a mere presentation of phenomena, but as a cognitive artifact that allows the student to interact and become familiar with the theoretical foundations that the prototype incorporates: expression of concrete thought and formalization of the traditional sketching in a way it can be now used as a shareable instrument of scientific research (Papert, 1996). The goal of the class is the architectural and environmental retrofit of an existent building to approach in a performative and computational manner.

As in the Form Manufacturing class, in the first phase *(Forming through performances)* students are asked to carry out a theoretical exploration through which they could acquire foundational knowledge about *matter*, in this case concerning the physical determinant of building elements versus environmental behaviors, and form, concerning their state configurations. As a basic activity, from this preliminary exploration, knowledge about theoretical and instrumental fundamentals is also produced.

The second assignment titled Options Building, concerns the decision-making process to be formalized, in a *scientific* manner, through the preliminary definition of assumptions, criteria, outputs and the adopted system for alternatives comparison as well. In some advanced cases and in very limited aspects of the projects, evolutionary computation is also solicited. The objective is not the identification, *tout court*, of a preferred solution, but the acquisition of the Design Optioneering methodology: the design optimization process recently redefined and practiced through a parametrical approach (Shea and Gourtovaia, 2005; Holzer, 2007). In this phase attention is devoted to communication and requires the translation of the digital entities of modeling in analogic shapes. For this goal students are asked to convert numerical reports in more understandable and shareable info-graphics and to give evidence of immaterial aspects of design such as temperature, wind, light, ... through 3D visualizations and HI-FI models that, because the digital information (the untouchable material) stored and processed in it, is able to give us a tangible and qualitative experience of the quantitative analyzed phenomena.

Materializing relationships and emerging effects between building and environment is also the final assignment titled *Materializing Behaviors* where students are asked to finalize their experience showing the changing state of this intra-active system under different conditions of forms, building elements, weather and *time* as the complementary entity of *form and matter*. Virtual representation through video animation is the required medium to show this relationship, but students are also encouraged to produce an interactive physical prototype using Arduino microcontrollers. For the realization of adaptive mock-ups students are supported by Mailab (www.mailab.biz) a university spin-off research laboratory on Multimedia Architecture and Interaction, giving them the opportunity to expand their learning experience in a professional research context.

STAGING INHABITANTS' BEHAVIORS

The last example is the workshop *"La casa di ..."* focused on designing a private house where the main goal is to invalidate the current use of standardized users' requirements and, more importantly, to disrupt the traditional approach in design-lab teaching where students work with a problem-solving attitude. For the final presentation students are required to realize an architectural video-mapping installation where the architecture (a Communal Condo resulting from the assemblage of all the individual houses) is in the background: a simple three-dimensional support to stage the daily life of each user or *"different biographies of many weak identities. (A. Branzi, 2009: 39)*

According with this goal, the assignment starts with the brief definition *(Client profile)*. A problem setting task that students are asked to cover using uncommon approaches for architects such as creative writing and daily activities scoring or other unorthodox instruments such as virtual shadowing (e.g. Vito Acconci's *Following Piece*). The goal is to provide a design program emerging from people as human beings: a complex anthropological subject, more than ergonomic and psychophysical entities where provocative and ironic approaches (e.g. Munari's Method, Architettura Radicale, Critical Design) were also solicited to restructure the problem.

In the second step *(Design Development)* students were asked: first, to work individually designing a private house fitting some assigned morphological constraints and users' requirements as set in the previous phase; second, to work as a group in order to realize a unique model reassembling all the individual houses in a Communal Condo to be manufactured in rapid prototyping.

The third step *(the Spectacular Communal Condo)* was devoted to reveal the daily behaviors of the houses and their inhabitants through videoclips. With the assistance of Mailab, these videoclips were assembled, edited and mapped on the physical model in order to obtain a video-installation staging the life of the Condo and to materialize a metaphor of the condition of contemporary design where objects are vanishing in a new scenario that

> *"pushes material artifacts to the background in favor of the actors within the system, [...] will invite designers to look for the 'dark side' of the object [...] that correspond, not only to the needs, but also to the aspirations, hopes, and life projects of their users!" (Findeli, 2001: 14-15)*

CONCLUSIONS

The discussed examples show how learning can have effective benefit from practices informed by scientific research or, in other words, by formalized and consistent methodologies supported by modeling.
According to Epron et al (1977) the better impact of modeling compared to other approaches based on regulatory methods or stylistic observation is also demonstrated in learning. In a broader context, some other corollaries concerning the adoption of the *Designerly Thinking* and Digital Modeling adopted in explorative more than experimental attitude, in Bardram's et al. (2004) interpretation, can be also highlighted in the following:

− form, matter and *time* are mutually interrelated in the manufacturing process and they can be effectively modeled through information materiality;
− problem setting and the *construction* of ad-hocratic tools are strategic and determinant in design practice facing new problems;
− HI-FI analogical representation can be a powerful tool to acquire awareness and to support the decision-making process as well as learning;
− qualitative and analogical comparisons allowed by digital computation, more than analytical

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measurements, can produce evidence and effective evaluation of alternatives in the early stage of design;

– provocative and disruptive approaches can stimulate students to interplay, to identify new directions and to expand their knowledge;

– new knowledge emerges from the interplay between the environment, artifacts and actors and, as a consequence, each learning project has different goals, methods and outputs.

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REFLECTIONS ON DOCTORATE IN ARCHITECTURE

The nature of architectural education remains the subject of an important debate. The research area in architecture is broad and heterogeneous - it embraces, inter alia, history of art and architecture, theory, criticism and different aspects of professional practice. this paper discusses the prospective profile of doctoral research in architecture on the background of formal and practical aspects of scientific context. The dynamic changes happening now in the architectural profession have a serious impact on the innovative thinking in education and research. The discussion about research in architecture still focuses on the relationship between the theory and practice.

INTRODUCTION

Doctoral research became a significant issue in the discussions on architectural education.

The evolution of architectural research may be described through the analysis of the substance, nature of the problems and investigation tools.

A question that lingers as a current issue in the ongoing discussion about doctorate: is an architect more a researcher or a professional? So, while analysing the local and European conditions we persistently deal with a comparison of a theoretical and a practical approach to research.

FORMAL AND PRACTICAL ASPECTS OF ARCHITECTURAL EDUCATION AND RESEARCH IN POLAND

In Poland, the tradition of architectural education dates back to the seventeenth century, when the first Polish Department of Geodesy at the University of Krakow was launched. According to the foundation act, the school taught also in the field of military construction. In 1632, at the same University, the Department of Geometry and Fortification was established. Until the middle of the nineteenth century, most European architects studied in the student/master system, while no attending any classes at the universities. The most common method to achieve proficiency in the profession remained this practice.

In the late eighteenth and early nineteenth century in many European countries, non-compulsory professional examinations were introduced. They were intended mainly for those who applied for positions in civil services.

During this time, many technical schools that also educated architects emerged in Europe. The first was the École Polytechnique–the elite technical university in Paris, founded in 1794. [1]

At the beginning, the education system in these schools was based on courses covering topics related to different technical fields, from which students chose the most suitable.

In those days, engineering schools were strongly associated with military activities.

An important event in the history of architectural education was the creation of the Warsaw School for the Royal Engineers Corps in 1789. At the same time, a similar institution was opened in Vilnius. In both schools, architectural courses were introduced.

In the middle of the nineteenth century, departments of a specific teaching profile were defined within the organisational structure of the universities. Schools applied interim exams and compulsory preparation of diploma thesis.

In 1826, the occupation authorities established Preparatory School for the Polytechnic Institute in Warsaw. It included the Civil Engineering Division, which offered, among others, the architecture and geodesy courses. The dynamic development of the school, which aspired to transform itself into a higher technical university, was stopped by the outbreak of the November Uprising (1830).

In 1898, Tsar Nicholas II established the Warsaw Polytechnic Institute, where studies were conducted in the Russian language. At the Faculty of Engineering and Building, architecture was one of the two specializations offered at the level of a diploma.

In 1915, after the removal of Russian authorities from Poland, Polish intellectuals attempted to create a new Polish University and the Polytechnic in Warsaw. The initiative was supported by the Society of Higher Academic Courses and the Association of Technicians. [2]

Initially, they planned to launch the architectural department within the Faculty of Engineering and Construction. However, due to the determination of the Warsaw Architects' Circle, an independent Faculty of Architecture was formed among the first four departments of the newly established university.

At the beginning, the Dean and the Faculty Council members were titled professors only by social custom, because none of them was formally entitled. They received nominations later, after 1919 (when Poland gained independence) and even as late as 1921.

Extraordinary (associate) professors were the only people who could be appointed for a certain chair. Thus, the academic staff grouped around chairs profiled according to the interests of the professor. It consisted of the professors, deputy professors, lecturers (adjuncts) and assistants. As a rule, adjuncts (Latin adiunctus - included) were required to have a doctoral degree .

Habilitation and the associated docent' title was popularised in the nineteenth century in Germany, especially in medicine, because the rapid development of higher education resulted in the need to give more lectures. Giving the title of the professor to all individuals who gave lecturers required the expensive establishment of the new chairs. In Poland, until World War II the situation was the

same, so habilitation allowed those who didn't hold a chair to conduct lectures. The end result of habilitation was the title of associate professor.

A doctorate was treated as a higher academic degree (after lower: master degree). It didn't entitle one to conduct independent research, but it was a step on the way to habilitation and professorship.

The first act in independent Poland, the Academic Schools Act [3] stipulated that the right to give lectures was held by professors or docents who contributed to the development of theoretical or practical sciences. According to the Academic Schools Act from 1933 [4] academics were people who contributed to the development of science and - in artistic schools (faculties) - also artists with achievements in the field of creative arts.

University teaching staff included: honorary professors, professors, associate professors, assistant professors and teachers of specialised subjects. The promotion procedures for professors and associate professors included several steps in assessing their scientific achievements. In the early years of the Faculty of Architecture, professorial nominations were obtained by people with professional experience –which was treated as a sufficient basis for scientific activities.

Initially, the title of assistant professor allowed one to give lectures as a substitute for a professor. This privilege (venia legendi), was granted by the Faculty Council to persons with PhD or - exceptionally - to those who were particularly prominent scientific researchers.

In Poland after World War II, the law precisely defined how to obtain a doctoral degree and described the procedure of carrying out doctoral studies in higher education. Architecture was treated as a domain of engineering sciences and - in terms of procedures and requirements - doctorates in architecture were similar to other areas of science.

The need to adapt to the general rules of the procedure resulted in a preference forhistorical and theoretical works. There was no path for practicing architects to reach academic advancement based solely on professional achievements.

Under the current legal regulations, it is possible to obtain the PhD title through a doctoral thesis, which is the work of design, construction, technological or artistic achievement. In practice, the architectural projects are considered only as a supplement to the scientific output. This stems from a long tradition of research work at the Faculty of Architecture at the Warsaw University of Technology. There are no procedures for the evaluation of possible practical achievements that could be the basis for a doctoral degree..

TRADITIONAL PROFILE OF THE DOCTORAL RESEARCH AT THE FACULTY OF ARCHITECTURE WARSAW UNIVERSITY OF TECHNOLOGY

To get a view on a scientific profile developed at the Faculty of Architecture WUT through the years, we analysed the subjects of completed doctoral dissertations.

The examination embraced more than two hundred (220) dissertations prepared after World War II.

They were prepared over a period of approximately 55 years (1960-2015) under the supervision of 94 research tutors and were related to studies on the problems of: architecture, urban planning, conservation, construction and structures, history of architecture and urban planning, rural settlements development, drawing and media.

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The collected works were classified into 7 focal thematic categories, based on analysis of the content and research results. On this basis, we gained the following information concerning the studied problems:

– research on architecture - 77 doctoral dissertations;

– urban planning, structure of the cities, regional planning - 72 doctoral dissertations;

– history of architecture and urban planning, monographs of objects and people - 42 doctoral dissertations;

– rural settlements development - 10 doctoral dissertations;

– issues of structural design and construction - 10 doctoral dissertations;

– media and processes in architecture, graphic communication - 5 doctoral dissertations;

– conservation of architectural objects and urban structures - 4 doctoral dissertations;

Doctorates in architecture are related to, among others, issues of functional and utilitarian features of objects for various purposes, development of architect's workshop, the use of different materials and architectural detail, as well as problems on the border of theory and architectural criticism. They refer both to constructed buildings and concepts or ideas.

In studies regarding urban planning, there appear problems of the structure of cities and urban interiors, composition and spatial relationships, urban design practice and large scale planning.

Research in the field of architectural history has a long and established tradition at the FA a WUT. Chairs of the History of Architecture and Polish Architecture have existed since the beginning of the School in 1915 and consistently realized a program of research on historical buildings and monographs of their authors. [5]

Research on rural development concerns spatial structures outside the city, functional aspects of agricultural buildings and production, and also studies environmental contexts.

Doctorates on the issues of building and construction were placed in a separate category (beyond architecture) due to the strong technical and technological profiling.

An interesting group created dissertations on issues of visual communication, the development of visual graphics and other forms of media presenting architectural works. In this category, we can also place research related to new media and the organisation of information.

A separate category was created for research on the maintenance and modernisation of the architecture. Doctorates in this group are related to concepts and techniques of therevitalisation of objects and arrangements of different scale.

When we analyse the subjects of doctoral research at FA WUT, it is evident that the majority are theoretical works, only partially referring to the real practice in architecture.

It is worth noting, that only two from the more than 200 analysed research works, were directly related to the real construction processes and can be treated as the promotion of practical achievements in architecture.

In 1964 Stanisław Bieńkuński defended doctorate dissertation titled:

The functional problems of the hotel design based on the example of the Grand Hotel in Warsaw. Doctoral dissertation based on a realised architectural work (Problemy funkcjonalne hotelu na

przykładzie Grand Hotelu w Warszawie. Rozprawa doktorska oparta na zrealizowanym dziele architektonicznym).

The research was prepared under the supervision of Professor Piotr Biegański, who was at that time a Head of the Chair of History of Architecture and Art. What is interesting is that the Professor's individual research preference was related mainly to the issues of the history and conservation.

In 1978 Maciej Gintowt elaborated a doctoral thesis about:

The impact of the multifunctional program of entertainment and sports halls on architectural shaping - based on the design and realisation of the sports hall in Katowice (Wpływ wielofunkcyjnego programu hal widowiskowo-sportowych na kształtowanie architektoniczne - w oparciu o project realizację hali widowiskowo-sportowej w Katowicach).

In cooperation with the same scientific advisor (StanisławTobolczyk), Bohdan Gniewiewski in 1982 prepared the dissertation:

Shaping the spatial layout of the facility zone in public buildings during the design process - based on selected own projects and realisations (Kształtowanie układu przestrzennego strefy zaplecza obiektów użyteczności publicznej w procesie projektowania – na podstawie wybranych projektów i realizacji własnych).

The remaining of the analysed works classified as doctorates in architecture embraced different issues related (in general) to the function and aesthetics of building design and were based on extensive research environment, involving both the Polish and foreign context.

The traditional profile of the doctoral studies at FA WUT, can be described through the characteristic of the contents of completed research works. From this analysis emerges a picture of a multidisciplinary field, in which the essential substance is architecture and urban planning (149 from 220 theses). Considerable attention is traditionally directed to historical themes. Other areas of research interest include no more than 15% of the total work.

PHDS IN ARCHITECTURE ACROSS EUROPE

The doctorate in the field of architecture was developed widely in European schools from the 1970s. At that time, different training programs for graduates were launched. They were organised to enable the expansion of research in the field of architecture.

As a result of the intense debate on architectural doctorates initiated before 2000 (conferences, e.g.: Doctorates in Design - Ohio 1999, Research by Design - Delft 2000, Research and Architecture - Paris 2000, Conference on Research and Design - Delft 2004, Knowing by Design - Brussels 2013), we can identify two main areas for development:

– to build structures such as research schools, in order to stimulate an effective environment for studies and create high quality standard for supervision and support;
– to initiate more taught courses and training components to broaden the perspectives and profile of doctoral candidates, not denying the strong role of the mentor.

The practice in architectural research can be discussed through the characteristic of the research programmes led by exemplary European architectural schools such as those located in Belgium, Denmark, France and Italy.

Belgium, KU Leuven

The university was founded in 1425. The education of architecture began here in the mid-eighties of the nineteenth century and evolved into a studies granted by a title of engineer architect in 1929. Before 1981, when the department of architecture, urban design and planning (ASRO) was created, the education of architecture was organised within the faculty of construction. The opening of a new department was also the beginning for 4 scientific groups elaborating mainly on research projects funded outside the university. There are three main academic standards constituting the criteria for the evaluation of doctoral works: formal (readability of the text, consistency of the structure and quality of the presentation); contents (sharpness of problem definition, originality of the work, competence and depth of the research); impact of the work (number and quality of publications, proofs of the value of the work).

Denmark, Aarhus School of Architecture

The Aarhus School of Architecture was established in 1965. The research education programme was introduced in 1988. The progress of doctoral teaching can be described in four phases:

The first step [6] (1988-1994) - characterised by the hesitation whether the architect is more an academic researcher, or a professional with the strong relation to the practice;

- a more structured approach (1994-1998) - when the research-training programme was developed and defined;
- consolidation (1999-2012) - in which designing and researching became integrated as a direction of scientific activity, embracing different positions, such as: traditional research, research by design and artistic research;
- a new direction - based on the courses focused on developing research skills and the critical attitude created among the PhD students.

France, School of Architecture, Lyon

The doctorate of architecture in France is a very recent conception. It was established as an element of academic structure in 2005, when the studies of architecture in France were reformed into a DMI system (Doctorate, Master, License). On this occasion the disciplineof architecture (its theories and practices) was placed in the section (18): ART, among, inter alia: decorative and plastic arts, performing arts, sciences of art.

In the school in Lyon, the doctorate is not only a thesis, it embraces two main components: the dissertation (product of work, evaluated by a jury) and the doctoral formation (the hours of compulsory training included into a curriculum vitae of a student as an individually created research profile).

Italy, La Sapienza, Rome

The history of the PhD programme in Italy begins in 1980. Traditionally, the way to get a teaching position at an Italian University is led through the „Libera docenza" - the professorship accreditation procedure, during which the candidate had to submit research publications for assessment. Then the title was replaced by „Dottore di Ricerca"(Doctor of Research).

In the field of architecture, the PhD programme offered courses in nine different disciplinary areas: Architectural Design, Representation, Planning, History, Restoration, Technology, Construction, Product Design and Design Economics.

The Italian doctoral education is currently going through a deep reorganization. The main goal of the reform is to improve the quality of the PhD programmes and to create more formalised system for this 3rd level of academic education..

CONCLUSION

In architecture, as in other fields, research is about new knowledge: to analyse the existent in order to reveal something innovative and original.

The dynamic changes happening now in the architectural profession have a serious impact on the innovative thinking in education and research. Universities are discussing the range and directions of reforms concerning doctoral education policy.

A very short review of the procedures and standards taken in different schools in Europe reveals only the general questions in the discussion on the doctoral education in architecture.

The changes, that occur in architectural education and research nowadays, are related to the current dynamic transformation of the profession itself. Idea to reform doctoral strategies, structures and processes begins with the need to make a more effective contribution to architectural advancement and innovation.

Furthermore, we observe a very strong tendency to negate the tradition of the doctorate as the production of a piece of individual research under the supervision of one professor, with very little emphasis on taught courses. [7]

The discussion about the research in architecture still focuses on the relationship between the theory and practice.

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DESIGN THINKING IN URBAN DESIGN EDUCATION

Sustainable urban design fosters the best possible development of a place, realizing its full potential. In the search for optimal solutions, the methodology of Design Thinking becomes useful. It describes a human-centered innovation process that emphasizes observation, empathy, collaboration, as well as prototyping and testing design solutions at an early stage of the design process. The article describes the authors experiences from urban design education, focusing on the question of "prototyping and testing urban space". The methods range from sketches, models, visualizations and scenarios to role-playing and temporary interventions.

CURRENT CHALLENGES OF URBAN DESIGN EDUCATION (IN POLAND)

Cities in Poland come across several challenges, one of them being the crisis of urban space. It can be addressed with the words of Jeff Speck (who comments on the situation in the United States):

> *"What characterizes the discussion on cities these days is not a wrong-headedness or a luck of awareness about what needs to be done, but rather a complete disconnect between the awareness and the actions of those responsible for the physical form of our communities."* [1]

The so-called deregulation of the profession of the urban planner in Poland in 2014 raised reflections not only about the professional practice, but also about the perspectives of education for prospective urbanists. A positive change will require improving policies, and the right decisions at a local level, as well as well trained professionals. Urban design education is an important challenge not for architects and planners, but also to instill general knowledge and an understanding of urbanism among future designers, other related professionals, as well as the general public and decision makers.

Sustainable urban design aims at envisioning a best possible future for a place, in different scales - from a district, through the neighborhood, to a place and a plot of land. Applying the principles of a compact and multifunctional city can promise optimal results with synergic effects for space, society, economy and environment. In search of optimal spatial solutions, there are several factors to be taken into consideration, and various stakeholders take interest in the process [2]. The meaning of public participation has recently been emphasized in processes such as *placemaking* or *charette* processes.

Education of urban designers and planners requires an understanding of complex, interdisciplinary urban issues and mechanisms of development, as well as a range of soft capabilities such as team work, negotiating and continuous learning. The popular notion of PBL (Problem/Project Based Learning) advocates for students working in teams and undertaking complex design challenges in an environment similar to real professional life.

The education process is aimed at gaining knowledge, competencies and skills, which will be useful in practice. Gordon Lindsay [3] discusses three necessary elements of optimal learning experience as:

– Immersion –students are immersed in a project whose "scope and complexity is greater than the capacity of the individual student". In other words, the projects are too complex for one student to be able to complete them on their own.
– Exemplarity –all work and processes related to the project is a good example of what is found in their profession.
– Social contract – while being accountable for their own learning, they also share responsibility for shared learning. Documenting sharing knowledge and helping others develop are two aims that are commonly stressed and assessed.

URBAN DESIGN THINKING

Literally design thinking stands for design-specific cognitive activities that designers apply during the process of designing. The term Design Thinking was popularized by Tim Brown [4]. Brown advocates a thorough understanding of the problem and needs before producing solutions, and describes five basic steps in the process. How are they related to urban design?

Empathizing means understanding the needs of the users of a given space. It implies getting to know all the complex layers of local conditions: connectivity, ecological issues and surrounding build form, to a broad scope of local heritage. This attitude prevents from failed "designer solutions". *Empathizing* seems similar to the method of *placemaking* [5] - however, instead of prioritizing participation ("*community is the expert*") is uses participatory processes as one of many tools to identify local potential, which shall be further processed by the designer.

Defining the problem is basically synthesizing and valuing the gathered information. It may also include focusing on key aspects of the challenge, and either acknowledging the design brief (such as the competition rules) or reframing the design task.

Ideating is the brainstorming phase of producing several potential solutions; well known to any designers. What is important here is not necessarily getting used to early ideas, and allowing for constant improvements.

Prototyping in urban design is an interesting issue on its own. It can range from producing comprehensive sketchy designs, to complex models. It can mean a design competition, provided its well prepared and "asks the right questions". One of the methods for urban design is examining alternative scenarios in which one of the project concerns took absolute precedence. The recent growth in availability of virtual and augmented reality technologies also brings about several ways of prototyping architecture and urban space in computer-generated simulations [6]

Another use of **prototyping urban space** is real live, makeshift interventions in places. This has been done by means such as temporary arrangement of public space, artistic installations, "stage design", events, the use of new media, etc. An eminent example was the New York Times Square

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redevelopment facilitated by Gehl Architects. Proposals of reducing traffic and pedestrianizing spaces were *prototyped on site* by reducing the space for cars by paint, tape or rolling traffic barrels, and watching how *people just appeared and poured into the space created*.

Finally, **testing** a design solution can range from confronting design solutions in a workshop or design competition, to real life evaluating of realized buildings and spaces. In any case we may agree, that some critical reflections of the outcomes of urban design process is crucial for improving the process and refining the solutions.

DESIGN THINKING AND URBAN DESIGN TRAINING

Teaching at the Architecture Faculty at Silesian University has shown positive results of combining design education with elements of qualitative research and the methodology of design thinking in order to generate solid, yet innovative student work [7], [8]. Experiences have shown the success of extending educational forms beyond traditional classes, and dealing with realistic subjects in the form of workshops, competitions, integrated projects, etc. The education in urban design and planning focuses on understanding complex, interdisciplinary urban issues and mechanisms of development; as well as soft capabilities such as teamwork, negotiating and continuous learning. On the entry levels of education, it is important to teach not just design basics, but to give some experience and understanding of the complex, interdisciplinary mechanisms that form urban space. For more advanced students, working in teams and undertaking design challenges, in an environment similar to real professional life, gives best results.

In general, in order to evoke students' engagement and interest them in urbanism, it seems essential to provide meaningful and engaging educational experiences, as mentioned above. Referring to the theoretical framework described above, for a few years now the author has been experimenting in teaching urban design with the insights from *Problem Based Learning* and *Design Thinking*. Three of these experiences will be described below.

Placemaking and Design Thinking - Real Live Prototyping

Placemaking and Design Thinking is an elective seminar in the 3rd year of undergraduate studies. Its purpose is to give a hands-on experience and introduction to urbanism, emphasizing the site's potential analysis, user needs and prototyping spatial solutions. Students have worked in teams of three to five on selected places in Gliwice, within walking distance from the university, such as: public spaces, bus stops or frontages of public buildings. The process was organized along the principles of *Design Thinking*:

- Getting to know the place and observing its functioning, using an adopted version of the Place Game by Project for Public Spaces [5], talking to people on site about their experiences and expectations, as well as a photo or video site analysis;
- Defining the key issues crucial for the site - both problems and potential;
- Generating various ideas to address the defined issue. The teams proposed improvements, ranging from short-term low-cost "urban acupuncture", to long term impacts;
- Prototyping - producing sketches illustrating the ideas. After discussing them among the group and teacher, the students went back on site to discuss the proposals with people on site;
- Testing the solution. Students were encouraged to produce a real-life, low-cost working prototype on-site, to illustrate the desired scenarios. The means usually included performance, cardboard, tapes, colour chalk, temporary urban furniture, music, food, etc.

Students' proposals were often fresh and innovative. Some examples were an an ad-hoc art gallery and library on a busy bus-stop, an info point promoting local culture on a bus stop near the

museum, large-scale games to enliven public piazzas, cardboard cut silhouettes encouraging to express opinion, or organizing a picnic in the frontage of a new university building, where there is no place to eat, etc.

Some actions also involved collaboration with social media. One of the teams worked on an abandoned part of a public square, near a hub bus stop. Having observed that the place needs activation, they set up an installation made of colorful balloons with catchy captions and compliments. The installation was observed by a local magazine and their Facebook page and within the day it received 1500 "likes" and several positive comments. The results of both the analyses and the evaluated events gave the students a simplified overview how their ideas interact with real people in the city.

Role Playing Stakeholders and Conflicts

An **Urban regeneration workshop** was a part of the EU funded course *Education of specialists in post-mining sites management in the Polish-Czech border area*. The objective was to make specialists from various fields sensitive to spatial aspects of revitalization, to facilitate future interdisciplinary cooperation. It focused on exposing specific aspects of revitalization by a simulation with reference to *Design Thinking*. The workshops were based on the case study of a former coal mine in Siemianowice Śląskie, which had a lot of features typical for brownfields in Silesia. The surrounding functions, as well as stakeholder desires constituted complex conditions for regeneration.

Empathizing meant understanding the desires of the potential stakeholders and getting to know complex layers of local conditions. *Defining* the problem was based on synthesizing the gathered information. *Ideating* is the brainstorming phase of producing a broad range of possible solutions and stakeholder needs. Role-playing was used in the generation of developmental scenarios, in which course participants assumed the point of view of different stakeholders, such as heritage conservator, roads administration, ecologists, local museum and a range of housing and commercial real estate developers. The selection of roles secured that the needs and objectives of particular stakeholders were different and sometimes intentionally exclusive, causing conflicting interests and evoking discussions and negotiations. This led to *prototyping* a variety of urban solutions; but most of all, letting the students experience a simulation of the multi-stakeholder process. Finally, the work was *tested* in a presentation, discussion and comparison of solutions by various teams. An example of the result was a proposal for an attractive mixed-use site for users and neighbouring inhabitants: new business and industry, a multi-trade company, a discotheque and retail; as well as adapting post-industrial buildings. The area site by the park was allotted to housing and recreation, with green areas cut through the settlements, connecting to the existing housing estates.

Within the exercise, students became aware of the relations among the functions, and of the difficulty in accommodating so many investments at one site. The group work resulted in diverse approaches – some sought compromise, others rejected some functions, whereas some proposed a creative combination of the functions and even presented their own, new ideas. Such formulation of the course objectives provoked the participants to the active acceptance of the roles and involvement in the design process. The effects of their work was "something tangible" - a concept of site management. The course was also an opportunity for the confrontation of the architectural and urban design teaching practice with the perception of non-architects - which proved a successful and meaningful experience for the students, who acknowledged and appreciated the practical hands-on experience [9].

AN URBAN DESIGN STUDIO - FUTURE SCENARIOS FOR A MULTI-FUNCTIONAL PACE

An **Urban design studio** dealt with a subject commissioned by the city of Katowice within an intra-university workshop - a sensitive and underdeveloped area around the Silesian Library - neighboring a housing estate, university building and commercial spaces. A team of eight students worked on the project. Empathizing included the site analyses, supplemented by questionnaires with people living and working in the area. The findings showed several drawback of the site, including spatial chaos, lack of functional spaces for people and illegible spatial layout. It also showed a lack - but also a potential - for seeking synergies between different neighboring functions and thus various user groups. Ideating led to identifying key users and functions, which were later developed into four alternative *maximal scenarios*: a library district and knowledge hub, a space most useful and friendly for the inhabitants, commercial space for investors, and finally - a space for students of local university and music academy. This allowed the extrapolation of the sites' potential in scenarios with different spatial layout, open space and built form ratio and functional arrangement. It later
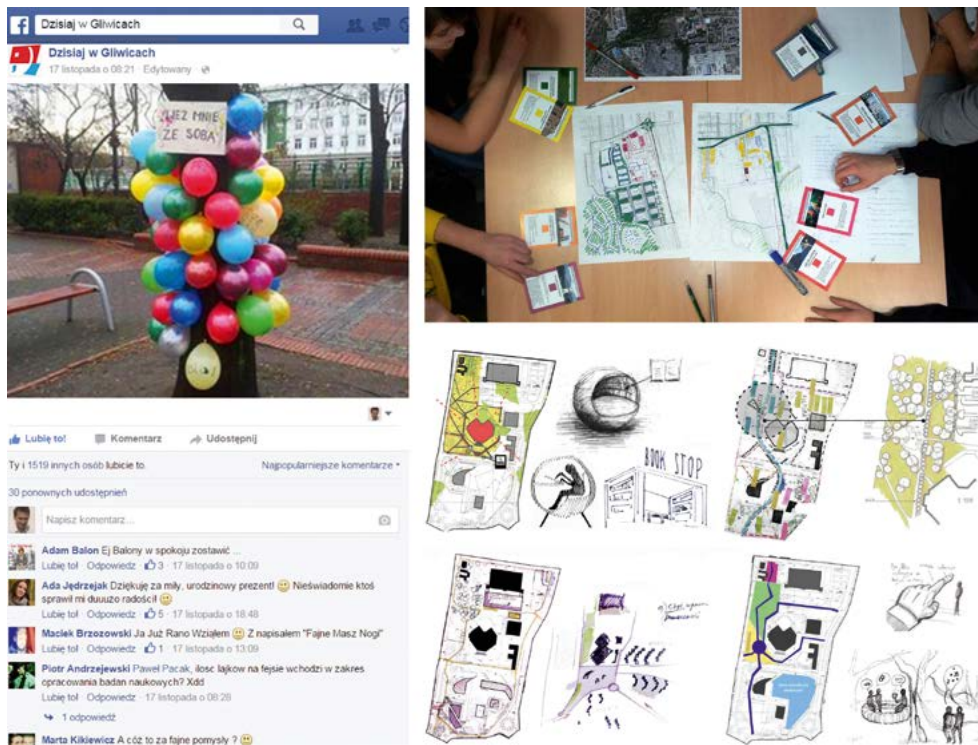
Fig. 1. Snapshots from the urban design courses – Facebook Board with 1500 likes for a students intervention in public space; regeneration stakeholders role playing exercise; preliminary alternative "maximal scenarios" for the area near the Silesian Library

Source: Compilation of photos by the author (2014-2015)

allowed the creation of a synergic conceptual design, envisioning a hub area for all. Tested against plain design approaches, the concept won the workshop for best use of the sites' potential. The students appreciated that this process was successful in showing them the complexity of urban design and raised further interest for urbanism.

CONCLUSIONS

Sustainable urban design aims at envisioning the development of a given place to maximize utility and benefits for the community. Urbanists usually assume that professional sense can promise optimal results. However, seeking the unique spatial sense of place and synergic effects for space, society, various stakeholders, local economy etc. may need more innovative solutions for optimal utilizing of local potential. Urban design is already influenced by the placemaking processes, which emphasizes the meaning of public participation. *Urban design thinking,* as described in this article, can be seen as a similar, yet broader approach to a *human centered process of seeking innovation.*

Applying the insights of *design thinking* to urban design training is worth consideration, as it may broaden the thought framework and techniques for the future urbanists, who will influence how the *spaces around us* are shaped.

The strengths of the applied method includes immersing students in a process similar to real professional challenges, and providing a structured way towards finding valuable solutions. It also includes elements of public participation and interaction, which backs the design and gives an insight into working with the community. This method of work has proven increased engagement and enthusiasm in students work, as compared with ordinary classes. A limitation on the other hand is the necessity to work in real life environment (streets, squares), which may bring organizational problems, and risks such as bad weather or some challenges in interacting with the people in the street and explaining the projects.

Urban design thinking, as described in this article, is of course nothing entirely new - the *human centered process of seeking innovation* has much in common with the general notion of human-centered design. Applied to urban space it is similar to e.g. *placemaking*. However, the clear structuring and simplifying of the process seems particularly useful for education. The described search for meaningful educational experiences recall the psychological theory *flow* [10]. It describes the conditions for optimal experience and efficient activity, which simultaneously gives satisfaction (in various aspects of life, including work and education). Csíkszentmihályi argues, that optimal effects and satisfaction results from performing realistic, concrete tasks, which have right defined goals, where feedback is available, and which give the possibility of using possessed skills. It seems that this principles applied to urban design education can result in higher quality, greater efficiency, increased motivation and other positive outcomes of the architects' education process.

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1:1 – THE MODERN PROTOTYPE, AS A UNIQUE MODEL OF THE BUILDING

1:1 - The modern prototype, as a unique model of the building is optional subject at secondary level studies of the Faculty of Architecture Cracow University of Technology. Conducted in the Laboratory of Architecture Social Services - A24, as a complementary to the design of public buildings, since the academic year 2014/2015. Remarks and observations based on experiences and examples of the first year implementation of this optional subject at the Faculty of Architecture Cracow University of Technology is the main scope of this article.

THE SCOPE OF ISSUES

The purpose of this issue is to show the process of how buildings arise as a result of prototyping. Our goal was to fill a knowledge gap in the field of architectural design as well in theory as in the practice. In order to that we focused our attention in the field involving on the creation of prototypes unique concept of building models in scale 1:1, using advanced methods and tools for modeling CAD and CAM production. In our works we wanted to emphasize that interdisciplinary teamwork is the most important part of the design process. We took the opportunity to stress the strategic importance of conceptual role of architect in design process.

FORM OF COMMUNICATION.

We conducted seminars basing on the selected method of prototyping such as: cogging model, hygroscopic model, 3D printing model, self-assemble model, and biological model.

Exercises examples and research which were presented during seminars were prepared in leading academic centers, such as ETH Zurich in Europe and MIT and Harvard University in USA.

Cogging model

It is an idea that is based on a modern transformation of traditional wooden cogging joints that transforms into a multisurface smooth wooden structure where each cogging joint is unique. Such construction is possible due to advanced CAD CAM technology and robot prototyping. Using robots allows one to produce precisely unique joints, which in consequence creates flexible forms of buildings. For more information please refer to Landesgartenschau Exhibition Hall, Stuttgart, Achim Menges, Tobias Schwinn, Oliver David Krieg.

Hygroscopic Model

It is an idea that base on observations of nature and how materials interact with humidity. In order to better understand this method we decided to take a closer look at the traditional, Polish folk object that was once used to predict the weather. Figures of women and man located in a small wooden hood, connected to each other by hair of horse`s tail moves in different directions depending on level of air humidity. Other example of how this method works is the Meteorosensitive Pavilion. In this case, the cone reacts to humidity and creates a self-moving structure of the wall. Deep study and research of wooden multisurface material and geometry combing with CAD and CAM technology allowed the creation of a pavilion in Orleans. Cogging joints was also implemented into this pavilion but the main idea of this structure was to improve environmental conditions. For further information please refer to the Meteorosensitive Pavilion 2013, Achim Menges, Olivier David Krieg, Steffen Reichert.

3D Printing Model

It is an idea that base on printing a building using 3D printer. At the beginning it looks very simple, however, when it comes to practice it becomes much difficutl. First of all, there is a problem of scale. It is easy to print part of the building, but it is hard to do it as a whole complex solid. The Digital Grotesque exercise performed at ETH Zurich show us problems and borders of implementation 3D printing into building creation. During this process limit of printers is as follows: 4.0 x 2.0 x 1.0 m, resolution 0.13 mm thick. In this case, design process takes 1 year, printing process 1 month, assembly process 1 day. Finally, we have first printed entirely a room 3.2 m high x 1.2 m wide x 5 m bright. For more information, please refer to Digital Grotesque. ETH Zurich. Michael Hanemeyer, Benjamin Dillenburger.

4 Self-assemble Model

it is a process by which disordered parts build an order structure through only local interaction. The process builds on multimaterial 3-D printing using a special material that can change its shape over time—and the author calls this process 'the fourth dimension'. This intelligent-smart printed material can configure and reconfigure following environment conditions. The role of architect using this idea is different today. It focuses on process of creation of material that can be changed into programmed direction, instead of creating building from readymade materials. For further information, please refer to Skylar Tibbits, Self-Assembly Lab MIT.

5 Biological Model

it is a concept that uses animals to create a building. The idea is old because animals were widely used during the history of architecture. However, the idea that was implemented in design of Silk Pavilion in the research supervised by Neri Oxman used Silkworm to create a pavilion is completely fresh and based on sophisticated research and exercise. CAD and CAM tools where used in process of creation to form complex geometric frame, which was later filled by the animals following people idea.For more information, please refer to Silk Pavilion, Neri Oxman, MIT media LAB.

INTERACTION AND IMPLEMENTATION

At the Laboratory of Architecture Social Services - A24, during the fall semester 2014/2015 Master program students of Cracow University of Technology – CUT - were asked to prepare an architectural design called "Adam Mickiewicz Institute in Beirut". This multipurpose building complex allowed various of possibilities for implementation of prototyping methods listed from above or even to present a new one. Only several projects showed new methods of

prototyping without the implementation of design. The final result was shown in a 30-second CD multimedia presentation that contains the implementation of one of the presented methods of prototyping to selected project within the framework of compulsory classes. The other, students prepared a presentation of a new method of prototyping that was not presented before. The next step was the discussion of the scope in architectural design and potential impact of the prototyping to methods of design, forms of the buildings and methods of construction. In this context, the role of the modern architect in this process of design was discussed. What was crucial in this process was the idea of creating a concept more than just executing it. This experience thought lead to a new approach to design and allow solving design problems in a creative way. As a result students were prepared for creative prototyping of the buildings. Below are some examples of prototyping ideas applied in student designs. We distinguished three groups:

– Application of earlier presented methods,
– New methods and implementation,
– New methods without implementation.

Application of the Earlier Presented Methods

As a result of given task – to design Adam Mickiewicz Institute in Beirut using new prototyping methods we managed to obtain number of interesting examples/works. One of them was presented by Mikołaj Kasprzyk who transformed idea from wooden Meteorosensitive Pavilion into movable bimetal steel curtain wall. Another student Maciej Kołak decided for 3D printed elevation that was later used in his design. Their ideas combined with new methods were more than just satisfying.

New methods and Implementation

Building Bits is a 3D printing structure presented by Anna Szudy. It was implemented in her Beirut design as an internal division green wall. Shadow and Sun is the base for prototyping elevation idea presented by Małgorzata Śmietana used to analyze the Beirut Mar Mikhail district and creation of this base external wooden steel frame system with different density to protect people inside the building.

New Methods without Implementation

In the TERMS idea presented by Bogna Gramatyka it is impossible to identify the command center in the termite colony. Somehow, termites share all the necessary information via chemical signals. Something very similar was made during a 4-year experiment by scientists working at Harvard University. Inspired by the behavior of termites, the Harvard research team designed the system TERMS, forming small inexpensive robots and software that allows them to build something unattended.

Salt Crystallization by Mateusz Andres used crystalized salt that creates a structure on an earlier prepared spanned net between frames. This idea allows one to create new forms of organic elevation and allows one to use the natural process of salt crystallization.

CONCLUSIONS

Prototyping as a process of design and implementation on construction site is still in a preliminary stage. However, the direct implementation of 3D computer model into real building is possible. Experiments show that in final stage on construction site robots are more efficient than printers. Robots are better because they have no scale limits like printers have. Robots are more expensive than

printers and for this reason we are looking for different strategies on how to use it in a more efficient way. One of the most popular ideas is to divide a problem and create a part for assembly a complex form. The creation of printable intelligent materials is an interesting and promising direction but scale limits are the same like described above. As a result of the experiments, we can observe that prototyping methods combines with traditional ones in different stages of the design and building process. Following this remark, we can note that today only a part of the building is prototyped. Looking for a relation between building and natural environmental processes is a very vital direction nowadays. Tools and software as well as materials used during prototyping process are different but still what plays the most important role is people's imagination. That is why we shall put attention to education process in order to obtain creative thinking, that is the basis of technological knowledge, which constantly changes. Conducting study exercises that involves designing of complex buildings in real conditions seems to be more interesting than doing it on experimental pavilions, because it helps to come closer to solving real design problems.

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TRAFFIC CALMING AS AN EDUCATIONAL QUESTION

The paper presents the issue of traffic calming in the training of professionals responsible for shaping space. The scientific and teaching experiences of the authors in research at universities in fields related to architecture, urban planning, spatial planning and constructions indicate that the problem of traffic calming can be one of the most important questions in courses related to engineering transportation. This is due to very strong relationships between widely understood issues in traffic calming with transport engineering and land development. The main and highly preferred aspects of the teaching is its interdisciplinary nature and relationship with sustainable development issues. The results of selected diploma theses of students at the I and II degrees and in postgraduate studies are also presented.

INTRODUCTION

Traffic calming according to authors of "Gambit" - The Integrated Programme for Safety Improvement in Poland can be defined "as the solution of an organizational nature, construction and legal disturbance to reduce car traffic by any restrictions imposed on transportation services and change the selected areas" [1]. Traffic calming solutions are as a lens, focused on the issues of traffic and parking motor vehicles, pedestrians and cyclists, and mutual conditions of transportation systems, land transport services, development of the forms of public spaces and social aspects. In addition, attention should be drawn on a fact that solutions of traffic calming fit very well into the concept of sustainable development. Their teaching is primarily designed to provide students with knowledge concerning the development of proper transportation solutions in spatial planning, taking into account the severe conditions in many areas both the environment and the social and economic.

The method of research used in this paper is based on the analysis of programs consisted of higher studies and theses, studies and projects made by the students of specialisations in fields of architecture, spatial planning, civil engineering and transport, on the first and second degree and post-graduate studies of urban planning and spatial economy. Some of the most characteristic studies take into account the diverse possibilities of application of ideas of traffic calming in urban areas, as well as the formulation of final conclusions.

THE EDUCATION OF ARCHITECTS, URBAN PLANNERS, CIVIL AND TRANSPORTATION ENGINEERS IN THE FIELD OF TRAFFIC CALMING

Knowledge of the interaction between the transportation system of the area and spatial planning at different scales, including city and metropolitan scale, district or team building, and scales of most detailed solutions street or square is very important. However, different aims and methods should be applied to training in each of the above groups of students.

According to the authors, the broadest range of knowledge concerning traffic calming has to be presented to students of architecture and urban planning in such courses as: "Transport in spatial planning, Sustainability transport, Traffic calming and transportation detail" as well as "Infrastructure for active mobility" - given at the Faculty of Civil Engineering, Architecture and Environmental Engineering of Lodz University of Technology, at Faculty of Architecture of Warsaw University of Technology, also Transportation Engineering at the mentioned faculty of Lodz University of Technology, because they will stay in the future decision makers in matters of a nature of the development in urban areas.

For students attending these courses, the educational processes of transportation engineering are very important feature in knowledge of transportation solutions in public spaces and technology, same as is its application in different spatial structures. A very important aspect of teaching subjects is to visualize and to emphasis to students the messages about necessities from the standpoint of the workshop architect and urban planner. Among other things, they must be able to communicate with engineers of roads and streets, and work together to create a better picture of land use planning, knowledge of the issues, traffic calming solutions, and other issues that could help them to significantly improve in the future. For students of building and road engineering courses: "Transportation Engineering" and "Design of roads and streets" at the Lodz University of Technology the technical aspects and the road – traffic conditions are the most important. Therefore, according to the authors,   other problems such as: urban, social, environmental, including spatial relationships thread transportation infrastructure solutions to various forms of zoning - usually neglected - in education of road engineers should also have their rightful place. These capabilities give education in the field of traffic calming .

However, according to the authors, the future engineers, regardless of specialty, should have an education in the humanities. Most of the courses taught on the faculties beyond architecture and spatial planning, are oriented mainly on technical issues – the structural and social thread in them is inherently ignored or treated very rudimentarily. Education in the area of traffic calming indicates the need for a strong social mainstream in solving technical issues.

In summary, after hearing lectures and study exercises, design student should have the conviction that the same technical solution, taking into account the concept of traffic calming in different spatial scales and using various forms of functional - technical, can be solved better with a larger benefit for its potential users, improving safety traffic and aesthetics and landscape in the area, which would be applied

For future transportation engineers (the course "Land transport infrastructure" at the Technical University of Lodz) teaching in the field of traffic calming should apply to both the infrastructure and spatial, as well as environmental and social aspects. Education concerning transport is primarily turned towards gaining knowledge of the applicable technical solutions: mechanical, electrical and computer. Relatively few are in the curriculum places for the issues of transport infrastructure, the relationship between the transport system, spatial planning and the environment and shaping a sense of aesthetics for the humanization of transport systems. These gaps can significantly filled by introducing traffic calming issues to the syllabus.

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Still other learning objectives and forms of education should be and are included in the program of the course "Transportation" post-graduate studies in urban and spatial planning at the Faculty of Architecture at Warsaw University of Technology. Regarding to these forms of education, due to the diversity of education of the participants seem to target the most important information about mutual interactions between transport systems, land use, the natural environment and society. Education in the field of traffic calming is particularly important for groups of employees in government offices in local and special administration, because these groups of people make decisions about shaped public spaces and transportation systems. Therefore it is necessary that these people got to know the proper ways of solving problems in the areas of transport services, taking into account the different methods of improving road safety, aesthetics and humanization of urban space and the natural environment.

Similar objectives, methods and content of education, according to the authors, should be taken in relation to spatial economy students (lectures and diploma theses on the course of "Transport in spatial planning" in The Spatial Economy Studies at Warsaw University of Life Sciences during the 1999 ÷ 2008). Taking into account the problems of traffic calming in the education of this group of students in the field of transport in the spatial planning should bear in mind that it is equally important aspects of traffic calming on a scale of towns and cities, go through the village, as well as scale of solution for architectural detail.

Graduates of this field of study, after graduation will be called on for planning and solutions – often design in the field of spatial planning. Knowledge of traffic calming solutions in different spatial scales is essential for making the right decisions at work. Differences in the education of students spatial and postgraduate this direction are small. Lecturer can choose the proper forms and methods of teaching for particular group.

SOME ASPECTS OF TRAFFIC CALMING IN SELECTED EXAMPLES OF GRADUATE WORK, STUDY AND DESIGN

The examples of some completed graduate work on issues concerning traffic calming in towns, or in which the aspect of traffic calming is an integral part of shaping the urban space or transport system are presented below.

Traffic calming zone in the centre of a big city is a subject of master's diploma thesis of Z. Walczak [2]. This study is concerning a concept of the transportation service in downtown of Lodz and transforming the central area into traffic calming zone. It ought to be an essential element of the development of transportation services and public space. In the diagnostic, he showed that downtown Lodz in 2005, operated one of the fundamental models of traffic calming in central zone [3], which are models SCAFT (Stadsbyggnad, Chalmers, Arbetsgruppen för Trafiksäkerhet) [4] elaborated in breakthrough sixties and seventies years of XX century widely regarded as the basis for developing a transportation service in the central areas of cities. In 2005, the scheme of transportation service in centre of Lodz was really similar to model SCAFT - a system of one-way streets within the central area.

Priority for pedestrian and bicycle traffic in form of pedestrian - cycling zone accessible only for cars to commute to the property was then carried along Piotrkowska Street. Support for public transport was carried through the streets collecting parallel to the Piotrkowska streets and limiting downtown area. Walczak recommended the extension of this solution in residential areas for the whole downtown area also located south of Pilsudski Av. It should be noted that the proposals of Walczak on traffic calming zones were developed in the Update Study Transportation System of

Lodz [5] and a new edition - 2015 of the Study of Conditions and Directions of Urban development of Lodz [6].

Similar solutions regarding the advisability of forming zones of traffic calming in the city of the historic urban layout were proposed by a study post-graduate thesis in downtown Radom [7]. The authors indicated that this is a desirable direction for development of public spaces and transport services and improve traffic safety in the inner city. It should be noted that proposed the idea in the downtown of Radom has been in implementation for several years.

Zones of traffic calming in the Polish medium - sized towns are presented in engineering thesis of J. Lopaciuk "Traffic calming zones in Chelm Lubelski" [8], that is an example of the determination of the conditions and opportunities for development zones of traffic calming in this type of cities. The author on the background of a detailed diagnosis of conditions functional - spatial and transport shows possibilities of development traffic calming zones with particular emphasis on residential areas. For one of the areas of single-family housing - estates Wolynska suggests possible transformation in zone of tempo 30 (speed limit of 30 km/h), and the itinerary of traffic calming on the streets surrounding the collective settlement – tempo 40 (speed limit of 40 km/h). Speed table on junctions and elevated islets with asylums at pedestrian crossings and speed limit reduction to 30 km/h are proposes to be implemented.

Traffic calming zone as part of a cycling network - this approach presented by K. Seklecka in her master's thesis "Conditions and possibilities of using a bike and the development of cycling infrastructure in Kutno" [9], in which the development of cycling infrastructure should take into account traffic calming zones, as areas that do not require the construction of special infrastructure, due to the need for traffic conditions friendly to cyclists (fig. 1). The author indicates that existing and potential traffic calming zone in the urban structure of centre of Kutno, of single- and multi-family residential areas and greenery. The system traffic calming zones, and non-investment significantly increases the availability of friendly infrastructure for cycling and promotion of active mobility.

Fig. 1. The concept of the development of a cycling network with traffic calming zones in Kutno [9]

Traffic calming zones: the centre - in red, single-family housing – in light brown, multifamily residential developments – in dark brown; source [9]
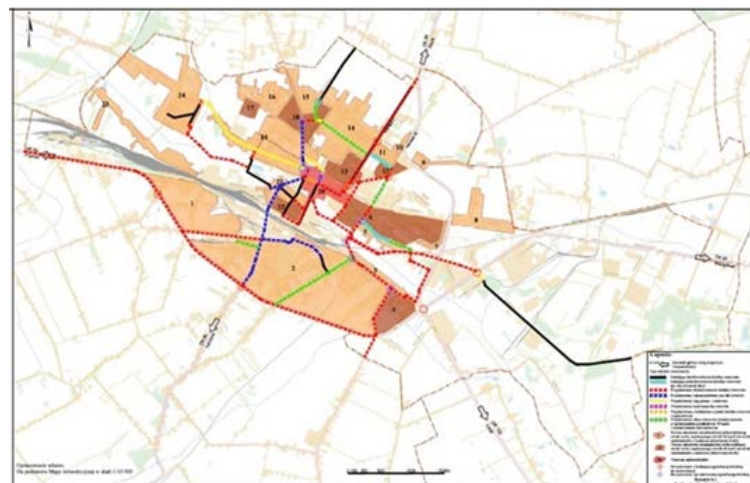
Preferences of users, opinions and efficiency of functioning traffic calming solutions – presents the master's thesis of M. Sobolewska "Traffic calming in the Warsaw district of Bielany" [10]. The author, in addition to presenting a vision of development zones, traffic calming in the district of Warsaw, has examined the operation of the existing traffic calming measures and their effectiveness, including the speed distribution at the speed humps and pedestrian crossings with islets with asylum. The results of research has confirmed a positive impact of the decrease of speed limit and improvement in the environmental conditions and the functioning of the residential areas in which they have been implemented.

Design Code method, used in the design of solutions to traffic calming presents the thesis elaborated in Postgraduate Studies in Urban and Spatial Planning Faculty of Architecture of Warsaw University of Technology [11]. The authors used design code, the method that is a set of design principles of space with developed library elements for the development of a particular area [12], to develop standardized solutions traffic calming zones "Dutch town" in the district Wlostowice in Pulawy. They placed special emphasis on the standardization of small and landscape architecture solutions, as form of traffic calming measures and a solution for greenery. Proposed solutions differ depending on the type of traffic calming area (tempo 30 and tempo 50) and a special focus zone in the area of primary school as requiring the use of special calming measures to improve road safety. The authors also present a method for evaluating the development and implementation (POE - Post - occupancy evaluation), indicating possible research methods and evaluation of the project, as well as to formulate a list of indicators of success of public space in relation to the analyzed project. They also note rating POE should be disseminated in the Polish conditions, because the design of the square, the street, the building, the house is a social process based on learning the consequences of different solutions and the repetition of those that come true.

SUMMARY AND CONCLUSIONS

In conclusion of the analysis presented above, it should be noted that the concept of zones and routes traffic calming fits the ideas of urban twenty-first century, closely connected with the knowledge society and sustainable development. It is present in a variety of spatial scales and functional areas and different types of planning studies and design.

Due to its interdisciplinary nature and significant potential with respect to the composition of public spaces, transport services, improving road safety and a positive impact on improving the conditions for the functioning of the natural environment and social development, as well as the synergies resulting from a comprehensive consideration of the above factors. Ideas of traffic calming should be widely disseminated and implemented in the educational process specialists in various fields of higher education. If we want to have aesthetic public spaces, which are functional and safe for use consistent with the principles of urban culture, questions of traffic calming should be an important and immanent part of the students' education and training. Even some proverbs whisper us the same suggestion: *"What the shell soak in his youth, this smacks of old age".*

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ACADEMIC ARCHITECTURE?!

The Faculty of Architecture of the University of Leuven (Belgium) is developing the concept of Academic Design Offices (ADO) as an answer to emerging challenges within the discipline in order to intensify the links between education, research and profession, avoiding the threat of parallel circuits of practice and academia in Architecture. ADOs consist of multidisciplinary teams where researchers, artists, practitioners etc. meet and use a pedagogical environment where students participate in practice or design based research projects. With ADO, the Faculty also wants to create new formats and possibilities for research output in Architecture.

INTRODUCTION

The status of architecture as an academic discipline has been a matter of debate for decades. In the recent years in Flanders, this debate has intensified when the programs of (interior) architecture and urban design and planning have integrated into a Faculty of Architecture within the University of Leuven (a process called 'academisation'). The 150 year old tradition of the former Sint-Lucas School of Architecture had to merge with the culture and tradition of the even older University. In order to maintain the culture and quality of the design school and at the same time to implement the excellent research based and research driven tradition of the University, the Faculty had to rethink the way it copes with education, research and "the outside" (practice, society etc.)

The newly inaugurated Faculty of Architecture (est. 2013) is developing the idea of Academic Design Offices (ADO) in order to clarify and to strengthen the bond between research, practice and education in the field of architecture. The Faculty sees ADO as an instrument to deal with some of the major challenges, possible threats and new opportunities created by the recent wave of academisation.

ADOs are multidisciplinary collaborations where design practice and research meet. By creating spaces for collaboration, the concept of ADO wants to give (research by) design a place in the academic environment as a possible way of generating disciplinary knowledge and insights. Too much focus has been put on the distinction between theory and practice, between research and design. The Faculty of Architecture wants to dissolve these distinctions by bringing both worlds together in the Academic Design Office.

At the same moment, ADO is a pedagogical setting where students actively participate in ongoing research projects. This way, the Faculty wants to prepare students for their future role in a professional context, where they will have to work in a constantly changing environment. This means students have to learn their own strengths and roles in a multidisciplinary framework, conduct studies for a new project, adapt to new situations and regulations, … In its educational mission statement (to be further developed in 2016), the Faculty of Architecture aims at helping students to become visionary and critical designers: they are challenged to think and act beyond real and actual problems and to formulate an answer to the needs of the future. ADO wants to be an instrument to fulfill this ambition.

PRESENTATION OF THE ADO PROJECTS

In 2015, four ADOs were installed as a pilot project at the Faculty of Architecture. A structural interaction with students within the ADO is embedded in the Faculty's Master programs and uses educational formats, learning outcomes and forms of evaluation that have been adapted to the new concept of ADO and that evolve in terms of complexity throughout the programs. In this paper, we would like to single out two of the newly installed ADOs as examples of how the concept of ADO forms answers to the challenges the discipline of Architecture faces: Studio Anatomy and Spaces for Economy in the City.

Studio Anatomy traces socio-historical layers, starting from the topography (geology, the vertical section) and stretching as far as the full scale architectural (constructive) detail (the section, again), incorporating construction in the design-research process from the very beginning. Doing so, Studio Anatomy covers the full stretch in architecture, from poetics to technics.

Methodologically, Studio Anatomy critically questions the too speedy nature at the surface of things we see (in architecture) — the superficiality of the world — by cutting into and under the skin of things (architecture). The section is used to anatomize architecture and its surroundings vertically, in its profundity, instead of horizontally (as a surface). Alberto Pérez-Gòmez suggests that the section is of a foremost importance in the architect's work, as a prediction on the casting of shadows, pointing at the anatomic nature of the section that, applied by the architect, *"break[s] the skin of things in order to show"* (Pérez-Gòmez 2006) [1], completing his argument with Merleau-Ponty, *"how the things become things, how the world becomes a world."* (Merleau-Ponty 1964) [2].

Spaces for Economy in the City (SEC) explores the relationship between the autonomy of built form and the influence this built form has on the city and its inhabitants. The ADO understands that architecture is a discipline with a rich history and deals with the question of the autonomy of the discipline. On the one side, SEC acknowledges the autonomy of architecture by the fact that it has its own rules, not applicable to any other discipline. On the other side, architecture never is fully autonomous, as it only makes sense the moment it becomes part of a place.

The ADO analyzes the relationship between the built form and the city by using multiple techniques: models, drawings on different scales, diagrams, text, images… Each technique has its own logic and rules and, in a way, is autonomous too. Together, these documents will give an overall understanding of the built form and will allow us to discuss about its influence on the city.

SEC is working in three stages. In the first stage ('discover'), exceptional 'spaces for economy in the city' (like companies, warehouses, studios…) are elaborately documented in drawings, scale models and text. The main focus during this stage is the tectonic development of the building in

a cultural context. During the second stage ('re-work') the ADO uses the knowledge from the first stage to set up a research by design project to look for new possible spaces for economy in the city of Ghent. The third stage ('re-discover') aims at documenting and disseminating the outcomes of the research from the first stages.

Both ADOs are multidisciplinary teams. Studio Anatomy consists of Mira Sanders (an artist and doctoral researcher), dr. Laurens Luyten (a structural engineer and post-doctoral researcher) and dr. Jo Van den Berghe (an architect with a small critical and investigative practice and post-doctoral researcher), who functions as a nexus and coordinator within the team. In this team, architecture (embodied by the architect) literally acts as a mediator between imagination (embodied by the artist) and materiality (embodied by the engineer).

Spaces for Economy in the City mainly consists of practice oriented architects with different expertise: Bram Aerts is an architectural engineer who coordinates the team of this ADO. He is the founder of TRANS, an office that

> *"designs spaces on the background, serving life to unfold in this space. Occasionally the space comes to the fore to clarify something we probably already knew, only to disappear again in a near absence." [3]*

The other members are Job Floris (head Architecture at Rotterdam Academy of Architecture and Urban Design), Patrick Moyersoen (a socially engaged architect with a focus on the urban scale) and Dieter Devos (an architectural engineer with a fascination for complex scales).

Both teams succeed in the ambition to blur the limits between academic oriented and practice oriented architecture in relation to education. While Studio Anatomy seems to have an academic focus, its methodology and results show a clear link with architectural practice. On the other side, the members of the SEC team are mainly practitioners. However, they connect with the academic

Fig. 1. ADO as a space for interdisciplinary collaboration

Source: Matilde Everaert (student), 2015

discipline by underlining the importance of the distribution of generated knowledge, both to academic peers as well as to society.

AMBITIONS

The Faculty sees ADO as an instrument to answer important issues raised by the academisation process of architecture. In order to create a stronger link between theoretical research, practice-based research and education, as advocated in the EAAE charter [4], The Faculty of Architecture has defined 4 ambitions for ADO.

Linking the 'parallel' worlds of academia and professional practice

An ADO is a group of people working together on a fundamental social or disciplinary issue (the ADO research project) it wants to put on the map. ADO has the ambition to be an environment where education and research meet to create possibilities for an interdisciplinary and creative collaboration between architects, researchers, visual artists, professionals and students. ADOs use and combine all these profiles and skills in order to answer innovative questions for architecture as a discipline.

In this sense, ADOs are not different than other architectural offices. We can say that ADOs prick the academic bubble by forming a landscape that exists on the border between academia and the outside world: ADO's work on actual themes and problems to generate disciplinary expertise and knowledge. In the near future, ADOs aspire to valorize their expertise in the form of studies, contract assignments, research projects, spin offs, …

The teams we described above aim at using the academic design office environment to develop an instrumentarium or methodology that can be used by in architectural practice. For example, the results of SEC will be presented as a database or catalogue that can be used by local governments as a spatial policy development tool.

Linking fundamental and applied research in architecture

Often, academic research in architecture is of a fundamental nature. The KU Leuven research Department of Architecture positions itself at the crossroads of different research methods and traditions. Its research has roots in both a poly-technical and an artistic tradition, enriched with a humane and socio-scientific dimension. Research at the Department of Architecture strongly believes in the wide spectrum of topics and wide-ranged view on the many ways in which research in architecture can be generated. It departs from the disciplines themselves of architecture, interior architecture, urban development and spatial planning, and nurses the design as a shared focus. The connection and interaction with the professional design practice is crucial, because within the practice as well, knowledge is generated.

Similar to approach within the department, ADO wants to link fundamental research in architecture with the practice in the field ("making buildings"). It aims at applying insights from fundamental research in a practice oriented environment and on the other side at valorizing practice based insights by linking it with insights from fundamental research.

For example, the research by Studio Anatomy appears to be of a fundamental nature, but applies the generated research outcomes by developing in instrumentarium that can be used by practitioners. The method of using a section to anatomize the profundity of materials and surroundings of architecture will be developed as a first step in the design process of new buildings as well.

Creating a new format for research output

In ADO research projects, the methodology of Research by Design is predominantly used to produce new disciplinary knowledge and insights. This ensures that *"(...) research results are obtained by, and consistent with experience in practice"[*5]. Research by Design calls for its own ways of sharing and communicating insights and understanding. Hence, it becomes evident to include non-text based material in the research output. Designs, models, buildings, exhibitions, ... are better ways to communicate the embedded knowledge. Architecture lags behind in accepting this research output as well as finding ways to assess the embedded knowledge in a rigorous way. This is the challenge of the upcoming years, and KU Leuven contributes actively to the debate. In order to ameliorate the valorization of architectural research, the ECOOM working group 'Research in the Arts' has defined the concept of 'Creation in the Arts or Design (AOR)' [6]. A system of peer review is being elaborated and a test panel will take place in spring 2016.

By labeling architectural research output as ADO output, ADO supports the collection and registration of the wide range of the architectural research output. At KU Leuven, Lirias is a document repository used to archive research output in a digital way. Lirias captures, stores, indexes, preserves, and distributes digital research material of the KU Leuven Association. Through Lirias, data are supplied for peer review.

In terms of output, both ADOs combine more traditional research output like peer reviewed publications and monographies with the production of scale models, drawings and exhibitions and the development of a toolbox with a reproducible methodology. The daily output of Studio Anatomy will be shown at annual exhibitions. Next to this, Studio Anatomy aims at organizing design research seminars and lectures by practitioners and academic researchers. After three years, the results of the work in the ADO by researchers, practitioners and students will be assembled in a book publication, consisting of visual production and written reflections. SEC focuses in its research output mainly on the social return, by inviting the stakeholders (e.g. the city council, neighbors, ...) to public events related to the ADO (lectures, jury evaluations, debates, ...). The ADO organizes a summer school to disseminate the instrumentarium they developed. The results of the ADO work will be communicated to academic peers through a journal publication.

Linking research with education in architecture

A thorough curriculum change in the Master program of Architecture in the Faculty resulted in a new program where students choose three studios (one in each semester before their Master Dissertation semester) as a deepening or broadening of their master program, according to their own ambitions within the field of architecture (their Disciplinary Future Self). Parallel to this, students collect their experiences within (and outside of) these studios in a portfolio that shows a clear design profile and that will be the fundament for the Master Dissertation (MD) Project in the fourth and final semester.

ADOs host at least one studio within this framework. In this studio, the ADO members invite students to work together on the ongoing ADO project. This way, students learn and achieve a scientific methodology and attitude 'by doing'. Evaluation is based both on the results of the work by the student (the design solution, the paper, ...) as on the scientific value of the work. Because the ADO functions as a multidisciplinary team, students become acquainted with the value of the different expertise in a team and, most importantly, their own value in a collaborative work. The ADO can thus be seen as an 'internal practice' or internship where students learn to apply an academic attitude and methodology in a research based and practice-oriented office. The ultimate goal of the Master program is to teach students to work on an academic level in a professional (practice) environment.

This new Master program has the ambition to direct students into developing a MD project that is strongly individual and that follows the principle of self-navigation. In their final academic year, students will formulate their own MD project, guided by an academic supervisor from one of the ADO studios they participated in. This means they will have to apply the knowledge, skills and attitudes acquired in the ADO studios on their own autonomous research project. By integrating the MD project in the ADOs, the program creates an ADO landscape that is both an educational and a research environment for students.

Both Studio Anatomy and Spaces for Economy in the city organize a studio in the Master program of Architecture. The SEC studio was held in the fall semester of 2015-2016 as a part of the internationally oriented (English-language) Master of Architecture. Studio Anatomy takes place in the current spring semester as an English spoken studio in the (Dutch-language) master in de architectuur. Being organized in English, both studios welcome the input of an international student group, which contributes to the ambition of ADO to involve people with different expertise and backgrounds. All ADO studios are presented on the Faculty's Master Studio website (http://architecturemasterstudios.be).

CONCLUSION

In last October's issue of the magazine Volume, Reinier de Graaf states:

> *"As a profession, architecture embodies a strange paradox. In economic terms it is a largely reactive discipline, a response to pre-formulated needs. In intellectual terms it is the opposite: a visionary domain that claims the future." [7]*

The ADO concept claims the bridging of both and creates as such a creative setting where students, researchers and practitioners meet and think out of the box. A new academic environment is established where research and practice come and grow together.

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MENTOR & STUDENT RESEARCH LAB: A NEW TYPE OF ARCHITECTURAL AND URBAN DESIGN WORKSHOP; NEW OPPORTUNITIES WITH VALUABLE RESULTS

The space around us has significantly changed during last years. Polish cities have undergone a major transformation following political, economical and social transition [8]. Similar change is noticeable at universities and their educational programmes for architecture and spatial planning students. Nowadays designers and activists tackle completely different problems and have different opportunities than their older colleagues from the recent past. One of these new opportunities is international collaboration between professionals or researchers from all over the world. Mentor & Student Research Lab is a project that gains from this phenomenon and helps to establish collaboration between professionals and students.

INTRODUCTION

Mentor & Student Research Lab is a project containing workshops and conferences based on the idea of students affiliated with the Gdańsk University of Technology Science Club: Urban Revolutionary Lab, also known as LEM-ur. They wanted to establish collaboration between professionals from the International Society of Planning and Regional Planners and Polish students. Nowadays, architecture and spatial planning students have many opportunities to work with professionals during numerous workshops, but LEM-ur members wanted to create research workshops - the kind that was not organized before. The first edition, entitled Urban Transformations, was held in Gdańsk, Poland in 2014. The second edition is going to begin in March 2016.

GENERAL IDEA

Cities are changing day by day, they are the frameworks of how their inhabitants live - their public spaces show the condition of public life. Due to that, cities and their space are the issue of utmost importance nowadays. The transformation Polish cities have undergone started after democratic transition, of which the 25th anniversary took place in 2014. It was a great opportunity to summarize and look closer what has been done and what still needs improvement. Mentor & Student Research Lab (abbreviation: MSRL) was a perfect chance to rethink urban transformations.

Key words:

Research-based Workshop, Urban Transformations.

Core Theme

There is an urgent need for an interdisciplinary discussion concerning perhaps the most significant issue that influences the quality of our life, namely space. The self-governance anniversary provided a great opportunity to think of how the Tricity (Gdańsk - Sopot - Gdynia) has changed in the last 25 years and to ask the question of what it will look like in the next 25 years. It is important to realize that in the post-war period, Gdansk underwent a unique transformation: from massive destruction to the recent fast urban development and most recently spectacular public and private investments, thanks to which the city can aspire to the role of a metropolis [7]. The occasion as well as the ongoing public discussion became an inspiration and basis for the core theme of the MSRL programme and for the undertaking of research projects by students and mentors.

Work Method

The aim of this project was to create an innovative formula of collaboration between students and urban planning professionals from all over the world. Together, they established a common ground where youth and ambition met with experience, professionalism and methodology to discuss the issues related to both the city and its region. Each so called "project actor" had a specified task to fulfill during the three months' period the programme was taking place. The research topic of the project, as mentioned above, was "Urban Transformations." This idea was based on the fact that the cities – both historic and contemporary – constantly undergo evolution and thus, change their appearance. All these cities share some common features, but on the other hand, each one is different.

Mentors who answered to an open call to join the programme were asked to specify the research topics from the proposed core themes. They were obligated to supervise a team of their own young, inexperienced researchers and to support PhD student teams with their skills and knowledge. On the other hand, students who decided to apply and join the initiative were supposed to be actively involved in international research work, which consisted of three workshop meetings and most of all online work and cooperation both with mentors and other participants. These, somehow experimental methods required responsibility for all work from each member of the group. It would not be possible without actively involved students.

Also worth mentioning is the fact that these programmes brought valuable benefits to everyone involved. For mentors, it was a chance to lead and shape urban or architectural focused research under their guidance and of their own design. Moreover, it gave the opportunity to guide a dedicated team of PhD candidates and students who valued their academic and professional input. The aim of the programme was also to invite mentors to participate in preparation of the report that addresses the relevant issues for the host city (Gdańsk). It gave students a chance to complete international work with support of practicing urbanists and architects. Furthermore, all participants could expand their knowledge of the design process with a good chance of publishing internationally as well as obtaining and gathering research and professional skills.

DEFINED RESEARCH PROBLEMS

For 3 months, five groups of students from Polish universities, supervised by the urbanists from ISOCARP, kept working on the research projects devoted to the challenges facing contemporary cities, focusing their attention on the Tricity and referring to both problems and good practices of the foreign countries.

The programme has designed and implemented an innovative modality - attractive, agile and dynamic to produce studies on the contemporary city in a relatively short time with an interesting

final product. A pattern of work that gets to bring students of different disciplines related to the study of the organization of cities.

Smart Infrastructure for Waterfront Cities: A Case Study of Gdynia

The first group was led by Alexander Boakye Marful, an architect and infrastructure planner and work on Smart infrastructure for waterfront cities. Their first step was to study aspects as the meaning of the prefix 'smart', defining 'infrastructure' and 'waterfront'. Enriched with that knowledge they moved on to further research on conditions for smart infrastructure development on three levels: Tricity, Poland and European Union and assess the current trends in this area. Thereafter, the group chose Gdynia, a Polish harbour city and a part of the Tricity, for the case study. They divided information into 6 thematic areas: development history, natural environment, land use & housing, transportation system, public utilities, socio-economic conditions and identifying areas for possible improvement. The outcome of their work was a set of proposals divided into groups: transport, basic supply infrastructure, social infrastructure, public order and protection, and economic infrastructure. All of the solutions can be implemented in Gdynia in a shorter or longer period of time. In the conclusion, the group's statement says that the quintessence of smartness is to collect information about the city and make use of it in the right time.

Improving Sustainable Mobility

Christian Horn, an architect and urban planner, specified his group research field as Improving Sustainable Mobility. First, the group chose five European cities: Antwerp, Basel, Frankfurt, Gothenburg and Helsinki and briefly analyzed the basic aspects of its mobility such as bicycles, mobility plans, car-sharing, parking policy, bus on demand etc. The next step was to conduct the research of mobility in Gdansk. They analyzed several aspects of mobility, first - bicycle mobility data from the Statistic Office or City Hall of Gdansk, solutions implemented in Gdansk such as cycling map with several proposals of 'recreational loops' or bike contra flows on almost 130 streets and quoted Gdansk's goals in bicycle mobility programme. Second, Christian Horn's group took into consideration the results of the mobility survey they had conducted. Third, they analyzed soft actions in Gdansk – events which took part in the Tricity etc. Then, the group presented results of the research on implementing mobility strategies. In the conclusion, authors emphasized the role of common initiative in bicycle mobility for entire Tricity.

Baltic Cities on the Southern Coast: Improving by Learning from Each Other

The group supervised by Markus Appenzeller decided to compare Baltic cities before and after changes in 1989. The analysis of the transformations that affected the cities after 1989 was to indicate possible directions for interventions that should be made by the authorities to ensure that the cities develop in the best possible way. The study consisted of gathering and analyzing data from domains as space, city branding and identity, transport, economy, society, administrative systems, legislative systems as well as identifying crucial problems and working on the selected aspects in details [1].

What Kind of Cities Do We Build? What Kind of Cities Do We Want to Build? Reviewing Three Different Urban Developments in Metropolitan Areas

The topic chosen and discussed by the group of Oscar Bragos from Argentina was sustainable development in metropolitan centers. Their aim was to answer the question of the direction in which the Tricity and its surrounding areas develop and whether it is an example of sustainable development, namely whether we can manage our natural, economic as well as other resources in

a reasonable way. Are housing complexes, especially the new ones, developing in a right direction? To answer these questions, the group decided to study a particular housing complex in Gdansk – Osowa – which is an example of a rapidly growing suburban center. The aim of the study was to find ways of achieving sustainable development. The outcomes were compared with a parallel study from Argentina, conducted by Oscar's students from Del Rosario University.

RECOMMENDATIONS RESULTING FROM THE RESEARCH. CASE: PUBLIC SPACE MANUAL

The project goal was to conduct research and analyze the issue specified by mentor. However, a few groups went one step further, drawing conclusions and working out proposals ready to implement in the urban fabric. The team led by Ric Stephens was working on public space and not only analyzed examples from all over the world but also took advantage of that knowledge and prepared recommendations for creators of public space.

Methodology

First, the group and its mentor, started from researching. Each member of the group was responsible for specific kinds of public spaces: green spaces, public space full of street art, etc. Researchers gathered data and analyzed international public space development to determine innovative approaches to creating vibrant cities. Based on the research results, the group reconsidered categories of public space they had assumed at the beginning. The next step was to prepare recommendations which would help inhabitants, NGOs, municipalities and other stakeholders create well-designed public spaces.

The authors made the manual as a user-friendly handbook. The contact with the manual starts from the flowchart, where the user, after answering a few questions, is directed to the exact section. The manual includes 7 sections (12 sections and subsections) with 67 recommendations, which are described below in more detail (Work effects – selected recommendations). The manual is full of inspiring quotes, descriptions and pictures of well–functioning public spaces and a glossary. The manual provides a holistic approach to planning for public space that is applicable to almost any city at any scale, from a small village to a megalopolis.

Idea

The authors prepared recommendations that were divided into 7 main sections: law, finance, participation, standards, place identity, mobility & safety and attractiveness. Moreover, attractiveness is divided into several subsections: aesthetics, greenspace, water, art, furniture and activeness. Each recommendation contains description in Polish and English and a table with basic information showing the level of involvement of three types of actors: inhabitants, municipality and experts, estimated costs and level of difficulty. Moreover, recommendations are supplemented with multiple examples from all over the world and colourful pictures.

The group of Polish students collaborated with students from University of Oregon to assist the community of Mt. Angel with their downtown plan. Thanks to that during the work on recommendations, the authors had an opportunity to test part of them. They presented it via teleconference to the Mt. Angel community, encouraged them showing examples of well-designed public spaces and answered their questions. The recommendations to Mt. Angel were published in the Oregon Planners' Journal.

Work Effects - Selected Recommendations

Section Participation contains the recommendation no. 5, Activate locals. However, it is shown that the involvement of municipality and experts is also fundamental. The author of the recommendation gives the example of Gdansk Days of Neighbourhood, and initiative that is popular among the diverse groups of inhabitants of Gdansk. The level of difficulty is specified as easy and costs are quite low. Other recommendations from this section concerned consulting projects, involving students or asking NGO's and art institutions for help.

The third section deals with standards. The recommendation no. 11, Choose materials wisely, shows a wide range of materials that can be used in creating public space. It also contains examples from Poland and photos of realizations. The level of difficulty is set as medium and costs as quite low. The level of involvement is the highest for experts, followed by the municipality and then inhabitants.

Recommendation no. 18 from the Place Identity Section shows how important it is to establish dialogue between the place and the people there thanks to story of the place. The author emphasizes that there are many ways to show the story to the people. He gives an example that activity is quite cheap and quite easy to implement. However, it requires more involvement from the actors.

Section Mobility & Safety considers alternative means of transport, systems against danger and universal design. Recommendation no. 29, Tame the light, shows how dangerous the light can be. The author shows solutions on one hand for the sunny days, and from the other, during the night for light pollution. The biggest role in implementing those solutions resides with the municipality. It is of medium difficulty and rather expensive.

The lengthiest section is attractiveness, which is the reason why it is divided into subsections. More than 30 recommendations are nothing more than a book of good practice. It contains ideas connected with illumination, music, gardening, water, street art, furniture, education, installations and fun. A multitude of examples show many ways that lead to the creation of a great public space. The authors intentionally dedicated more than half of the manual to propagate fun in the public space and encouraged people to act [10].

FUTURE RECOMMENDATIONS

What Worked, Where the Improvements are Needed

Without any doubt, the programme idea, in which there is a close cooperation of mentors and their students appears to be a success. Each group conducted numerous studies. Organized workshops became a unique opportunity to express everyone's opinions, sharing ideas and creating interdisciplinary teams. It showed a brand new quality of urban workshops. Furthermore, the results from 3-months of hard work were valuable final projects and reviewed publications.

However, there are some improvements still required in this new work method. The difficulties resulted mostly from online work. In the second edition, the most important modification concerns PhD students who will be the most important project actor, becoming a "key" between students and their mentors. They will be responsible for leading the group of students by supporting them with their knowledge and ideas as well as assisting and managing the communication between the mentor and the research group. The aim is to create a platform for effective cooperative learning that will provide an opportunity for PhD students to master their methodology skills and teaching methods by conducting international scientific research.

Improving Work Method - Further Steps - The Second Edition

The MSRL second edition research will focus on the Baltic Sea Region, considered a multidimensional urban phenomenon, with Gdansk acting as a hub for the research teams. The research teams will be sharing experiences and proposing strategic recommendations to strengthen sustainable urban development initiatives for Baltic Sea Region at international, regional and local levels. The aim is to define cities and their networks challenges, visions and ways forward by analyzing maritime spatial planning as a tool and process, contemporary port and maritime industries as growth drivers, multicultural challenges and the new urban policies as well as the ways of integrating eco-systems approaches into design in coastal cities[1].

CONCLUSIONS

Summing up, it should be emphasized that the MSRL programme, which was closely monitored from different places in the world, was a great success, receiving numerous positive opinions from both the participants and the observers. It is a form of work that immediately puts students in contact with a particular problem, allowing them to analyze and interpret it. To quote Ric Stephens, ISOCARP President and former MSRL mentor's opinion, "The Mentor & Student Research Lab is an extraordinary programme that combines research, field work and collaborative design. This integrated approach yields a variety of innovative findings, recommendations, as well as planning and design solutions. For everyone involved, it is a meaningful and memorable experience." [6]

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STUDENT WORKSHOPS AS A METHOD OF DEVELOPING A CURRICULUM

Being a university teacher is connected with the constant search for the best methods of working with students. It is always a pleasure to see how first year students develop into independent and creative thinking. This kind of a dedicated attitude is visible also during the architectural workshops. Observing the effectiveness of this type of education inspires one to investigate its methods in order to choose what is most valuable as well as to try to offer it within a regular curriculum.

INTRODUCTION

The Idea of a Workshop

For many years among architects, both practitioners and theoreticians, there has been a debate concerning the issue of higher architectural education. Both the curriculum as well as the forms of education is under discussion [1]. The necessity of this discussion is obvious in the perspective of constantly and rapidly changing conditions of life, society and economy. The formerly existing model of a master professor is already a legend of the oldest and most respected faculties of architecture in Poland. However, none of the currently existing patterns of teaching is not free from criticism. In the aspects of architectural education, like orientation on a process of designing, a practical side of studies or theory of architecture, the best didactic solutions are still being sought.

One of the forms of architectural education, popular in many countries and gaining importance in Poland in recent years, are workshops or so called "summer schools" for students. Definitions of the word "workshop" differ, however their main features remain similar. In terms of a professional education significant is its first meaning, which is *"a room or building in which things are made or repaired".* According to Oxford Advanced Learner's Dictionary [2] workshop, in the considered context, is *"a period of discussion and practical work on a particular subject, in which a group of people share their knowledge and experience".* In the book 'Workshops: Designing and Facilitating Experiential Learning' [2] (Brooks-Harris, Stock-Ward, 1999) the authors give the following definition *"A workshop is a short-term learning experience that encourages active, experiential learning and uses a variety of learning activities to meet the needs of diverse learners".* It is possible to assume that the main characteristics of workshops are a short time of realization, a focus on a particular problem, practical aspects and strong cooperation of participants and participant engagement.

The benefits of this form of education are highly recognized within a majority of domains. In a field of architecture, workshops might take different formulas but all aim at deepening knowledge by changing the approach to design problems into more practical ones. However, even if in many cases it finally comes to preparing a project, the approach and presentation of a problem, circumstances of work, expectations and presence of visiting teachers and students create a new experience for participants.

Types of Architectural Workshops

It is possible to briefly divide workshops into two types. The first one is concerned with finding a design answer for a particular issue. It could be a specific project situation with defined demands and circumstances or a more open task searching for a variety of solutions for an interdisciplinary problem. The second type of workshop is the one having as its objective building a structure or making a model in 1:1 scale in real surroundings.

The workshops striving to produce a project as a final result may vary in scale and function so the range of theme options is relatively wide. The subject can concern not only small, local interventions, urban furniture design but also masterplans for brownfields or a development of new areas. In a less literal meaning, the task result might be not an architectural project, but a set of profound analysis and guidelines.

The "building" workshops might seem more attractive for students as they cope with an assignment that is not an obvious element of the curriculum. This kind of workshop includes also a design part but its nature is different, as it becomes a documentation for construction works. The task usually deals with small objects possessing an uncomplicated functional scheme, however, what is crucial, is that it should be a solution of a particular demand of e.g. a social association or a cultural event.

What is substantial in every case, however, is a wider perspective while pondering over a problem. It is crucial to make students aware of social, economic and ecological context of each intervention in space.

An essential aspect of each workshop is that it should depict a real problem, because only then can it offer a new value of experience to the participants. The subject of a workshop could be derived from the needs of a municipality, a public or private investor. In some cases close cooperation with "a client" is possible, which is highly beneficial and roots the whole process in actual setting, not only physical. The necessity to cope with problems such as financial limits or personal expectations also brings the idea of workshops closer to practice, which is always missing during the implementation of the curriculum. In perfect conditions, the expected final result of the design workshop should be a realisation that strongly derives from the solutions the students delivered. In case of a construction workshop it is crucial to enable the students to complete the project on their own.

Considering all beneficial aspects of a workshop, there is a temptation to try to adopt its features in order to enrich regular curriculum of higher architectural education.

The aim of this article is therefore to analyse examples of student workshops and try to define weather and how they can be useful and adaptable.

CASE STUDIES: FAENZA, PAVIA AND LODZ

This research gives a closer investigation into three examples of workshops, in which the author either participated as a tutor of a group of students from Lodz University of Technology or was an organizer. The aim of the investigation is to define main features that might help decide on utility of a workshop as a tool in a curriculum.

"The Space Inside"

The first example is an architectural workshop "The Space Inside" held in Faenza, Italy, in October 2013. It was organised by the society Faventia Sales in cooperation with the Department of Architecture of University of Bologna and dealt with a general theme "Contemporary Restoration of Public Spaces in the Historical City".

The society was in charge of managing the area of the former Salesian School, located within the walls of the old town of Faenza. The society has already restored and adapted the main buildings of the whole complex into new educational functions. The expectation of the society and a task for the students was to produce a proposal of "a creative use of external areas" within the complex and to create a new set of public spaces. Crucial to the design problem was the aspect of connecting the spaces within the zone with the surrounding neighbourhood and the public spaces of the old town.

Students from four universities (Bologna, Ferrara, Tel Aviv, Lodz) were working in seven groups during four days of the active workshop. Besides working, the participants also visited some historical buildings, the town hall and the museum of ceramics to learn more about the environment in which they were designing.

The results were supposed to be prepared as graphic materials and an oral presentation. Typical of architectural students, the participants chose to make sketches of plans and perspective views, some groups also prepared small physical models.

As a result the students came up with very different design ideas. Most of the groups decided that important aspects are greenery, art, as well as creating places for the community and inhabitants from the closest surroundings. Among others, the following titles appeared: "Through the Gallery", "Living Flow", or "A Stage for the City".

"Smart Community and Sustainable Development"

Another example of workshops is the summer school "Smart Community and Sustainable Development. Concept for an Innovative Housing in Milan", organized by University of Pavia, Italy, from 15th to 20th September 2014.

The task for participants was to work on an innovative concept of residential building in a real location in the northern Milan – a specific area of a diverse community. It was important to take into account the aspects of integrating both private and public properties, individual and collective functions, the needs of dwellers of different age groups, nationalities, lifestyles and urban behaviours. The question appearing within the task referred to the relation and interplay of community and its role in (re)defining of an urban and architectural form.

There were six groups made of students form the Universities of Pavia, Padova, Plymouth and Lodz, and some participants from Egypt. At the beginning of the workshop there were introductory lectures acquainting the students with urban planning in Milan and a visit to the site. All visiting professors and tutors were invited to give lectures in the following days of the workshop, in reference to its title.

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The students were supposed to prepare a printed board and a section model of the design, also placed on the board. With support of multimedia presentations the groups were explaining their ideas.

The effect of work of all groups had a strong relation to social aspects, as it was expected, however, sometimes the proposal was less engaged in offering a definite architectural solution. The projects focused on the interplay of public, private and semi-private spaces ("Art Promenade. Interact, Experience, Learn"); functions of learning, recreation and exchange ("Market", "Exchange and Learning Community. A seed that spreads and grows").

"Temporary City Spaces"

The last workshop described in this article was carried out in Lodz in September 2015 under a title "Temporary City Spaces". It was organized by Lodz University of Technology with participants from nine cooperating universities from Germany, Portugal, Slovakia and Turkey.

The task for participants was to find the solution to the problem of the empty plots within the downtown of Lodz, which are waiting for future investments. The subject of the workshop was to prepare for these places a proposal of temporary design, that could be used for particular plots, but at the same time would be a modular system possible to apply in many different locations. As the intervention was supposed to be temporary, it should consider the aspects of low costs, multifunction, ecology and recycling.

The proposals created by five groups strongly tried to manage all these requirements. Some students focused on designing simple, repetitive structures that could be used in many ways; others decided on stronger and longer lasting interventions, like using colours on a larger scale. Groups prepared demonstration boards and physical models and presented their concepts, accompanied by a multimedia show.

Elements of Student Workshops

When reflecting upon student workshops, it is possible to distinguish a few elements that need to be assessed. These elements are: the subject and task, the form of a workshop, expected result, components e.g. lectures, organisation as well as educational impact. Other criteria of evaluation refer to the results of the workshops in the context of the final outcome and didactic benefits. Making allowances for the final outcome the following elements are to be judged: solving the problem, innovation of the idea, realization possibilities, compliance of ecological, social and economic aspects. The didactic benefits could be evaluated on the basis of students' feedback, describing gained experience, knowledge and social skills of working in a group.

Table 1. Elements of
Student Workshops:

a Comparison of Case
Studies.

	Faenza	**Pavia**	**Lodz**
Topic/Task	*to produce a proposal of using external spaces / to create a set of new public spaces*	*to work on innovative concept of residential building*	*to prepare a proposal of temporary design for empty plots within the downtown of Lodz, considering modularity of design solutions*
Form	*project work in groups*	*project work in groups*	*project work in groups*
Components	*introductory lecture, group work, local trips*	*lectures, site visit, group work, Venice Biennale trip*	*lectures, site visit, group work*
Result	*graphic presentation (handmade materials) of ideas and examples of particular design of public spaces*	*printed posters and section models placed on a poster*	*printed presentation boards and physical models representing the idea*
Practical Aspect	*proposals for a society managing the site to be applied*	*searching for innovative housing idea*	*preliminary interest of using the ideas from the City Architect Office*

APPLICATION POTENTIAL

This section focuses on the deliberation of the mentioned features of the workshops in the context of possibilities of implementing them into a curriculum.

The general principle of the workshops concentrates on the idea of solving a particular problem. It can be assumed that any design task is such an example. The curriculum of architectural studies already consists mostly of this type of work. However, the methods of a standard design studio differ from the way of working during the workshops. In comparison, the perspective in which the design problem is considered should be broader and numerous aspects e.g. social, should be taken into account. All the mentioned characteristics resemble the approach included in the method of Problem Based Learning [4]. One of the crucial conditions of PBL is giving the students freedom of acting, and therefore the role of a tutor it is less of teaching and more of guidance [5]. This attitude also resembles the structure of supervision during workshops.

Another main feature characterizing workshops is its short duration. The circumstances force students to be fast on their feet while designing, and at the same time require careful consideration of the numerous side factors. Brainstorming and discussions are necessary in this mode of working and give good results in development of both the project and the students. The experience of tutoring first year students shows that the short term assignments are very well suited to this level of education. Obviously, this way of designing is not able to produce highly advanced solutions, but it is effective and quickly gives visible results.

The visible results are a subsequent attribute of the workshops. It occurs differently depending on the character and the task of the workshops. The result could be a presentation of a project design or a construction of an object or a model in 1:1 scale. In case of the "building" workshop the duration has to be extended in order to give the participants a chance to make both the design and the construction work. It sometimes raises doubts from organisers, who are afraid of making an event lasting too long and hence becoming tiring or boring for participants. Another obstacle that might appear is the necessity of funding for materials and supervision. If such an activity is included within a design studio or classes, the question of time and supervision is no more an issue. Therefore, it seems to have a potential to compose a part of a regular curriculum.

Last but not least is the importance of teamwork, being the basis of the workshop structure. This component should appear in the course of studies much more often. The group work allows one to

gain the skills of communication and cooperation, which is crucial to the work of an architect. It also gives a chance to enhance exchanging ideas, to arouse discussion and to stimulate thinking. Team work should become a tool in the curriculum, sometimes as a whole project work, in other cases only as a stage of e.g. preliminary analysis.

SUMMARY

Currently, the architectural student workshop is a particular form of education, dedicated to a specified number of participants. It is a type of activity for students that are interested in doing something more than the average, which is simply participating in obligatory classes. For the participants the workshops are a chance to acquire valuable experience on many different levels, of which gaining knowledge is not the most important.

It is justified to look at the workshop objectives also in a wider perspective. The objective of the student workshop can be: strengthening partnership, transferring knowledge, promoting a place, getting acquainted with an issue or developing learning cooperation and team work. Taking into account the above, it can be assumed that workshops as such should be an important element complementing the curriculum.

Irrespective of creating the possibilities for students to participate in the workshops, there should be an effort made to incorporate their components and features into regular curriculum activities. As described previously, it seems that relatively effective and appropriate solution is the method of Problem Based Learning as well as the application of short time assignments. It would be a valuable enrichment of the curriculum that could be applied immediately. Obviously, it is not a comprehensive answer in search of the solution for higher architectural education. Nonetheless, it is worth trying and verifying the effects.

Therefore it can be summarized that workshops have double influence. The first, a direct one, is a participation in workshop, which offers multiple benefits mentioned above. The second one is created by applying methods derived from workshops to standard curriculum. By changing the focus of the objective and ways of working, new values and qualities are added to the syllabus. Such change gives a chance to enhance student activity and develop their professional self-reliance. It also shows a new perspective on studying and enable more mature approach to gaining knowledge and skills, from the point of student perception "you have to learn this" to "I want to know how to do this". In this way the curriculum is being developed toward awaking students' engagement in their learning process and composing a program emphasizing creativity bound with applicability orientated on a human, as a main objective of architecture design.

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"MY DESIRE - TO PERFECT MY SKILLS THROUGH JOURNEYING" [1]. RESEARCH JOURNEYS AND STUDY TOURS OF ARCHITECTS IN THE AGES OF ENLIGHTENMENT AND MODERNISM

The author provides examples of research journeys of architects to demonstrate that such events are an indispensable form of essential and continuing education, as well as a helpful means of finding inspiration. The narrative focuses on two periods that were very characteristic in terms of architecture: classicism and modernism. Research journeys are classified by their nature. Attention is drawn to the methods of studies conducted, account taken of the impact thereof on the travelers' careers and on the evolution of their general views on architecture.

JOURNEY, WAY. INTRODUCTION

Journey as a symbol of self-improvement process has for ages been present in cultures and religions. It plays a major role in the Christian teachings (*"I am the way [...]"* - John 14:6), as well as in the Far East philosophy (Tao – Way). The journey theme has been present in literature since the ancient (Homer's Odyssey) until contemporary times (Kerouac's On the Road). Road movie is a separate film genre (Hopper, Easy Rider). The literary topos of homo viator is a symbol of human destiny, a journey to seek the sense of life.

In Polish, the words "way" and "journey" have a common etymology. However, a journey planned as an event of a circular nature, a journey treated as a challenge, undertaken with an expectation of uncertainty, new experiences and creative inspirations, and with the intention of coming back home - offers a totally different perspective. Starting a journey means being ready for the achievement of the subsequent stages of maturity. This also relates to professional development. Since long ago, the journey theme has been present in many rites of passage. The English word "journeyman" recalls a rite of passage – a ceremony for candidates who aspired to achieve a higher level of craftsman's qualifications. This custom has survived in the German speaking countries (Wanderjahre). Young apprentices, having completed their learning, have to set out on a journey full of ritual principles and limitations.

Research journeys taken by architects throughout ages are an important element of architectural education. When studying the biographies of famous designers one can realize the importance of research journeys, which frequently shaped a given designer's views on architecture and often were a decisive factor in shaping his career.

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Grzegorz Rytel_"My Desire - To Perfect My Skills Through Journeying". Research ...

ARCHITECTURAL STUDY TOURS – AN ATTEMPT AT CATEGORIZATION

Depending on the stage of professional development of a person setting out on a research journey and his itinerary, study tours and research journeys taken by architects can be ascribed various roles and purposes:

Initiation journey – to some extent a reflection of ancient rites, as a result of which novices enter the "first circle" of experience, which makes them realize how diversified and challenging walk of life they have chosen;

Formation journey - which enables one to order and re-evaluate views on certain subjects in view of the newly acquired experience and newly obtained information;

Study tour - which broadens knowledge in a given field of interest and improves professional skills;

Purpose journey – taken for the purpose of collecting information materials and conducting own research and observations, in relation to a concrete action to be implemented or planned.

ARCHITECTURAL JOURNEYS OF THE ENLIGHTENMENT

In the 18th century, in line with the enlightenment paradigm, special attention was paid to empiricism and rational cognition. A need was expressed to follow fixed rules based on nature and reason. In the field of architecture, this prompted artists to give up the expressiveness of the late baroque in favor of reviving the principles worked out in ancient Greece and Rome. Around the mid- 1800s, architectural journeys and study tours to Italy gained in importance in the process of education and became very common. The itinerary of architects journeying around Europe in that period included also Paris and London. Such voyages must be viewed as a professionalized variation of the Grand Tour - a custom of journeys made by young noblemen focused on developing their education and knowledge, which was well-established in England at that time and which spread to the Northern Europe.

For those targeting Italy, Rome was a must-see full of cultural treasures and top works of art and architectural inspirations. Inasmuch as in the first half of the 18th century admiration was reserved chiefly to works of baroque art and architecture, the second half of the "age of reason" focused people's attention on the heritage of ancient Rome. Piranesi's etchings of Rome greatly contributed to the development of interest in the ancient heritage. As a consequence, archeologists started systematic work on Pompeii and Herculaneum. The "newly" discovered Doric temples of Paestum, Segesta and Agrigento became compulsory sightseeing attractions. Popular journey destinations also included the Aegean Sea region - then under the Ottoman rule – where the classical style in Greek architecture was born.

The most famous journeys of that time were described by Johann Wolfgang von Goethe [2] and Karl Friedrich Schinkel [3] in their diaries, letters and drawings published after their deaths.

Karl Friedrich Schinkel, the most important of the German classical architects, visited Italy twice. His first journey, started in 1803, lasted two years, and the second one was taken in 1824. The first one was a study tour as at that time, despite relatively young age, Schinkel must have already been a full-fledged architect. The second one was a purpose journey to explore museums and exhibitions arranged therein. His work files from both journeys include more than 400 drawings and sketches. His thoughts and observations, gathered neatly in diaries and letters, were published in fragments since 1862.

The period of the most intensive research journeys to Italy by the architects of the age of classicism falls within the time of king Stanisław August Poniatowski's reign in Poland. He was elected the king of Poland in 1764.

Pursuing his long-term cultural policy, Poniatowski funded scholarships abroad for architects and artists. The ben   eficiaries of journeys sponsored by the king included: Efraim Szreger – to Italy and Paris (1766-68), Szymon Bogumił Zug to Italy (1771-72), Jan Chrystian Kamsetzer to Constantinople and Greece (1776-78) and to Italy, Paris and England (1780-82), Jakub Hempel (?-1789) and Fryderyk Albert Lessel to Italy (1791-94). The majority of those journeys were study or purpose tours.

The majority of the materials gathered during those studies and research by the Polish classical architects include ambient survey drawings – plans, sections and facades, sometimes also in the form of copies of the already made drawings. Interior drawings present decorative plafonds and walls. Significant importance was attached to measured survey drawings of details, richly decorated stone parts of antique constructions – capitals, architraves, friezes, tympana, etc. Surveys and drawings were made both *in situ* and in collections which then developed into museum collections. Perspectives were not drawn as often as would be thought; maybe not all the journeying architects were able to make such drawings. The research documentation is complemented with notes describing towns and villages as well as with descriptions of selected buildings.

Sketches, which were chiefly made in the open air, required subsequent time-consuming refinement, which was done during the winter months of the journey. However, a lot of drawings were finished only after coming back to Poland. Sketches were made with a pencil or pen and ink; wet-on-wet paintings were less frequent. Final drawings were usually made in a wash technique – with pen and brush with the use of ink or bistre. Using a very limited range of color was an exception.

The journeys of Johann Christian Kamsetzer, his research and studies, working methods and results thereof, are known relatively the best [1, 4]. During his tour of Constantinople and Greece, apart from drawings which documented a journey of the Polish diplomatic mission to the Sultan of the Ottoman Empire, the architect had also made survey drawings of the Hagia Sophia temple and, on a clear request of the king, he made a comprehensive documentation of the Turkish baths – including plans, perspectives and explanatory notes. Thanks to Kamsetzer's exceptional skills, today we can enjoy a collection of landscape and architectural paintings that depict Levantine architecture as well as the heritage of the ancient Greece.

The fruits of his Italian journey include exclusively the results of his architectonic surveys. During the stay at Paestum and Agrigento, Kamsetzer made painting sketches as well as plans of temples and measured survey drawings of details, some of them drawn to 1:1 scale. The study drawings dedicated to proportion analysis were dimensioned and accompanied by explanatory notes. In a letter to Marcello Bacciarelli, Kamsetzer wrote that he

> *"keeps studying, not satisfying himself with mere easy sketches, but he examines objects up close, how they are made, which is the most important for an architect" (Batowski, 1935: 184).*

He had also ordered gypsum castings of selected elements and sent them to Warsaw where he planned to use them in an architectural education scheme during which he pragmatically intended to present ready-made models to the king's craftsmen and plasterers. Account taken of his interests and skills, he also brought numerous architectural perspectives and landscape drawings from his Italian journey.

The documentation of both Kamsetzer's journeys is deemed the broadest and the most interesting collection from among the hitherto examined journey documentations of the Polish architects of that period.

JOURNEYS OF THE MODERNISTS

Since the beginning of the 20th century, a lot of materials have been available concerning the research on the ancient architecture – descriptions, photographs, perspectives, survey drawings of plans, sections, facades and details, genuine fragments of stonework in museum collections. Thus, what were the expectations of modernist architects who set out on a journey? What did they expect to experience when directly exposed to the impact of the heritage left by the founders of the European culture and architecture? Based on the available materials one can retrace a course of „Patient Search" [5] – an attempt at capturing the atmosphere of a place in the changing daylight, at contemplating the balance of stone masses, at recording impressions grasped in a drawing, penetrating the mystery of *"skilful, accurate and magnificent play of masses seen in light" (Le Corbusier, 1987: 218).*

In 1911, Le Corbusier set out on his third research journey, which is well-known thanks to the published diary „Journey to the East" [7]. From Istanbul, which was the easternmost destination in his itinerary, he reached Mount Athos. The observations made in the Athonite State of ascetic monks and conclusions formulated later have been reflected in Le Corbusier's views on collective housing. A strong belief in the importance of ascetism for broadly understood every-day life hygiene was still present in his works in more or less overt form. It was at the Acropolis of Athens where his aesthetic experiences culminated. His main records, apart from notes, included mostly black-and-white sketches capturing his impressions rather than details – views, plans and sections to analyze composition issues, full of information on spatial and structural solutions. The focal points emerging from the study of the 1911 sketches are different than those highlighted by Frédéric Boissonnas' photographs which were chosen by Le Corbusier for the first edition of „Vers une architecture" [6]. Apart from the observations put down in the 1911 diary (which was redacted by its author in 1965 before the first publication), the key conclusions are formulated by Le Corbusier in that very book from 1923, which is fundamental for modern architecture. Only a combination of juvenile fascination with strong views of the already mature architect can give a good impression of how much can be learned by an aware observer who has seen the Acropolis of Athens up close. So, an initiation journey which sweeps off your feet for a long time? A formation „time bomb"?

Louis Kahn travelled to Europe twice. Both times, the subject of his studies included exclusively ancient architecture. The first 12-month-long journey in 1928/29 led through Northern and Central Europe to the Mediterranean countries. Kahn travelled very slowly, and his drawings featured extreme precision in taking account of the details. He used pencil, charcoal and watercolor. He came to Europe for the second journey in 1950 for 3 months as an architect-in-residence at the American Academy in Rome. From there he was travelling through Italy, Greece and Egypt. He produced drawings more intensively than during the first journey. The drawings made in charcoal and pastels focus on studies and analyses of a play of light and shadow on geometrized architectural forms. The drawings become synthetic in character, and in some cases they are similar to colorful abstracts.

> *„Years later, when asked what he did while he was a resident at the Academy, Kahn replied, 'I watched the light'" (McCarter, 2005: 57).*

We know about Louis Kahn, the author of the „Silence and Light" essay, who regarded light as essential material for architectural design, that since his coming back from his second journey to Europe, his designs were always influenced by heavy construction and the spaces shaped by

massive masonry, which impressed him so much in Europe, and he had never again made use of lightweight steel structures, which were essential features of his designs before the journey. It seems that in case of Kahn we can observe an interesting inversion. The first journey of a young, not yet 30-year old architect was a study tour; it was undoubtedly important, but it did not impact his creativeness in a significant way. After more than 20 years Louis Kahn made a formation journey, which had a strong impact on his development as an artist, and was a turning point as regards his views on architecture.

Not all frequented destinations of study tours are for greenhorns. Those special ones require an appropriate level of maturity. Rome is undoubtedly such a place. Le Corbusier was positive about a need to be appropriately prepared for experiencing the fierce intensity of aesthetic emotions provided by the Caput Mundi:

> *"The lesson of Rome is for wise men, for those who know and can appreciate, who can resist and can verify. Rome is the damnation of the half-educated. To send architectural students to Rome is to cripple them for life. Scholarships in Rome and in Villa Medici are like cancer penetrating the French architecture" (Le Corbusier, 1987: 173).*

It seems that Le Corbusier used more blunt words to express what Goethe, who in Italy sometimes presented himself as an architect, observed more than 130 years earlier:

> *„So, at last I have arrived in the capital of the world! If I had visited it fifteen years ago in good company, guided by someone truly intelligent, I would have thought I was a happy man. If, however, I was destined to sightsee on my own, it is good I can enjoy this pleasant opportunity so late in my life" (Goethe, 1980: 110-111).*

Louis Kahn expressed his respect for the impact of the Roman architecture somewhat differently; spending long hours in the American Academy gardens in Rome he claimed that

> *"Roman ruins needed to be contemplated from a distance to be fully understood" (McCarter, 2005: 57).*

Purpose Journeys

Some research journeys of architects have a relatively narrowly defined concrete purpose. Before starting work on the equestrian statue of Józef Piłsudski, Paweł Wędziagolski – a tutor at the Faculty of Architecture of the Warsaw University of Technology, made a research journey to Italy in 1926. He came back with the measurements of four equestrian statues: Macus Aurelius in Rome, Cosimo de' Medici in Florence, Bartolomeo Colleoni in Venice and Gattamelata in Padua.

Notes made by Wędziagolski during the journey were also to have been the basis for his doctoral dissertation. His tragic death stopped the work. The drawings, which today decorate the interiors of the Faculty of Architecture, are proofs of his skills – a lesson of mastery in drawing and a lesson of how to make a notation of an architectural survey.

In 1928, Edgar Norwerth won a contest for a design of a campus of the Central Institute of Physical Education in Warsaw. Since the task was quite specific, before starting work on the design, he set out on a research journey to see similar developments. He targeted physical education universities in Czechoslovakia, Italy, Germany, Denmark and Sweden, including Gymnastiska Centralinstitutet (GCI) in Stockholm – erected in 1813, Deutsche Hochschule für Leibesübungen in Berlin-Charlottenburg and Accademia fascista di educazione fisica at Foro Mussolini in Rome – both still under construction at that time. In Norwerth's opinion, none of the examined examples of architecture could be a starting point for his new project in terms of the general planning of the campus. However, abundant information collected during the journey concerning the design of

sports grounds, sports halls, swimming pools and many other specialized technical details turned out to be very useful at the stage of working design preparation [9].

Exceptional Journeys

In spring 1956, after the doctrine of socialist realism in the Polish architecture was abandoned officially, the Society of Polish Architects (SARP) organized the first official journey behind the iron curtain. The route led through Czechoslovakia, Austria, Switzerland, France and Italy. During 5 weeks, 30 architects enjoyed an opportunity to see selected individual buildings and architectural ensembles, both historical and contemporary ones. They could analyse solutions in terms of functionality and structure, learn about new technologies and finishing materials. The news about the journey echoed widely among the architects. The initiator and organizer of the journey, Tadeusz Barucki – an architect, researcher, critic and traveller, wrote:

> „Until today, when I meet the participants of that journey, they recall it as the greatest event in their lives" (Barucki, 2007: 12).

Study materials collected during the journey, documented in the form of photographs and systematized in a number of individualized variants of private collections, were presented in the professional circles of architects. This contributed to spreading information on the trends in the contemporary modernist architecture in the west, and one can risk a claim that it had impact on the Polish architecture of the turn of 1950/1960s. For some of the participants that was obviously a study tour, but for some of them it was undoubtedly a formation journey. One can also risk a teasing opinion that it was a purpose journey, the aim of which was to eliminate differences resulting from the lack of information flow and exchange of views during the Stalinist period.

SUMMARY

This article does not exhaust the topic of research journeys of architects and it has to be hoped that a lot of interesting themes from the biographies of many architects can complement the studies on the subject. One can refer to the results of research by Bernard Rudofsky, architect-traveler, which are presented in lectures, exhibitions and publications.

Even though this article has presented the topic of research journeys in such a narrow perspective, one can clearly see how important a part of educational process they have been, and how helpful in collecting and ordering information, and in developing professional skills.

It seems that also today, despite easiness of recording, disseminating and accessibility of architectural images, study tours and research journeys have not lost their importance, and as in the past, they still have a major role to play in the continuous education of architects.

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THE LATENT PEDAGOGY OF THE ARCHIZINE

Architecture fanzines - known as 'archizines' – provide a vehicle through which students can critically reflect upon their learning experience and/or discuss emergent or even 'radical' issues that are often absent from the usual suite of academic and trade journals. For students in particular, the archizine often provides the only space in which their concerns are articulated. This paper will seek to define the latent pedagogy of the archizine – and consider the unrecognised value of this vital vehicle for achieving learning, empowerment, critical and inclusive discourse and interdisciplinary collaboration.

'Like architecture, DIY publishing comes burdened by physicality. In a strange twist of fate, however, it is the distribution network of little magazines that unburdens architecture.' Mimi Zeiger, Loud Paper 4(4) [1]

Architecture fanzines - known as 'archizines' – provide a vehicle through which students and professionals can critically reflect upon their learning experience and/or discuss emergent issues that are often absent from the usual suite of academic and trade publications & journals (Redstone, 2012) [2]. There are 78 post-millennial archizines in existence at the time of writing [3], which suggests that this is a genre and format that has enduring appeal. The long and diverse chronology of archizines has been effectively captured within two exhibitions: 'Clip/Stamp/Fold: The Radical Architecture of Little Magazines' (Columina 2010) [4], which focuses upon the archizines of the 1960's and: 'A Few Zines: Dispatches from the Edge of Architectural Production,' (Loudpaper, 2009) [5] which explores the interdisciplinary influences within architectural zines during the 1990's [6]. Whilst the millennial rise of online communications have lured some archizine producers away from the traditional (and often more costly) printed medium, printed literature has recently experienced a renaissance [7,8], renewing the appeal of the 'object-ness' of these hand-made, often photocopied and stapled artefacts. For students in particular, the archizine often provides the only space in which their concerns are articulated; concerns that both academia and practice-oriented publications often seem to entirely ignore (Berman, Z. 2013:2) [9]. As Nina Shen-Poblete, founder of 'event based live fanzine' Black Grout observed (2013) 'archizines are often a reaction to a lack of critical engagement in the profession, disjunctions between education and practice and an elitism in architectural discourse, (Shen-Poblete, 2013) [10]. Indeed, many archizines address these agendas through geographies, typologies, formats or themes (Berman, Z. 2013) [11] as a means to ensure that their content addresses a point of conflict. The chosen agenda for this paper

concerns the way in which archizines address points of conflict in education – for example, where school value systems, what constitutes knowledge, design studio issues, or curricula content or delivery are being contested, and the pedagogic implications of such acts - a subject that has not been previously reflected upon within architectural literature. Subsequently, this paper seeks to address this gap in knowledge by providing an overview of the nature of archizine-specific, student-generated pedagogy and; examine the extent to which fanzines are tacitly aligned with established learning theories. Furthermore, this paper seeks to substantiate the claim that archizines play a vital pedagogic and practical role in offering more than a basic understanding of contemporary architectural theory and practice - and instead – offer more inclusive, empowering and societally responsive ideas and discourse than conventional academia and trade publications (Freire, 1968) [12].

Methodologically, five archizine case studies are scrutinised, focussing particularly upon student-initiated or engaged archizines: **NATO** (Narrative Architecture Today), (1983-86) **Fulcrum** (2011-14), **2ha** (2013 – on-going), **Archigrrle** (1999-2000) and **Pollen** (2001 - 03). Each of these case studies is chosen on the basis that they exemplify the defining characteristics of the archizine genre. The latter two were produced by the author during her student years. The decision to include these somewhat subjective archizines was intended as a means to incorporate auto-ethnographic [13] research methods into this enquiry and provide an interesting counterpoint the traditional methodologies used to examine the independent archizines.

Fig. 1. Cover and front page of NATØ.

Source: Image courtesy of Mark Prizeman (NATØ)

NATØ (Narrative Architecture Today)

NATØ emerged from the Architectural Association School Unit 10 in 1983 and was active until 1987. It's name was ironically appropriated from the original acronym for *Northern Atlantic Treaty Organisation* – UK Prime Minister, Margaret Thatcher's Cold War defence team, whose intention was, "to safeguard the freedom and security of its member states", (Castle, 2005) [14]. Arguably,

Harriet Harriss_The Latent Pedagogy of the Archizine

NATØ was similarly concerned with 'freedoms', but these were creative, and explored through mixed drawings, photographs, writings, collage and montages from others magazines and even performances and live events, drawing inspiration from 'zines' and other radical publishing practices in literature, music (Jameison, 2014)[15]. Indeed, in much the same way that interdisciplinary pedagogy has been described as a, 'formation that confounds the disciplines and creates a vacuum of institutional context,' (Penny, 2009)[16], so too did NATØ. Furthermore, NATØ was written within what Martin Kreiswirth called the 'narrativist decade', whereby, 'narrative, like "grand" or "meta" concepts such as "language" or "reason," has begun to leave the reflected light of specific disciplinary, institutional, or methodological arenas and become a source of illuminary convergence,' (Kreiswirth, 1992, p.630) [17]. Similarly, the convergent nature of narrativism aligns with recent literature concerning the narrative nature of pedagogical content knowledge within interdisciplinary learning, and its ability to order to an otherwise chaotic curriculum (Gudmundsdottir,1991)[18]. In effect, NATØ were using narrative to make architectures 'chaotic' 'disciplinary & institutional' methods and processes make sense – drawing inspiration from art, fashion, pop music and nightclubs. As Castle highlighted, 'NATØ's urban design and consumer spaces have so seamlessly entered received knowledge, that its influence has been denied', (Castle, 2005) [19]. Ultimately however, NATØ's sense of zeitgeist – described by Villanueva-Brandt as a "largely responsive" (and by implication unstable) nature - may have propelled toward its downfall (Castle, 2005) [20]. Yet, it was NATØ's ability to 'make sense' of the interdisciplinary practices underpinning the Post-Modern rhetoric of the time that positions it as one of the most salient commentaries of that period of architecture, and a lens through which to examine the 'chaos' of interdisciplinary pedagogy too.

Fulcrum

The next case study presented for consideration is Fulcrum, founded by architecture students Jack Self, Graham Baldwin and Aram Mooradian and published weekly from 2011 to 2014 at the Architectural Association School in London. Fulcrum's design was 'based on the idea of a pivot – a line drawn down the centre of the page, on either sides of which two articles sit and discuss a particular topic' (Self, J. 2013) [21], with the reverse of the page featuring an indicative illustration or image. Its intention was to address, 'the agency of the architect as a construct in the late neo-liberal economic model,' (Self, J. 2013) [22], and to challenge to the lack of engagement between the AA students and the outside world (Dutton, R. 2014) [23]. Pedagogically, it provided a critique of the economic forces influencing practice and their influence on education and in effect shared the educators burden of responsibility in opposing neo-liberalism, by bringing democratic political culture back to life,' (Giroux, 2011, p.73) [24]. Whilst churn within the editorial team combined with the size and frequency of the editions highlighted its instability, its lack of curricula or credit-driven preoccupation manifested as a thematic agility more able to respond to emergent concerns, such as the Occupy movement of 2012 (issues 32-37). It was also notable for creating an equal platform for discussion between students and staff, often using the vertical divide down the centre of the page as a means to pair an established academic or writer with a student - without giving either primacy. Aside from the democratising outcomes, this approach encapsulates the best of autodidactic or student-led pedagogy (Michael, 2008) [25]. It also enabled students to propose and direct - and not just absorb or react against – established thinking. The frequency of publication and coherency of the agenda led Fulcrum to be one of the most successful and influential archizines: at one point, it had over 7000 online readers [26]. Of all the recommended academic texts imposed upon students in their course reading lists, one wonders how many have achieved this level of popularity, or inspired as many imitators. The potential for archizine influence over curricula should not therefore be underestimated.

2ha

Irish archizine 2ha works with architects, academics and artists to create work that both examines and re-imagines suburbia,' [27]. For several decades, suburbia has been maligned or simply disregarded within architectural history. 2ha's analysis and reimagining of suburbia takes a different view, highlighting its inherent beauty and latent visual intrigue. It also offers a sublime critique of planning systems and categorisations. The title itself is a double-entendre – makes reference to land metrics (2ha meaning two hectares) but also the geographical context in which the magazine originates: the Irish word "tuatha" refers simultaneously meaning people and the land they inhabit. This reflects their belief that, 'the modern Irish suburb, the land, and the way it is used, is still inextricably linked to the people that use it,' [28]. For many years, architectural historians disregarded suburbia. However, rising house prices coupled with student debt has renewed their appeal, and architectural literature has more recently renewed its interest in this typology. Arguably, suburbia is more recently undergoing a renaissance, one which positions 2ha as something of a zeitgeist in being one of the first to highlight the suburbs previously neglected importance. Pedagogically, 2ha shares the critical and co-creational characteristics of Fulcrum. Furthermore, 2ha operate a model of 'Situated Learning' (Wenger & Lave, 1991) [29], whereby legitimate peripheral participation in community contexts such as the suburbs enables learning by doing. Similarly, Robert Brookes analysis of the American suburb identifies it as the site where students develop a more 'robust citizenship' and a 'place-conscious' education can take place, (Brooke, 2015) [30], which seems a fitting description of the pedagogic dimension within 2ha. Furthermore, by 'engaging in regional and local issues and conditions,' (Holland, 2004) [31] 2ha engenders a greater sense of citizenship (Carpini, 2000; Colby et al, 2003) [32]. Arguably, literature that serves to help increase architects commitment to public service not only benefits students and society but the profession as a whole.

Archigrrle

(1999-2000) was set up by paper author Harriss during year two of her undergraduate degree at Manchester School of Architecture. Archigrrle was inspired by a concern over the lack of female representation in architecture and specifically intended to give female architecture students a voice through the medium of comic strip and poetry. Most of the content was intentionally droll but there was often a tacit, more serious agenda at play. For example, Archigrrle tackled issues tacked as diverse and complex as maternal bereavement, the loss of workshop technicians in the school due to budget cuts and the sexual-political dynamics operating in the design studio. This aligns with the pedagogic principles of Freire (1968; 2000) [33] who argues that students should considered less as mere consumers of established knowledge and instead critical commentators and co-creators of the forms of knowledge that prove to be both empowering to them and to society as a whole, (Freire, 1968). Whilst only two editions were ever published due to involvement in other projects, Archigrrle provides an interesting, historic snapshot of the changes taking place in architectural education - at a time when higher education still offered grants to students from low-income backgrounds. Furthermore, the auto-ethnographic subjectivity of the comic strips illustrated how architectural education was experienced – providing a critique of the student author, and not just the system. This critical-of-self approach traces its origins back to Descartes famous method of 'rightly regulating reason', which is in effect a form of autodidactic pedagogy, 'a sceptical meditative process by which one expels faulty beliefs' (Taylor, 1979) [34], replacing them with a clearer and better informed sense of certainty. In effect, Archigrrle captured the way in which education was interpreted and then applied to everyday experiences, exemplifying the 'reflection upon and in action' pedagogic model espoused by Schon (1983) [35]. In assuming a critical-of-self approach by allowing for knowledge and beliefs to be continually questioned, refined and edited a process of iteration occurs. In effect this involves keeping discourse in a state of responsive instability – is a key hallmark of the archizine genre.

Pollen (2002-2003)

like the other archizines -used a thematic strategy to set agendas about ideas or issues they considered important – but that were not being explored within their MA architecture & interiors program at the time. For example, Issue 01 'Property' addressed gentrification but also explored notions of 'ownership' in relation to the marriage contract. In contrast, Issue 03 'Fight,' was intended to challenge the government's decision to re-enter the gulf war in 2003. Pollen's content mean that it exemplified self-directed learning (Knowles, 1975)[36] and in some ways became a refuge from the design studio, even proving to be more intellectually consuming than the design briefs. As the name was intended to suggest, Pollen was specifically interested in the dissemination of ideas between disciplines, and how architecture related to and integrated the other forms of creative practice. Subsequently, each edition would sponsor art & design students to produce limited edition artefacts: interdisciplinary pieces for the limited edition print runs, as a means to foster interdisciplinary collaboration (Wagner, 2012)[37] between students from across the college. The pieces ranged from a fanzine sized body-bag with a pink silicon knuckle-duster (Fight issue), a sexually provocative, printed tea-towel that could be used many times and show signs of wear (Age issue) and a version of the archizine exploring animation that was printed on a dress pattern intended to exaggerate a woman's curves (Fat issue). In some ways, Pollen offered a critique of the college's lack of opportunity for interdisciplinary exchange, since these opportunities were few and far between at the time. Finally, whilst Archigrrle took a clear position on feminism (as the name affirms), Pollen assumed a more tacit approach, using the bodies of the two female authors as harbingers of our feminist take on the theme: from computer-aged depictions for the Age issue to wearing wedding and spinster gowns in the Property issue. These tactics facilitated a feminist reading of the content by using the implied (rather than the actual) – a tactic which contemporary feminist theory has identified as, 'a new facet of agency that rhetorical theorists have heretofore neglected,' [38].

CONCLUSIONS

Archizines offer an important, if unconventional, medium through which pressing architectural concerns are imaginatively considered and critiqued and yet their pedagogic prowess had not previously been considered. Archizines handmade roughness & thematic immediacy capture a certain zeitgeist about the need for alternative ways of scrutinising architecture, and they prove to be a more accessible format than a conventional publication, academic article or trade journal through which students can participate in the co-creation of architectural knowledge. What this analysis of five case studies identifies is that archizines offer not only an important critique of architecture in practice, but of architectural education too. Indeed, by establishing some of the ways in which archizines are tacitly enriched by good pedagogies - such as inter-disciplinary collaboration, civic engagement, self-directed learning and autodidactic learning – demonstrating their educational functionality too. This is further supported by recent scientific evidence that the tactility of printed artefacts are more effective than their digital counterparts at achieving 'deep' reading and by implication, learning, (Keim, 2014) [39]. Subsequently, this paper contends that archizines should be considered a key part of architectures literary and pedagogic canon; a methodological tool for data gathering on nascent concerns and for measuring pedagogic efficacy and impact; and as a means through which students' autodidactic capabilities can be developed and expressed.

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Research

"Unanticipated novelty, the new discovery, can emerge only to the extent that his anticipations about nature and his instruments prove wrong."

- Thomas S. Kuhn, The Structure of Scientific Revolutions

This second part entitled research brings together a selection of works that rely on new technologies or new investigations. 'Reflections on the Insertion of Technologies in Architectural Curricula' by José Duarte introduces challenges and benefits of bringing the theme into education and our general attention. We have featured numerous works on the latest technology applications on architecture and spatial design.

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REFLECTIONS ON THE INSERTION OF TECHNOLOGIES IN ARCHITECTURAL CURRICULA

Based on the author's own experience, this article reflects on the motivation for inserting new technologies in architectural curricula, on the problems one may face while undertaking such an endeavor, and on the principles of a strategy to overcome them.

In this article I reflect on my own experience of inserting the teaching of digital technologies in architectural curricula. I have done it twice, one at Instituto Superior Técnico and another at Faculty of Architecture, both at the Technical University of Lisbon. And I have just started a new endeavor in this regard at Penn State University (Fig. 1). Looking back, what I find surprising is how much effort goes into human, organizational, and financial issues, rather than into technical aspects. But this should not come as a surprise. In any case, before embarking on such an adventure, full of roadblocks, one may ask why is important to insert technologies in architectural curricula. Below I address this question and then, describe some of the problems and the principles of the strategy that I have used. For detailed accounts on my efforts to insert new technologies in architectural education mentioned above, please refer to [1], [2] and [3].

There are a number of reasons to invest in new technologies. Architecture has always reflected the technology of its time and so there is no reason for not using the technology of our time in the design and construction of buildings. Technology permeates society and our lives. We talk to our friends on Skype, we drive electronically controlled cars, and we watch 3D movies. It is, therefore, not reasonable to expect that we conduct our business without being affected by the same kind of technology. Moreover, some of the issues we have to deal with today are caused by technological evolution, such as environmental problems, increase in human population, strong urbanization, and so on. It is only reasonable that we use the same technology to curb some of its negative effects. In addition, in our contemporary competitive society of knowledge, architects and designers in general need to become acquainted with technology and learn how to use it in appropriate ways.

The insertion of new technologies in architectural curricula, however, faces several challenges. It puts a stress on architectural curricula by requiring the teaching of new matters and additional teaching hours or the revision of current course contents. It also represents a challenge from the

financial viewpoint because of the need to build an appropriate infrastructure and buy hardware, software, and new machinery. This is a novel situation for many architectural schools, which then have to face rectors surprised with the new, sudden demand of budget increase to acquire, operate and maintain such equipment. The other difficulty is caused by power struggles that emerge as a consequence of new technologies and their popularity among young students. Faculty who do not control these technologies might feel that they might lose influence within the school. Finally, there are technical problems. These might be connected to the need to install and maintain the basic infrastructure, but they might be linked to the need for mastering architecture-specific software and hardware. And, more importantly, it might stem from the need to understand how these can be woven to traditional architectural teaching and practice.

There are several strategies that one might follow when inserting new technologies in architectural curricula. I have used one that seeks to translate research results into economic growth. This strategy includes several principles.

One principle is the inclusion of new technologies in the early stages of architectural education, along with traditional technologies. This permits future professionals to acquire the ability to select and use the most appropriate technology for each design problem, allowing them to develop innovative solutions, but innovation may be considered in the selection of traditional techniques, as paradoxical as it may seem. This approach does not pre-exclude anyone from a possible solution, thereby promoting social inclusion. For example, the proposed solution can make use of traditional technologies such as earth construction, but combining it with new design technologies may enable novel solutions and create jobs in new and traditional areas, simultaneously. The result can be a rich and diverse productive fabric in terms of sophistication, but also in terms of adaptation to changes in the economic environment, avoiding major disruptions.

Another principle is the assumption of knowledge as a whole. That is, the division into scientific fields resulting from increased knowledge and consequent specialization is artificial, and it may be useful and even necessary in resource management, but it is harmful in addressing problems that require integrated solutions. For this reason, such a division should be counter-, by promoting the training of professionals with diverse knowledge and the integration of different professionals in shared situations and spaces. For example, in the university curriculum, there should be a range of elective theoretical courses that enable to form professionals with slightly different profiles, overlapping with other professionals, and therefore able to communicate with them. Similarly, there must be practical courses with the participation of students from different area organized into multidisciplinary teams to solve complex problems. I remember a project in which I participated that included students and professors of medicine, architecture and engineering. The goal was to develop a mathematical and geometric model of the dynamic behavior of the spine, to rehearse solutions before surgery with the introduction of prosthetics in spinal patients. The physicians provided the results of magnetic resonance imaging of the patient with which the architects created a dynamic 3D model of the body; in turn, the engineers used this model to study the static and dynamic behavior of the spinal structure while rehearsing different prosthetic solutions to provide doctors with the most suitable one.

A third principle is to demystify the idea that each professional can only work in his narrow field, as the opposite may be desirable. Considering the previous example, an architect and an engineer do not necessarily have to work on the design of buildings, but may also work on problems that on a concrete level seem very different but on abstract level may be similar. The human body is our first house in the world and as such is subject to the same laws of gravity. Seeing reality through this prism allows one to maximize the contribution to society and the sense of personal fulfillment.

The fourth principle is related to collaboration. The emphasis should be on cooperation, not on competition. It is by collaborating that we can find appropriate solutions to the problems that affect us. If the only thing we do is to compete, we will never have the opportunity to find such solutions. Collaboration should exist within each institution, but also between different institutions. Collaboration reduces stress and allows one to optimize resources.

The fifth principle is to build bridges between educational and research institutions and the society in which they operate. It must be the reading of reality that should feed education and research, in order to ensure that they form professionals sensitive to the needs of society, able to be a part of and contribute to it. This makes it easier for research results funded by public or private funds to be translated into social benefits. This does not mean that the institutions should only do applied research. Basic research is necessary, although social benefits may not be immediate. It is due to the gravity laws discovered by Newton in the eighteenth century that we can build the boldest buildings in unlikely locations today.

The last principle that I would stress is ethics. It is the glue that sticks all the other principles together. Without strong ethics everything disintegrates, it is impossible to cooperate, but also to compete. For example, a company that gets a prominent place in the productive fabric of a country by evading taxes will have a hard time to competing internationally. Tax evasion means lack of cooperation, as it consists in the use of resources for which we do not contribute. We cannot compete because we do not add value to products but artificially lower production costs by not paying taxes. As in business, ethics is fundamental in institutions dedicated to research.

By abiding to these principles one may tackle the challenges that affect the profession today. It is essential to train diversified and flexible professionals, who are able to work with professionals from other areas and to apply the knowledge acquired to other realities. These professionals should remain open to personal growth, learning to operate new techniques and in new realities. Collaboration is essential, reaching out to help and to assist. This also means that society must be attentive to reality, which includes a core of people with less training in certain areas; it is necessary to take this into account when it tackling problems. For example, designing for a region using construction techniques that use the local workforce is a smart solution. This may mean to use local techniques, but also to introduce new ones that can be sustainable in the future, that may be assimilated and incorporated in the local community. Social exclusion must be avoided at all costs as it is not sustainable, leading to disruptions that negatively affect all, included and excluded people. We must work in both directions: on the one hand, perceive reality, the valences of the existing labor force for designing new realities and, on the other hand, the labor force must remain open to learn. The architect must think about the use of local building solutions, but local workers should be available to learn new construction techniques.

The insertion of new technologies does not mean to get rid of old ones, but to enlarge the range of opportunities at our disposal. For architects, it may mean to widen the scope of our intervention.

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TOWARDS THE UNDERSTANDING OF SPATIAL ORDER AS A CULTURAL ISSUE

The thesis that in a situation of two different cultures, using the same spaces, their perception and evaluation of spatial order differ in several ways, has been proven using the case study of traditional Jewish neighbourhoods in central Poland. The research framework brings together several disparate studies in anthropology and semiology, with the emphasis on nonverbal aspects of communication, namely kinetics and proxemics. Formal features of outdoor spaces, i.e., their scale, rhythms, corrugation of facades, etc., have been assumed as the formal equivalents of those non-verbal expressions, providing a large part of the contextual content of communication.

INTRODUCTION

The influence of culture on everyday life in a globalising world is underestimated, the scarcity of research on the role of the cultural framework in urban design leads to misunderstandings in the evaluation of the urban fabric. The built form is often said to be an artefact of the cultures and societies that created them, the explanation of which requires the concerted efforts of several disciplines, the minimum list comprising: urban design, urban morphology, anthropology and cultural studies. Eco (1997) presents a solution to this problem, explaining architecture and more largely the built environment as a semiological system, through the meaning attributed to physical structures. His theory, while giving some initial insights on the mechanisms of how culture influences the shapes of built forms, still leaves room for further speculation. With a multitude of dispersed theoretical work on the ground of anthropology, a more comprehensive and explicit theoretical apparatus is called for, to properly evaluate the existing structures. I believe that embedding the notion of spatial order, which remains a well-known and accepted term in urban design, into the considerations on the culture-related meaning of urban space is key to understanding the impact of culture on the built environment. In the current paper, I explain an attempt at such a theory, using the example of prewar Jewish-Polish neighbourhoods in central Poland. After introducing a case study, I briefly discuss the methodology, which further serves as explanation of the noticed features of urban settings. The summary and future research avenues conclude the paper.

CASE STUDY

The current paper explores an empirical case study of the urban settings formerly inhabited and largely constructed by Jews in central Poland, mostly in the 19th and early 20th centuries. The analyses of people's behaviour in the outdoor space, the careful study of their everyday practices and habits, as well as a detailed examination of the underlying norms, allowed me to pinpoint features, both with regard to urban structures as well as specific spatial practices and behaviours, and their mutual relations. Moreover, the examination of norms of this group as well as the study of the acculturation processes in its diachronic aspects led to analyses of their impact on the shape of urban forms. In the current paper, due to its limited volume, I briefly introduce the explanation of a few of the most representative culture related features of the traditional, orthodox Jewish neighbourhoods in central Poland.

METHOD – THE VARIOUS ASPECTS OF THE MEANING OF THE BUILT ENVIRONMENT

Eco (1997), in his seminal work on architecture as communication, gives an interpretation of the conscious portion of the message delivered by built structures. Semiology defines a sign through the codified meaning that a cultural context assigns to a given marker. Architectural signs contain a marker, the detonator of which is the function that an object may perform. Depending on its cultural context, a single object may carry many markers and, with time, be assigned varied meanings (Eco, 1997). Further in the same essay, Eco (1997) considers the reference to a more general anthropological system, the one discussed by Levi-Strauss (2009), which rules all human behaviour. He puts forward the proxemics theory by Hall, and mentions also kinetics and proxemics as if extending communication with behavioural components. In my interpretation of meaning of urban environment (Hanzl, 2013), I hypothesised on a parallel of communication by urban environment and spoken communication. Next to the articulated message, which, referring to architecture, should be understood, as Eco explains, through function and its explicit manifestations in space, there is also an unconscious part, provided via the forms of urban structures, which triggers our senses in a more direct, nonverbal way. Messages in this group are carried by such parameters of urban spaces as their scale, rhythm, wall corrugation, etc., all of which are behind the creation of a certain atmosphere or sensation, which may also be approached through a more general notion of aesthetics.

Situation and its settings

The urban contexts may enhance human encounters with their semantics, thus providing a replacement for a part of communication (Hall 1989). In the case of high context cultures, the settings' contribution to the information processes confirms the validity of the assumed norm. The territorial distribution and exchange of nonverbal cues serves a communication purpose and may be attributed certain semantics, similarly to the behaviour of a human group, which reflects its internal organisation [Goffman 1959]. The set of identifiable, spatially related cues, qualified by Rapoport (1990, pp.106-107) as culture-specific, includes features like: *"quality, size, shape, enclosing elements, paving, barriers, and links, etc."* The concept of situation, comprising both human behaviour and the environment where it takes place, challenges the form of urban settings, understood as a theatre of human activities (Perinbanayagam 1974). Anthropologists developed elaborated theory on ways in which a site is converted into a meaningful 'place', by inscribing human activities into the surroundings.

Social organisation and sociometric layout. Proxemics

Group behaviour depends on the relations among the people entering the situation, as well as on the situation itself. Hillier and Hansen (1984: 223-224) approach encounters and interactions of people as a system which acquires distinctive properties with different manifestations in space, and should be understood as an evident spatial component of culture. The rules of group behaviour, including spatial distribution and the established network of paths that result from the hierarchy of group members and from their recognised habits, are visible both in static situations and during the coordinated movements of the group. The same set of behavioural patterns, relatively stable in a given culture, serves as a set of rules for construction, thus they become reflected in the distribution of sites and structures and in their sociometric layout. Another approach to this phenomenon has been presented in the recent study by Marshall (2009), who explains the arrangement of pieces of urban structure on the backdrop of the social structure of a given community. The interpersonal distances between crowd members are related to the cultural conditions of a given community, and are the subject of proxemics, which, constituting a part of the anthropological approach, relates the human environment to the behavioural patterns seen for distinguishable cultures. Differences in personal distances influence both the perception of space and its production (Hall 1966).

Aesthetics

Adorno (2011, p.5) points out the role of artworks as a medium reflecting the unconscious aspects of culture, which refer to urban settings catering to community needs, including the aesthetic criteria. Strzemiński (1974) explains the phenomena of the adjustments of some visual patterns in built environments, e.g., repeating rhythms, to patterns ruling group behaviour, with the evolution of visual awareness, which transformed together with the changes of the socio-cultural settings. He finds the roots of this correlation in visual awareness, understood as the "cooperation of seeing and thinking" focusing on the role of the cognitive absorption of the perceived visual stimuli. The changes of visual awareness followed civilisational development, such as economic and technical factors, as well as the transformations of the social structure of a given group of people in a defined historical context.

Spatial order

The above considerations provide a framework for the description of physical structures in relation to the customary ways they are used and produced. The anthropological order, discussed both by Levi-Strauss and Eco, manifests itself in the physical form of any built environment. An inherent part of a given culture, a spatial order may be understood and accepted against the backdrop of the basic set of assumptions, culture related practices and ways of thought and judgement. The two distinct epistemological perspectives, respectively anthropology and social science, and urban design, rely on different premises, thus terminological clarity is necessary. While in the case of spatial behavioural practices the non-verbal communication component may convey the general notion of situational meaning (Hanzl 2013), for the spatial distribution and form of physical settings the concept of spatial order applies.

DISCUSSION

The current paper draws on some elements of the traditional, or, as it used to be called, starting from the turn of nineteenth century, the orthodox Jewish culture which was once present in central Poland, to illustrate how different cultures interpreted the same space in different ways, with the notion of spatial order which once triggered many controversies.

Disorder versus order

While places inhabited by Jews satisfied their needs, for Poles they seemed unordered and chaotic, and were often described as requiring beautification. Already in the second half of the eighteenth century one reason to consider the transformation of Jewish districts was their assumed disorder (Bogucka, Samsonowicz, 1986). When discussing the urban structures of Jewish districts, most authors continue using features attributed to these settings, including: overcrowding, chaotic distribution, fragmentation, unplanned parcellation changes, etc. (Piechotka, 2004: 63). Hubka (2005) attributes the dense, non-geometric spatial layout of the Jewish districts in small towns of the eighteenth century to the incremental growth and restrictions placed upon the Jewish community through legal regulations. Not questioning the problems which persisted as a consequence of poverty, which were, for all that, also present in prevalently Polish neighbourhoods of a similar social status, a part of this apparent chaos may have resulted from a different perception of spatial order. The difference in perception was clear for Jews living in pre-war Poland, some places appearing homely, others inimical or even hostile. For Jews, the neighbourhoods they lived in catered to theirs needs in terms of daily life, with the semiotic code attributed to their elements in a way which, not only rich and complex, but also resulting directly from the expectations and written rules, remained deeply engraved in the tradition which had formed through the centuries.

Functions

Regardless of the initial framework, which were in both cases the same, and consisted in most cases of medieval patterns of towns laid down under German law, the way this layout was filled in differed. Jewish life consisted of two fundamental spheres: sacrum and profanum. In the first, the focus was initially on the synagogue, which later on expanded to several additional structures, at first beit midrash, then yeshivas and shtibl. Hall (1969) distinguishes cultures that are of a more concentric or more linear nature. I believe this used to be one of the key differences between traditional Polish and Jewish organisation of space in prewar times. The concentric nature of Jewish spaces is particularly apparent when looking at synagogues' courtyards, which, setback inside a block's interior, gathered around all the necessary community institutions. With time, their location dispersed, but the main rules of spatial organisation remained. In the profanum sphere, the focal point was the market place, Jews tended to settle in the proximity of a main square, which attracted them by catering to their economic needs. The third focal point was interior streets, courtyards and in later times backyards where daily life took place. This was the domain of women who had their separate role in traditional Jewish life.

Social organisation and sociometric layout

The territorial constraints of the land where Jews could settle, as a result of the privilege de non tolerandis judeorum or zones for Jews in many towns, along with the huge attraction of prospering urban centres, and the high population growth, resulted in very high densities in Jewish neighbourhoods. This led to extensions, usually illegal, of the former structures. This vernacular development followed patterns suited to the Jewish organisation of space, regardless of the Polish cultural environment, but still using local materials and construction solutions.

At the turn of the eighteenth and in the nineteenth century they often settled in old, yet Medieval parts of towns. The network of public streets was enriched with additional small scale passages, nooks, etc., which served as communication without having this function assigned as a primary one, being just parts of courtyards. The transformation of the former parcellation followed a different social organisation. The community – kehilla, both very strong and practically independent from the town's regulations, functioned separately from the surrounding town, even if well integrated into its structure, catering to the needs of towns' citizens and visitors. This position had its reflection in the

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urban structure, with interior space within Jewish quarters, seemingly unordered and uninviting to visitors, but for Jews serving as extensions of their domicile and space of interior circulation, the last observation is confirmed with the tradition of eruvim - temporary cords distinguishing private space during Sabbath.

Proxemics

As a rule, in traditional Jewish neighbourhoods' streets were narrower than elsewhere, which is the proxemic feature of Jewish culture where interpersonal distances are smaller than in the case of Polish culture. Physical contact with other members of the community in Jewish Ashkenazi culture is something natural, we find many descriptions of lively disputes between Jews, during which they touched each other. Efron, in his comparative study, analysed in detail Jewish and Italian migrants' kinetics behaviour with regard to acculturation processes (Efron, 1941). This feature had its reflection in the preferred scale of physical outdoor space created by Jews.

Aesthetics and spatial order

The quantitative study of the physical form of several streets and squares which I carried out with the use of Grasshopper scripting, showed much greater irregularity of facades in Jewish neighbourhoods, both in the vertical dimension and corrugation of facades. While, along with Classicism and geometrisation of plans, the corrugation became less apparent, the variations of the rhythms of facades continued. I believe that this apparent disorder had as its origin a different notion of spatial order suited to Jewish culture. This had raised concerns ever since Polish government's elaborations on the ways of improving city life, which, starting from the second half of the eighteenth century, emphasised the necessity to order "extremely messy Jewish quarters". Yet, while Jewish masses who inhabited considered neighbourhoods were poor, their poverty not only did not differ from the Polish quarters elsewhere, but usually Jews prospered quite well in comparison. Hubka (2005) attributes this feature to the unplanned, more vernacular way they were built. Another reason could also have been a lack of care for external manifestation of prosperity, once attributed to Jews, which resulting from the insecurity of the Jewish situation, served to avoid provoking hostility against this group.

CONCLUSIONS AND FUTURE RESEARCH AVENUES

The current paper provides a basic outline of the main features specific to the Jewish traditional urbanscapes of pre-war central Poland. The case study illustrates the methodology of analyses of formal aspects of urban space derived from several disparate yet seminal theoretical works in social anthropology, namely those by Eco, Hall, Goffman and Hillier. The social structure and its reflection in sociometric layout has been also analysed against the backdrop of the theoretical explanation given by Marshall (2009). The presented analyses prove the existence of a separate spatial order, specific for the distinguishable Jewish traditional culture which once developed in Poland. In the situation of two different cultures using the same spaces, their perception and evaluation of spatial order differ in several ways.

The presented text summarises the discoveries of a larger study, which approaches Jewish-Polish physical spaces and culture of central Poland in a diachronic way. Further steps, apart from revealing civilisation changes, as a result of time span, which for Polish Jews lasted ca. one thousand years, take also into consideration the complexity stemming from, on the one hand the enrichment of professional opportunities, on the other acculturation and transformations of religious life as a consequence of development of Hasidism and reformed Judaism, as well as changes resulting from the rich political life.

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TransEko sp.j

SOCIAL RESEARCH IN URBAN DESIGN: KONSTYTUCJI SQUARE CASE STUDY

The paper shows the results of a research project which main aim was to seek ways to improve the quality of urban space in Warsaw on selected areas of squares and streets using simple, low-cost solution by, mainly restricting vehicle parking and lowering traffic capacity of roads and intersections. During the project a detailed study on traffic and pedestrians flow has been carried out. Besides quantitative methods widely used in traffic flow research, other methods describing social life were also adopted. The choice of research tools was based on work of Jan Gehl and Jane Jacobs.

INTRODUCTION

Currently, we are witnessing how rapid growth of cities and increasing motorisation rates affects the transformation of urban structure. From an urban planning perspective, these changes often cause many problems. The construction of new housing estates and prioritizing road infrastructure frequently results in the degeneration of the quality of public space. Urban planners in Western Europe and United States are already aware of these negative consequences of rapid urbanization. Currently, western cities conduct an increasing number of urban rearrangement plans, trying to reclaim public space and improve walkability (such as in New York or Copenhagen).

Foreign examples were an inspiration for an approach to recreate such design projects in Warsaw. The capital of Poland is a city especially troubled by negative consequences of modernist urbanisation. The goal of described project was to propose a conceptual plan for improving the quality of public space on chosen fragments of squares and roads, using simple and low-cost design. Thanks to the involvement of university students from two different departments – traffic engineering and urban planning – an interdisciplinary approach was possible, which helped to find complex solutions for public space in urban environment.

The article begins with a brief historical outlook of social life in urban space research, which was the inspiration for the selection of tools used in this project. It focuses mostly on the work of Jan Gehl and Jane Jacobs. The next section presents the assumptions on which the research project was designed. The fourth chapter presents the main conclusions gathered from the collected data and outlines a synthetic characteristic of analysed urban space. Subsequently, based on those conclusions, some recommendations on urban reorganisation are described. The article ends with

a brief summary of the utility of used research methods, as well as suggesting some possibilities of further research in this field.

THEORETICAL BASIS

The student project presented in this article was based on a research in urban space, inspired mainly by the work of Jan Gehl, who further developed and described the approach to research on social life in urban space initiated by Jane Jacobs in the 1960's.

Jacobs, a journalist and a resident of one of the districts of Manhattan, observed and described everyday life of the local community. In her publication, she criticized modernism in urban development and described destructive impact of car traffic and expanding road network on life and vigour of its surroundings. Jacobs underlined that people cannot be turned into pedestrians by force. A street needs to meet a range of requirements in order to be „alive". Its functions need to be well balanced and harmonized. The public space needs to be clearly distinguished from the private one. The fronts of the buildings should face the street, so that their inhabitants can witness the events happening there. People-watching itself can be an attractive activity, and it can increase safety of the passers-by [1]. Parallel research was carried in New York in the 1960's by Whyte, who studied the city's squares and parks that came into existence during construction of the skyscrapers. In his work, Whyte explains which areas attracted the passers-by, which did not and why. The author used photography to document life of the analysed places during different times of the day [2].

In the late 1970s, Jan Gehl undertook research on life in urban space. At present, in Poland, he is the most widely recognized author in this field. His views and research [3] made a significant contribution to the discussion on trends in urban planning in Danish cities in the 1970s. Today, his works are still very popular, not only among the architects, but also the urban activists and, increasingly, city decision-makers.

Gehl distinguishes between three types of human activity in the city, i.e. essential, optional and social activities. The essential activities include obligatory activities, such as shopping, waiting, commuting to work, school etc. These activities are not particularly influenced by the surroundings. The optional activities encompass i.a. strolling, standing, sitting and sunbathing. These activities are voluntary and they are undertaken when time allows. Social activities require contact with other people. This category includes kids' plays, greeting people, conversations, i.e. active actions, as well as the passive ones, such as staring or eavesdropping. Wherever there are two people, there is a social activity, even though it can be very limited (e.g. noticing the other person).

The common denominator of aforementioned studies is a human being who spends time in a designed city and makes use of it, his/her impressions and emotions. Architecture should be a background of the events and be designed in a way that favours urban activities described by Gehl.

In another publication, Gehl and Svarre enumerate and structure tools available for researching social life and urban space [4]. The most important ones include: counting, mapping, tracing, tracking/ shadowing, looking for traces, photographing, keeping a diary and tests walks.

PROJECT DESCRIPTION AND METHODOLOGY

The main aim of the project was to seek ways to improve the quality of urban space in Warsaw on selected areas of squares and streets, using simple, low-cost solutions, mainly restricting vehicle parking and reducing traffic capacity of roads and intersections.

This project was carried out as a result of cooperation between two student associations interested in two connected areas: urban planning and traffic engineering. The effect included skill- and perspective-sharing and adoption of interdisciplinary approach to urban planning. The project was developed during 6 months and it was carried out by students from the Faculty of Civil Engineering of the Warsaw Technical University and the Faculty of Geography and Regional Studies of the University of Warsaw. The project was mentored by PhD Eng. Andrzej Brzeziński form the Warsaw Technical University.

The works were divided into three stages:

1. Choice of places potentially fitting the criteria
2. Selection of the spots and places for future analysis
3. Traffic study and conceptual project

During the first stage, the researchers established criteria for selected places. First of all, the concept should concern a fragment of a street or square that functions or could potentially function as important part of Warsaw's urban space. The space should be open and accessible to everyone and have clearly defined urban plan. It should have supra-local relevance and an important social function in urban space. Moreover, its road network should be oversized or poorly designed. At the same time, pedestrian infrastructure should be degraded or poorly designed. Public transport stops should be located within walking distance.

31 places were singled out. They were subject of inventory during stage II of the project. The inventory included traffic organization, function, traffic intensity, public transport routes and evaluation of pedestrian traffic intensity and main directions thereof. Eventually, two places were chosen for detailed analysis: south-eastern corner of Konstytucji square and northern corner of Trzech Krzyży square. For each of them, conceptual projects were prepared. This article details research and suggestions for Konstytucji square.

For further analysis, a section of the square located in its south-eastern corner were chosen. Its boundaries are clearly defined by street-facing buildings and roadway of Marszalkowska street and Koszykowa street. On the ground floor, there are several establishments, including municipal premises – club of local activity. On the square, there are five gastronomic outlets and, on the adjacent Koszykowa street (close to the square), there are two more. In the neighbourhood, there is also a public library. Traffic infrastructure and parking functions are predominant in this part of the square.

Closer to the eastern boundary of the square, there is a double line of trees, which forms part of the urban greenery on Konstytucji square. Some of the tree trunks are surrounded by benches, which constitute the only permanent city furniture in this section of the square. During spring and summer season, there are also pavement cafes.

STUDY OF FUNCTIONING OF THE SQUARE

In order to recognize in detail the needs of the square users and identify barriers and impediments to its functioning, a detailed study was carried out, using some of the tools described by Gehl and Svarre [4]. First, the square was photographed, and its appearance and human activity documented on the pictures were described. Second, pedestrian traffic was analysed. This research comprised of two stages. The first one consisted on identification of basic routes used by the pedestrians and traffic intensity in these corridors. This study was carried out by filming the square. The second stage included observation of the square and note-taking. The aim of this part was the

identification of people visiting the square, the length of their stay, their activities and interaction with the surroundings.

Photographic inventory

Picture 1 to 6 on Figure 1 shows the present use of the subject of our analysis. Photograph 1 shows entrance to the square from Marszałkowska street. From this perspective, the whole square seems to be aimed as a parking lot. The view of the pedestrian area has been completely blocked by cars. Picture 2 shows functioning of the square from closer perspective, from the candelabrum-shaped street lamp. Even from the platform of the lamp, the pedestrian area remains invisible. Photograph 3 was taken from the point of view of a passer-by standing on the south-eastern corner of the square. Cars are a dominant element, the place in question lacks functional connection with the rest of the square. Photographs 4 and 5 show pedestrian traffic around the candelabrum-shaped street lamp and its use. On a sunny, but not too hot day, it constitutes and attractive place to rest, located on the main North-South pedestrian route. Photograph 6 shows people in pedestrian area of the square. People visible on photographs 4 and 6 did not participate in any social interaction between each other, even though they were at the square at the same time.

Pedestrian traffic

At the first stage of the study, cameras for measuring traffic intensity were used. The footage was later analysed in order to identify pedestrian traffic routes. The study was carried out on a weekday, between 4:30 p.m. and 5.30 p.m.

The square is a significant part of North-South pedestrian route in Warsaw's downtown area. It is located close to important destinations for pedestrians, e.g. subway stations, the Warsaw University of Technology, offices and entertainment establishments. The square was monitored for one hour. During this time, it was crossed by about 900 people who were mostly moving along the North-South axis. Also, Koszykowa street was recognized as an important pedestrian connection. Thanks to the measurement, the crossroads of the most pedestrian routes was identified, i.e. pavement, in front of the building on Marszałkowska street no. 50, next to the zebra crossing in the south-western corner of the square. In an hour, it was visited by about 600 pedestrians. Interestingly enough, more than a half of the pedestrians walking along the North-South axis chose the shortest route (section A-A). This stretch does not meet the requirements for pedestrian infrastructure: the pavement is less than one meter wide and it is adjacent to buffer line of the street with speed limit of 50 km/h. Moreover, the pedestrians have to cross the street twice in places that are not marked as a pedestrian crossings. This route is unsuitable for safe pedestrian traffic. The pedestrians tend to avoid the parking lot, although some people walked the roadway. Picture 7 is a graphic representation of the result of the study.

The second stage of the study consisted of observations of people on the square. The analysis was focused mainly on the people spending time in pedestrian area with trees. Its small dimensions and compact character enabled the researchers to observe all its users at the same time.

In the daytime, the square is used by people from different age groups. Young people slightly outnumbered the elderly; however, the latter stayed on the square for longer. Usually, the elderly sit on the benches and watch the surroundings. Observation of the surroundings is the most popular activity among all the square users. Consequently, the benches closer to the parking spaces, are more popular than the more distant ones. The benches facing shop windows are sometimes completely empty. Nobody sits facing elevation of the building.

Service establishments on the ground floor are not the destination of the people coming to the square. Warsztat was closed at the time of the research, and the other establishments were visited sporadically. The auction house windows attracted the most attention. The auction house is located in the point of the busiest crossroads of pedestrian paths. Some people did not use benches, but rather stood closer to the parking lot, waiting for somebody.

Description of parking pattern

The study of parking patterns was aimed to identify the users of the parking spaces and level of occupation of the square. The study was carried out at two different times of the day: in the daytime, at 1:30 p.m. and late in the evening, at 10:30 p.m.

1. In the daytime, 49 cars were parked, including those on the stretch of Koszykowa street integrated in the study. Some of them were parked outside the designated parking spaces. 24 vehicles had a parking permit, 25 a parking ticket (or lacked such a ticket).

2. Late in the evening, there were 30 cars parked, including those on the stretch of Koszykowa street integrated in the study. 15 vehicles had a parking permit, and 4 taxis were parked outside designated parking areas.

In the daytime, the rotation of vehicles was very low. During one hour of observation, the researchers noticed change of cars only on two parking spaces.

CONCLUSIONS FOR DESIGN AND A PROPOSITION OF TRANSFORMATION

The results of the study served as a basis for establishing functional and communication guidelines for the conceptual plan for the fragment of Konstytucji square in question.

The measurement of pedestrian traffic showed that the North-South axis is the most heavily loaded direction. The existing designated pedestrian route does not meet functional requirements: more than a half of the passers-by chooses the shortest way. Hence, the North-South pedestrian route should be marked out, using the shortest possible way (figure 8). It must be free of architectural barriers and ensure safety of pedestrian traffic. This basic principle should be complemented by restriction of parking in this area of the square. At present, the centre of the square serves as a parking lot with capacity for about 200 vehicles. At night, on the analysed square, there were about 15 cars with parking permit (cars belonging to the local residents). The square mostly satisfies the needs of people who visit the area in the daytime. It also serves as a meeting point and spot for picking up the passengers. It should contain designated areas for temporary stops, e.g. for a maximum of 15 minutes. The square is also used by taxi drivers, but in the close neighbourhood there is a taxi stand, e.g. in front of MDM Hotel, so the conceptual plan does not need to ensure parking space for taxi drivers.

People visiting the square use benches, facing away from the buildings, and choosing places close to the centre of the square (and one of the North-South axes). The pedestrian route needs to be directed closer to the resting spots. It will allow mutual observation and interaction between the two groups: the passers-by and the people spending time on the square. Moving those two zones closer may encourage the passers-by to stay on the square for longer. The existing greenery should constitute the centre of the relax zone and the activity on the square. The space between the trees should be arranged in a cosy manner, encouraging integration, and urban furniture should address the needs of the elderly, who are a significant group among the people visiting the square.

For the sake of safety of the pedestrians, the vehicle access to the square from West should to be closed. The traffic needs of the square should be satisfied by Koszykowa street, which at the same time would be the only place to park a vehicle.

The conceptual plan (figure 9) was drawn taking into account the guidelines emanating from the research. It also meets the basic assumptions of the project. The proposed changes should be easy to implement and low-cost.

CONCLUSIONS

The paper shows the concept for the reorganization of the public square, including new barrier-free pedestrians paths, to better cater for their needs. The study shows that because of car traffic, the potential of the corner is not fully used. At present, pedestrians walking through the square corner are separated from people spending time in this place. Because of this same reason, social functions are limited.

The main assumption of the established concept was to connect two groups of square users – pedestrians walking through and people spending time in this place. This should encourage pedestrians to slow down and improve the environment for those who already use the corner as a place to spend time. This concept proposes radical limitation of parking space availability. However, the research shows that parking lots are used by visitors rather than residents.

The team working on the project came up with an idea how to reorganize and refresh the fragment of Konstytucji square in a simple and low cost way, but an equally important achievement was interdisciplinary cooperation of two student associations. It resulted in achievement of a fresh look in this part of the city, based on detailed research and using tools from two different fields: traffic engineering and social life studies.

The advantages of described research tools are their simplicity and low cost. They can be used in other, more complex and advanced urban projects, and are also a valuable evaluation tool, that could allow tracing the influence of urban space redesign on improving city liveability and accessibility.

In more complex cases than the described above section of Konstytucji square, it could be useful to apply computer-based methods of traffic analysis (simulation of traffic) in order to examine traffic conditions and evaluate impact of planned undertakings on traffic surroundings. These methods are used in Warsaw e.g. for traffic analysis concerning redesign of Świętokrzyska street. It consists of introducing existing factors into computer program dedicated to this purpose. After implementing planned changes into the program, its tools enable quantitative evaluation of effects of the proposed solutions.

The city of Warsaw has at its disposal very detailed data on the incidents registered by the police. This database could serve for identification of places requiring intervention and add to the analysis of a given spot. A redesign project may improve not only the quality of an urban space, but also the safety of unprotected traffic participants.

Warsaw Barriers Map created by SISKOM Association is another valuable source of information. It is designed as an open platform allowing to mark and describe places that do not meet requirements of accessibility in public space, e.g. too high road kerbs, uneven pavements, stairs without wheelchair ramp etc. These data, together with register of road incident, can be useful for detailed analysis of a place in question.
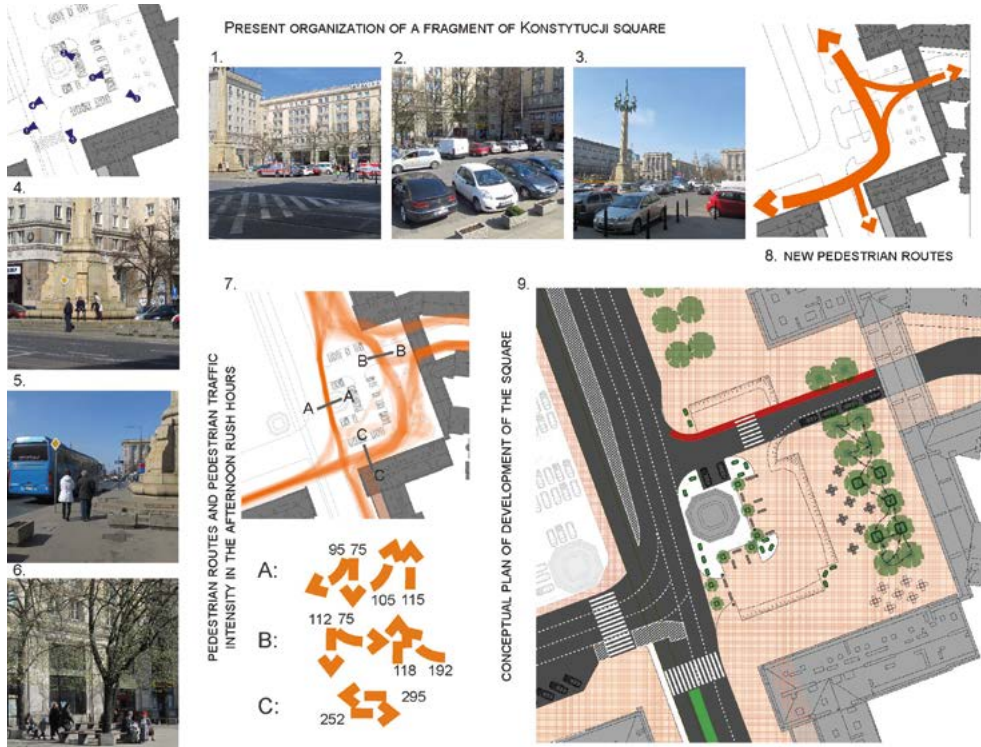
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THE CITY AS A COMMON GOOD CASE STUDY: URBAN MANAGEMENT OF A NEW DISTRICT CONSTRUCTION IN PRACTICE. UNDERSTANDING BY FIELD RESEARCH IN PARIS

Zone d' Aménagement Concerté (ZAC) Paris Rive Gauche is an urban renewal operation considered to be the largest since the Haussmann's era of changes in Paris. For 25 years, the procedure has been constantly adapted to the actual requirements for efficient management of this particular task. For the instrument of planning law, i.e. ZAC, the public joint venture, responsible for the development on the chosen site, was created. Since this way of managing the urban renewal operation does not exist in Poland, the study was made. The project is still going to be developed within next years.

BACKGROUND

The current critical state of spatial planning laws and practices in Poland was the motivation to undertake a wider research. The further step of the study led to a comparison of different countries (here: France and Poland).

After a political transformation, starting in 1989, Poland moved from the communist system to a re-born democracy and capitalism. Poland has slowly moved from a production-based to a service–oriented economy. Spatial planning laws had to adapt to the open market. For the construction and real estate markets, this meant re-estimating ground value, prioritizing public investments in a new way as well as learning how to operate with new private and corporate investors. The administrative reform of the 90s resulted in the cancellation of several existing master plans, which increased the distance between the small amount of prepared spatial documents and the dynamics of new investments localization (which require to be precedent to master plans). The general lack of master plans encouraged foreign investors, burdened with the less taxes than in the countries of western Europe at that time, to start constructing many office centers and commercial housing. Warsaw, as the capital, was particularly exposed to such a situation.

25 years after the major switch happened, planners and academics of different disciplines still deliberate on the way of how to bring coherent development.

OBJECTIVES

The aim of the study was the search for more advanced laws and practices to consider as an example to evaluate.

The land price pressure fosters a continuous interest in new developments for the needs of the changing society. In Paris, the conservation of existing well-functioning districts and monuments is still the priority, but it is a place where the pioneering works of urban regulations were led in the times of Haussmann. Paris is also a capital city of the country that gave birth to one of the first democratic constitutions. Paris has a different history and culture - it never was as severely destroyed as Warsaw.

The case is unique in terms of the scale of the investment, as it is rare to re-organise such an important surface within the city borders. It deals with the challenge covering 26 hectares of railways for future developments on top of it.

The aim of this research has been to answer questions on how a new district in Paris is constructed.

Another question arising was about which aspects of this procedure might be adapted to the way of administrating the zones in Warsaw, which are being developed without a master plan.

METHODOLOGY

Research Context

During doctoral studies at the Faculty of Architecture, Warsaw University of Technology, I was given the opportunity to conduct my own research. A part of the study was planned in Paris, where I consulted the idea of the case study and the proposed methodology with planning professors in Université Paris Sorbonne IV – UFR Géographie et Aménagement, students and other researchers. This work will be followed by a comparative study with a parallel district - Powiśle, in Warsaw, which is also a location of the University and public library in a former industrial zone along the river.

Case Study

Urban planning and its application is a complex discipline, involving economic planning of operations, including social changes within the area, treating natural conditions and transportation issues as integral parts of the project.

The choice of research methodology was specific to the process-orientation of the current development of the site in 13th district of Paris. The described investigation concerns the urban study case of the *ZAC Paris Rive Gauche* operation. The analysis is deepened by literature research.

The challenge of this research is connected to the fact that the realization of this project is ongoing. The way the design is implemented changes along the way as the result of a complex approach and a multi-layered structure of a management within a number of organizational participants. This excerpt gives an opportunity to examine one of several zones ZAC.

Conducting the described single case study consisted of:
- **Onsite scouting, which was the direct observation of the zone.** It allowed investigating the state of development visually, getting user experience of chosen aspects of the district (green areas, river access, public spaces, shops, public institutions, etc.). It led to the evaluation of the quality of the built and functioning ensemble. The documentation of the space was in photographs and was presented later as an exhibition.

– **Document analysis.** The literature study (primary and indirect sources - general research though libraries, archives and online database) of local management was the foundation of the understanding of tendencies of change. The document analysis of legal tools of urban design (law documents and definitions; description of urban planning procedures) gave an overview of their role in the shaping of the city.
Site-specific documents (such as: particular project documentation and press, financial tools, ground acquisition, operational documents; studies on local community, documents of the creation of the ZAC, ground analysis, reports from gatherings, discussions, consultations, projects and plans) were a proof of actions taken in the process of producing the new city area.

– **Interview realised with key participants in the development of the project.** To understand the complex procedure, actors playing a role in this project were listed (for open-ended, but also structured surveys with a questionnaire). People of impact were identified as district council representatives, urban development manager, urban developer of the specific plot, architects of buildings on specific parcels, technicians at the city council, users and inhabitants. Professors of planning were also asked to share their knowledge during the interviews.

RESULTS

French Urban Planning Aspects of the Case

The capital city of France is characterised by a tradition of important city management operations. The most influential to evoke are works from the times of Georges - Eugène Haussmann, a Prefect of the Seine (from 1853 to 1870). The particular way of managing major changes within the city tissue from his era lasted for decades and the times of his influence in planning can be seen over 100 years later. It includes the city composition along the designed axes, main infrastructure works, the organisation of a typical city block and house repartition, etc.

Joanna Maria Koszewska_The City as a Common Good Case Study: ...

The organization of the area of *ZAC Rive Gauche* refers to those times in a modern way. For example, the main axis of *Avenue de France* is a reference to 19th century boulevards. This wide avenue organizes the space of the *ZAC*. It provides bus transportation, car access and metro as well as city train *RER* stops. In the central part of the cross-section, the bike and pedestrian path is arranged with bike parking facilities, trees and benches.

Paris city governance is centralized, although there are separate districts (*Arrondisements*). The town is entirely covered by the Master Plan *PLU (Plan Local d'urbanisme),* which is a tool of local management, together with ZAC (*Zone d' Aménagement Concerté*) and others. Previously *ZAC*s that were out of the main plan are now are included in the document of PLU. Urban laws and regulations are constantly updated and represent the framework of the specified operation.

Case Report

Case study: ' *Zone d' Aménagement Concerté' - Paris Rive Gauche*.

This zone is entirely located in the 13th district, in the South-eastern part of Paris, along the left bank of the River Seine. This type of a special status for important investments is adapted when the priority is in localising public facilities, which refers strongly to the idea of common good in a city. In order to acquire a plot sufficient for a public use, the public operator must be given priority. The ways of easing it might be in the obligation to owners of selling private parcels (even lowering their cost). It might be also in giving a special mission to the institution capable of realizing complex operation of doing so. In this case such a body is *SEMAPA* (*Societé d'economie mixte*), created in 1985.

The priorities of the project are: facilitating access to the river bank from its southern part, the integration of university campuses within the city structure, renovation of the train station and covering its infrastructure to densify the development, and to open-up the hospital complex (La Pitié - Salpêtrière) to the district it is located in. The political will of giving an access to these investments to the public was put into practice by realising the above mentioned steps.

The case of universities is worth reflection. One was relocated from the old university district, *Quartier Latin*. The former concentration of universities in one area resulted in the in the revolutionary occupation of their buildings (1968.). When the old campus needed restructuring, it was decided to make a new, open and well integrated into the neighbourhood set of faculties. This idea worked for the creation of the new district, as its spatial layout forces users to commute between the buildings of the same establishment and generated a flow of pedestrians, although it disintegrates institutions in terms of their own composition and functioning.

Surface	Date	Aims	Program
130 hectares	*Beginning:* *1988 - First studies*	*Technical:* *26 hectares of railways to be covered and built up*	*Mixed:* *2, 5 mln m²*
26 ha out of 130 are developed on covered railways	*1991 - City Council accepted the zone for the operation called " Seine Rive Gauche" and launched public company to coordinate it*	*Urban:* *Developing a new district in the city, with mixed functions around major public facilities,*	*Offices,* *Public facilities (central – universities, National Library and local),* *Social and commercial housing (multi - family and student housing),* *Programmed services for commerce and recreation:* *artisanal workshops, shops, innovation research laboratories,*
planned green area 98 000 m² on site	*Ongoing*	*Nature:* *Ease an access to the river banks*	*Activities connected to the river proximity, greenery*

Urban Projects for Rive Gauche. The operation was divided into 4 smaller parts, organised around public facilities (see: Table 2.). The construction started at the eastern part and continues towards the west, where eventually high-rise buildings might be allowed for location (which is rare in Paris). This particularity is due to the long process of the realisation of the *ZAC Rive Gauche*. During the years of its development governments changed, presidents changed, the market changed and finally the practice or so-called doctrine for urban evolution changes.

The design of this zone is multi-layered. After the main partition was created, competitions for urban concepts of its parts were announced. On the base of depicted ideas and regulations for each stage, private investors run competitions set for particular building designs.

The representatives of *SEMAPA*, the company responsible for whole the process, survey and assist all the negotiations until a detailed building permission dossier is be presented at the city council.

Austerlitz	Tolbiac	Masséna	Bruneseau
around the building and infrastructure of the Gare d' Austerlitz train station	*the part in surroundings of Bibliothèque Nationale de France François Mitterand*	*the university zone at Grand Moulins regrouping: l'Université Paris 7 - Diderot, l'École d'Architecture Paris -Val -de -Seine and l'Institut National des Langues et Civilisations Orientales*	*terrains on the west side of the Boulevard Périphérique*
Austerlitz Gare *Coordinating architect:* *AREP - Jean-Marie Duthilleul / Ateliers Jean Nouvel* *Landscape :* *Michel Desvigne* *Austerlitz Nord* *Coordinating architect:* *Christian Devillers*	*Tolbiac Nord* *Coordinating architect:* *Roland Schweitzer* *(Quartier Tolbiac Bibliothèque)*	*Masséna Nord* *Coordinating architect:* *Christian de Portzamparc et Ateliers Lion & Associés* *Landscape :* *Thierry Huau* *(Quartier des Grands Moulins)*	*Bruneseau Nord* *Coordinating architect:* *Ateliers Lion & Associés*
Austerlitz Sud *Coordinating architect:* *Reichen et Robert* *Landscape : Jacqueline Osty*	*Tolbiac Chevaleret* *Coordinating architect:* *Pierre Gangnet* *Landscape : Empreinte*	*Masséna Chevaleret* *Coordinating architect:* *Bruno Fortier, Jean-Thierry Bloch et Ateliers Lion & Associés* *Landscape :* *Jean-Claude Hardy*	*Bruneseau Sud* *Coordinating architect:* *Ateliers Lion & Associés*

Table 2. Designers of four main stages and smaller parts of ZAC Rive Gauche.

The zone of the ZAC PRG was divided into four major parts. Within those parts smaller terrains were designed and coordinated by different teams, chosen in competitions. Each project had a set of urban composition rules defined. Architects of particular buildings planned in the zone have to adapt to set principles.

Evaluation of Case Study Aspects

The environmental outcomes of the project are: covering of railways, setting the public transportation, and organisation of multi-functionality. Because of the instant inclusion of the different dimensions of the urban project, their placing was addressed. All of the listed elements are playing a role in sustainable development, since the densification of the city, within its borders prevents from the urban sprawl (covering the railways to develop buildings on top of it, densifies the urban tissue). The mix of functions results in the use of space in different day a week cycles.

The use and composition related achievements are: architecture of high quality and well located public spaces. Although realised – squares (and similar) are criticised for not being functional enough (e. g. the ground floor of a BNF Library is not easily accessible, especially to people with reduced mobility). Transportation by car, bike, ferry and public transport is in place (parking places are available). Urban life is still evolving, but already seems to be lively, especially during the warm season, along the river bank.

DISCUSSION

Social, as well as financial costs of poorly-led construction operations, especially within the public sector, are hard to change or re-adapt. The trend of neo-liberal economy of '*laisser – faire*' of the market appears to be too costly to afford (especially after the global economy crisis of the year 2008, that still echoes in the construction market and the planning system).

A wider view of how a city is being produced might foster some reflection on how to improve practices in local circumstances. The research will be continued by the analysis of the Powiśle district in Warsaw. The results are to be presented to the representative of the municipality in Warsaw, to people active in the field of spatial planning in Poland and at international seminars in Paris and in Warsaw (to inspire reflection on possible practices and directions of development of this discipline locally).

The creation of a state-run society of mixed economy, devoted to the management of a particular urban operation can be considered as a reference example for newly developed districts or zones in Warsaw as it is in Paris. This is an active element of a logical sequence from the analysis, through the plan preparation, to the realisation and its management, with this state – launched company being the representative of the municipality is an interesting organism and can serve as a reference both for financing and management of new urban operations.

This example shows a particular awareness of public power in the construction sector, where different actors play parts. Having taken into consideration all the participants of the planning system the way the described district is being organised and built, contributes to humanising a new space.

The complex process of planning this district often ends by international architectural competitions and this results in high-cost housing. At the same time the pre-set program assured the implementation of student as well as social housing. The result is that wealthy population lives next to poorer citizens. The concept of integrating both societies seems to be just. Although in terms of social integration, it is questionable whether living side by side is sufficient for the interaction. The local social centre should be also functioning nearby to facilitate real steps towards building a community.

The architectural aspect of the development is of value. The composition of volumes and materials of façade is a result of negotiations, competitions and agreements made between qualified specialists of the discipline. Since international competitions have similar requirements, granted projects resemble each other. Some of the users of this district complain that it lacks of local identity.

CONCLUSIONS

The thesis concerns the essential value of research of various urban procedures oriented towards coherent practices. The research in the urban planning is based on learning from possible solutions, which concern the analysis of different law frameworks and the research made before planning the operation of change for particular zone. The local investigation includes the study of natural conditions, financial costs, law and ground property requirements of plots, construction possibilities and ground capacity, social structure before and after the realisation of the operation, history of the terrain and built heritage; as well as financial costs and possible earning within the planned process. These steps contribute to the success of the concrete investment. Although all the listed elements are analysed before creating a Master Plan in Poland (*miejscowy plan zagospodarowania przestrzennego - m. p. z. p.*), they do not directly apply to the situation, in which a particular planning

decision is made for a single plot (*decyzja o warunkach zabudowy - d. w. z.*) when the Master Plan is missing. The result of the accumulation of such decisions is the lack of spatial coherence.

Positive outcomes of the French urban planning practice, which is an executive tool of a public company managing a particular operation, can be useful to begin a discussion on the efficient implementation of planning documents in polish law system currently.

The interpretation of planning rules and practices as a way of managing a social common good evokes the responsibility to make it in the best way for the current state of arts.

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THE APPLICATION OF DYNAMIC TRAFFIC SIMULATION TO THE CITY PLANNING PROCESS

This paper is dedicated to the process of city planning. This description has been made from the point of view of a transportation engineer. The first part explains the whole process to complete a transportation system project for a city or a portion thereof. It is a review of all aspects of works, step by step, which have been taken into consideration with the aim to create a properly working system. The last part is a description of dynamic traffic simulation performed by the author in 2006 in Bucharest and related to the design of the expressway city by-pass.

FORMER APPROACH TO THE TRANSPORTATION PLANNING

The key to urbanism is the transportation system. One of its main components is the arterial and street network which links all elements together within a city like blood vessel network.

Previously, the city planning process was as follows: an inter-professional team designed the city; architects and city planners worked on the general conception of the city. The economists prepared economical programs for different district of the future city. The sociologists worked on a sociological study of the city. The landscape architects designed the city's green areas. Engineers were in charge of the preparation of the infrastructure network projects such as drinking water, wastewater, electricity, heating, gas and transportation.

Practically, the same process was used when it came to build a new city or a new district of an existing city. A similar work was performed during the revision of the existing or the preparation of a new Master Plan for a city.

In that context the transportation engineer was in charge of all following aspects:

A. transportation strategy;
B. roads network;
C. railways (heavy rails) network;
D. public transport network
E. parking strategy;
F. pedestrian travels strategy;
G. airports; and
H. harbours.

Ad. A. The above tasks consisted in establishing the main features of travelling through the city and were aimed at establishing an Integral Multimodal Transport System (IMTS) [1] for the city. Its functions were as follows:

– to determine all links between the existing and future zones of agglomeration, as well as the time of travel and the comfort of the access;

– to define different modal split transportation (*"a modal split is the percentage of travellers using a particular type of transportation or number of trips using said type."* [1]) in the percentage of sharing between them in the daily passenger flow;

– to check the capacities of modal split transportation for the next twenty years;

– to describe the transportation policy of the city (agglomeration) for the next twenty years; and

– to define which district of the city should be protected against the traffic and what should be the transportation policy to characterise the modal split between the private and public transport.

The two main studies providing information about the population transportation needs are as follows:

a) O-D survey and traffic survey;

The study named Origin-Destination Survey consists of:

– dividing an agglomeration into zones (using natural borders if possible);

– finding in each sector a key point for traffic survey;

– preparing forms for the investigators;

What is determinant for each zone is the number of the inhabitants and work. Usually this kind of survey takes between 48 hours to one week. The investigators will stop the cars and ask the drivers about the origin and destination of their trip as well as other relevant information about the trip.

Habitually the survey traffic is performed at the same time. The goal of this survey is to assess the value and composition of the traffic flow.

Once the investigations are finished all the data will be analysed in the office and the matrix O-D survey will be created.

b) Household Survey.

This study must be organized using the previously defined sectors of the agglomeration. The forms prepared for the investigators will be sent by mail to the random inhabitants.

It is also possible for investigators to interview inhabitants at home (door to door).

The information to be gathered is such as:

– the place of work;

– number of daily trips;

– mode of transportation;

– duration of the trips etc…

Ad. B. This task consisted of designing a network of the arterials linking all districts of the city between them and also connecting then with the external roads network. Likewise, to propose a proper streets network, ensuring all movements in the district according to the proposed transport policy. Generally, the network is classified according to its functions and technical class. The technical classification of the network is normally based on the design speed and the number of

lanes in the cross section as shown in Table no. 1. This is a parameter determining the safe speed on the roads. For example, if the design speed is 70 km/h then all geometrical elements (vertical and horizontal curves and cross falls) must guarantee for the cars safety running at this speed

Type	Definition
Motorways (EU) / Freeways (USA)	*Divided highways with full control of access;*
	Two or more lanes for the exclusive use of traffic in each direction with EML;
	Opposing directions of flow are continuously separated by a raised barrier, an at-grade median, or a continuous raised median;
	Provides uninterrupted flow;
	All interchanges must be grade-separated;
	The access to the carriageway is possible only via interchanges.
Expressways	*Divided highways with two or more lanes for the exclusive use of the traffic in each direction;*
	Opposing directions of flow are continuously separated by a raised barrier, an at-grade median, or a continuous raised median;
	Intersections could be grade-separated or at-grade controlled by the traffic lights;
	The access to the carriageway is possible only via intersections or interchanges.
Arterial streets	*Divided or undivided highways with two or more lanes;*
	Intersections must be controlled by the traffic lights;
	On the cross section the tramway track could be on the right-of-way.
Secondary streets	*Two lane highways;*
	Intersections could or may not be controlled by the traffic lights;
	On the cross section the tramway track is not be on the right-of-way.
Local streets	*Two lane highways.*
Pedestrian streets	*Streets converted to the pedestrian area in the downtown;*
	Sometimes allowing the passage of the tramway or bus / trolleybus
Traffic calming streets	*An area where car traffic is grudgingly admitted and where the pedestrians have a priority.*

Ad. C. This task consisted in designing a network of railways going through the city with all necessary facilities including stations as intermodal nodes and correctly linked with the external network.

Ad. D. This task consisted in designing a network of all public transport. The size of the city determines which kind of public transportation will be necessary. It depends on how large is the city and how stretched it is over a large area. The public transportation is divided on rails as shown in Table no. 2 and on wheels ones as shown in Table no. 3.

Table 2
Public transport on rails [2]

Type	Description	Capacities [passengers / hour]
Heavy Rail (regional speed trains)	*On the surface, in the tunnel, in the open cut or on viaducts;* *Power supply by the catenaries 3kV or 15 kV/50kHz, or electro-diesel locomotive;* *High acceleration and deceleration;* *Average commercial speed about 60 km/h;* *Distance between stations 1.000 – 2.000m.*	*until 60,000*
Underground / Metro so-called "heavy system"	*In the deep tunnel (5.2 m), under surface (4.2 m) or in the open cut;* *Power supply by the third rail 750 - 800V;* *High acceleration and deceleration;* *Average commercial speed about 40 km/h;* *Distance between stations 500 – 1.000m;* *Exists in some cities like the automatic metro without the driver.*	*until 40,000*
LRT so-called "light-metro"	*On the surface sometimes with the grade-separated intersections, in downtown area in tunnels (5.6 m);* *Power supply by the catenaries 750V;* *High acceleration and deceleration;* *Average commercial speed about 30 km/h;* *In the tunnel "no ride on view" – necessity of the signalization;* *Distance between stations 500 - 800m.*	*until 20,000*
Modern Tramways	*Existing track on the streets surface or on the "right-of-way";* *Power supply by the catenaries 600V or induction;* *High acceleration and deceleration with direct access from the platforms level;* *Average commercial speed about 25 km/h;* *Distance between stations 400 - 600m.*	*until 20,000*
Classical Tramways	*On the streets surface or on the "right-of-way", gage 1.000mm or 1.435mm;* *Power supply by the catenaries 600V;* *Low acceleration and deceleration;* *Average commercial speed about 15 km/h;* *Distance between stations 400 - 500m.*	*until 5,000*

Table 3
Public transport on wheels [2]

Type	Description	Capacities [passengers / hour]
Modern Buses Guided Modern Buses	*Ergonomic construction for the passengers with direct access from the platforms level;* *Corresponding to the environmental exigency (noisy & pollution) – Diesel or gas turbine or electro-diesel engine.* *Special device permits to the bus to be still on the middle of its lane.* *Even for the speed of 70 km/h two buses could cross itself on the corridor of 5.5 m width.*	*until 5,000*
Bus Rapid Transit (BRT)	*Modern buses on the bus lanes or bus-carriageway with priority on the intersections or grade-separated intersections (very costly solution)*	*until 15.000*
Classical Buses	*All buses construction until 1990;* *Usually very noisy and pollutant.*	*until 5,000*
Trolleybuses	*"Softer" system as a tramway but still limited by the power supply.*	*until 4,000*
Electro-buses	*The hybrid between a bus and a trolleybus or tramway used Diesel engine outside of downtown and electric engine in the downtown with the power supply by catenaries or rails;* *Sometimes it could be an electro-diesel engine;* *Another solution is a tramway on the pneumatics with electric engine needing a power supply.*	*until 5,000*
Taxis	*Practically each city has some taxis companies;* *Usually the taxis can use the bus-way and HOV or HOT lanes on motorways.*	

There are also unconventional public transport systems but they are not very widespread due to their low capacity and high cost of exploitation.

For small and medium size cities the bus or trolleybus and tramways would be sufficient. The main stations of the public transport have to be organised as intermodal nodes in order to ensure easy connections.

Ad. E. This task consisted in establishing a strategy for parking policy in the city, which depends on the area of the city. The rules are different for the centre of the city, highly urbanised areas and lowly urbanised areas. The needs of the parking policy have to be calculated as well as all strategic car parks and all Park & Ride have to be defined.

Ad. F. This task consisted in establishing a strategy for the pedestrian facilities such as path walks, squares, etc. Some areas in the city should be accessible only for the pedestrian, for example the historical areas. These areas should be linked between them by the path walks (no longer than 2 km). Some streets in the downtown should be organised as pedestrian – public transport only, for example tramway + pedestrians [3].

Ad. G. This task consisted in checking if the city needs one or more airports. Air transport is usually located outside of the city for the reason of noise and the need of big surfaces. Some cities have airports very close to the centre but in that case air traffic is limited and the possibilities of development are practically impossible. Sometimes, near the centre there is only a heliport. The modern airport can be compared with an autonomous city. The biggest European airports such Heathrow, Frankfurt or Paris CDG need over 150.000 employers. These airports consist of several

passenger and cargo terminals. The connection between an airport and a city needs a quick link access of large capacities. Usually it is provided by a motorway or an expressway and a railway line. Also the car parks must have the capacities of a few thousand places for a big airport.

Ad. H. This task depends on geographical position of the city. It can be a sea harbour or a river harbour. Both need a connection with a city by routes and / or railways. Usually near the harbours there are factories and warehouses.

Referring to points above the overall plan should be checked to see if it is appropriate for main ideas. Such verification is required for each discipline of the planned city.

Transportation engineers need some data from architects concerning the transportation aspect of the master plan. These data include:

– the number of future inhabitants of the city;
– the location of the future urban nodes;
– the ratio between inhabitants and workers;
– the determination of the work areas; and
– the determination of the inhabitation areas.

The transportation engineer had to translate these data into the potential number of passengers in purpose to obtain the traffic forecast data. Formerly this task was done manually. The city was divided into regions. In each region the number of inhabitants and the number of workers were determined. In each region a centroid was determined and the distances between all centroids were calculated.

As a first step the transportation engineer produced the traffic distribution model - a mathematical model to create a matrix of the movements between all areas. The most common form of the traffic distribution model is the "gravity model". The Figure no. 1 shows the graphical presentation of the passengers flows between and inside the sectors of the traffic distribution model (on the left side). The width of links is proportional to the numbers of passengers in rush hours. During a day there are two rush hours: one generally from 7am to 9am and the second from 4pm to 7pm.

For the transportation engineer the second step consisted in determining the rates of all modal split transport including pedestrian flow (usually the 100% of the travellers are walking until a distance of 0.5km and over a distance of 4km 100% of travellers are riding). He also had to codify the road network so that he could calculate the traffic assignment model on a mathematical model. A trip matrix may be allocated to these routes to give the expected traffic flows on each road.

There are some models to calculate traffic assignment as follows:

– **All-or-nothing assignment:** a method used in traffic assignment modelling that allocates all the trips taking place between a pair of zones to a single route;
– **Capacity-restraint assignment:** a method used in traffic assignment modelling that takes account of the level of congestion on the road network in choosing the routes used to travel between zones;
– **Deterrence function:** a probability function used in traffic distribution modelling to describe the probability of a trip taking place between a pair of zones at a given measure of separation between them.
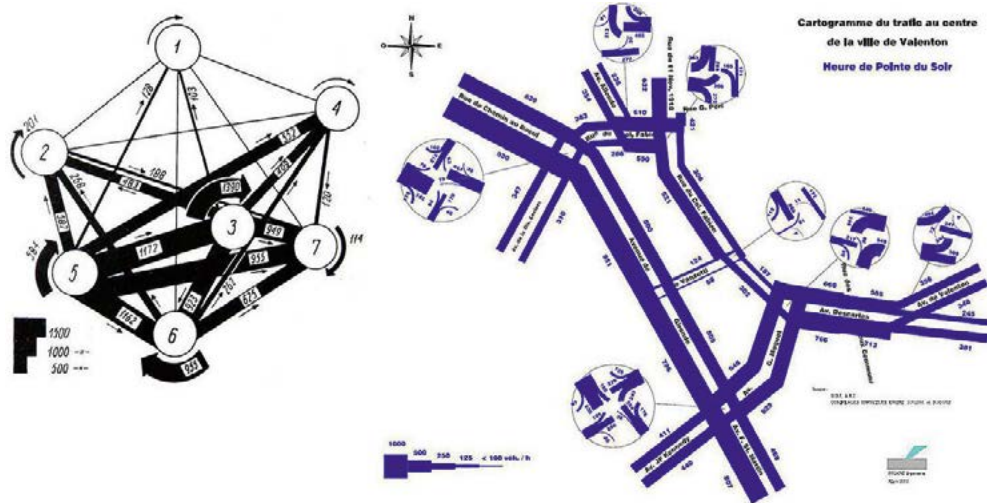
The transportation engineer had to translate that data into the potential number of passengers. Further, he had to convert them into the number of cars and the public transport vehicles per rush hour. The process was cumbersome and time consuming.

In the past this task was done manually, but today there some specific applications available. One of the most widespread is the PTV Visum.

"Is the world's leading software for traffic analyses, forecasts and GIS-based data management. It consistently models all road users and their interactions and has become a recognized standard in the field of transport planning. Transportation experts use PTV Visum to model transport networks and travel demand, to analyse expected traffic flows, to plan public transport services and to develop advanced transport strategies and solutions" [4].

As the results these applications gave a chart of the distribution the traffic flows on the streets network as shows the Figure no. 1 (right side).

Fig. 1 Gravity model of transport. Distribution of the traffic flows on the streets network.

Sources : left [5] & right [6]

Such an approach allowed the transportation engineer to determine the streets network dimension as number of lanes on the current sections and on the intersections. The modal split of passengers permitted to establish the number of lines and the public transportation frequency for each street.

Very often the obtained results were not acceptable from the urban planning point of view. In this case it was necessary to re-calculate and re-design some of the elements. Later, after the realization of the plan mistakes very often highlighted undersized street network or more rarely oversized.

NEW APPROACH TO THE TRANSPORTATION PLANNING

Today transportation engineers have efficient tools that enable them to design or modernize easily street networks. For more than 20 years there have been different applications that allowed engineers to measure all elements of the network such as the number of carriageways and lanes, shapes of intersections or interchanges depending on the traffic intensity. The dynamic traffic simulation shows vehicles allocation within the network and potential "black holes" of the traffic jams. Transportation engineers can now correct these problems by proposing new links, changing the street geometry such as the number of lanes or the allocation of the lanes to the public transportation.

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In addition, applications give the possibility to apply a special transportation strategy for the whole city or for some areas only. For example, it is possible to restrict cars access to downtown areas or to increase public transportation services where it is necessary. Applications can also indicate all sectors where the pollution is too high (graphically showing the level of CO_2, or NO_x). Some of the applications can assess and indicate sectors where the traffic noise pollution exceeds the environmental standards.

All applications show simulation on the background of aerial pictures or maps. There are applications that show 3D traffic simulation and allow to 3D implantation of buildings to increase the reality of the simulation.

Some of the applications can also simulate bicycle and pedestrian traffic.

Other useful tools of such applications include the possibility to anticipate future changes in the urban tissue which can generate higher traffic in the future for example: a new shopping centre, an airport, a railway station, a new link between city districts or a new bypass.

These applications are used on the whole world on the different scales of planning. Sometimes they are used for checking for a simple intersection, interchange up to the whole agglomeration network. During the 15th ITS World Congress that took place in New York in 2008, the author admired the dynamic traffic simulation prepared for whole agglomeration of Hong Kong.

A short example can help understanding the process.

In 2006 the authorities in Bucharest decided to close an expressway around the downtown which was the first bypass of the downtown. One segment of this expressway was missing, as it was very complicated to build. A long viaduct was needed to overpass the main railway line.

In order to limit the related costs, the authorities used a design made in the 1970s'. This decision gave rise to two main problems:

- first, the geometric solutions did not meet the applicable road safety parameters;
- second, it did not take into account the new shopping centre next to the main interchange which generated more than 1.000 vehicles / hour /working day

The author was in charge to demonstrate to the Bucharest authorities that such planning errors can provoke inefficiency of the envisaged construction of the missing expressway segment.

As the authorities refused to change the geometry, the author was obliged to find three other variants using only the dynamic traffic simulation. The author had only the possibility to change the vertical signs in order to modify the priority of the traffic.

This study was completed using the dynamic traffic simulation software called TSIS 5.0 (Traffic Simulation Integrated System V 6.0 developed by University of Florida) for the afternoon rush hour. The simulation was carried out for 15 minutes [7].

The first simulation

In this situation the traffic flow on the main south carriageway of the expressway has the priority. The traffic flow from the shopping centre via the entry ramp has no priority because it is blocked by the yield sign.

In this case the traffic is fluent on the main carriageway of the expressway, but it is completely blocked on the entry ramp. Consequently, the exit from the shopping centre is also blocked.

The second simulation

In this situation the traffic flow on the main south carriageway of the expressway has no priority (the priority is on the right side). The traffic flow from the shopping centre via the entry ramp has the priority. The idea is to unlock the exit traffic from the shopping centre. In this case it can be easily understood that the traffic flow on the main carriageway is disturbed by the right entry from the ramp. Additionally, the situation becomes dangerous because cars on the main carriageway drive with higher speed than these on the ramp.

In this case the traffic is fluent on the entry ramp, but it is very difficult on the main carriageway of the expressway. The queue of cars expands for a few hundred meters.

The third simulation

In order to avoid the waving area the exit ramp is suppressed and the entry ramp continues separately from the main carriageway until the next entry ramp. It seems to be the best solution from the traffic and safety point of view.

In this case the traffic is fluent on the entry ramp and on the on the main carriageway of the expressway.

Final results

Although the preparation the data for the application took few hours, the obtained results are spectacular.

To start the project the transportation engineer has to define all segments of the road network and enter all parameters as: length of segments, number of lanes, lanes width, longitudinal slopes, design speed. The same has to be done for the nodes (points linking segments between them). Traffic lights and parameters of the cycle time controller, value of the entry traffic flows and their distribution on each node have to be programmed as well.

Once such model is saved it can be easily modified in aim to check another variant. The modifications relate to the same parameters from the list above.

The results are dynamically displayed on the screen for the whole programmed network

During the visualization it is possible to use the functions such as: zoom in / out, acceleration / deceleration, stop / start and cars flagging. By default this application shows cars flow in three colours: white – going straight, yellow – going right and green – going left. Others representations of cars are possible such as: driver type, fleet type and acceleration.

The application calculates over than 100 parameters for each segment of the analysed network such as: delays, density, gas emissions, fuel consumptions, person delay, person trips, speed, stopped vehicles, travel distance, travel time, volume cars etc...

Each of the parameters can be displayed on the screen at any time of the presentation or can be printed at the end of show.

It is possible to programme the presentation in such manner that each segment dynamically changes the colour over the time. For example the level of the CO_2 emission can change the colour from green (zero emission) to red (1kg/mile/hour).

The Table no. 4 shows few calculated results related to the above example from Bucharest.

Parameters'	Situation with yield sign		Situation without yield sign		Situation without the exit ramp	
	On main carriageway	On ramp	On main carriageway	On ramp	On main carriageway	On ramp
Delay [s / veh]	0.0	237.0	2.887	0.797	0.396	0.015
Average speed [M / h]	25.1	0.646	9.21	14.23	16.65	23.54
Stopped vehicles	0	32	51	17	0	0
Capacity [veh /h]	3.400	128	2712	892	3284	1104
CO2 emission rate [kg/mile-hour]	0.739	3.746	0.801	0.501	0.527	0.935
Fuel consumption [gallons]	3.051	1.669	3.521	0.686	2.090	1.250

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GEOMETRIES OF CITYSCAPE: ANALYSIS AND DETECTION OF PUBLIC SPACES BENEATH TALL BUILDINGS BY 3D-NEGATIVES

The urban observation of a cityscape with respect to its geometrical complexity is a main premise for considerations on relation between localization of tall buildings and systems of public spaces beneath. This specific relation is investigated by introducing computer-based methodology of 3D-NEGATIVES in virtual city models. The paper focuses on detection and analysis of the geometric structure of space between buildings. The method and research presented in the article examines the geometrical typology of open spaces beneath tall buildings, introduces new computer tool for detection and analysis of urban parameters in 3D virtual models, and proposes of parametric interpretation of public spaces. The case study in this paper uses three European cities.

CONTEXT AND GENERAL APPROACH

During last decades of development in field of computer techniques, urban analyses supported by computer tools became important in the field of scientific and practical exploration. The process is driven by development of software applications and mathematical methods for spatial data interpretation [11]. Trends in 3D geodata development are widely presented by Zlatanova [13]. One of the most widely popularized and developed data environments are virtual city models. We can also observe the development of 3D models for open-access purposes (Google Earth etc.), and professional systems for spatial analyses [16]. However, there remains a challenge for virtual city models in the standardization of data. The most widespread data format for analytic purposes seems to be cityGML – part of GML (*Geography Markup Language*), an encoding standard of the Open Geospatial Consortium [6]. The characteristics and potential of cityGML, in combination with CAD and GIS, enable wide range of urban analyses. The cityGML data also becomes more common and open to users (recently the entire virtual city model of Berlin has become free to use). This very interesting field is using virtual city models for observation of urban structures – particularly public spaces. The "life between buildings" [4], defined as spatial behavior of inhabitants of cities, occurs within the specific geometry of urban structure. This geometry is the scope of the presented approach.

Space between buildings seems to be a challenge for measurable and parametric interpretation. The space is part of the overlapping worlds of physical objects, human behaviors [4] and invisible

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geometry. Although appearance and geometry of buildings is clearly visible, the geometry of public spaces is quite unnoticeable. The theoretical concept and notion of the 3D-negative (empty, open space between buildings, called initially the 3D-void) was described in previous papers [17], [18]. The 3D-negative derives from 'positive – negative' relation between built-up structure and space between. If Space Syntax's approach [5] goes towards measuring existing and proposed spatial layouts' and City Form Lab's 3D analyzes buildings and general built-up areas, the presented concept focuses on *geometries of public spaces* by introducing missing geometry of 3D-negatives between buildings in virtual city models.

3D-NEGATIVE GENERATION PROCESS

The general assumption behind 3D-negative is that all the open spaces between buildings can be defined and observed as three-dimensional geometry – kind of a 'negative' in relation to 3D objects representing buildings and structures in virtual city models. The entire process of generating 3D-negatives uses geometry of virtual city model and the "positive-negative" principle for automated detection of volume between built-up structure. CityGML standard of models introduces different classes of objects (terrain surfaces, ground surfaces, wall surfaces, roof surfaces etc.) and can be represented in five different Levels of Detail (LOD0 to LOD4). In a technical sense, semantics provided by cityGML standard [7], [8] allows the extraction of walls, roofs, floors etc from virtual city elements. The standard provides also structure of primitive component geometries - points, lines, faces and solids [6]. The 3D-negative uses this structure for detection of geometry between buildings and to perform parametric interpretation on the level of primitive geometric components. A very important feature of cityGML is the compatibility of geometric data with individual databases providing access to number of attributes for parametric interpretation, as it is available in GIS systems [10]. The automated procedure of detection and generation of 3D-negative was developed within Cyber Urban Center (Rubinowicz, Zwoliński, 2014). The entire process consists of 6 succeeding steps.

CityGML Import

The initial point of the procedure is importing the cityGML model. The data import tools for GML, XML data formats are available (FME, ArcGIS interoperability tools, Sketchup GML reader etc.). The existing converters produce cityGML data readable for GIS environment and selected CAD applications. The main platforms used during the process are AutoCAD, Google Sketchup and Quantum GIS. The most appropriate data cityGML data for 3D-negatives is LOD2 (geometry of buildings with roof structures, but without architectural detail). LOD1 data can be also used for simplified urban analysis. The result of data import is structured geometry of building components – walls, roofs, floors etc.

Point Cloud

The following step is partly inspired by LiDAR data [12] in form of point clouds from 3D scanning. The objective is to detect automatically the XYZ point cloud from all component geometries within a virtual city model. Initially, the geometry of city model is exploded into lines that are divided in groups of vertical, horizontal and inclined lines. Afterwards, automated detection starts to generate XYZ points for each node of geometry in 3D model. The individual computer algorithms for point cloud detection were written in AutoLISP for AutoCAD (Rubinowicz, CUC, 2014) and in Python for Quantum GIS (Jarzemski, 2015). The result is a XYZ point cloud for all nodes of geometry. Further operation to reduce number of data is the automated elimination of multiple X,Y axis points with different Z coordinate. In fact, only the top points of each wall remain. The lower Z coordinate points are moved to separate layer excluded from further actions. The remaining point cloud of top

Z points (similar to DSM Digital Surface Model or DEM Digital Elevation Model) is used for further steps of 3D-negative detection.

Triangulation

The detected data from cityGML data point cloud is transferred in .TXT format to Quantum GIS platform to perform 2D Delaunay triangulation adopted from field of applied geometry. All the XY points are linked in triangular flat surface, which is transferred back to CAD platform. The triangulated point cloud is a surface including both geometries in virtual city model – built up structures and spaces between buildings.

3D Surface

The GIS platform loses Z values from point cloud during triangulation. A new algorithm in AutoCAD allows conversion from 2D triangles to 3D surface restoring Z coordinates for each point. The result is 3D triangulated surface attached to the top of virtual city model objects like a ceiling or shell floating over urban space.

3D Solid

Another algorithm has been developed to automatically generate geometric solid between the floating triangular surface and profile of terrain. The algorithm uses the extrusion process to give a certain thickness. The entire virtual city model turns into a 3D solid with the triangulated surface at the top and the terrain profile at the bottom.

3D-Negative

The last procedure performed on 3D city model uses a simple 3D Boolean operation to subtract built-up structures from the newly generated geometry. The remaining part represents geometry of space between buildings and is called the 3D-NEGATIVE. The application is going to use this geometry to analyze geometric structure of cityscape in sense of open public spaces between buildings.

SAMPLE AREAS

The impact of tall buildings is the main objective of the undergoing research project 2TaLL, so initially the selected sites are in direct relation with location of tall buildings. The presented example of parametric interpretation by 3D-negatives method in virtual city model was performed on approx. 1x1 km areas of 3 European cities: Delft (NL), Loerrach (GER) and Rotterdam (NL). In the sense of urban morphology and impact of tall buildings, the cities have different characteristics. Delft is a small Dutch city on regular gird, with mostly uniform scale and height of buildings, located on flat landscape, with two tall building historical dominants of New Church and Old Church located in the city center. The city of Loerrach in southern Germany is also small city, but located on hilly landscape, with small town type of buildings and single dominant of Town Hall tall building located in the city center nearby railway station. The third is Rotterdam, located on flat landscape, with many tall buildings grouped in the Stadsdriehoek area.

The cityGML datasets used for analysis of 3 cities were open source data. CityGML model of Delft was LOD1 quality without terrain surface, Loerrach has the best quality LOD2 data with terrain a model, the model of Rotterdam is also LOD2 including textures – a terrain model was not used in this case.

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PARAMETRIC INTERPRETATION BY 3D-NEGATIVES

This article introduces details of the 3D-negatives method, overviews possibilities, indicates types of urban analyses possible to perform and presents sample application. The main goal for the parametric interpretation of space between buildings was to observe urban parameters in areas around tall buildings, observe how they appear in direct surroundings, how sudden the impact and how the geometry of 3D-negative performs in different configurations of tall buildings. The paper presents only a sample interpretation of proposed parameters and indicates the potential of using 3D city models in urban analyses regarding the geometry of public spaces. The generated 3D geometries of public spaces were put under proposed types of parametric interpretation. These types are: type 1 – city spectral profile (CSP), type 2 – typology by slope (TBS), type 3 – typology by length (TBL), type 4 – typology by area (TBA). The abbreviations are proposed to simplify further explanations.

City Spectral Profile (Type 1)

The proposed CSP is based on a spectral approach using a series of sections through the geometry of 3D-negatives. The observation of a number of subsequent sections is intended to recognize changes in public spaces volume and profile in different types of cityscape where tall buildings are located. The CSP consists in this case of the automatically generated 11 sections. The distance between sections was set at 10 meters. The sections were generated through the area where the tall buildings are located. Putting sections in one matrix allows recognition of some geometrical regularities in tall buildings' impact on direct surrounding. A uniform scale for all matrixes was used. A useful parameter describing the relation was angular change of height within space between tall building and surrounding buildings. The angle stands not only for height of the building but also indicates the ratio between height and width of adjacent open space.

CSP	Max. angular change [°]	Type of impact	Tall buildings arrangement
Delft	*41-56*	*Average*	*Single*
Loerrach	*36*	*Soft*	*Single*
Rotterdam	*56-68*	*Intensive*	*Group*

Table 1

Measurements of angular change in profile of open space beneath tall buildings with type of impact

The lowest maximum angular change was noticed in CSP of Loerrach (30-36°) and corresponds to the rather soft impact of the shorter Town Hall building located in area with more open space around it. In this case, the size of the space surrounding the tall building has a positive effect on its perception within the city. The higher value of Delft (41-56°) is caused by sudden effect of single dominant of tall building located in the dense and low-height surrounding city structure. The CSP of Rotterdam shows the highest maximum angular change (68°) because of the irregular concentration of tall buildings in a limited area and the proximity of low and tall buildings. Loerrach is also interesting because of the observation of impact from user point of view, because the CSP also shows angular change in the profile of terrain in relation to angular change of the city profile.

Typology by Slope (Type 2)

Each 3D-negative has its unique triangular structure. All the 3D triangles have their own unique inclination resultant from Z coordinates of all 3 XYZ nodes. The TBS parametric interpretation has similar objective to previous CSP analysis, but allows the creation of a color map of the cityscape for areas where tall buildings are located by the slope of 3D-negative triangles. Assigning colour attributes to a specific range of slope allows the creation of a map of geometric structure of space between buildings. For this sample application, 6 equal Triangular maps show in color range and impact of tall buildings on the cityscape. The number of adjacent triangles and their slope delimit

the impact area. Different typology of impact is clearly visible when comparing case or Rotterdam and Delft. Irregular 3D-negative of space between tall buildings in Rotterdam is completely different from case of Delft with a single building of limited impact area.
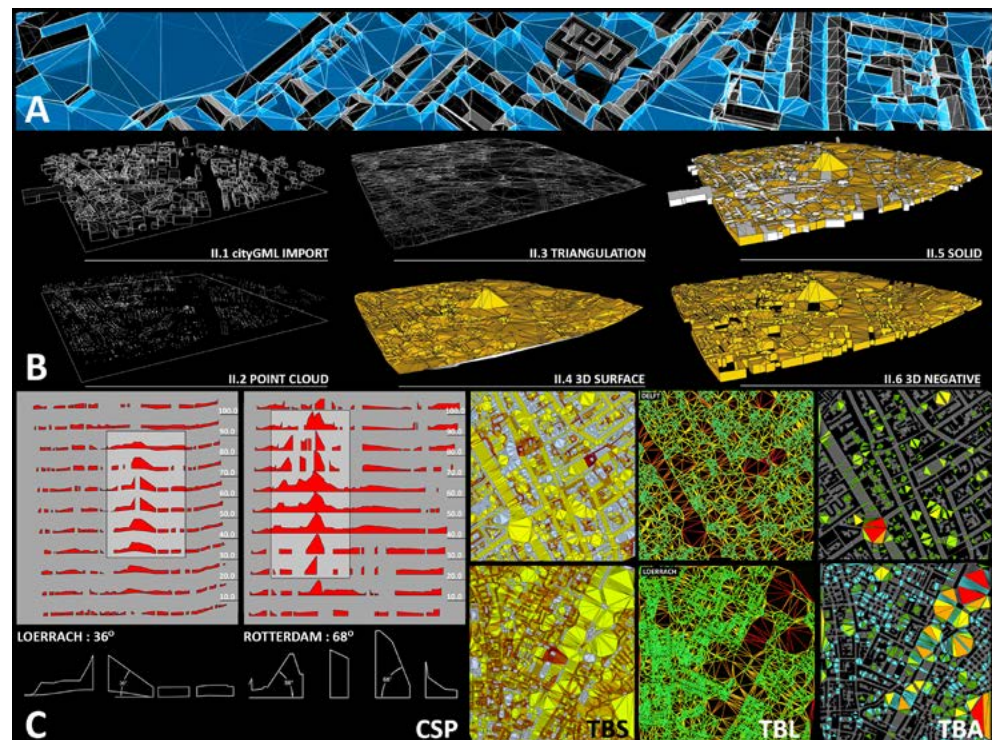
Typology by Length (Type 3)

The TBL interpretation of 3D-negatives focuses on the observation of spatial integrity and the general morphology of public spaces. All the connections of triangulation represent distances between components of urban structure (buildings, etc.) and indicate regularity of space between buildings. The length of connections can be measured as lines in 3D within triangulated 3D-negative. The lines represent different diagonals of open spaces. The presented example includes 6 length intervals (5 to 200+ meters).

The TBL maps show geometric regularities of open spaces by the concentration and number of certain line lengths in city structure. In Delft and Loerrach, open spaces of diagonal over 80m are located around tall buildings. In Rotterdam, the concentration of tall buildings in the limited area causes, that such a distance is possible only outside the area. The TBL map for Delft shows clearly the size of impact of tall building on a main city square.

Typology by Area (Type 4)

The last proposed type of observation of geometry of 3D-negatives is TBA. The concept is related to TBL maps, but instead of line lengths bases on parameter of the area of particular component triangles of the 3D-negative geometry. The TBA assumes also 6 intervals, but for total area of single triangle in 3D-negative (1 to 5000m2+). TBA can be also performed in 2D or 3D mode. The result is a color map with the location of different public spaces with respect to their size and relation to location of tall buildings. Red triangles indicate location of largest public spaces.

Fig. 1. A) General concept of 3D-Negative; B) 3D-Negative generation process – all 6 stages; C) Sample of a parametric interpretation of 3D-NEGATIVE: type 1 – CSP, type 2 – TBS, type 3 – TBL, type 4 - TBA

Source: All figures by authors

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Some interesting results of parametric observation by TBA were achieved for Loerrach and Delft. In Loerrach, the concentration of large open areas corresponds with the location of the main tall building, but in Delft, the largest open space in city structure is in different location in relation to the tall building. Loerrach 3D-negative indicates linear scheme of large open space along railway route, in Delft single large open space appears at main cross-road in the city.

CONCLUSIONS

The presented geometric approach introducing the missing geometry of 3D-NEGATIVES is the only one selected aspect of to the general phenomena of the "life between buildings".. The method focuses on geometrical parameters of public spaces. The technical challenge of the method is calculation of enormous data within virtual city models. It was tested on a very limited area of 1 km2. Apart from clearly defined cityGML structure, there is still incoherence in spatial data from different sources. The very high geometrical accuracy also remains a challenge for data import. Presented example application of 3D-NEGATIVES for the parametric observation of space in-between shows potential for comparable studies on public space systems in different types of cities. The case of tall buildings emerging in cities is very relevant because of the close relation between the localization of tall buildings and a system of public spaces in different urban structures.

ACKNOWLEDGMENTS

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VISUAL IMPACT SIZE METHOD IN PLANNING TALL BUILDINGS

The article introduces the Visual Impact Size (VIS), a method of computational analysis based on the 3D isovists theory to provide to analyze the impact of tall buildings on the cityscape. In many instances, the negative consequences of an inappropriate location of a tall building especially in European cities resulted from inability to foresee its spatial impact. The VIS method uses the virtual city models as basis for calculations. It allows: a) to identify all locations in the city from which the planned tall building can be seen; b) to show not only real visual impact range but also imaging of the impact power (visual impact size) of the building. The method was applied in author's professional praxis to verify locations and parameters of tall buildings.

TALL BUILDINGS PHENOMENA IN EUROPE

In recent years, tall buildings have become increasingly popular. The majority of contemporary tall buildings in the world were built 21st century. This phenomenon does not any longer apply to only the largest metropolises, but also medium-sized cities. Especially in Europe, this is an important urban planning challenge. The European cities and their surrounding cultural landscapes have evolved gradually over centuries, if not millennia. Their built heritage, when not ravaged by war, is substantial. (Van der Hoeven and Nijhuis, 2011, p. 279). The development of tall buildings involves major threats to landscape cohesion and integrity of those cities. Specific architectural and urban arrangements reflected in the silhouette of a city are an important part of the protected cultural heritage (Rubinowicz and Czyńska, 2015). Due to their broad visual impact range, tall buildings frequently induce unfavorable and unplanned interaction with historical buildings. They diminish the influence of primary architectural dominants (e.g. towers of churches and town halls) as regards to their role in the overall composition. For this reason, plans to develop tall buildings trigger conflicts and controversies (Fig. 1a). In order to proceed with an objective discussion on the role of tall buildings as such, we need to develop a methodology for assessing and planning such buildings in a city landscape. We need to fully document the future, planned visual impact to formulate reliable and competent planning guidelines and strategies for landscape protection and development.

The current planning mechanisms do not fully utilize the advancement of modern technologies and analytical tools. The development of computer aided techniques, increase in computing power, as

well as growing accessibility of virtual city models significantly boosts and expedites the verification of specific planning decisions, in particular those regarding tall buildings. However, we still are missing a clearly defined methodology for diagnosing the phenomenon and dedicated analytical support. The planning of new tall buildings necessitates analyzing the urban structure of a city at various scales: from global, including the impact of a building on the space of the entire city, partial external exposition within skylines, to internal views of public space (squares and streets) (Zwoliński and Jarzemski, 2015). For planning purposes, a relevant synthesis is necessary – determining the sum of visibility fields for a planned tall building. The use of scientific theories concerning determining of isovists 3D in analyzing visual aspects of tall buildings is particularly valuable. The Visual Impact Size (VIS) method presented in the article enables determining all locations in a city from which a planned facility can be seen. This helps define whether a new vertically dominating architectural structure may appear in areas of strong spatial values. This helps foresee potential changes in the skyline of a city.

APPLICATION OF ISOVIST FOR URBAN STUDY

Isovist theory

Visibility analysis allow us to apply mathematical certainty to the experience of urban and building environments (Turner, 2003, p. 657). Many attempts to use isovist in architectural and urban analysis have taken place. Since Benedikt (1979), isovists have been an active field of research. A number of authors have suggested techniques to calculate isovists, describe their shape, thus gaining insights into urban morphology. Isovist is usually defined as the field of view, available from a specific point of view. An isovist can also be understood as the area not in shadow cast from a point light source. In general, the isovist is a closed 2D polygon (Morello and Ratti, 2009, p. 839). In Space Syntax theory, isovist is the sum of the infinite number of lines-of-sight (or axial lines) that pass through a single point in space (usually at eye height) and that occupy the same plane (usually parallel to the ground plane) (Conroy Dalton and Bafna, 2003).

The possibility of applying the isovist software can be broad and cover a number of research areas. For the majority of potential applications, reducing the simulation to two dimensions only is sufficient. However, visual analyses of tall buildings requires introducing an isovist in its full form of a 3D space. A 3D isovist defines the 3D field of view, which can be seen from a vantage point with a circular rotation of 360 degrees and from the ground to the sky. Adding the vertical dimension helps to better simulate the physical environment observed from the vantage point (Morello and Ratti, 2009). Yin (2013) in his doctoral thesis summarized the limitations of 2D and 3D visibility calculations. Suleiman et al. (2013) explored ways of calculation 3D visibility and introduce a new algorithm based on vector GIS data. At the 3D level, the structure of a city is more complex. Therefore, 3D isovist in a given point of a city opens a wider space for potential analyses. It includes for example visible parts of the area (depending on topography), visible sections of facades and roofs.

Isovist 3D and tall building impact

The literature includes a number of examples of practical isovist application (Łubczonek, 2008; Moser et al. 2010;Pal Singh et al. 2013). However, there fewer examples referring to visual aspect of high development. Van der Hoeven and Nijhuis (2012a,b; 2011) describe analysis of the visual impact of Rotterdam's and Hague's buildings on the open landscape by means of GIS. They describe two aspects of visual information: visual coverage and cumulative visibility, which represents the intensity, or amount of high buildings in the skyline of the city. Yamano and Yoshikawa (2005) refer

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to studying visibility and visual size of a tall building. Another example is the study of tall buildings performerance for Helsinki (*Korkea Rakentaminen*, 2011). Isovist was used to examine the visual impact of tall buildings, with particular emphasis on the exposition above the Gulf of Finland. The professional experience of the authors also confirms applicability of the isovist for analyzing tall buildings. The method was used several times for studies on city landscape. Major observations refer to increase of the impact area of a building with the increase in its height. The observations enabled formulating objectives of the method described in the article as the Visual Impact Size (VIS).

VISUAL IMPACT SIZE (VIS) METHOD

VIS assumptions and computation rules

The method aims at showing a total impact of a tall building in a city. This leads to developing a single visual impact map (VIS) which facilitates the interpretation of results and their application in planning. A novelty of the method is imaging of not only real visual impact range but also imaging of the impact power (expressed in intensity of color used). Relevant number and height of thresholds, depending on a specific nature of a city, are crucial for the quality of results. If the number of thresholds is too large, the result is not legible. Usually seven thresholds are assumed (20, 40, 50, 60, 80, 100, 150 and 200 m) for which the analysis are performed. Computer simulation produces a map with all locations from which the planned building can be seen. Colors used in the map reflect the strength of exposition of a planned building in space. It is the most visible from areas marked red according to the chart (Fig. 1b). The impact area can be presented in a projection and in two axonometric or perspective views (Fig. 1c, d). The VIS simulation reflects a real impact of the building in a city landscape.

The sequence below (Fig. 1d) enables examining how particular 3D isovists change depending on the location of a tall building against the analyzed urban structure. Based on examples of the urban fabric we may draw general conclusions concerning the exposition of tall buildings in a city. It is possible to examine the change of the visibility area depending on different heights and locations of a building. We can also observe relations between the location and shape of the visibility area. Relations with the urban composition become clear. As a result, terms such as street axes, shapes and size of squares, visibility foreground gain new meanings in relation to the exposition of a tall building.

Application of the VIS method in planning

The application of the VIS method can be observed using the example of a real city space – e.g. part of Frankfurt center. The city has its individual landscape where tall buildings prevail (Fig. 1e, f). The study examines a location situated at one of squares in the middle of dense structure of streets based on a historical grid in the immediate neighborhood of a tall buildings cluster. The analysis indicates location of strong exposition (Fig. 1e). Usually, the result is limited to the examination of public space, understood as all undeveloped sites in a city. Simulation, however, may include examining of tall building visibility from other buildings and all predefined geometrical elements of the 3D city model. In this particular case of the Frankfurt old town, these include adjacent axes of streets lead towards the building. Along the river of Main, visibility of the building is excellent, since the building is exposed from 40 m in height. Provided there are limitations to the development of the city skyline from the side of the river, the above analysis could help determining the maximum permitted height of buildings at the square. The major advantage of this method

is that it determines all locations of visual exposition of a building in a city, which is crucial for determining planning guidelines.

The analysis of Frankfurt was developed using the computer program developed by the authors (C++). Input material included a CityGML model of a city with precision of LoD2 imaging (with geometry of roofs – Fig. 1f). VIS simulations can be performed using conventional GIS software and available tools. Differences apply to the precision of simulations. The algorithm used in the program developed by the authors emulated VIS maps using a vector model of a city as a basis. GIS tools such as ArcGIS (with 3D Analyst application) by ESRI use the Digital Surface Model, which reflects the geometry of a city in a simplified manner. The precision of imaging of the model is important in the case of analyzing a complex geometry of buildings comprising historical skylines of European cities. They contain a number of tower like elements. Neglecting them may distort results of the analyses and impede their interpretation in urban planning. However, analyses based on DSM models are frequently the only solution possible (in case CityGML model is not available). In such a case, results of the VIS analyses depend on the precision of the model. The larger the number of measured points per meter in DSM model, the better simulation results achieved. The advantage of DSM, however, is the possibility of examining large sections of a city and reduced cost of data acquisition. This has been described more extensively in other publications (Czyńska, 2015).

Fig. 1. a) Panoramic view of Frankfurt from the river side; b) interpretation of colors used in VIS method; c) VIS analysis for a schematic build-up development model; d) simulation for 5 different locations of building; e) VIS analysis for location of tall building in old town area of Frankfurt; f) CityGML model of Frankfurt

Source: All figures by authors
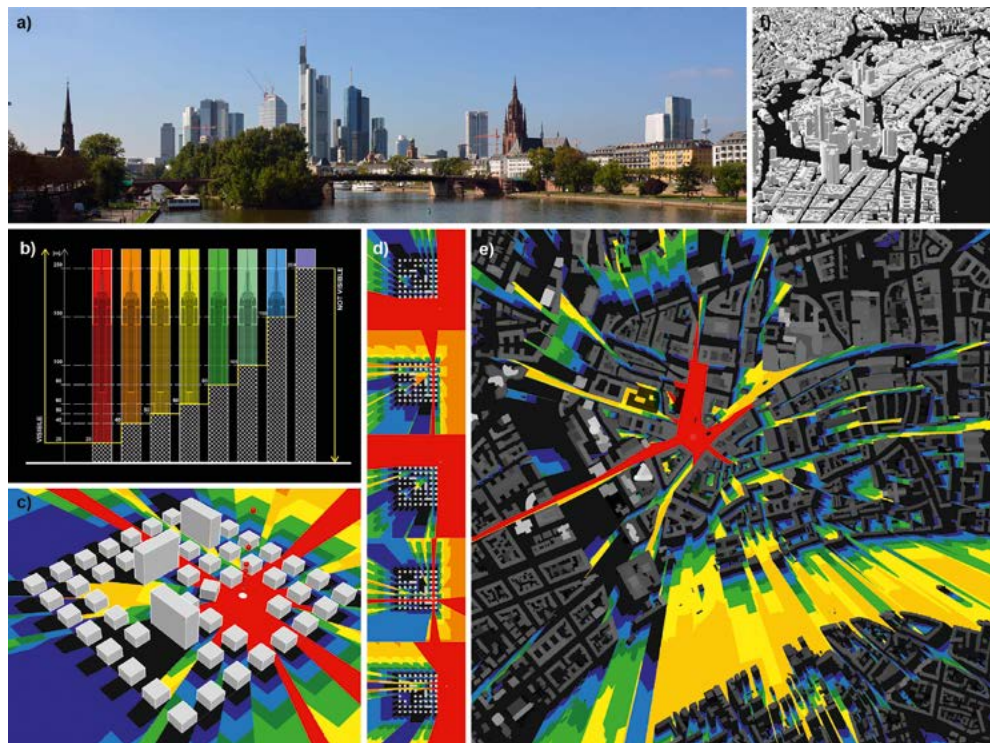
In the professional practice of the authors, the VIS method proved to be particularly useful (Czyńska, 2009). It was used in 2007 to verify potential locations of tall buildings in Szczecin, Poland. The studies were implemented under a contract with the local government (Czyńska et al., 2007). The studies analyzed in total 10 potential investment projects. The aim was to determine the impact of planned facilities on the city landscape while taking into consideration cultural values and also define detailed guidelines concerning their height and form. Yet another example of the application of methods is the "Impact study of the new library in seminar gardens" developed in

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2015 (Marzęcki et al., 2015). It aimed at determining rules for new buildings height in historical skyline of Warsaw.

CONCLUSIONS

Developing tall buildings in European cities is controversial and generates strong emotions. There are probably as many supporters as there are those who are skeptical to such a development. To bring the discussion to the level of objective and measureable arguments it is necessary to develop tools that enable analyzing the phenomenon at its geometrical level. In other words, analyzing it in an objective manner to the extent possible so the result achieved is not debatable. In many instances the negative impact of tall buildings on the city landscape is the result of mistakes in the planning process, disregarding of important views in analyses, etc. Although a realistic visualization of a new investment project has become a standard element of the architectural design process, a reverse action which involves determining all locations in a city from which a building can be seen is a larger challenge. The use of the isovist theory enables examining such relations.

The VIS method, outlined in the article, is a proposal for imaging of the tall building impact on the landscape of a city. On the one hand, the objectives of the method resulted from research by the authors, and on the other, they are the result of their professional experience from developing guidelines for potential tall buildings (where the method was applied). An important part of VIS is to visualize the impact of a tall building. With the increase in accessibility and precision of digital 3D city models, the possibilities for using the method in real urban planning increase as well. The simulations presented in the article were developed using a special computer program developed by the authors, dedicated to analyzing CityGML models. However, it is possible to generate approximate VIS using DSM models and LiDAR data (LAS). It is also possible to simulate approximate VIS results by using different GIS programs. The main limitation and challenge is the size of data to be processed, which is applicable mainly to large cities. The VIS analysis should cover the entire space of a city and sometimes also its wider landscape context.

ACKNOWLEDGMENTS

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CONTEXT VERSUS UNIVERSALITY

The city is developing with the same rate as people are changing and evolving. The way of thinking in society is changing, too. On the first plan at all times, there are different priorities and they exist as a characteristic of a certain age. By studying historical processes in society it becomes possible to find a reflection in city planning. «Planning is a messy, contentious field; planning theory should provide the means to define and address these debates and understand their deeper roots» (Campbell & Fainstein, 2003, p. 5). This paper tries to see this causal relationship of history and city planning, analyze current situation, and to foresee a future path of development.

REVIEW OF HISTORY

First it is needed to consider the history and understand the basic algorithm of communication with urban planning. City planning is a reflection of the social structure of society and it is changing at the same time as the ideals and values of society change. In each empire, country or period of history we can deduce the main postulation on which it was based, what was the main principles of society of the time, and in what way and by what methods the society solved these issues. When society finds the answer, a step to the next level has been made. By solving one issue we can come to the next question. Development is just to find an answer for the common question. This paper does not cover every historical period, as it is only a key.

Starting from an important period in city planning development – Ancient Greece and Athens. This civilization has made a tremendous contribution to the development of culture and many forms of art that are still seen today. Public library, theatre, places of public debate and discussion - this part of life in Greece was at a high level. In order for such initiatives to develop, the Athenians necessarily appropriated places and urban structure. In ancient Athens, the city was planned so that the street network connected citizens to the central public space, manifesting the importance of participation and the political equality of the citizens. Athenians valued their cultural life, democracy and the ability to communicate with each other. Therefore, any street in the city could guide you to the main square, where you can find many people, which made some activities; beautiful views and buildings, and many of them cultural. Thus, one of the issues, that people tried to decide – was to ensure the cultural lives of citizens.

Another type of city planning development happened in ancient Rome. The Roman Empire conquered other countries and peoples, and they were feared. Rome was a symbol of the military power of the empire. Temples, basilicas and triumphal arches in the heart of the city underlined the military might of Rome. So, we have the basic plan consisted of a central forum with city services, surrounded by a compact, rectilinear grid of streets, and wrapped in a wall for defense. The Roman Empire – it's glory, majesty and power. Spacious, wide streets, on those townspeople greeted the winner's army. Arches and column along the city. A common question for Romans designers in this case is - to emphasize the greatness of the military city, Rome – is the city of winners. Every citizen must be proud of this.

After the fall of the Roman Empire, there was «the great migration of peoples» in Europe. They did not want to stay in one place for a long time; they tried to find a great life elsewhere (Gottdiener & Hutchison, 2006, p.30-33). As is natural for people that are in fear. European citizens were making small towns that needed to be able to defend themselves. So we got the medieval towns that were surrounded by city walls. And these cities ruled out the possibility to grow outwards. Therefore, they grew in height in order to keep up with a growing population, and to provide for the needs of the people. Definitely, the growth in population also largely brought problems of crime, poverty, and disease to the city. And we got to the city, which became a cage. The uniting question for the community of that time was how to ensure their safety, protect themselves and their families from foreign attack. For the people of the Middle Ages it was the best decision - the city fortress and we got a new phase of urban development and city planning.

The next important period in the history is the Renaissance. Rome was the central city and a symbol of faith and of the Catholic Church. Many people around the world dreamt to get there, and every year many of them went. This required a new type of city planning: squares and monuments, as well as boulevards connecting them, in order to create movement. The great example is Florence with their ideal city planning. According to Siegfried Giedion "Space, Time and Architecture" *"The Renaissance was hypnotized by one city type, impressed upon utopian schemes: this is the star-shaped city".* Radial streets extend outward from a defined center of military, communal or spiritual power. Cultural life of citizens was an integral part of city planning in Renaissance. One of the main questions for the Renaissance is finding an ideal city, a humanistic city. The Renaissance's intellectual basis was its own invented version of humanism, derived from the rediscovery of classical Greek philosophy, such as that of Protagoras, who said, that *"Man is the measure of all things".* This new thinking became manifest in art, architecture, politics, science and literature.

The next rise of European urban life came with industrialization. With the advent and development of economic relations and of capitalism the city began to develop quickly. (Gottdiener & Hutchison, 2006, p.36-40). Society received new knowledge and the speed increased. So in the middle of the 19th century, many cities were industrialized. The cities that developed during industrialization did not follow a religious principle like earlier periods did. Capitalism ruled, which resulted in cities that separated the rich from poor, and many of the issues that modern day urban planning deals with, in fact, date back to industrialization. During this time, people who had the power often embarked on ambitious attempts at rebuilding their cities as a showpiece for the grandeur of the nation. Calamity and disasters were often a catalyst for planned reconstruction. The same situation occurred in London after the Great Fire of 1666. The city was rebuilt almost from scratch, but now it considered all the new demands of the times - hygiene and fire safety with wider streets, stone construction and access to the river. The great nation idea is to show industrial power, triumph of machine. This philosophy we can find in literature, architecture and art.

Around 1900, theorists began developing urban planning models to mitigate the consequences of the industrial age, by providing citizens, especially factory workers, with healthier environments

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(Nissen, 2014, p.6). And we enter the era of Modernism. This way of thinking was formed under the influence of the functionalist idea, the creation of Le Corbusier, who observed the city as a machine (Ellin, 1999, p.34). His scheme for a "Contemporary City" for three million inhabitants (Ville Contemporaine) in 1922 - generated a lot of noise. *"Ville Contemporaine aimed to put a man into an abstract representation of nature. The sun and the air, space and greenery - all this was, according to the architect, was necessary for modern man to feel happy"* according to Nielsen book "150 years of Urban Development". This project generates a new understanding of the ideal city, where everything is subordinated to one idea and operates according to certain laws. The designer tried to create an artificial environment identical to natural and it had to work like a machine, an installation. The dream was to create a mechanical city and shift the routine in it. As a result, people can get more free time for their affairs. Society would like to feel free from the routine of non-binding things. But the man is part of nature, and it needs to be in contact with it, especially after the age of industrialization. So we can conclude, that people wished to feel freedom. They "want to see the sky", not only buildings and industrial progress, they want to feel nature. And city must give them this opportunity. That is why architects of Modernism choose subtle materials, bright windows, and we see the emergence of an emphasis on ergonomics – all for the human convenience.

From this short historical review one can see that designers always try to find an answer for a national question: a common answer, which corresponds to the global idea. We have a collective purpose to find a solution, and rise to a new stage of development.

THE CURRENT SITUATION

Society always asks too many questions for their time, they always have such of requirements for all life. People always want live in comfort and in convenience. We have a demand - comfortable working conditions - spacious, with natural light, fresh air, not below ground, preferably in a park area, not far from the house and other social infrastructure. Such requirements to the workplace are current. But those are in fact always been – in Ancient world or the Middle Ages, in Modern or Postmodern. And probably always will be. It can be seen in different forms – house, apartment in the high-rise building, flat, or medieval castle, or beautiful palace. But we can not change human nature. If we talk about living – we must feel safe and be able to rest and relax. And we can not forget about public relation. A place, were people are connected by public spaces, squares, areas that must be attractive for citizens. Therefore, dark place with a bad smell, faint lighting, etc. - we can not call this a good public place. And we hardly would choose such a place to meet with friends or family. Perhaps we would have preferred a pleasant park or a wide street. Thus, the basic requirements of human society to the city may never change, until such time as will not change the nature of man. But we have a time requirement which comprise the main purpose of humanity at this stage of evolution. This factor and this aim may be constantly changing. As we see the goals and values of people, countries and societies are permanently changing - in fact, this is development. Only human nature and its needs are stable. So for the city is paramount to satisfy exactly these demand of peoples – great workplaces, comfortable houses and convenient public places.

But what about the variable values of the society?

City always tries to find a universal answer.

That is why it is necessary to analyze history. We can identify the main purpose for society in different times - what goals they are trying to solve. We understand main values for peoples, so we can find answers and solutions of this question in the city planning and urban design. We have a large goal to connected people together, to find the most effective solution. And all architects and

designers are working in a common space. They can express themselves from their buildings, and all projects are different, but we can see a red line, a big aim, which is to connect this entire project in one big era. People thinking about Industrialization find a new material, a new construction. Different artists are on different paths. One of them are making living houses another making a store – they are very diverse. But we can see the common desire sing to exalt the machine, this triumph of society.

"Urban planning today is mostly concerned with superficial discussions concerning aesthetics." (Nielsen, 2008, p.30). . The XXI century is the era of the "Scientific and Technical Progress" and Postmodernism philosophy, which states "You can have your own truth, and no one can deny this". And what do we have? For the most part architect and designers obsessed with self-expression. They try to create their house different from others in their city, country and history. With its unique philosophy of project, each building tries to turn the world. Creators are most fixated on the their need for the building to be included at the top of the world charts, magazines and websites. And no one can deny his opinion. They think "in the context" and then your building, your answer is perfect. Now designers are not looking for a "universal response" in the city. People are united, and sought a common, universal response. Each of creators has his own way of thinking, but they are complying with the main objective. Now everyone has a little fragmented system of values. People do not join forces to address a common idea. Contemporary society gives you the right to choose. You can have your own philosophy, and thinking in this context. The winner is "context" and the desire to express themselves, to tell something of their own society. "Context versus universality" means that now we have a selfish era of urban design. "Universality" is a way of thinking, when every people help to find a solution of common problem. "Context" is a way of thinking, when every building and project can exist, all depends from your ability to protect it.

Can we implement a common national idea? Or is the essence of the national idea and values is so transformed, that allows us to solve completely different ways, and we no longer need to search for "universality" answers in the form of "the city " to satisfy all human needs.

Today one part of architect and designers try to solve an ecological and climate question, another group finds answers for multifunctional houses and "vertical towns", the third group thinks about what needs to be done with slums. Modern life asks too many questions that have not previously appeared. There are more and more new technologies and new requirements that must be met. And the speed of these changes is growing. But perhaps society would not be able to step into a new stage of development, as long as everyone is in its own contextual design philosophy. We must look into the past and take from there the best examples of problem-solving.

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CURVILINEAR FORMS IN CONTEMPORARY ARCHITECTURE

The curvilinear form has always been present in architecture. It was a result of the experience with the available material and technical capabilities but it also played an important formal and semantic role. Currently, the curvature of a surface in architecture is present in many various configurations. It is influenced by a variety of creative attitudes among architects and technological capabilities. The subject of the paper explores themes related to modern trends like iconic buildings, inspiration by nature and tools as well as their origins in history of architecture.

INTRODUCTION

Architecture always comes from a specific time and place – it is a child of its times. Since the antiquity, a thought or idea is the most basic material of architecture. However, a thought alone is not yet architecture. A project in the form of a drawing or a model is still an idea, necessary to create a building. The relationship between the idea and its materialization as an object depends on the time and place of the object's creation. The form, quality and functionality of architecture appear initially in the architect's mind. Independently of the historical staffage, rationality and aspirations, architecture is marked with the world it comes from. This happens through the thoughts of the designer (Juzwa, Świerzawski, 2014).

Curvilinear forms were used in architecture throughout history. The ability to build these forms depended on known techniques and experience. The first human shelters consisted of curved surfaces. Branches dug into the ground connected at the top formed a hut. Further development of construction and building techniques contributed to rectangular buildings (Tobolczyk, 2000). Domes are a commonly found curvilinear form in the history of architecture. In some Arabic regions, domes were used for housing because of the accessibility of brick material. Objects like the dome of the Tomb of Agamemnon are connected not only to building experience but also to ideas about life and death. The same holds true for the dome of the Pantheon. In history the curvilinear form of domes was both a basic form of building as well as a very prestigious element.

Currently, in the age of digital design techniques, curvilinear forms are commonly used in architecture. New, big projects of curved, undulating buildings are described in literature, magazines and on the internet on a daily basis. Architects refer to different kinds of ideas and inspiration for these buildings. Among others one can hear about functionality, economics, aesthetics, science

and technological possibilities. Adapting to the society's changing needs, one can observe an increasing ability of joining features like: functions and aesthetics, homeliness and identity as well as showing the prestige and the use of techniques and technologies. New methods and possibilities in designing and constructing together with a suitable "intellectual ambiance" of the creation are affecting the worldview of the architects. This is also influencing human dreams, which form the first idea of every design and are constantly changing (Juzwa and Świerzawski, 2014).

Designing curvilinear forms is only one of many possible directions of contemporary design. Architects use it often to build recognizable, impressive structures. Some use is as an analogy to science and nature while others tend to explore the technological possibilities of digital tools. For a better understanding of curvilinear forms in contemporary architecture the following directions of artistic pursuits can be distinguished:

– Continuation of expressionist trends, designing buildings as "icons" or "symbols" depending on the artist's subjective thoughts and feelings (Kozłowski, 2013).
– Science and nature as inspiration for designing forms, functions and environmental impact to name a few.
– The use and exploration of technological potentials of designing and building, allowing to create curvilinear forms more easily than by hand.

EXPRESSIONIST TENDENCIES

Expressionist authors went away from the actual representation of reality to emphasizing emotions, feelings and thoughts. Architects made drawings that were very recognizable but almost impossible to build structures. The form was more important than the function. Such drawings by Bruno Taut or Hans Scharoun inspired others. Architecture and buildings were treated like monuments, symbols. Tadeusz Kozłowski points to Erichs Mendelsohns Einstein Tower in Potsdam as such a building – icon (Kozłowski, 2013). This tendency of looking for originality and dissimilarity can also be observed nowadays. Architects and investors are looking for original, new designs that will stand out from their surroundings. They often turn to curvilinear forms in numerous configurations and geometries. Many new, distinguishable structures are meant to become icons of regions, companies or cities. It is important to notice that contemporary references to expressionist tendencies may not be intentional. Designers may not be aware that their idea or solution occurred in the history of architecture (Kozłowski, 2013).

Researchers of architecture pay attention to the large variety of modern architecture and multitude of attitudes. Many trends and directions can be distinguished, which are intertwined with each other. There are different, even contradictory interpretations of buildings' meanings and forms possible. Charles Jencks refers to it as a "mixed metaphor" and adds:

> *"Architecture, like the other arts, can refer to anything today, including nothing and its own abstract systems" (Jencks, 2005: 209).*

In a consumerist society of media coverage, the recognition of a product and a company is of great importance. A very well-known example of an icon in architecture is the building of the Guggenheim Museum in Bilbao designed by Frank Gehry and the associated "Bilbao effect". The museum, whose construction cost 100 million US dollars, was supposed to influence the image of the city, which had been mainly seen through its collapsing shipbuilding industry. The building was erected on the banks of the river Narvio. The extensively sculpted, curvilinear form of the building is clad with titanium panels that, together with the river, reflect the sunlight and the surroundings creating a play of light. The characteristic form was commented worldwide and created a tourist boom in the region. The investment brought multimillion profits and publicity to the region transforming it into a

tourist attraction. Other examples are the Sydney Opera House by Jørn Utzon or the TWA terminal by Eero Saarinen (Jencks, 2005).

The Al Hamra Tower erected in 2011 is described by its authors, Skidmore, Owings & Merrill, as „iconic". The 412 m tall building is the tallest building in Kuwait and it draws attention through its original form. The Al Hamra Tower has the form of storeys cut out from a vertical cylinder. Due to the conditions, i.e. insolation on its southern side and the vistas spreading from the west, though the north to the east, each storey has had a fragment removed. The removed fragments are rotated by an increasing angle on each storey. As a result an empty space is created that forms a vertical spiral along the building and two hyperbolic-parabolic surfaces. The empty space is located in a way enabling optimal views from the inside of the building, at the same time preventing its overheating. The twisted surfaces have been finished with a stone facing on its southern side. The expression of the stone elevation and the localisation of the core of the building on the southern side allow the other facades to be fully glazed to make use of the vistas and to prevent overheating of the building (Agarwal et al., 2007).

SCIENCE

The perception of the world and the understanding of nature by a given society is also reflected in architecture that was subjected to given views of nature's laws and culture. Some contemporary designs follow this logic as well, but the understanding of the laws of nature has changed over time. Curvilinear forms, surface curvature, non-linear relations are commonly found in nature and science. For some architects this is an inspiration to create nature-like forms (Jencks, 2005).

References to nature are made in varying ways. Sometimes inspiration by natural forms is more or less abstract, sometimes the sources of inspiration are processes observed scientifically and described mathematically. It is rarely possible to define the exact source of inspiration.

References can be made to shapes known from biology. For example, a wavy, double curvature geometry of the roof of the Bridge of Peace in Tbilisi is inspired by the forms of water animals (Świerzawski, 2014). Designers who design buildings with organic forms like Zaha Hadid or Peter Eisenman, despite distancing themselves from naturalistic associations, their designs raise such associations through the fluidity of their form. Even if references to nature are not the main motive of the design, nature in a broad sense is often mentioned by the authors of buildings as an important element or aspect of their designs. This often takes place in connection with increasingly popular conservation of energy and resources (Jencks, 2005). Aspirations are seen for the objects to interplay with the mechanics of the environment. This approach in many cases recognises and harmonises with natural mechanisms, matching the form to such factors as insolation, wind intensity or loading. This results in increased efficiency of the buildings. For example, in the skyscraper of Norman Foster, 30 St. Mary Axe in London, its form and utility were influenced by aerodynamic analyses (Słyk, 2012).

The advent of digital design tools for architects facilitated the use of mathematical and geometrical concepts for shaping architectural forms. From considerations, among others, of planes, surfaces, fractals and topology, the contemporary approach to the themes related to mathematics and architectural form is an important aspect of the current discourse. Frequently, it uses descriptions and inspiration by such phenomena as emergence, topology and evolutionary algorithms, which are used to generate the building's form using computers (Burry, Burry, 2012).

The architects from the UN Studio drew their inspiration for the form of the Mercedes Museum from the world of mathematics, looking at issues relating to the topology of the trefoil knot. A trefoil

knot is the simplest non-trivial knot, i.e. such a curve in the three dimensional space which cannot be transformed into a circle without cutting it up or dividing. The symmetry of this knot resembles the logotype of the star on the Mercedes vehicles. Halls with exhibits are arranged on nine storeys. At first, the museum visitor travels with one of the lifts located in the atrium to the top from where they can start exploring the facility and the exhibits. When using one of the two spiral paths, visitors meet again in the atrium where they can decide to take the next path of exploration (Słyk, 2012). The building belongs to the trend of searching for geometric and mathematical dependencies by the UN Studio, as, for example, in the Möbius House or the Arnhem Central design (Burry, Burry, 2012).

DIGITAL TOOLS

The ability to build curvilinear forms is associated with the progress of techniques and technologies in the field of design and construction. The development of software and computer hardware has created new possibilities in visualizing designs and has also offered the ability to create mock-ups using machines. Computers and digital design and manufacturing technologies affect the architect's way of working. This is due to the availability of a variety of different media and tools, which can be creatively used and that affect the construction process. This allows one to explore complex geometries in architecture. The popularization and increased accessibility of these tools allows the creation of curvilinear forms more easily, faster and cheaper than with older techniques.

Numerical tools functioning in a numerical environment changed the medium in which architecture is designed and executed. Digital environments can operate in many dimensions and simulate various processes, and the designer may creatively use this. The possibility of working on a three dimensional model or an animation supported, among others by genetic algorithms, parametric architecture has resulted in new forms, equally in study designs, as well as in architectural executions (Januszkiewicz, 2010). The virtual space forms an important broadening of the architectural environment because it changes the limits and possibilities of transfer. The content is modelled in real time thanks to interaction mechanisms. The perception of space changes, influencing the formation of architecture. A building is not only a monument anymore, but a place that can react to the environment - opening new possibilities of exploration. This enables changing the message and influences the method of recording and giving information in architecture. For example the façade of the building of the Kunsthaus in Graz is equipped with lamps creating a large display, enabling a change of the picture displayed on the façade (Słyk, 2012). The great weight of this approach to architecture is seen in the words of Ewa Węcławowicz-Gyurkovich:

> *„Buildings of the 21st century will be perceived as animate objects seemingly controlling senses and reacting to the environment" (Węcławowicz-Gyurkovich, 2013: 198).*

Digital design techniques changed the flow of information between the designers and the contractors. This has influenced the construction process. The traditional technical documentation has been replaced or complemented by a digital file with information for fabrication and montage. The process of communication, exchange of information or models starting with the designer, and ending with the contractors creates a so-called "digital continuum" (Januszkiewicz, 2010). The development of computer technologies and numerically controlled machines form important aspects of the current architectural discourse. They unify the design and creation of objects, allowing the consumer to participate in the production and the mass manufacture of elements of varying shapes. They allow creating elements of desired shapes. The cost of operating such machines can be similar in the cases of identical and differing geometries. At least in theory, they allow the creation of varying objects at a similar cost as in the case of identical elements. This decreases the distance between design and manufacture, the technique being connected with the concept of mass customisation. This means the manufacture, in large numbers of individualised,

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differentiated various elements while maintaining the cost of production at the level of the costs for identical elements, facilitating a departure from the opinion characteristic for modernism of using identical prefabricated elements as the most economical and rational solution (Klein, 2014).

Complex digital techniques were employed in the realisation of the Rolex Learning Center designed by Sanaa in 2004. Achieving the effect of creating a landscape inside the building was possible thanks to the use of one undulating surface as the floor. The boundaries between various functions become fuzzy. The roof extends in parallel to the floor. From the phase of concept development, a construction model was being developed along the digital model of the architectural form. The model contained information about the geometry of the concrete shells and the steel roof. The curved, concrete ceilings of the surface area of 7500 m2 required the creation of an appropriate formwork. Due to the double curvature of the geometry and large dimensions, the manufacture of the formwork had to be automated. The creation of the formwork to a large degree consisted of creation and updating of the appropriate computer model that allowed automated manufacture of the elements of the formwork. On the basis of a computer model, three sets of drawings for the formwork were produced. The drawings contained information about the height of the ceiling at a given point and the coordinates of the elements of the building as well as the flow of the height of the edges of the patio (Weilandt et al., 2009).

CONCLUSION

Surface curvature has always been present in architecture. It was affected by human ideas and dreams that give forms different meanings. Nowadays a variety of objects of varying ideas, forms and meanings are being designed. Among many prestigious objects, there are some whose curvilinear form gives them characteristic properties or look. Some architects aspire to design an icon standing out among the built context, built in an abstract form and enigmatic formal meaning. The curvilinear form is often supposed to influence the utility of the building. In order to find energy

Fig. 1. Collage by author using Al Hamra Tower by Mohdalg (CC BY 3.0), Rolex Learning Center by Gabriel Garcia Marengo (CC BY 2.0), Mercedes Museum

Source: Author's own work.

and cost efficient solutions, some architects try to cooperate and interact with mechanics of nature and find curvilinear forms as an optimal solution. In these cases science and nature often provide an inspiration. Digital design and manufacturing techniques provide tools that allow a cheaper and easier realization of objects of complex, curvilinear geometries.

The described aspects do not exhaust the subject connected with curved surfaces in architecture. Discoveries are made, new projects and ideas appear that use the curvilinear form along the development of tools and the emergence of new technological and material possibilities.

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MULTI-LAYERD CITIES. FEATURES IN DESIGNING

This question is topic for contemporary architects, urban planners and designers all over the world. Architects often meet face to face in designing in multi-layered cities. My aim is deeply understand specific features and principles of designing living spaces through research projects in foreign developed cities and compared to the design in the Ukrainian cities. It is necessary to define the idea of a contemporary multi-layered city, I here propose an extensive definition informed by numerous sematic and historic features

According to R.Freestone

"Historically, the multi-layered city has always been evident, but there has been a reluctance consciously to engage with its complexities. Contemporary multi-layered cities are one of the composite images. There are displays of power and wealth, epitomized in corporate, downtown areas. It is both a social and spiritual 'coming together' of similarity and diversity, chaos and order, fascination of tolerance and feeling of belonging. The city in the twenty-first century is rapidly undergoing fundamental changes in its formation and meanings, with a relentless speed and scale of urbanization on the one hand and shrinking cities on the other. This challenges the conventional practices and theories of urban research and design".
(R.Freestone, p.224)

The building of the city is as body, inhabitants exist and breathe. *Urban planning has to deal with two key issues which have a relationship with multiplicity, multiculturalism and pluralistic societies. (R.Freestone, p.240)* The first is the equity of the planning process. Planning policies must stand up to scrutiny in terms of justice and how they meet the distinct needs, wants and demands of citizens. This cuts across gender, age, ethnicity, ability, religious affiliations, life stage, and sexual orientation. Equity must be evident in both procedural and substantive aspects of policy. Planners need to be able to assess cultural bias in their work, as well as, suggest ways to balance competing mainstream and minority demands. The second aspect is the enclave.

This maybe defined as an area that has a high proportion of people from a particular ethnic background living and working in the locality. There is also a balancing act between the `advantages of neighborhood homogeneity` and the `goal of openness and equal access by all`.(Qadeer,p.483)

So, how does contemporary creation of living spaces in theory and in practice respond to the challenges created by multi-layered city? My thoughts are mainly similar to the author's descriptions and opinions.

My analytical work is also based on the experience and principles in the field of urban planning in European and American cities. The PIU «principles of "intelligent urbanism" evolved from the city planning guidelines formulated by the International Congress of Modern Architecture (CIAM), the urban design approaches developed at Harvard's pioneering Urban Design Department under the leadership of Josep Lluis Sert, and the concerns enunciated by Team Ten. PIU is related to the theory of urban development, consisting of a set of ten axioms intended to guide the development plans of cities. From my point of view these principles are the most suitable for development of residential spaces for towns in Ukraine. I want to focus on those principles that are most important in the design of living spaces in the multi-layered cities.

PRINCIPLES OF DESIGN

The first aspect about justice and human needs is very important - it includes the needs and desires of all inhabitants in some areas of the city without any exception. To design living spaces with all human needs considered, a planner should include different abilities, opportunities and wishes of all people, who lives and works in the city. Obviously, architects or urban planners cannot include all needs of each and every person, but may try to hear and understand all cultural groups. One of the main points is also to avoid discrimination between different society groups to avoid conflicts between people in the future. In contrast, my opinion builds on such idea: to connect all cultural and society groups in common places. This aspect is important and should not be forgotten in urban planning. Making joint public spaces to feel more community between people is a good tool for successful planning of living spaces in the modern multi-layered city.

As noted before, if the city is multicultural, the design is also hard and extensive. While designing architects must build architecture objects, which will be acceptable in the context of the city and the design must take into account the needs of the local population. So what we should do to design in cities? Today professionals in the field of design and planning must consider each individual space indoors and outdoors. First, before each design in the multi-layered city it is necessary to make a detailed analysis of the design space. So, in addition to technical analysis and research studies we should plunge into the historical, social and cultural researches and analysis work.

"Balance with tradition is intended to integrate plan interventions with existing cultural assets, respecting traditional practices and precedents of style" (Spreiregen: 1965). This urban planning principle demands respect for the cultural heritage of a place, especially in a multi-layered city. It seeks out traditional wisdom in the layout of human settlements, in the order of building plans, in the precedents of style, and in the symbols and signs that transfer meanings through decoration and motifs. This principle respects the order engendered into building systems through years of adaptation to climate, to social circumstances, to available materials and to technology. It promotes architectural styles and motifs designed to communicate cultural values. This principle calls for orienting attention toward historic monuments and heritage structures, leaving space at the ends of visual axis to "frame" existing views and vistas. Natural views and vistas demand respect, it is important to assure that buildings do not block major sight lines toward visual assets. Embedded in the principle is the concern for a unique cultural and societal iconography of regions, their signs and symbols. All these symbols have special meaning foe inhabitants of the area. Unfortunately, here there s a problem in Ukraine, many developers prefer massive and inelegant structure that are insensitive to the surrounding and tend to ruin memory spaces and historical heritage sites. For architects, however, it is a good way to make profit.

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PUBLIC ZONES AND PLACES

One of ten principles is enclave. This principle is initiating social interaction in places designed for personal entertainment, leisure time with friends, romantic places and social activity. In evaluating thousands of public spaces around the world, Poject for Public Spaces (PPS) has found that to be successful, there places generally share the following four qualities: they are accessible; people are engaged in activities there; the space is comfortable and has a good image; and finally, it is a sociable place: one where people meet each other and take people when they come to visit, which are situated directly near the civil quarter or buildings. Due to principles of "intelligent urbanism» (PIU), we can clearly understand the structure in social design. For successful urban design without discrimination and inconvenience there are examples of public and semi-public zones near neighborhoods.

A place for the individual

The goal of intelligent urbanism is to create places of solitude. These may be in urban forests, along urban hills, beside quiet streams, in public gardens and in parks where one can escape to meditate and contemplate. According to the proponents, these are the quiet places wherein the individual consciousness dialogues with the rational mind. Places of the individual cultivate introspection. These spaces may also be the forecourts and interior courtyards of public buildings, or even the thoughtful reading rooms of libraries.

A place for friendship

This axiom insists that in city plans there must be spaces for "beautiful, intimate friendship" where unfettered dialogue can happen. This principle insists that such places will not exist naturally in a modern urban fabric. They must be a part of the conscientious design of the urban core, of the urban hubs, of urban villages and of neighborhoods, where people can meet with friends and talk out life's issues, sorrows, joys and dilemmas. This second tier is important for the emotional life of the population. It sponsors strong mental health within the people, creating places where friendship can unfold and grow.

A place for the neighborhood

Smaller household domains cluster into a higher social domain, the neighborhood social group. Good city planning practice sponsors, through design, such units of social space. It is in this fourth tier of social life public conduct takes on new dimensions and groups learn to live peacefully among one another. It is through neighborhoods that the "social contract" amongst diverse households and individuals is sponsored. This social contract is the rational basis for social relations and negotiations within larger social groups. Within neighborhoods basic amenities like child care, early learning centers, preventive health care and rudimentary infrastructure are maintained by the community.

A place for communities

The next social tier, or hierarchy, is the community. Historically, communities were ethnic groups who shared cultural behavioral patterns. In contemporary urban settings communities are formed of diverse people. However, these are people who share the common need to negotiate and manage their spatial settings. In plans created through the principles of intelligent urbanism these are called urban villages. Like a rural village, social bonds are found in the community management of security, common resources and social space. Urban villages will have defined social spaces, services and amenities that need to be managed by the community. According to proponents of

intelligent urbanism these urban villages optimally become the administrative wards, and therefore the constituencies, of the elected members of municipal bodies. Though there are no physical barriers to these communities, they have their unique spatial social domain. Intelligent urbanism calls for the creation of dense, walkable zones in which the inhabitants recognize each other's faces, share common facilities and resources, and often see each other at the village center.

A place for the city domain

The principles of intelligent urbanism call for city level domains. These can be plazas, parks, stadia, transport hubs, promenades, "passages" or gallerias. These are social spaces where everyone can go. According to this principle the rules of human conduct puts order in this domain's behavior. It is civility, or civilization, which protects and energizes such spaces. At the lower tiers, one meets people through introductions, through family ties, and through neighborhood circumstances.

These domains would include all freely accessible large spaces. These are places where outdoor exhibits are held, sports matches take place, vegetables are sold and goods are on display. These are places where visitors to the city meander amongst the locals. Such places may stay the same, but the people are always changing. Most significant, these city scale public domains foster public interaction; they sponsor unspoken ground rules for unknown people to meet and to interact. They nurture civic understanding of the strength of diversity, variety, a range of cultural groups and ethnic mixes. It is this higher tier of social space which defines truly urbane environments.

When we talk about accommodation such aspect as comfort is necessary to remember. Currently, in the Ukraine these mentioned principles in the design of the system in the cities began to work and progress, which is a good indicator of proper urban development. Architects blind eye to problems, create new objects with new problems. Ukrainian architects should not forget the spaces for people are not only in their own apartments, but also around them. That is to equip the place for communication between people, their privacy, rest, especially if we are talking about multi-layered city. The development of living spaces and homes need to follow the example of European post-Soviet towns or cities that were saturated with Soviet architecture, areas like East Berlin. The construction or rehabilitation of Kiev residential spaces in residential areas should be based on practical experience of multi-layer cities like Berlin, Warsaw or Tallinn. Such Ukrainian cities like Kharkiv can develop based on urban design found in Lodz or Leipzig. In those cities such principles, which were aforementioned, are working now.

For example, Slovenia held a renovation project. Before the implementation, the project space in Velenje was in degraded condition. There was a playground, pressed between residential buildings on the street Koželjskega near Gorica, which is considered part of a multicultural city. The public space has an area of 3.386 square meters and is surrounded by six houses. Thus, the main concept of the project was the NewTown advantage of the socialist tradition - the active involvement of residents in the process of revitalization.

ReNewTown - the organisation had two main objectives: first. creating a multifunctional public space to meet the needs of all generations; second. strengthening the link between local communities by establishing inclusion and multicultural dialogue and active involvement in the process to take care about new place by inhabitants. Before the implementation of the project, the authors consulted with local residents and conducted a survey to find out how to develop the courtyard according to the wishes of the local community and their subsequent involvement in the revitalization process. The survey involved 39% of the inhabitants of the surrounding residences. More than 71% of respondents expressed a desire to volunteer and help in the implementation of the pilot project on renovation the area. Project partners were the following : eight public institutions in the Czech

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Republic, Germany, Poland, Slovakia and Slovenia. It was based on four pilot projects implemented in Nowa Huta (Cracow), life Mesto (Prague) in Velenje and Hnushtya. A concept developed in Wroclaw to upgrade buildings, built in the style of socialist modernism was lso employed. These examples can also show how we can work in Ukrainian cities. Societies, that do something by themselves, feel more commitment to the community and will protect their living space. Architects and citizens should listen and help each other. As a result we will have European houses, public spaces, pedestrian zones etc. Due to this paper research on such subject now it is easier and clearer to make decisions on these statements and definitions, which might help me in a future work. According to above-mentioned rules and statements people in my country can understand how they can work with local architects and make living spaces more attractive, convenient and useful.

In conclusion it is appropriate to add:

"To be good an effective planner in this challenging environment necessities moving beyond the inherited professional wisdom – reinventing modernism`s 'activist commitment' (Holton, 1998, p.39) – towards a humanistic and sensitive practice where 'the others' viewed with respect and valued in the planning process. It is also means genuinely contemplating the possibilities for a shared common culture". (Sennett, 1994)

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RESEARCH-BY-DESIGN BEST PRACTICES IN ARCHITECTURAL LIGHTING DESIGN: DEFRAGMENTING RESEARCH THEORIES FOR THEIR EFFECTIVE USE IN THE PRACTICE OF ARCHITECTURAL AND SPATIAL DESIGN AFTER DARK

This paper aims to combine theory and applied science; academia and practice for the creative transformation of spaces after dark taking into account a consistent environmental awareness. It is based on the premise that design research in the realm of architectural lighting design should function as a development of practice, instead of being a distraction to it. Architectural lighting design is a field within architecture and spatial design that concerns itself primarily with the illumination of architecture, including academic/institutional, corporate, hospitality, monumental structures, residential, retail/entertainment and site/facade projects after dark.

INTRODUCTION

Keywords:

Architectural Lighting, Research Theories, Spatial Design, Design Research, Research-by-design.

Design research refers to the scholarly inquiry that seeks to advance design by studying and improving it in systematic and scientific ways by expanding, testing and operationalizing the findings of design science; in the context of transferring general fields of research to practice, design research impacts practice in a variety of ways [1]. It includes both art and science, in clearly identifiable fields related to the applied sciences and the social sciences [2].

Literature reveals that design research from diverse realms have relevant implications in the practice of architectural lighting design. For example, medical studies on the 'biophilia hypothesis: human preference for nature and natural settings' is finding several applications in modern architectural lighting; environmental studies on seasonal migratory patterns is resulting in lesser death rates of birds by collision with architecturally lit building facades and turtles by disorientation from glary urban skylines. Boyce [3] however, argues that research plays little or no role in the design process, as designers are confident in their ability, creativity, and judgment and seldom require inspiration from research results. Popovic [4] further argues that research has not been very common among designers because of its nature and the way that professional practice operates. Additionally, the connections between design research and practice has not been well defined in the realm of architectural lighting design. Therefore, the need is for a collaborative culture between design research and practice, and a relevant research knowledge base that can be utilised in practice.

Defragmentation is a process used in the realm of computing to reduce the fragmentation of a file by concatenating parts stored in separate locations on a disk. Building upon this analogy, the paper argues that a similar defragmentation process can be used to concatenate design research from

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different realms for its effective use in the practice of architectural lighting design. By exploring the role of state-of-the-art research in the evolution of innovative approaches towards design and implementation, it will showcase best practices in architectural lighting design.

METHOD

Popovic [5] has proposed an applied research and innovation framework that situates design research within a social structure constituting people, activity, context and culture to generate new knowledge and support innovation through the following four modes: (1) research conducted before design commences (2) research conducted concurrently during the early design stage (3) research conducted concurrently during the design development stage (4) research conducted when the completed design is in the market. The paper draws inspiration from this framework to develop a defragmentation framework. It also utilises the three modes of engaging with research listed by Lee et al. [6] as a defragmentation tool: (1) knowledge – the subject of the research, (2) process – ways of researching and finding knowledge and (3) resources – ways of accessing knowledge.

THE DEFRAGMENTATION FRAMEWORK

The defragmentation framework consists of three modes: (1) research conducted before the design commences, (2) research conducted concurrently during the design stage, and (3) research conducted when the constructed design is in use.

Research conducted before the design commences

Research conducted before the design commences is a mode that acquires knowledge utilising relevant research methods to be applied in designing architecturally lit spaces. Architectural lighting design teams can perform various activities such as literature reviews, feasibility studies, user surveys, and site analysis to be well equipped for the design process. The project example used for describing this mode is the Harbour Crane at Kotor Bay in Montenegro [Fig.1a]. Before proposing a lighting design concept, the design team had to undertake an extensive site analysis of the bay, which is a UNESCO World Heritage Site. The crane, being the tallest and most visible element, became the automatic choice for highlighting its history [Fig.1b]. However, special care had to be taken so as to cause minimal disturbance to its nighttime natural beauty as well as the adjacent residential development. Therefore a dual-scene lighting concept was proposed that evokes the memory of the crane function, and reduces light-spill as well as its associated energy consumption as the night progresses: Early- and Late-night scenes [Fig.1c & 1d].

Fig.1b. Harbour Crane.
Source: Light Bureau

Fig.1c+1d. Early- and Late-night scenes.

Source: Light Bureau

Fig.1e. Rays of light create a 3D form of the Twin Towers.

Source:
K.M.Zielinska-Dabkowska

Fig.1f. Tribute in Light.

Source: Schutterstock/
Sean Pavone

Fig.1g. Sundial Bridge - floodlights directed upwards and downwards towards water.

Source: Fotolia/Leah McDaniel

Research conducted concurrently during the design stage

Research conducted concurrently during the design stage is a mode that exemplifies research-by-design. The early design stage is crucial to the innovativeness of the architecturally designed lighting scheme as it encompasses analytical and critical thinking. All designs are conceptualised at this stage and several lighting design concepts usually emerge. Design teams perform several tasks such sketches, lighting calculations and 3D visualisations to critically evaluate the design. This enables the design team to identify, recall and apply the relevant knowledge required [7]. During the design development stage, additional research may be required to either develop detailed lighting concepts, produce final lighting designs or site-level mock-ups to understand the impact of light. This is a stage where the highest knowledge transfer can occur, as different experts from various realms tend to contribute to the overall design. The project example used for describing this mode is the Tribute in Light in New York City [Fig.1e]. The 9/11 aftermath led to a design team of artists, architects, and lighting designers proposing a symbolic reproduction of the form and image of the WTC Twin Towers using high-power white light [Fig.1f]. However, the team faced several questions during the design stage: How far would it be visible from? Can the air be used as an illuminated surface to reflect light? How powerful, how many and what type of luminaires should be used? How to locate them to create an illusion of a 3D object? Several mock-ups were conducted in the Las Vegas desert and New York City. Additionally, laser measuring devices, digitally controlled instruments and long-range walkie-talkies were used to arrive at the precise location and direction of the searchlights so that the installation could be viewed from anywhere in Manhattan and beyond.

Research conducted when the constructed design is in use

Research conducted when the constructed design is in use is a mode to evaluate the overall success of the proposed architecturally designed lighting scheme as well as explore new strategic opportunities. The proposed scheme can be evaluated in various ways such as user comfort and

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cultural response, visual appeal, human health and productivity based on the overall scope of the project. The research findings can be applied to generate better-lighted environments for the future. The project example used for describing this mode is the Sundial Bridge across the Sacramento River in California [Fig.1g]. While this pedestrian bridge itself is very aesthetically designed, its nighttime lighting with large floodlights directed upwards and towards the water is causing serious environmental issues. Current observations state that the lighting is creating a trap for the migrating wild salmon in the river. Fish usually migrate at night cued by the illumination levels to avoid predators. Predators such as birds and other animals position themselves under these lights to locate and capture the salmon. Post-occupancy survey of the bridge shows that as the bridge is painted white, even reduced illumination levels will not help as the reflected lighting from the bridge causes permanent illumination of the water.

CONCLUSION

Architectural lighting designers can use these modes as guidelines to systematically search, collate and apply research in their design projects, as well as document these projects for future reference. As a broader goal, more and more architectural lighting designers can be involved in the development of these guidelines. Involvement in guideline development provides experience and insight into the process of identifying, appraising and analysing available research and developing recommendations for practice [8]. In doing so, the paper attempts to bridge the long-standing divide between researchers and designers who consistently work towards the betterment of architecture and spatial design after dark.

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THE IMPACT OF INSOLATION REGULATIONS ON THE DETERMINATION OF THE MAXIMUM BUILDING VOLUMES AT AN EARLY DESIGN STAGE

The aim of this research is to verify the impact of insolation regulations described in Polish building regulations on the maximum building volume and to determine the correct sequence of steps involved in the process of its delimitation. In this article, the outcomes of student work performed during a design studio course are presented. The performed analysis showed that the determination of maximum building volume in relation to insolation regulations is a multifaceted process and, as it is not deterministic, it could be treated as a form-finding tool, where many solutions are possible while having the same preset initial conditions.

INTRODUCTION

While contemporary computational design tools allow for quick and precise simulation of shading conditions and solar irradiation, the process of validation of architectural designs fulfilling national and local regulations regarding daylight conditions might be very time consuming. New architectural developments, especially high-rise buildings planned in downtown areas, are affecting daylight conditions of the existing urban structure. Reduction of daylight quality of residential spaces may influence many aspects of these spaces, ranging from the quality of life to the value of the property. Depending on the national building rules the minimization of this impact in order to preserve minimal daylight conditions may significantly reduce the investment opportunities of planned new developments.

In cities like Warsaw, which are currently experiencing intense redevelopment processes in downtown areas, those laws and urban regulations are some of the main aspects influencing the forms of new buildings [1]. The process of analysis of architectural design in order to fulfill daylight regulations for buildings planned in downtown areas has a large impact at the design concept stage. The complexity of this task makes this process very time consuming.

In order to reduce the necessity of insolation analysis of all possible design solutions on a given plot, the concept of the maximum building volume (MBV) is used. It is a three-dimensional volume inside which the building form has to fit in entirely in order to fulfill the daylight regulations. The main aim of this research is to verify the impact of insolation regulations described in Polish building regulations on the possible MBV and to determine the correct sequence of steps involved in the process of its delimitation.

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BACKGROUND: POLISH BUILDING REGULATIONS REGARDING DAYLIGHT, INSOLATION AND OCCLUSION OF BUILDINGS

Polish regulations regarding daylight conditions of residential spaces result from the ideas of modernism movement from the beginning of the XX century. In its manifest - Charter of Athens – the authors recommended that there should be a minimum daylight time required for a dwelling unit in order to ensure physical and mental health for its inhabitants [2]. This recommendation was further studied and formalized by legislators in individual countries. Polish building regulations are also based on health regulations established in 1963 in Soviet Union [3]. They set the minimum requirement of 3 hours of insolation during the days of equinoxes, which can be reduced by half in city centers.

According to [4] daylight regulations for rooms assigned to accommodate people are reflected in the ratio of window to floor area, which should not be smaller than 1:8.

The provisions on occlusion of windows describe that the window is not obscured if between the arms of an angle of 60° set in the horizontal plane with the apex located in the inner face of the wall on the axis of the window of the occluded room, there is no shielding part of the same building or other shielding object at a distance less than occluding height, for occluding height of up to 35 meters, or 35 meters, for shielding objects of occluding height of over 35 meters. The occluding height is measured from the lower edge of the lowest-lying windows of the occluded building to the highest occluding edge of the occluding building or its part.

These regulations should be met for all planned and existing windows, for which the lighting conditions can be changed due to the construction of the proposed building. For the downtown locations, the number of windows that should be analysed can be significant. That is why it is often necessary to conduct preliminary studies, which enable selection of windows, which should be subjected to further analysis. All these windows can potentially affect the form of the maximum building volume.

CASE STUDY

Course Description

In this article, the outcomes of the student work conducted during the Design Studio 3 course on the 3rd semester of Architecture for Society of Knowledge International Master's program at Warsaw University of Technology are presented. The course was tutored by Sławomir Kowal and Krystian Kwieciński. The design studio was supported by the Techniques Integration seminar tutored by Agata Pasternak.

As part of the design studio course, the students were introduced to the subject of designing high-rise office buildings. Issues related to the location of the building, its impact on the environment and the current building law issues were discussed during the consultations with specialists from PricewaterhouseCoopers International Limite and BuroHappold. During the analytical stage of the project, students were working in pairs. Their task was to set the main urban parameters for the new development, including the maximum height and area of the building and primary assumptions regarding spatial dispositions in relation to the urban context. In the next stage, groups were searching for the maximum building volume that could fulfill the chosen assumptions and law regulations. Finally, students worked on their individual design solutions, which had to fit in the maximum volume.

The seminar supporting the project concerned the technical aspects of design such as weather and environmental analysis and optimisation techniques. During these classes, students learned software used in the early stages of building design. Taught programs included Grasshopper plug-ins such as Ladybug and Honeybee, Galapagos, Octopus and, finally, a software dedicated to insolation and occlusion studies - PRC Analysis.

Insolation Analysis

In Poland, the common method for the assessment of insolation of rooms is based on a sun ruler, which is a type of horizontal sundial, introduced by Mieczysław Twarowski [3]. Architects have to examine each window individually to determine whether it is influenced by the designed building. This process requires a large amount of tedious work that has to be done repeatedly to analyse several design variants and their impact on the surrounding.

With the development of architectural 3d software, programs that allow solar analysis were developed, such as Shadow Analysis for Google Sketchup or Autodesk Revit with built-in insolation analysis tools. These programs have a fairly high precision of determining the position of the sun. They produce reliable results, but they lack the procedures for automatic optimisation of analysed building volume.

PRC Analysis software, developed by Jacek Markusiewicz [5], is used to analyse sun occlusion and exposure time, as it is defined in Polish building code. Sun position for a given location and the selected date and time is calculated using the raytracing method. The program allows grouping of windows into rooms and rooms into apartments, thus makes it possible to check automatically whether the required times are met for at least one room in the apartment, as specified in the building regulations.

After the insolation analysis, the windows are divided into three categories: windows for which the sun is not obscured by any element of either the proposed building or any part of existing buildings (category A), windows for which the sun is obscured by an element of an existing building (category B) and the ones for which the sun is obscured by the proposed building (category C). The last situation can be modified by the designer by changing the building shape. It can be adjusted within the software, which has the capacity of optimising the building volume, so that it meets the predefined insolation criteria.

To limit the number of windows that should be considered in the optimisation process, thereby significantly accelerating the calculations, it is recommended to conduct a preliminary shading analysis. For this purpose, the students created a procedure using the Grasshopper Ladybug component to determine windows that are shaded longer than 1,5 hours. After that they had to specify windows that belong to housing and educational institutions and group them into rooms and apartments. In some cases another manual selection of windows, taken into consideration, was made.

Building Volume Optimisation

The process of optimisation of the building volume can be performed automatically but it can also be done manually by the user. The optimisation of the building volume performed by PRC involves the trimming of that volume, so that it does not block sun rays required for insolation of the analysed windows. If during the process of insolation analysis, there have been determined windows, which had previously not met the requirements, the proposed building volume cannot at all obstruct the apartment. After analysing at which hours the designed building block is shading selected windows,

it is cut in such a way that at least one room in each apartment satisfies the insolation requirements, and in the same time the building has been reduced by the smallest possible volume. The accuracy of the optimisation depends on the determined degree of segmentation of the building blocks into horizontal slices. The lower the slice thickness the more accurate the process of optimisation is. The software also allows for manual modification of the building volume based on the preliminary insolation analysis. After selecting a window it is possible to control how the proposed shape of the building is cut, by selecting trimming surfaces that are defined between the arms of an angle set by two sun rays projected onto the window in five minutes interval.

Results

Within the framework of the design studio, students task was to design a high-rise office building located in Warsaw downtown. The chosen plot at Chmielna Street creates excellent conditions for verification of the impact of insolation regulations on the MBV. The analysis was performed using a common 3d model of the surrounding prepared by the students. The digital model had to include the existing buildings located within of the impact area of the designed building and all of the windows that could be potentially shaded. Selection of these windows depend on the initial volume assumptions adopted by each group, for example lower buildings create a smaller impact area, since it depends on the length of the shadow, which is cast on the equinoxes. At this stage the preliminary assumptions concerning the size and location of the building are important. The more the initial form is treated schematically, the more general the optimisation results are. If a more detailed design idea is a subject to the optimisation process, then the result is just a verification of it, rather than a determination of the maximum building volume.

The outcomes of students' analyses (Fig. 1) showed that the resulted maximum building volumes differ significantly from each other. Even small changes in the selection of windows that were analysed can influence the outcomes. The optimisation process gives different results depending on the initial building volume. Also, within one design scenario there can be diverse possible MBV's. The automatic optimisation procedure embedded in PRC Analysis aims at trimming the building volume as little as possible, but in the same time fulfilling the insolation regulations for all windows. It always produces convergent results. When using a manual procedure for trimming the building it is possible to get other results while still meeting the requirements. The designer may want to protect certain parts of the input form more than others and care less for the overall volume of the output form. Sometimes it may be that in the automatic optimisation the volume of solids is little reduced, but it has been very fragmented. Also the insolation time for every window can be divided into various subparts, differently affecting the proposed building volume.

While working on individual design solutions students could use all of the determined maximum building volumes. Forms 3rd and 4th, as the most general, were the most frequently used at this stage of the process. Projects labelled A-H (Fig. 1) show the final forms of the buildings designed by students.

INSOLATION ANALYSIS: METHOD FOR MAXIMUM BUILDING VOLUME DELIMITATION

As a conclusion resulting from the research conducted on the described cases, we suggest the following sequence of steps that are necessary to implement in order to determine the maximum building volume, using the PRC Analysis software:

– Step 1 - model the urban surrounding located in the impact area of the proposed building. It requires specifying the maximum dimensions of the building to determine its impact area.

– Step 2 - select windows affected by the proposed building, choose only windows that belong to apartments or education institutions, shaded by the proposed volume. Due to the limitations of the computational capabilities of the program, we suggest a reduction of the number of windows to only those that are crucial for the given location. For this purpose, a procedure has been developed with the use of Ladybug component for Grasshopper. It calculates the number of sunrays, determined on the basis of the EnergyPlus weather file, that intersect with each window. If the window do not meet the required criteria, and it insolation level is at any rate affected by the new building it will be included in the analysis. The next step is to group the windows into rooms and apartments in PRC Analysis.

– Step 3 - run insolation analysis and trim the proposed volume in order to insolate category B windows, which do not have the required insolation level, before the designed building is taken into consideration. In this case, all sun vectors blocked by the designed building should be released, by appropriate trimming of its volume.

– Step 4 - search for the maximum building volume in order to insolate category C windows that are affected by the proposed building and their insolation time is below the required level. This can be achieved through automatic optimisation procedure or manual trimming of the building form in the PRC Analysis. Depending on the selected method, different results will be obtained. Automatic optimisation will produce one form, of which the volume will be least cut. Using the manual mode may result in a form of a smaller volume, but of the spatial form, which better suits individual preferences of the designer.

CONCLUSIONS

This research, which followed the principles of research by design [6], allowed the simulation of a real architectural problem in an urban context. The research investigated conditions for designing high-rise building in downtown location, fulfilling Polish building regulations on providing minimum required daylight exposure. Impact of specific, national insolation regulations on the design process was verified with a use of dedicated software and custom parametric procedures. The problems that were identified include both legislative and technical aspects of the analysis process.

The first group of problems, which include the selection of the analysis data, imprecisely defined terms used in the regulation [7] or the relation of this regulation to astronomical issues, were omitted in this paper [1]. The conducted study showed that the insulation regulations are not explicitly described. This situation leaves place for interpretation and possible abuse. These conditions are also not deterministic and can give various solutions of maximum building volume, which are fulfilling identical criteria and therefore it cannot be used to calculate the maximum plot absorption.

Although complex urban conditions, which might significantly reduce the scope of possible solutions on a given plot, can exist, the described process can also be treated as a design tool, if the manual trimming mode is used. Another aspect is related to the spatial model of the existing urban structure. As the city of Warsaw does not provide a 3D model of its urban tissue, it had to be modeled by students and therefore it can have some inaccuracies due to limited capacity to collect data.

In order to perform correct sunlight studies, it is necessary to determine the proper set of windows for analysis and group them into rooms and flats. As the information on the internal layout of buildings is not widely available, the windows affiliation stemmed from students assumptions. For this analysis, the changes of the apartments layouts made by the owners, compared with their original state, which should have been also taken into account, has been omitted for reasons of time limitation and the research nature of this process.

The other group of technical problems, which were identified during this study, is related to the analysis process itself. As the set of windows, that can be potentially exposed to changes resulting from the creation of the proposed building, can be very large, this affects the complexity of such calculation. Because of that, students had to narrow down the list of analysed windows in order to simplify the calculations and shorten the duration of this process.

The performed analysis showed that the determination of maximum building volume in relation to insolation regulations is a multifaceted process, based on hardly accessible data. Additionally, this research proved that this process does not have to be deterministic and it could be treated as a form-finding tool, where many solutions are possible while having the same preset initial conditions.

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DAYLIGHT IN HIGH-PERFORMANCE INTELLIGENT SUSTAINABLE OFFICES: SIMULATION STUDIES

This paper presents how innovative simulation methods, techniques and tools for analysing office building performance can be used to arrive at informed design decisions. It investigates the methods to evaluate and validate design ideas at the early stages of architectural design process, to improve daylight availability, energy efficiency and well-being of building users. This paper focuses on the ways of evaluating the performance of building form, various façade solutions, daylight distributing and redirecting systems, and shading devices. DIVA, Autodesk Ecotect, Radiance, Daysim, Evalglare and Climate Consultant are the software that were used in studies carried out by the author.

INTRODUCTION

Scientists project that wide-ranging climate-related impacts will grow in number and intensity. In some cases they will pose significant threat to human health, the natural environment, and our way of life. Rising levels of greenhouse gases, particularly carbon dioxide, are linked to global climate change, and buildings both in developed and developing countries are responsible for one-third of greenhouse gas emissions. These buildings are also responsible for more than 40% of energy use and consume resources unsustainably. Many scientists claim that buildings are the most significant cause of environmental damage. Historically, developed countries were to blame for the majority of emissions, but predictions are that buildings in rapidly industrializing countries will surpass them in the near future. Our duty is to create buildings with thorough knowledge of their impact on the planet's ecosystems over the long term. UNEP reports that we are faced with the necessity of reducing greenhouse gas emissions by at least 50% to avoid the worst scenario.

Thorough changes in the building sector are needed. Consciousness grows that the performance of buildings of the twenty–first century will have to be significantly better than the performance of those of the twentieth century. Moreover, the building sector has large potential for delivering environmentally friendly, cheap to run and comfortable for their occupants buildings. Energy consumption is the main source of GHG emissions from buildings and this consumption can be cut substantially. In the most modern offices energy demand has been reduced by 30 – 40%. The building sector faces thorough changes ahead as stricter laws are being passed to improve buildings' sustainability and, further, there's growing interest in an evidence-based approach towards building design amongst leading architectural firms.

EFFECTIVE INTELLIGENT BUILDING

Some practitioners link energy efficiency with intelligent buildings. The term 'intelligent building' appeared at the beginning of the 1980s. At the moment three distinct periods in the history of the IB can be identified. They are: automated buildings (1981 – 1985), responsive buildings (1986-1991), effective buildings (1992 >). Nowadays, the concept of intelligent building is being commonly adopted, but very often engineers don't realize that effective intelligent buildings should first of all provide an environment which is more flexible, convenient and comfortable for office users. Moreover, they should be energy efficient, operate efficiently and be capable of responding to changes in the work practices and the structure of organisations. The first IB models were concentrated on the provision of information and communications technology, as well as the use of automated systems. However, this attitude didn't solve problems of low indoor environment quality. Automated IBs - glazed, sealed, air-conditioned deep-plan offices didn't meet the needs of their occupants.

Elements of a new paradigm of high performance buildings' design include: "setting high goals early, using an engineer-integrated process, maximizing daylight, using natural ventilation when possible, limiting glazing area, maximizing insulation, and validating each of these design decisions with a combination of design simulation and experience" (Anderson, 2014: 1) [1]. Extremely high-performing office buildings, which are naturally ventilated, day lit, and designed to prevent the risk of overheating, achieved a 70% reduction in energy demand. More and more often an objective of supreme importance is to accomplish office building's primary energy consumption during operation under 100 Kwh/m² annually. The high performance of buildings should be achieved through passive (architectural) means, not by the sole addition of technical systems. An understanding of solar geometry is crucial, because some of the main features of passive buildings are connected to solar radiation. Examples of these characteristics are control of heat gain and heat loss through building orientation and form, use of solar radiation for lighting and heating, but primarily comfort control without using fossil fuels.

The main challenge for architects is to support building users with design solutions that give them control over their indoor environment, because one of the primary goals is to enable users to feel comfortable. In addition, numerous research has proven that properly day lit office spaces contribute to improved health, wellbeing, and productivity amongst building occupants [4], [5], [6]. Daylight synchronises the human circadian rhythm and regulates hormones' discretion. Making daylighting design choices is a very difficult task, because the complexity of light propagation in buildings and daylighting systems is significant. There are many factors and variables that need to be considered. Moreover they usually conflict, for example the need of daylight transmission and the requirement of protection against sunlight and glare. Writing about daylighting the author uses the meaning defined by Reinhart:

> *"a day lit space is primarily lit with natural light and combines high occupant satisfaction with the visual and thermal environment with low overall energy use for lighting, heating and cooling" (Reinhart, 2014: 23) [6].*

Simulation Methods, Techniques and Tools

Early design decisions, made by architects in conceptual phases of a project, affect passive strategies and architects need to have the means to assess them. The design of intelligent sustainable offices depends on knowledge about building performance and it has to be informed by studies on solar energy, daylighting quality, energy efficiency, airflow and users' comfort. One of the best strategies is to begin developing a design process that would enable architects to evaluate their ideas and make better design decisions. Reinhart emphasizes that

Currently the comparison of early architectural designs is made possible by state-of-the-art computer daylight simulation tools. The programs offer the ability to have the design decisions evaluated and validated in a relatively short period of time. Moreover, the software is designed to be useful and intuitive to architects, allowing them to play with design solutions. Anderson suggests that

"architects should design higher-performing buildings when they actively engage in design simulation" (Anderson, 2014: 5) [1],

because they would become more knowledgeable about the effects of their decisions on energy performance. Anderson notices also that energy efficiency can be achieved through better design, because building materials and technologies already exist to create high-performance buildings. The only weakness is that they aren't organized properly through the design process.

Climate classification is a starting point for high performance office design. Today, climate data have been collected at many weather stations worldwide and are available for free download, for example on the U.S. Department of Energy website. The author used annual weather data in the EnergyPlus Weather file format, which is the standard format throughout the world. These powerful files contain hourly data for a whole typical year - 8760 entries. Every design process requires a consideration of a combination of climate data graphs and charts unique to the design strategies and solutions being considered. One of the most important outputs produced by Climate Consultant, software used by the author, is a psychrometric chart. This chart was used to interpret effective passive design strategies for analyzed office building that could provide indoor thermal comfort without the use of mechanical systems. The psychrometric chart shows the interrelation of air temperature and relative humidity. Hourly climate data are plotted with dots on the chart and the density of dots is used to evaluate average climate conditions. Two boxes represent the Summer and Winter comfort zones and dots enclosed by the zones represent hours where indoor comfort is provided. The analysis showed that only 7.3% of the occupied hours would be comfortable with no design strategies in a selected location in the south of Poland. Passive design strategies enclosed additional areas of the chart, expanding the comfort zone, for example Passive solar direct gain high mass and Sun shading of windows.

High-performance office design begins by understanding solar geometry and establishing a solar design strategy. The potential positive impacts of solar irradiation, for example solar energy that can be harvested in winter, should be considered against the negative impacts like overheating, increased cooling loads, and glare. In central Europe, offices require cooling most of the year, because they usually have high internal heat gains. Moreover, reducing cooling loads is much more effective than reducing heating loads [1]. The most effective strategies to reduce the amount of cooling through heat avoidance are building massing and orientation that provide shading of direct solar gains, window sizing and orientation, and shading systems. A balance should be provided between solar heat gains in winter and preventing overheating in the cooling season, that is the crucial aim of studying solar geometry. Reinhart mentions three methods to select a period when windows should be shaded [6]: Solstices Selection, Degree Day Selection, and Thermal Balance. He suggests that the Thermal Balance method should be recommended practice. The author analysed an office building with a narrow floorplate, that could be daylit and naturally ventilated. During studies two main building orientations were simulated - along south-north and east-west axes. Various facade solutions, lightshelves, and fixed shading devices were designed. The presence of neighbouring landscape and buildings wasn't considered. The design of shading devices needs to respond to the geometry of the sun, therefore positions of the sun in the sky was read from tables

and off sun-path diagrams created by the Solar Tool, a part of Autodesk Ecotect program. The model of analysed office was created using Rhinoceros program.

The next step of presented studies was design simulations carried out in the DIVA environment. DIVA is a daylighting and energy modelling plug-in for the Rhinoceros modeller. The DIVA environment is an example of holistic approach to high-performance offices' designing. It enables architects to assess daylight availability, visual comfort, energy consumption, and GHG emissions. Variations to the façades, lightshelves, and shading devices were tested using a variety of different programs, that were available in the DIVA environment, including Radiance, Daysim, and EnergyPlus.

The main environmental performance evaluations done by the author were climate-based daylighting analyses. Daysim, Radiance-based program, was used to carry out these simulations. The software enables researchers to apply static daylight performance metrics as well as dynamic performance metrics [3], [4], [5]. The author predicts that the future belongs to dynamic daylight performance metrics, which are founded on the actual climate data contained within standardised climate files ('climate-based daylight modelling' - CBDM). Dynamic metrics take the entire average "climate" year into account. The most popular metrics founded on CBDM are Daylight Autonomy (DA), Useful Daylight Illuminance (UDI), and Spatial Daylight Autonomy (sDA). DA measures the percentage of occupied time through the whole year that the minimum lighting threshold input by a simulator is met. In the author's opinion UDI is an interesting metric, because it separates daylighting levels into three categories: useful daylight - 100-2000lx; potential glare - UDI>2000lx; underlit - UDI<100lx. Illuminances higher than 2000lx indicate visual as well as thermal discomfort and higher risk of overheating. The area of analysed space, where an oversupply of daylight might lead to discomfort, can be further investigated using temporal maps. These maps show horizontal illuminance at a selected point throughout the entire year and can be used to evaluate when the use of a shading device is required. The analysed space was simulated with fixed shades and lightshelves, without shading, and with manually and automatically operable shades. Different scenarios of occupant behaviour were also investigated. Daysim generates annual hourly occupancy schedules, electric lighting energy use and the status of operable shades and these data are input into EnergyPlus in order to perform thermal simulation studies.

DIVA environment also provides ways to predict visual comfort, enabling simulators to evaluate discomfort glare and a view to the outside. Glare analyses, calculated by Evalglare program, take into account the luminance distribution in the field of view of a building user. A photorealistic Radiance rendering of the selected view is created and Daylight Glare Probability (DGP) metric is used to predict glare and map it visually onto the image. A simplified method is also available which produces the overall appearance of discomfort glare over the course of the year.

The results of presented design analysis methods can be showed to practitioners without expert simulation knowledge using a "daylighting dashboard" [6]. A "daylighting dashboard" presents all performance simulations' results for an analysed space: 1) Daylight Availability: DA, UDI, sDA - spatial patterns of daylight over the whole year; temporal maps of annual horizontal illuminance; 2) Visual Comfort: annual DGP profiles; percentage of the occupied time throughout the year when users have a view to the outside; 3) Energy Consumption: annual energy use for heating, cooling and electricity; annual carbon emissions. The form of a simulation results' presentation is graphic, visually accessible to architects; moreover, design simulations deepen an architect's understanding of how building performance is affected by design decisions.

CONCLUSIONS

New philosophies of architectural design, based on constant evaluating of built environments, have enabled multidisciplinary design teams to create high performing office buildings in observance of the principles of sustainable development [2], [3]. One of the main goals of these new philosophies is to consistently apply strategies to achieve high performance at each subsequent stage of the building life cycle, i.e. from design to construction, occupation and adaptive reuse. At all stages of the life cycle of a building the knowledge, which improves existing and future buildings, helps to update design guidelines, norms and regulations, is being developed. For example, the most complex, advanced and holistic approach to the development of knowledge about buildings' quality is offered by the Building Performance Evaluation (BPE) method [2]. The method enables feeding the knowledge produced throughout one building life cycle into the next cycle. Nowadays, the process of making buildings better performing has been strengthened. It begins at stages of planning, briefing and conceptual design more efficiently, because architects are assisted by the use of state-of-the-art simulation tools. As there are no universal high-performance building design strategies, working together as an interdisciplinary design team can be regarded as the most efficient approach towards how to strike a balance between many factors. Design teams must be holistic in their scope, because nothing helps achieve high-performance goals so effectively as better communication among practitioners, and between providers of buildings and buildings' users. The nature of daylighting simulations is one that emphasises a holistic approach toward built environment's designs. This means that not only daylighting, but also energy efficiency and occupant comfort are taken into account. Not only architects, but also engineers and energy analysts participate in the integrated design process. Increasingly, research confirms the importance of using simulation programs at first stage of designing high-performance, passive, sustainable office buildings as being supreme to leaving the natural environment to future generations without damage. Anderson emphasizes that

> *"in terms of societal cost, it is much cheaper to reduce energy use through design and retrofit (…) than it is to increase energy production. For this reason, informed building design is one of the least expensive pieces of an overall strategy to minimize energy use and associated climate change" (Anderson, 2014: 2) [1].*

Building performance analysis programs teach architects how their decisions affect occupant comfort and building performance, are intuitive and graphic, give the ability to test ideas while designing, keeping the architect from proposing incorrect strategies, improve cross disciplinary communication, these are the main advantages of using them.

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WHAT YOUTH IS USED TO, AGE REMEMBERS: AN ATTEMPT TO MEASURE PROECOLOGICAL ASPECTS IN STUDENT RESIDENCES

Student residences are buildings dedicated to young people, where they begin the first chapter of the adult life. Far from their homes and families, ready to adopt new knowledge, habits and behaviors. Why are student residences important in context of energy and water consumption? Are there any dedicated factors to measure the scale of proecological aspects in these buildings? To answer these questions number of proecological aspects with the scale of appearance were identified. The case study was Berlin, Germany. Through source reviews, study visits, and observations I prepared the analysis that summaries the basic characteristics of student residences in Berlin and reveals the number and scale of proecological solutions.

INTRODUCTION

Student residences are important in context of water and energy savings, as well as in broaden sense of sustainability due to following reasons:

– Energy and water usage are invisible for students in dorms.

Students usually do not pay bills – they pay a fixed price. Lack of even basic feedback – for example energy and water bill, as well as lack of consequences result in unsustainable habits. The example of Wrocław University of Technology, where meters were introduce in some of student residences (1 meter per 4 person modules), show about 10% reduction of water and electricity[1].

– Student residences consume significant amount of water and energy.

It is not easy to determine the relation between consumption in student houses and average residential building. The cause is fragmented data from student dorms. There were attempts to compare particular student houses with average data consumption, but the conclusions vary from each other, and usually depends on universities and student dorm type [1, 2, 3]. What can be estimated is a significant potential of decreasing energy and water usage. There are many ways to approach the topic. Firstly, the visualization of usage which may result in about 8% reduction [4]. Secondly, feedback and gamification [5], which may save up to 50% of energy, however in this particular case data was evaluated only for the time of an experiment.

– Student residences belongs to the university, or public organizations so they indirectly represent the attitude of those organizations towards the proecology and in a larger context -

towards sustainability

Universities can play a "pivotal role" in creating a shifting point in solving world's problems connected to climate change [6]. What is more, universities are in the perfect position to behave sustainably and further educate the population on sustainability issues [7]. There are many ways universities can help to reduce energy and water consumption, as well as introducing different sustainable behavior. One is to introduce courses and integrate sustainability in formal education. Another is to invest in extracurricular activities to concentrate not only on education but also on forming proper habits – for example by fostering and incentivizing sustainable behavior in student residences. Sustainable student residences – in the sense of buildings features and rules inside – create a coherent message with a general sustainable policy of the owner. Finally, studies indicate that students who live in "green" dorms engage in more recycling and advocacy behaviors than students in conventional dorms [8].

– From the psychological point of view, students are in the phases of human development named late adolescence/young adulthood

"Adolescents develop a more complex understanding of moral behavior and underlying principles of justice. They question and assess beliefs from childhood and restructure these beliefs into a personal ideology (...). Decisions and values are less influenced by peers. (...) Identify values and viewpoints that work for oneself while respecting viewpoints/values of others".

In this stage, person has ability to make independent decisions, and has higher concern for the future [9]. For people in this stage of development, it is easy to learn and to adapt new habits, because it is a period when human personality consolidates [10]. It seems to be reasonable to concentrate on forming their habits at this stage for their lives.

Reducing energy and water consumption is one of the main goal of European Union, and also a goal of many European cities. I was curious if there is any connection between green policy of the city and the condition of student residences. The scale of proecological solutions in student residences in Europe was also interesting.

Student residences as a building type is a topic rarely describe in the scientific literature. There is no specific data on number of student residences in Europe, neither statistics on types or age division. There is also no specific evaluation system dedicated to student residences. As any other building they can be accessed via multi – criteria certificates, for example: LEED, BREEAM, or DGNB, but the scheme of evaluation in these certification systems is very detailed and complex. Other evaluations methods used in the EU concentrate mainly on energy. The aim of this study was to coordinate indicators that enable showing a general profile of student residences, rather than precise calculation. In my research, I concentrated on empirical data, and when available information from particular buildings management. The city chosen to conduct the research was Berlin. Germany has the largest student population in Europe [11] and Berlin with its 160 000 students is the largest student city in Germany. Second, Germany is well known for its pro environmental policy. Third, according to numerous multi – criteria evaluation systems on sustainable cities, Berlin is one of the most sustainable cities in the world. Sustainable city index from Arcadis – 6 position out of 50 evaluated cities in the world, Siemens Green city index, provided by Siemens – 8th positon from 30 evaluated European cities, 1st place in category: buildings.

The outcome of the analyses did not show close connection between the sustainability level of the buildings in the city (measured by international evaluation systems: Green City Index and Arcadis) and scale of energy and water saving solutions incorporated in student residences in Berlin.

Student residences in Berlin are well maintained and are being refurbished, but there are still major problems that are not solved – for example, students do not pay bills for energy and water usage and the scale of actions connected to energy and water savings, as well as to education, is rather small. There are not any education programs connected to water and energy on the campus. There are no smart meters. It is also worth underlining that there is no example of student residence built in passive standard.

The outcomes of the analysis show aspects that may be improved in the management and technical equipment of student residences in Berlin.

METHODOLOGY

The biggest challenge of the research was to set the indicators of proecology in a student residence. Starting with the term proecology itself, it is important to explain this term clearly. In everyday life terms: sustainable architecture, green architecture and proecological architecture are used interchangeable. The table below bases on summary from Berardi [12] and proecological aspects pointed by Wines [13].

Major issues of the performance	Sustainable	Green	Proecological
Consumption of non-renewable resources	x	x	x
Water consumption	x	x	x
Material consumption	x	x	x
Land use	x	x	x
Impact on site ecology	x	x	x
Urban and planning issues	x	x	x
Indoor well being	x	x	
Greenhouse gas emission	x	x	x
Solid waste and liquid effluence	x	x	x
Longevity, adaptability, flexibility	x		x
Operations and maintenance	x		x
Facilities Management	x		
Social (access, education, inclusion)	x		
Cultural perception and inspiration	x		x
Economic considerations	x		

Table 1:

Sustainable, green and proecological architecture

Major issues in sustainable, green and proecological buildings according to Berardi and Wines

Sustainability is the most holistic approach that takes into consideration the largest number of factors. Green Architecture and proecological architecture cover some parts of sustainable architecture, but, in general, they are more focused on how the building interacts with natural resources. I decided to use the frame of proecological architecture and include in this frame some social aspects, but in a different meaning than it is pointed out in "sustainable architecture" factors. As I mentioned, student dorms may play a significant role in context of ecology (ecology as a part of sustainable development triangle ecology – society – economy). It is important to think about student dorms not only as buildings in the architectural sense, but also as places where particular communities live. I added to Wines definition of proecological architecture some social aspects, such as: presence of tailored energy and water saving education programmes, possibility of involvement in extracurricular activities in the student residences (connected to sustainability), visualization of the water and energy consumption, smart meters (ex. Nest thermostat), and bills. I divide the main analysis in four categories. The first category describes the main characteristics of the building. The next three are: Energy (14 points), Water (14 points), and Education (14 points).

Energy criteria are:

Energy 1 - energy refurbishment of facades and roof + windows exchange (3p.)
Energy 2 - mechanical ventilation with heat recovery or possibility of natural ventilation (1p.)
Energy 3 - exhanged elevators (after 1990) or small scale of the building (1p.)
Energy 4 - active solutions, such as PV, Solar thermal, Wind turbines (2p.)
Energy 5 - Relation between north and south façade's glazing (=2 p; x=1=1 p;xp.)
Energy 6-external shadings on south or west façade (1p.)
Energy 7-no rooms on North Facade (1p.)
Energy 8- access to daylight in main corridors (1p.)
Energy 9- students pay bills for electricity (2p.)

– Water criteria are:

Water 1 - grey water systems (6p.)
Water 2 - rain water harvesting systems (5p.)
Water 3 - student pay bills for water usage (2p.)
Water 4 - student pay for laundry (1p.)

– Education are:

Education 1 - urban farming (2p.)
Education 2 - visualisation of water and energy consumption displayed in common space or in the room (3 points)
Education 3 - Peer education programs – e.x.Green Ambasadors in USA, Green Team in UK (5p.)
Education 4 - Bicycle storage (2p.)
Education 5 - Places for recycling inside and outside the building (2p.)

In the research, I analyzed only public-owned student residences. In Berlin, they are in possession of Studentenwerk - a student service organization that cooperates with universities and city administration Studentenwerk manages 33 student communities (Wohnheimen - WH). I have analyzed 25 out of 33 WH. They are: Eichkamp, Frauenhoferstraße, Sewanstrasse, Aristotelensteig, Hans und Hilde Coppi, Alle der Kosmonauten, Spandauer Damm, Hardenbergstraße, Internationales Studienzentrum Berlin, Franz-Mehring-Platz, Hafenplatz, Ferdinand Thomas, Nollendorfstraße, Potsdamer Straße, Siegmunds Hof , Haus Unger, Augustenburger Platz, Neue Hochstraße, Mollwitzstraße, Dauerwaldweg, Danckelmannstraße, Hubertusallee, Victor Jara, and Halbauerweg. For each category, I presented a sample of detailed research scheme (for 5 buildings) and a summary of findings for 25 communities.

FINDINGS

Basic Characteristics of Student Residences in Berlin

The scheme of analysis used in this part of the research is shown below on example of five buildings - Siegmundshof – (Buildings from 2 to 9; 12;13), Franz Mehring Platz, Augustenburger Platz.
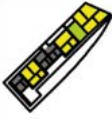
Name	Sieg.H2-9	Siegmundshof H12	Siegmundshof H13	Franz-Mehring Pl.	Augustenburger Pl.
Year of built	1961	1962	1964	1964	1998
Architect	Peter Poelzig	Klaus Ernst	Klaus Ernst	H. Mehlan H.Stingl	Linie 5 Architekten
Typology	Point House	Corridor Block	Corridor Block	Two joined Corridor Blocks	Gallery Access Building
Schematic Plan					
Nr of floors	3	13	4	21	7
Nr of places	16	132	46	672	150
Comfort(How many people per bath./ kitchen)					
Facilities					

The charts below shows the summary of the analysis for the 50 buildings in 25 Student Communities (WH). The largest group of buildings was erected in 1960s (22), the second large in 1970s. It is worth underlining that only 2 WH were built after 1990 and none after 2000. The typology chart shows the overwhelming number of corridor blocks, which is coherent with the function, but results in necessity of usage of artificial light in corridors –often 24/7. There are 16 buildings with fewer than 4 floors, where no elevator is needed. On the other hand, 7 buildings are higher than 10 floors, and they host the majority of students (more than 350 in each), usually in corridor structures. There are 8 small student residences (Siegmundshof), which are point houses, with large common spaces. The analysis on comfort show that most of the buildings offer accommodation with private bathroom, or shared with one person (34/50), however only in 20 buildings students can have also a private kitchen. The largest number of students/per bathroom is 8-10 (9 buildings) and >10 in one building. The most common indoor facilities in WH are fitness room (gym) and common room.

Proecological Solutions for Student Residences in Berlin

The next three categories of the analysis are connected to proecology. Below I showed the detailed scheme of this analysis, again on example of five residences. For each category –Energy, Water and Education the dorm could achieve maximum 14 points.

Name	Siegm.H2-9	Siegmundshof H12	Siegmundshof H13	Franz-Mehring Pl.	Augustenburger Pl.
Energy 1	3	0	3	3	3
Energy 2	1	0	1	0	1
Energy 3	1	0	1	1	1
Energy 4	0	0	2	0	0
Energy 5	1	2	2	1	2
Energy 6	0	0.5	0.5	0	0
Energy 7	1	1	1	1	1
Energy 8	1	0	0	0	1
Energy 9	0	0	0	0	0
SUM	8	3.5	10.5	6	9
Water 1	0	0	0	0	0
Water 2	5	0	5	0	0
Water 3	0	0	0	0	0
Water 4	1	1	1	1	1
SUM	6	1	6	1	1

Name	Siegm.H2-9	Siegmundsh H12	Siegmundshof H13	Franz-Mehring Pl.	Augustenburger Pl.
Education 1	2	2	2	0	0
Education 2	0	0	0	0	0
Education 3	0	0	0	0	0
Education 4	2	2	2	2	2
Education 5	2	2	2	2	1
SUM	6	6	6	4	3
SUM - TOTAL	20/42	10.5/42	22.5/42	11/42	13/42

The summary below shows the ranges of scores achieved in each category. In the "Energy" questions, there is one building which achieved "0" points out of 14, and one building that achieved more than 10 points (10,5 – Siegmundshof, building 13). 14 buildings scored between 4 and 6 points – less than half of all points.

23 buildings are energy refurbished, or meet the energy criteria. In 3 buildings, I did not have sufficient data to determine the scale of energy refurbishment. One building has mechanical ventilation with heat recovery, and in 6, students can effectively ventilate their rooms. In 24 buildings, there are relatively new elevators, or the scale of the building does not demand one. PV, Solar thermal or wind turbines are installed in 4 dorms. 10 dorms have positive relation between north and south glazing (there is more windows on the south façade). In 6 the relation is negative, in 14 it's neutral. There is no external shadings in the buildings, however, in some of them there are loggias.10 residences offers rooms on the north façade. Students do not pay bills for electricity.

In the "Water" category, the scores are generally lower than in "Energy" part. 27 buildings score between 1 and 3 points, and 3 dorms between 4 and 6. The highest rate - 6, was achieved by 3 building types in Siegmundshof - Building 1, 2-9 (point houses), and 13. They all have rainwater harvesting systems.

There is no building with a grey water system installed, and 3 buildings with rainwater system installed (however in 3 cases there is no data on this topic). Students do not pay for the water usage, however, in all dorms they pay for the laundry.

In the "Education" category, points are divided between ranges 1-3 (16 buildings), and 4-6 (14 buildings). In 2 communities, there is an urban garden. In only one building is there a visual display connected to energy (but it's actually production of energy, not consumption). No peer education programs were identified. In all dorms, there is a place for bicycle storage and for recycling outside the building.

CONCLUSIONS

The analysis revealed that there is no public-owned student residence that fulfills all criteria set for the purpose of this research. It can be observed, that energy solutions are more often introduced than solutions connected to water usage reduction or to education.

In the "Green City Index" report, Berlin is in first place in Europe in category "buildings". The 3 criteria for this category are: energy consumption, energy-efficient building standards, energy efficient building initiatives (promotion). In the "Arcadis" report, one of the indicators was energy consumption and efficiency. Energy is, then an important factor in these reports, and according to them, residential buildings in Berlin are the most efficient in Europe. This trend might be also seen in student residences if more complex research would be provided. My method of research was mostly based on available sources. Because of the lack of data on energy efficiency and energy and water consumption the final conclusion on proecology scale of student residences cannot be yet provided. However, the analysis confirms that energy saving solutions are to some extent introduced in student residences, but they are rarely followed with water saving solutions or education. In addition, the scheme of analysis allows one to make the comparison between student residences. It also shows the general trends in student residences (like energy refurbishment in most of the buildings, policy of bills included in the rent, or paid laundries), as well as particularly good or bad examples.

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SMART STREET LIGHT WITH CAPABILITIES BEYOND INDUSTRIAL STANDARDS

The street light presented here combines conventional and traditional elements of public lighting based on proven design and technology with modern illuminants controlled by computation. By utilizing all technologies at hand the goal is just not illuminating public spaces, which is defined by the conditions of an industrial standard, but to explore the capabilities thereof. The result is a prototype that merges simple illumination and sophisticated colorful installation into one device.

INTRODUCTION

The project presents a prototype of a street light installed in a second-hand enclosure. The created device integrates different types of light sources and sensors into a state of the art smart street light, that combines environmental stimuli detection with directed lighting and an animated installation.

Fig. 1. Dual nature of a smart street light.
Source: Author's own work.

As a prototype it demonstrates a possible link two different concepts or systems of lighting.

Lighting Systems

Lighting systems to illuminate public open spaces are categorized in two distinctive groups based on their appearances: The vast majority are functional lighting systems with blanket coverage comprised of white light sources as substitute for daylight. The typical case is a permanent public street light system build of stationery luminaries on an underlying regional grid.

The other group are colorful lighting installations, sometimes labeled as sculptural, artistic or theatrical lighting. They are usually temporary and designed for special places. The intersection between both groups is, for a variety of reasons, rather marginal and therefore should be addressed.

Conventional Street Light

The historic luminaire, as we all know it, is just a lamp with two states, on or off. It is powered from sunset to sunrise at full strength through out the night, even when nobody is around, and it is turned off otherwise. Commonly these lamps are grouped and controlled by a single switch, triggered by a timer or a light sensor. This scenario is still accepted for the majority of public street light systems.

Intelligent Street Light

In recent years, the manner of illumination has changed. With the introduction of new technologies like solid state lighting, especially with LEDs (light emitting diode), more differentiated sensors and network connectivity a single luminaire becomes controllable both individually and as part of a network. The individual street light, on which the public systems are based on, is drastically improving. The standards of public lighting are switching from simple on-off system based on a grid to more sophisticated adaptive systems.

A typical modern smart street light is equipped with LEDs, sensors and maybe micro-controllers to create new lighting pattern based on individual needs. Their main advantage is the reduction of power consumption, but also maintenance costs, reduced light pollution and safety issues. LEDs by themself are very energy-efficient, and the utilization of local sensors to detect if a lamp has a recipient can save even more both in terms of cost and the lifetime of the bulb.

Street lights with LEDs just as simple replacements exclude almost any possible progress. Not do they not provide any mentionable improvement, they waive all possible advancements of the technology itself.

Lighting Installation

 With the introduction of LEDs colored light installations have become widespread. As result of their inherent mode of operation, their handling of colors is quite simple. LEDs always have a single color, but due to their small footprint they can be grouped. Then colors can simply be added as part of the group of diodes.

Before that, the white light from filament lamps was passed through filters to get one single color. Changing colors was rarely smooth.

In addition, more powerful LEDs have become available and, with it, the instruments to control them. Colored LEDs have already become the basis of modern lighting installations with rapid changing vivid colors.

BUILDING THE LUMINAIRE

Usually street lights are off-the-shelf industrial products. Even smart street lights, although individually controllable, are designed for mass production. With the advancement of small programmable micro controllers, high power LEDs and 3D-printing, common items and techniques from the maker culture, this assumption has become obsolete. It is possible to make a smart street light at minimal costs on your own.

Maker Culture

As already stated a combination of both concepts is not on the short list of the manufacturing industry. They are solely focused on traditional lightening and brightening. Hence other means have to be employed to create a device that serves both illumination and installation.

To build a prototype, techniques from the maker culture are adapted. It is a form of both rapid prototyping and custom made objects or things. The defining characteristic is its dedicated hands-on approach. The maker culture is a technology driven DIY-culture (Do-it-yourself) based on "electronics, robotics, 3D- printing, and the use of CNC tools, as well as more traditional activities such as metalworking, woodworking, and traditional arts and craft" [1].

Concept

Incorporating the two different concepts into one single lighting device was the main task. To control several different sources the conceptual layout follows the rule of a channel design.

A single lighting source, be it a white lamp for directed light or a color channel as lighting component of a colored light, is controlled by one output channel. As results all lighting sources are individually accessible and controllable by one computer, which should be a micro controller with hardware-channels. In addition, some channels should be available for sensors. Hence, the number of channels is only limited due to hardware constraints.

The same concepts is applied to the sensors as input channels. While it is contemplated, that all kind of sensors might be useful, most important are light-sensitive sensors to switch the device on and off and to regulate the amount of light to be generally disseminated, and motion sensors to detect the presence of people and to regulate the actual needed amount of light. The lamp as simple functional street light should only work if it is dark and if people are in its proximity.

The installation, which is conceptual unrelated from the functional elements, is comprised of the three color channels of an RGB-LED. They are controlled programmatically and can be combined into a larger installation. Hence some computational connection or network should be established.

Arrangement

For functional and directed lighting three white LEDs are used. They are arranged horizontally to illuminate sectors at 120 degrees each around the street light.

Three equally arranged motion sensors cover the same area. The matching constellation enables a fine-grained detection of pedestrians, bicycles and cars in order to illuminate their localization and their projected path. Additional sensors like temperature or noise sensors can be applied.

For the dissemination of colored light a single RGB-LED is implemented. In combination with a fitting reflector this system allows for almost infinite variations. The colored part of the street light source disseminates vertical against a reflector to produce equally bright colors to all directions.

Without protection high-power LEDs can potentially cause damage to the retina. Hence the casing of the used old street light is used to diffuse the very bright disseminated light in order to eliminate any possible risk.

In total the configuration of the street light presented here claims 6 controllable light channels as output channels and another four, three for the motion sensors and one for the microphone, as input channels. This is about between a half and 2/3 of the capacity of a typical micro controller.

Construction

As groundwork the disassembled enclosure of an old mushroom shaped street light is employed. It provides both the necessary space for the technology and the accepted iconic shape of a traditional street light.

All LEDs are individually mounted on heat sinks. According to the technical data the small ones are sufficient for the white LEDs, while the RGB-LED require a larger one. The contacts of the LED have to be soldered to a wire. This part is not really the work an architect is used to, but given the enormous savings it is beneficial, besides the fact that such a layout is not available at all and has to be custom-made by some manufacturer. The almost same procedure would deliver a device at more expenses and lesser degree of flexibility. Regarding the eventuality of installing and testing different sensors the same notion is even evident.

Altogether there are about 4 layers of construction. Underneath the corpus the three motion sensor are mounted on a platform. The bottom of the case is used for the main installation, power supply, central micro controller, the LED-channels' controllers and additional sensors. The next layer in the center of the corpus, at the very same place the removed light bulb was located, is a cylinder on which the three white LEDs are mounted. These light sources are disseminating horizontal in a slightly downwards direction.

The remaining space in the upper part of the enclosure is reserved for the upwards beaming color LED with its big heat sink and its reflector on top of it.

Tests as Installation

All controllers are connected to an ac to dc converter power source which is connected directly to the power line with high voltage. An initial test without the enclosure demonstrated some initial results. The light of the LED was reflected and its color could be observed by the reflection of the white wall. However, without eye protection it is almost impossible to observe.

Then, with its casing, the color of the LED is presented by the encapsulating diffuser.

Additionally, a microphone and a temperature sensor have been tested with the prototype. Especially the sensing of noise in combination with the presence of people can produce some interesting effects and transform the street light into a sophisticated installation.

The final test arrangement loops through all rainbow colors at an interval about a minutes. As simple demonstration it points towards the capability of the lamp to show all colors at any time frame.

Communication

Communication is one of the main feature a smart street light should provide. This refers both to the relation user-machine, as between a pedestrian and a street light, and machine to machine, as between two or more somehow related different smart street light with fully configured sensors.

In case of the user-machine communication a simple Bluetooth interface is installed and provides initial results. It is contemplated that an upgraded interface enables a communication channel to mobile phones and hence opens the lamp for interactions with nearby users.

In case of communication between different devices and maybe some controlling servers all related lamps should be grouped into a network. This can be either based on a technology named power line, where the signals are transferred through the existing power lines via an overlaid Ethernet connection, or based on a mobile telephone network. Both systems have their advantages, but also drawbacks.

Because by now only one single street lamp has been built, this task is left for some future studies with more lamps, probably more users and maybe some remote computers as dedicated servers. The main problem is neither the technology itself, nor is it the funding but the space where a couple of such lamps could be installed and tested.

SUMMARY AND OUTLOOK

While the concepts of smart street lights are evolving, the single purpose of all lighting installations being a piece of art is mostly neglected. Commonly, colorful lighting installations are not regarded as part of a public street light system. If such a system is installed and presents itself, it is usually temporary and isolated.

On the other hand the public street light system has no means to present itself as an installation. Here its single purpose is the illumination of public spaces.

The street lights presented here, as prototype made with techniques obtained from the makers' culture, demonstrates a concept and some ideas that should be neither limited to pieces of arts nor to simple public illumination. By utilizing modern technologies, a new type of street light has been created.

Although, it has still some constraints and is by far not a typical industrial product yet, as handcrafted prototype by the means of makers, it envisions some yet unknown appearances of illumination in public spaces. It goes beyond the simplicity of just brightening places and it will go further than just the luxury of presenting art.

As a type of installation then, this kind of colored lighting is not implicitly limited to artistical approaches. Colored lights with some elaborate controls can achieve other purposes. Especially

they can signal some states of a location without the support of additional signs, like in the case of an emergency.

Building the smart street light by hand based on techniques from makers already proved to be adequate in an urban context.

Evaluating which parts of the presented prototype are valid or, as in the case of the temperature sensor, may become void, will be crucial. What features should be kept and enhanced, and what attributes could be dispensed without affecting the overall acceptance of a public lighting system will become part of a future research. and evaluation.

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Buro Happold Polska

FROM DESIGN TO ENERGY PERFORMANCE ANALYSIS: THE ROLE OF ALGORITHMS IN INTEGRATING DIGITAL TOOLS IN ARCHITECTURAL PROCESS

The emergence of computation resulted in the replacement of the physical model with digital model, which aims to integrate all the necessary data (material attributes, function of elements, analytical results, historical and physical context) for each stage of the building process. The article covers a visual programming algorithm developed by the author, which allows to export clean 3D data to an energy simulation software (IES) and facilitates the data exchange between IES and CAAD/BIM software.

THE MODEL AS AN EXPERIMENTATION TECHNIQUE

Every hypothesis is supposed to be validated, verified or refuted. Experimentation is thus essential, which can be conducted by prototyping or by representations of reality. As architecture experimentation via full-scale prototyping faces obvious difficulties due to complexity, size, cost and ethical issues, construction design and engineering is strongly connected to the use of models.

A model, as a theoretical concept, is a simple way of expressing causal or structural relations stripped away of any irrelevancies and complexities of reality, so that they become easier to understand. [1]. Across the practice, a model is a representation of reality, and provides the possibility of exchanging information thanks to a given communication code. Although this code may vary depending on the cultural and traditional background, media that channels the information are universal, and can be grouped into 5 categories [2]: text, image, sound, video and model (both physical and digital).

Physical models have always been an important medium in different stages of architectural process (shaping, presentation, exchange of information). They are capable of representing aesthetic values, functional and structural solutions; through simulation (Filippo Brunelleschi's models of Duomo of Santa Maria del Fiore, Gustave Eiffel's structural and aerodynamic models), form-finding optimization (Antoni Gaudi's catenary structures, Frei Otto's research on self-constitution processes and structural optimization) or one-to-one scale experimentation (Heinz Isler's wet fabric inverted shells).

The emergence of computation resulted in the creation of the digital model, which can integrate multiple data (material attributes, function of elements, analytical results, historical and physical context) and can be complemented with other media (text description, additional model). This facilitates its multiple usage and enhances the possibilities of analysis and simulation [3]. A digital

Keywords:

Simulation, Energy Analysis, Digital Model, BIM, Custom Tools.

model is the base of contemporary Computer-Aided Architectural Design (CAAD) tools that use geometry and the information about it as the core of the design workflow; Building Information Modelling (BIM) goes one step further and aims to integrate all the necessary data in every stage of the building process.

A digital architectural model pursues multiple objectives such as precise visual representation, marketing and client-oriented visualization (both persuasive and informative) and the performance analysis simulation (digital experimentation technique that aims to simulate the behaviour of the building against weather or usage conditions) [4].

THE IMPORTANCE OF THE MODEL IN ENERGY PERFORMANCE ANALYSIS

An important aspect of contemporary simulation is the Integrated Building Performance Analysis Simulation. Energy aspects of building's lifecycle affect not only the cost of exploitation but also have impact on the environment, and they are a key factor for successful developments, in which high ratings in sustainability certifications such as LEED or BREEAM are more and more common. In addition, integrated performance analysis are also essential for engineering designers, who need them to size and select the proper equipment for the building systems.

There are multiple tools and standards for performance analysis, which makes uniform solutions difficult. Even though contemporary BIM software intents to integrate every aspect of the building, this variety of technologies and regulations makes it almost impossible to find a single workflow that will serve the architects, the client and the consultants equally well in different projects, locations and phases.

During this process, properly modelling the building on which the energy analysis will be performed is an essential part of the Integrated Building Performance Analysis Simulation. The native application for 3D modelling in current energy simulation software such as IES is not intuitive enough to allow fast modelling and it has obvious limitations when it comes to more complex geometries.

Plug-ins for multiple CAD tools have been developed in order to help dealing with these issues. The Green Building XML schema or gbXML is also being widely used, which intents to facilitate transfer of building data stored in BIM models to performance analysis tools. However, the workflow is still not optimal. This is mainly due to the fact that these 3D models are done externally – e.g. architecture offices– and do not take into consideration the 3D modelling essentials necessary to make the export process smooth and successful. This results in the necessity to rebuild the model again from scratch, which makes the 3D modelling process (as well as the tracking and updating of changes that occur during the design process) a time-consuming task that absorbs a large part of company finances.

Concerned with this time-consuming task, firms look for alternatives. One of the possible solutions is the algorithm described in the article. This algorithm created by the author in BuroHappold Polska is currently being used in real projects both in Poland and abroad. The workflow allows direct 3D data exchange from Rhinoceros to IES, using a Grasshopper algorithm developed by the author. IES (Integrated Environmental Solutions) is an integrated analysis tool in which multiple environmental analyses are performed through a single 3D model. Rhinoceros is a commercial 3D computer graphics and CAD application software developed by Robert McNeel & Associates.

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THE RHINOCEROS-TO-IES EXPORTER COMPONENT

The tool described in the article exports Rhinoceros geometry as a GEM file, which is the native geometry file for IES. It's a component developed in Grasshopper, a visual programming language created by David Rutten at Robert McNeel & Associates, which is tightly integrated with Rhinoceros' 3D modelling tools.

The Grasshopper exporter tool translates the geometry built in Rhinoceros to GEM code. The accuracy of the results depend greatly on the quality of input information, meaning that the Rhino model needs to be developed with the best practices and workflow considered. However, these modelling essentials are not the objective of this paper.

Table 1 describes a sample GEM file for a given volume; this scheme will be repeated as many times as objects in the model.

sample GEM file	notes
LAYER	
1	[
COLOUR	
1	
CATEGORY	General information of the geometry
1	
TYPE	
1	
COLOURRGB 16711690	]
IES Office_L04_ext	IES & name of the geometry
8 6	Number of vertices & number of faces
2.537590 -1.411210 39.930000	[
2.537590 -7.536209 39.930000	
6.587590 -7.536209 39.930000	The vertices of the geometry (x, y and z coordinates): the order
6.587590 -1.411210 39.930000	in which the vertices are given (from 1 to n) defines then how
2.537590 -7.536209 43.560000	the faces of the geometry are going to be described
2.537590 -1.411210 43.560000	
6.587590 -1.411210 43.560000	
6.587590 -7.536209 43.560000	]
4 4 7 8 3	[
0	For each pair of lines: the first number of the first line
4 1 6 7 4	corresponds to the number of vertices forming each face. The
0	following numbers refer to the order in which the vertices were
4 2 5 6 1	sorted before 4 (from 1 to n). The number in the second lines
0	describes the number of perforations
4 3 8 5 2	
1	If the number>0, the perforation needs further information:
4 0	number of vertices & type (0=window, 1=door, 2=hole)
2.875000 0.150000	
3.875000 0.150000	Vertices of the perforation (x and y coordinates in a new
3.875000 2.850000	construction plane)
2.875000 2.850000	
4 7 6 5 8	Following faces of the geometry
0	
4 2 1 4 3	
0	]

Each line of the code in the first column is explained in its corresponding line on the second column.

The exporter tool intends to be as user friendly as possible. It has two main inputs: on one hand, rooms and zones need to be built as closed polysurfaces, which will be then referenced together, regardless of their function, level or other feature. On the other hand, openings need to be defined as closed curves, meaning that a boundary polyline representing the opening will be drawn on the surface of the rooms. Shadings can be built as surfaces or polysurfaces, and need to be referenced along with the rooms and zones.

Once the main inputs are referenced into the Grasshopper definition, the algorithm re-organizes the information for each geometry, according to the pseudo code defined below:

– It extracts the information regarding the type of geometry (room, shading, adjacent building, topographical element) from the Rhinoceros layer.

– It automatically creates the basic information for each geometry. If it exists, it extracts the generic name of the geometry from the Rhinoceros layer; if not, it creates a name automatically.

– It deconstructs each room (closed polysurface) into faces, vertices and coordinates (x, y, z).

– It assigns each opening (close curve) to its closest surface.

– It extracts the information regarding the type of opening (window, door, hole) from the Rhinoceros layer.

– It deconstructs the opening curves into vertices and coordinates (x, y).

– It double-checks potential risks such as duplicated points or non-closed polylines or polysurfaces.

– It writes a file following the schema explained in Table 1. This is the file (the *.gem file) that will be later imported into IES.

The exporter allows to model geometry in proper 3D modelling software, which speeds up the process of building the model as these software are specifically designed to do so. In fact, it also allows one to simulate complex geometry that would not be possible to model otherwise, as the example shown in Figure 1. However, different approaches to modelling can be conceived depending on the skills of the user and the original material provided.

Fig. 1. The Dubai Museum of the Future

Source: BuroHappold Dubai
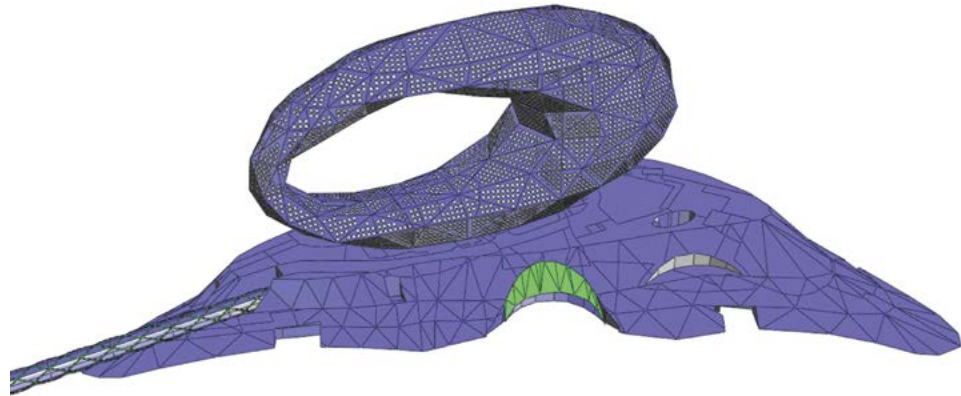
Energy model created from scratch

The original CAAD data (plans, section, 3D objects) are used as reference layers upon which the new model will be built. Making sure that the model is built in a clean manner is essential to ensure a smooth and successful export process. A tutorial was written in order to explain these modelling essentials.

Although the GEM file only contains geometrical information (and therefore, no construction nor location nor thermal information), Rhinoceros layers may be used as information holders, which facilitates the later assignment of the IES project's features, such as thermal templates, groups or levels.

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CAAD-based energy model

Visual programming languages, such as Grasshopper for Rhinoceros or Dynamo for AutoCAD, could be used to reference and transform original CAAD model objects in order to ensure a smooth and successful export process.

This workflow relies on the initial model provided by architects, whose quality and re-usability may vary. When clean models are provided substantial time-savings are to be expected.

BIM-based energy model

Visual programming languages, such as Dynamo for Revit, could be used to reference and transform original BIM model objects in order to ensure a smooth and successful export process. This workflow also relies on architect's model, but its potential is larger than in the CAAD-based workflow.

BIM models store more information than CAAD models. One of the most useful piece of information is the string that defines the unique room name, which can be exported to IES as well. This implies double benefit: on one hand, it facilitates the understanding of the energy model and the easy assignment of the IES project's features. On the other hand, the analytical results can be imported back into Revit, as they are easily referenced by their original name.

Improving this workflow is the objective of the on-going research in BuroHappold Polska (Szepietowski, Baławaniak and the author), which pursues the closing of the circle of the energy simulation workflow: from BIM to Energy Simulation and back to BIM.

SUMMARY

The author believes that Integrated Building Performance Analysis Simulation software available on the market does not –and neither will in the near future –facilitate a comfortable 3D modelling experience. Due to the wide range of 3D modelling programs and the fact that the logical development of the practice is moving towards the optimization of the import and export processes, adapting such specialized analytical software for modelling purposes should not be a priority.

Although the gbXML schema is an alternative currently being developed and improved, the author states that visual programming languages and custom-made algorithms –such as the workflow explained in this article –will become more and more common. Therefore, demand for parametric or algorithmic skills will also increase. Instead of searching for a universal solution that will definitely solve the complexities of the building design process, a *perpetuum mobile* scenario seems more probable, meaning that new needs and constrains will have to be constantly dealt with. This prediction would thus imply the necessity of a shift from a user-based frame towards a creator-based frame, where the worker is no longer a mere user of software of technology, but a creator of design processes or workflows, through software or technology.

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OPTIMIZED MATERIAL DEPOSITION. ADDITIVE MANUFACTURING STRATEGY FOR ARCHITECTURE IN THE AGE OF SCARCITY

The paper describes the socioeconomic conditions and technological determinants of a method that aims to develop process of design, simulation, optimization and fabrication of architectural elements with engineered internal structure based on cellular materials logic. The developed procedure is described through the use of digital computational tools and the way these tools were utilized in order to achieve an architecture of improved micro-optimized mechanical properties and a more efficient material distribution. In the final part of the paper, a preliminary experiment that was designed to verify initial assumptions is presented and summarized by process outcome and future development direction.

ARCHITECTURE OF SCARCITY

As we are moving through the 21st century, it becomes obvious that we cannot any longer ignore or perceive only in a theoretical sense, one of the key aspects of the theory of the design society — negation of the schema-of-unrestricted-resources axiom [1]. Even the superficial analysis of social, political and ecological conditions show that current economic models and the practice of industrial production lead to discontinuities and even a real dearth of key resources. Some of this lack is due to their natural availability, as in the case of oil or gas, some is result of human mismanagement as with wood or water. Others are determined by uneven social and geographical distribution and speculation on what is supposed to be humanity's common good. In architectural discourse, for many years, this problem was largely marginalized and often brought up only in specialized area of sustainable design. However, in the coming decades the outlined problem will become more and more pressing for architects and designers who will to have to face it. Perhaps confronting the reality of scarcity might lead to a total change in the philosophy, methods and tools of practice [2]. In fact, the architecture sector should be one of the first to pursue a positive change as it is one of the most important players in the exploitation of natural resources. Recalling data from a variety of reports and studies the construction industry accounts for around 45-50 percent of global energy usage, nearly 50 percent of worldwide water usage, and around 60 percent of the total usage of raw materials. At the same time, the industry contributes up to 23 percent of air pollution, 50 percent of climate change gases, 40 percent of drinking water pollution, and another 50 percent of landfill wastes.

On the other hand, an act of creation in a context of resources scarcity can be a powerhouse for implementation of new innovative design strategies and releasing architecture from its past boundaries [3]. This might be seen as a situation analogous to the interwar crisis in Germany that was crucial to the emergence of the Bauhaus design philosophy. The words of Josef Albers, *"Ladies and gentlemen, we are poor, not rich. We cannot afford to waste material or time."* [4], gain new meaning in the mentioned context of both scarcity and the new mass customization revolution. Today's situation can be seen as analogous. In the authors opinion, a revolution during which one of the key elements leading to creation of a new quality of designed environment will be architectural fabrication based on additive methods of production.

FABRICATION OF AN ARCHITECTURE

The additive fabrication shift from rapid prototyping through rapid tooling to rapid manufacturing allows for imaging, designing and production of architectural objects of an end-use quality. It also presents a new field of research that requires new digital modeling and simulation tools that consider material properties as well as 3d printing constraints [5].

The use of additive manufacturing technology in the contemporary architectural discourse occurs in the form of two essentially extreme concepts. The first of them refers directly to the issues of free form design and the fabrication of complex geometries, based on existing commercial solutions [6]. The second concept is based on the rapid manufacturing of architecture, seen as a method for the creation of architectural elements and even entire buildings carried out with the help of digitally controlled, scaled fabrication tools that deposit layer upon layer of building materials like concrete [7]. A limited number of publications address the idea of connecting both above concepts. The author proposes to use additive manufacturing tools it their actual scale and micro-precision for fabrication of building-scale architectural elements. The article aims to situate the above issues in the context of sustainable design by describing experimental design strategy for the rational use of resources, which aims at the reduction of material weight and waste while maintaining objects' mechanical properties.

ENGINEERING OF A CELL

In 1665, English naturalist Robert Hooke made a breakthrough discovery resulting from his invention of the microscope. In his work *Micrographia: or some Physiological Description of Minute Bodies made by magnifying glasses with Observations and Inquiries there upon,* Hooke described and illustrated a set of magnified natural objects, one of which was a cork bark. This observation allowed the naturalist to define the basic, interval unit of this plant structure. In this way, for the first time in history, the cell was identified. The Robert Hooke's discovery has been the source of inspiration for generations of scientists and engineers. In the present terms, cell materials or materials with cell structure can be described as any materials that contain many cells (open, closed, or both) within its volume.

In practice, objects that surround us are made of material whose cellular structure can be seen at a certain level of approximation. In some cases, it is visible to the naked eye, in others it requires the use of an optical or electron microscope. In other cases, recognizing internal structure calls for the understanding of interatomic bonds occurring within it. Additive manufacturing technology allows the use and control of heterogeneous structures within materially homogeneous products. Based on this possibility, the author proposes the use of convex uniform honeycombs (taking into account the capabilities and limitations of technology) as the model for introducing engineered internal structures in architectural elements. At the same time, the proposed method cuts off the purely aesthetic considerations of additive manufactured architecture. The research attention is *devoted*

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to performative, engineering based approach to the issues and therefore programing of intentional voids within materiality of the bespoken object. An important feature of cellular materials is their anisotropic nature. This means that the internal structure of the cells has physical properties, depending on the direction in which it is considered. For directions that have to bear an increased load, the material amount is increased as well, similarly reduced load equals reduced amount of a material. For example, in the trees the greatest load is caused by wind pressure force and operates along the trunk and branches. Thanks to its internal honeycomb-like structure with a variable alternating wood density it is much stiffer and stronger in longitudinal than in cross-section. In turn, human bones, due to the weight of a body, are exposed mostly to compressive forces, and their internal sponge like, trabecular structure improves their rigidity and strength in vertical direction.

MICRO-OPTIMIZED ARCHITECTURE

Taking into account the above considerations, the author sees the possibility of using additive methods of production for manufacturing of architectural elements with internal structures designed in accordance with the logic of cellular materials. This approach might lead to the increased rationality of material consumption through its strategic distribution within the requested object. Recalling the anisotropy in nature, each bone in the human body works in a different way, under a different load, which causes increased growth of the trabecular tissue in different directions. Analogously each architectural element, each building module, should be designed in accordance to its intended purpose. After all, the top of the wall does not transmit the same loads as its base. Today, we already have both computational and production tools to implement the idea of micro-optimized architecture.

Process

The experiment designed by the author is an attempt to simulate the processes of optimization mimicking one that might be observed in the nature. To this end, two digital environments were used to generate form and simulate behavior of internal spatial structure. Both elements were used alternately in a recursive process of optimizing network structure of a bespoken object so that with each successive iteration, it would present better mechanical performance.

Design, simulation, optimization

In initial part, the visual programing language Grasshopper for Rhino 5 was used in order to describe the geometry of the future structure by using an ideal cell model that was based on material engineering principles. Since most of the networks are possible to describe as an aggregation of solids in space, as in example of the Weaire-Phelan model, a definition that automatically designates all the edges of input objects was developed. At the same time, to avoid mistakes at the later stage of the work, the described program recognizes and removes any duplicate line segments that make up the network. In this way, a wireframe model is produced based on the elements composing the desired set of solids in space such as the convex uniform honeycombs, including irregular Voronoi and Delaunay 3D tessellations and other possible aggregations. Finally, a fragment of the script responsible for parametric generation of solid elements was developed.

Having developed a model, the next step was to extend the base functionality of the definition by introducing optimization based on a specified data. Attractor's strategy was adapted. Arbitral defined points positioned within an object were alternating the size parameter of the items based on their vicinity At first the scale and the force of an impact on the parameters was strictly geometrical. The closer the item was to the attractor the thicker it became and analogously the farther it was

the thinner it got. Later on, this relation was changed and the reaction power was based on the outcome of the simulation, precisely the stress value in the given point.

After developing the principles of shaping the internal structures, the next stage of the experiment was to acquire the relevant data for the optimization procedure. A number of different software solutions were considered based on their ability to perform advanced computer simulation. The final choice of Autodesk Simulation Mechanical software was driven by accuracy and amount of the feedback data it could provide. A wide range of features included in the software's functionality gave the possibility to compute, simulate and study internal stress forces, degree of deformation, shear moments and many others all based on precisely described physical conditions. By using this tool, it was possible to introduce a computer model, a direct representation of the designed object with material properties specified in association to the selected method of additive manufacturing. Consequently, by simulating specified loads, we could receive information about internal von Mises stress occurring in the designed structure at almost any level of resolution. Information, from the whole module through a single rod element and up to an individual vertex point of meshed geometry, could be received. This, in turn, allowed the introduction of a degree of precision as a yet another parameter of the optimization process. Simulation results data is presented both in the form of a fixed color map rendered over 3D model and as a numeric data matrix representing control elements/points with related values. These, in turn, were imported directly to form generating software and used as attractors.

Results

The functionality of the described method was verified during Experimental Design Studio - Examining Structural Qualities taught at Architecture for Society of Knowledge's Master Degree Program. Students were given a task to design and parametrically describe a bio-inspired internal structure. Student-designed voids populated a test volume (10x10x10 cm cube) and then were optimized using the above-mentioned procedure. As expected, thanks to the design process, simulation and optimization in the digital environment, it was possible to generate better performing elements both from a mechanical and material usage point of view. For example, in one of the designs it was possible to reduce the maximum and minimum stresses by more than 50 percent while increasing its mass only by one third with merely one iteration. In addition, optimization helped reduce the minimum stress by an additional 50 percent, which, in turn, allowed the prediction that it would be possible to further reduce material needed for fabrication of the item.

In the context of both positive experience and findings of the studies and critical analysis of research, a preliminary experiment described in this article allowed the formulation of the next steps in the further development of the proposed strategy.

– Simulation software. Paradoxically, one of the key problems associated with the simulation tool was in fact its precision. Often the feedback generated for a test model consisted of a few tens of thousands of control points along with the simulation data. As a result, the import of the data and optimization in visual programing language was long lasting and in some examples even impossible. This was due to the amount of computational operations that had to performed simultaneously each time a single parameter was changed.

– Data flow. The second issue mentioned already above is data exchange during the procedure and necessity to simplify the process. In practice, a form generated in Rhino must be exported to the .STL format. Next the file has to be opened using Inventor software, after changing some basic parameters so that it can be exported as a .DWG file. This, in turn, can be opened in Simulation Mechanical. Then, after running the simulation, analysis results need to be exported to a .CSV text file which can be imported back to Grasshopper using a specific code written in C# command. The resulting procedure is not a seamless flow, and the data is not

exchanged in real time. Thus, the procedure prevents creating a fully evolutionary algorithm, which is sought to obtain a mechanical balance between elements of the structure while at the same time seeking to reduce the amount of used material.

Both above issues can be solved in the next iteration of the method by introducing Autodesk Robot in place of Simulation Mechanical. The program is far less rigid than the originally selected one, yet its logic seems to be converging on the creation and optimization of objects based on wireframe like objects. In addition, the advantage of this solution is that it enables real time communication with the Grasshopper. Another aspect of the ongoing research will be a comparative analysis of different networks in terms of their mechanical efficiency while maintaining reference material consumption.
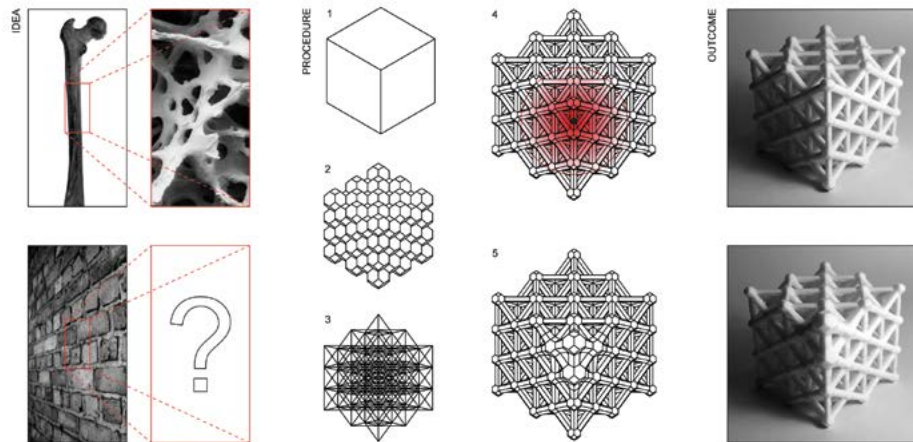

Fig. 1. The image presents the crucial aspects of the described method: initial idea of the optimized material deposition, steps of form generation and finally physical models printouts presenting outcome of procedure on example 5cm cube.

Source: Author's own work.

CONCLUSION

In this article, some economic determinants behind the necessity of a paradigm shift in field of architectural design were pointed out. At the same time, the formal aspects of cellular materials and fabrication via additive manufacturing methods forming the basis for proposed strategy of producing micro-optimized architectural elements, were outlined. Furthermore, the paper describes the logic and intent of the designed procedure as well as presents an experiment aimed at the implementation of its objectives.

Considering all these aspects and the results of the experimental part of the research the author believes that with the current pace of development of additive manufacturing technologies, with respect to both solutions and implementation in field of architecture fabrication, the proposed method can significantly reduce material consumption and hence positively impact the environmental and economic costs of construction industry.

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ANALYSES OF PUBLIC UTILITY BUILDING DESIGNS AIMED AT THEIR ENERGY EFFICIENCY IMPROVEMENT

Public utility buildings are formally, structurally and functionally complex entities. Frequently, the process of their design involves the retroactive reconsideration of energy engineering issues, once a building concept has already been completed. At that stage, minor formal corrections are made along with the design of the external layer of the building in order to satisfy applicable standards. Architecture students do the same when designing assigned public utility buildings. In order to demonstrate energy-related defects of building designs developed by students, the conduct of analyses was proposed. The completed designs of public utility buildings were examined with regard to energy efficiency of the solutions they feature through the application of the following programs: Ecotect, Vasari, and in case of simpler analyses ArchiCad program extensions were sufficient.

WHAT DOES THE FUNDAMENTAL TASK INVOLVE?

Architecture students in the course of their studies prepare at least a few designs of public utility buildings as a part of specialist design class. Typically, these could be educational facilities (kindergartens, schools, higher education institutions), health care facilities (out-patient clinics, hospitals, health resorts, public nursing homes, etc.), cultural facilities (multi-screen cinemas, theatres, concert halls), sports, tourism, commerce and service facilities, etc. Owing to the high complexity of dry buildings as well as a limited amount of time (students have one semester), designers are focus on functional and space issues, construction and material issues as well as aesthetic matters. Energy related, pro-environmental issues are not solved or considered in secondarily, after finishing the concept of the objects.

Within the scope of the course of "pro-environmental architectural design," a student chooses one of already completed designs of a public utility building which he/she then analyses and evaluates in terms of ecology in architecture. This is a new factor, which needs to be taken into consideration

in the process of design, and among numerous pro-ecological architectural solutions a lot of attention is paid to energy-related matters in architecture.

What Aspects Are Analysed?

Several public utility building designs were analysed. The completed designs of public utility buildings were examined with regard to the energy efficiency of the solutions they feature through the application of the following programs: Ecotect, Vasari, and in case of simpler analyses (shading, insolation of building planes) Archicad program extensions were sufficient. The following aspects needed to be examined:

– location: Is a building properly positioned relative to the direction of the world? Does the southern façade receive sufficient amount of insolation? Isn't the building shaded with other structures – chiefly at the time of equinox – 21.03 and 23.09?

– shape of the building body: Is it shaped in such a way that its own shadow interferes with room light? Which building body planes receive the most solar energy? Are internal patios and breaks in the body of the building properly shaped?

– amount of daylight and of solar radiation in particular rooms: How much light do the provided window openings allow into the rooms? How do they function in intense insolation? Is the body of the building sufficiently "open" to southern insolation?

– annual thermal balance, itemized into individual months: What is the demand for heat at specific, constant coefficient value of external envelopes insulating power (solid walls U=0.15 W/m2K, roofs and flat roofs U=0.1 W/m2K, ground slab U=0.1 W/m2K, windows U=0.7 W/m2K, glass curtain walls, doors U=1.2 W/m2K). If it was calculated what proportion of thermal energy demand is covered by solar radiation gains, what proportion is obtained from gains generated by people and devices, and how much needs to be supplied from conventional sources of heating. For the summertime, the question is how much energy will be consumed by the air conditioning that cools the buildings.

Note – to ensure the comparability of results, all the designed buildings featured the same insulating power properties of external envelopes as specified above. The building had the same insulation power of external envelopes before and after design changes.

As a result of the conducted analyses, the authors themselves recognized significant defects of their own solutions. Such defects needed to be listed and described. The most frequent defects included:

– failure to take into account the differences in insolation of the body of the building on southern and northern façades,

– inappropriate location of rooms in the building relative to the directions of the world,

– inappropriately shaped body of the building (high value of the ratio defining the relation of external planes to cubature), breaks causing high shading, excessively shaded patios,

– inappropriately designed window openings and curtain walls,

– lack of solutions related to operation of the building in the cold and hot seasons.
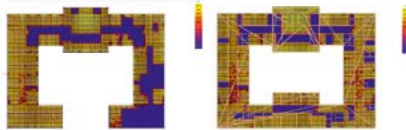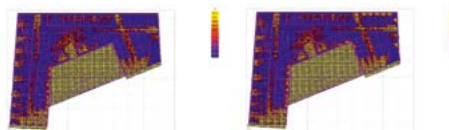
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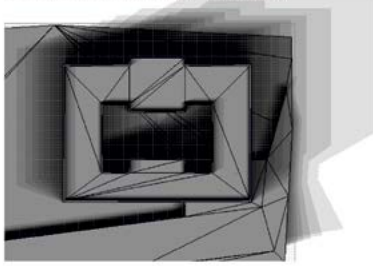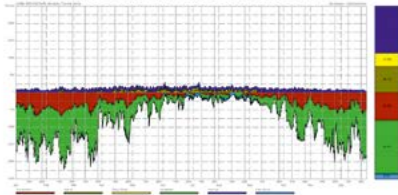
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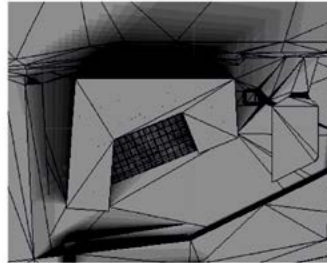
ROOM SUNLIGHT ANALYSIS

ROOM SUNLIGHT ANALYSIS

THE ANNUAL HEAT BALANCE
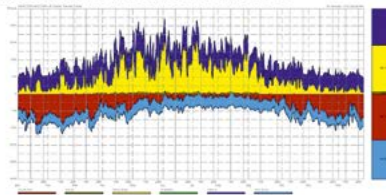
THE ANNUAL HEAT BALANCE

Fig.1. Design and analysis of the Medical Clinic building – A summary analysis of the object before and after the changes (shading, lighting sunlight envelope planes of the building, interior lighting by daylight, the annual heat balance); the author - student A. Chrobrowska, under the direction of prof. M. Wołoszyn

Corrections or a Complete Change of the Original Designs?

The flaws found in analysed designs had to be corrected. Additionally, designers were provided with extensive information on simple and efficient passive systems of using solar energy. Design corrections eventually became substantial redesigns. Knowing the functional diagrams of previously designed buildings, designers found it easy to incorporate changes and the supplementation of new solutions increasing energy efficiency. Consequently, the architecture of the facilities became different from the original one. The changes involved:

– remodelling the form of a building, in order to decrease the building's own shadow, e.g. softening breaks or reforming them in such a way so as to prevent them from shading adjacent parts of the building;

– shaping the form of the building in such a way that a longer façade has been created on the southern side;

– redesigning a room layout so as to enable temperature zoning of building rooms (warm from the south or the centre of the layout, cold from the north or as an external buffer from the windward side);

– addition of a greenhouse / conservatory as an integral structure element;

– incorporation of other passive systems of acquiring thermal energy from solar radiation;

– conceptual solution of air circulation in winter and summer time;

– proposal of a system of heat recuperation from ventilated air and a way of preliminary heating of air introduced into the ventilation system;

After the completion of so many analyses and necessary changes, the building designs became new, different designs of the same functional program but solved in a new form, re-examined in terms of energy. A conservatory (greenhouse) is now one of the fundamental elements integrally connected with the building. It constitutes not only a supplementation of entrance, recreation,

catering and other types of space, but it is also an element improving the building's energy balance. The energy aspects related to that solution must be examined and solved. The functioning of the space during winter and summer time also needs to be considered. Several aspects that needed to be solved by way of schematic diagrams include: cooling, heating, air circulation and the use of air from the greenhouse.

Energy Analysis of the Redesigned Building

New building designs were subjected to similar examinations as the original designs, whose focus was on:

- location,
- shading,
- shape of the form of the building,
- daylight amount and amount of insolation in individual rooms,
- annual thermal balance including an itemization of individual months.

According to the assumption, all external construction envelopes in a new and in the original design feature the same thermal insulating power. This enables a comparison of thermal balances devised for original and post-conversion designs. The differences in thermal balance results exclusively from different architecture of both form of the building and not from any mechanical increase or decrease of thermal insulating power of external envelopes in the designed body of a building. As demonstrated through calculations and simulations, energy efficiency of the redesigned building is significantly greater than that of the original building, while the participation of passive systems in the thermal balance is very substantial. Such systems enable significant savings in the consumption of conventional energy carriers. Both in the autumn and in the spring, those gains eliminate the use of conventional heating, which is clearly visible in the diagrams simulating heating in particular months. The conducted calculations of thermal balance for the original and redesigned buildings energy savings are up to 50%. It should be emphasized that the savings result from a change in space solutions and new function layouts, and not from increasing insulation power of external envelopes in newly designed buildings. The insulating power of the envelopes remains unchanged, in order to demonstrate to designers/architects how significant is the role that architectural solutions of a building play in energy efficiency (form, function, construction).

An analysis of monthly thermal balances demonstrate that after the incorporated changes, the buildings of more compact form demonstrate lower losses related to thermal transmittance (coloured red in the diagram) and simultaneously higher gains related to passive systems of solar energy use (coloured yellow in the diagram). The thermal balance of the buildings does not precisely account for the use of warm air from conservatory in the ventilation system. Moreover, the benefits from introducing ground-coupled heat exchangers and recuperators into the ventilation system of the building are not taken into consideration.

CONCLUSIONS

The 21st century designs of public utility buildings should always be energy efficient and feature other pro-environmental solutions. Energy efficiency must not be an element supplemented in a technical design through an increase of thermal insulation layers and the application of glazed surfaces of higher thermal transmittance. The addition of liquid or photovoltaic collector to a building has become a newsworthy event. The analyses conducted with the use of Ecotect and Vasari programs revealed energy efficiency related defects in the building designs. The analyses demonstrated that form and internal space layout have a significant impact on the energy efficiency

of a building. Buildings of the same functional program and similar cubature, but with modified architecture are twice as energy efficient. It must be concluded that an energy efficient building using simple architectural passive application of solar energy must be developed from the start in keeping with such assumptions. Consequently, its energy efficiency is substantially higher than the one obtained through an increase in thermal insulation of external envelopes. Therefore, the role of an architect is a crucial one, since an architect ought to consider energy efficiency from preliminary design concept.

Energy efficiency further entails the right form and space layout of a building, and even function solutions, not merely insulation elements of external envelopes and some technical gadgets.

An ideal solution would involve the existence of advanced Building Information's Managements-type computer software that would provide remarks on an ongoing basis in the course of concept formulation, informing of the energy efficiency of a developed body of a building. Each change incorporated by a designer would be assessed and presented as a commentary on energy efficiency results. Such helpful operation of BIM programs would provide significant assistance in making the right design decisions. I am convinced the use of such programs is a question of the not so distant future.

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Creativity

"It is the tension between creativity and skepticism that has produced the stunning and unexpected findings of science."

- Carl Sagan, Broca's Brain: Reflections on the Romance of Science

The third and final part of the book – creativity – contains a collection of works showing how different areas of knowledge can be synthesized to bring about unexpected results. Jill Scott's opening work introduces us to non-traditional experimentation methods and exchanges. The remaining selected works conclude the book illustrating different views on cityscapes, spatial and architectural analyses, building typologies, digital reality, environmental impact, processes and prototyping.

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RECOMPOSING CREATIVITY

Some build art experiments in order to understand life, some design them for audiences to experience while others invent more creative approaches to apply the results. But what happens to the experiments, when lateral and critical thinkers join into the project? It is the uncertain porous and process oriented borders of tacit and lateral knowledge, where trans-disciplinary teamwork resides: a place where building in order to understand in the scientific context is often compared to personal visions in the arts or architecture. Here I explore how some artists and scientists are already sharing their "hands on" lab experiences with the goal to search for fruitful exchanges. They are willing to take risks for the outcomes to be "turbulent" or inappropriate for peer-to-peer contexts. By looking at some practical building of experiments I will explore how the exchange of disciplinary processes might provide new inter-spatial potentials in the future, especially if these teams want to work together on solutions for our fragile environment.

RECOMPOSING CREATIVITY

In 1967, Edward de Bono, a Maltese physician and neuropsychologist, coined the term "lateral thinking" to define the solving of problems through an indirect and creative approach, "using reasoning that is not immediately obvious and involves ideas that may not be obtainable by using only traditional step-by-step logic" (de Bono 1976) [1]. This is a trajectory that may require researchers to let go a little of the outcomes, let them fail or be useless or offer the public various layers of meaning for interpretation. More recently, Michael Polanyi claimed that this lateral method is part of our "tacit knowledge". He believed that creative acts (especially acts of discovery) are charged with strong personal feelings and commitments resulting in visions or ideas that explore the tangible and the experiment as an intervention for interaction (Polanyi 2000) [2]. In our related arts and science facilitations cultural anchorage and social negotiation is mostly perpetrated by "hands on" experimentation and here the accumulation of "tacit knowledge" seems to be part of the porous border between objective and subjective methods (Scott 2010) [3].
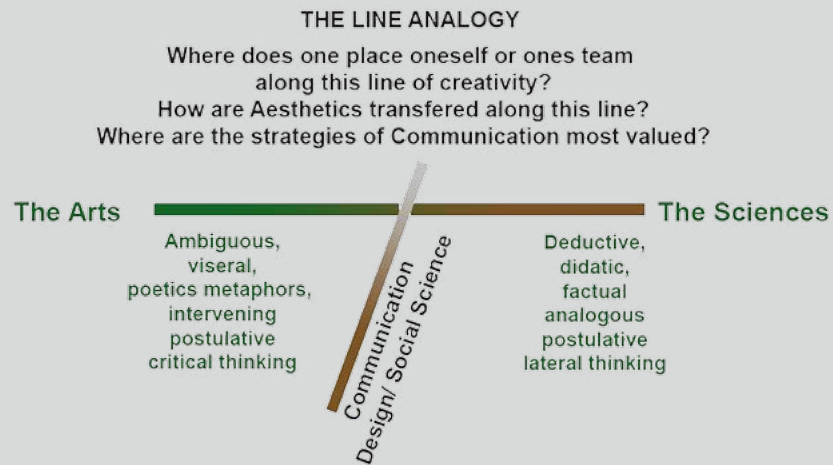
In experiment building, the main divisive problems between the arts and the sciences are based on epistemology and ontology. While scientific experiment building requires a hypothesis, motivation, an access to a body of systematic knowledge, an ability to correctly formulate research problems and to define a comprehensive problem space or search space, in the fields of art design and architecture, creative experiment building is linked to the processes of bringing something physical and entirely new into being. Methods like assembly, reduction or play often require a combination of physical and tacit skills. However, today, both these disciplines bring our awareness to what was previously hidden and point to new ways of thinking. In any lab, weather it be in design, art or science, deductive or inductive thinking is applied and therefore often starts with the same basic research question: "What would happen if?" Therefore, most researchers share self-directed, self-disciplined, self-monitored and self-corrective ways of thinking. By comparison, lateral thinking is a critical method of consciously making associations from unrelated fields, based on the idea that the brain is a self-organizing system. The lateral thinker not only questions common wisdom, but he or she observes the behaviour of others and their processes and networks in other disciplines than their own to search for shifts in perspective. In agreement, I claim, that creativity in experiment building is encouraged by the opportunity to think laterally and critically in a different way with others rather than only stay with your own learnt experiences and perspectives! I think that new ways of thinking can be lateral and critical as well as deductive and inductive. Perhaps, answers to this question may be explored by comparing traditional art and architecture motivations as well as science and science communication motivations with today's motivations.

Comparing Motivations

In the last century, different disciplines have followed quite traditional motivations and line analogies were developed:

Fig. 1. The old linear analogy with the arts on one side and the sciences on the other.

Source: Scott 2015.

THE LINE ANALOGY

Where does one place oneself or ones team
along this line of creativity?
How are Aesthetics transfered along this line?
Where are the strategies of Communication most valued?

The Arts — The Sciences

Ambiguous,
viseral,
poetics metaphors,
intervening
postulative
critical thinking

Communication
Design/ Social Science

Deductive,
didatic,
factual
analogous
postulative
lateral thinking

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Designers, communicators and architects were focused on the discussion, show casing and development of projects that have implications for society. They asked: how can great ideas reach and help everybody? The relationship between context and creativity was prioritized and re-enforced by the Bauhaus model[1]. Alternatively, the fine artist model was to offer him or herself for a subjective experience, with the aim to produce food for thought in a spatial environment and illicit tacit or filter implicit information as a pure inspiration stream. They were interested to explore the subjective process of how ideas develop as a research agenda and find that one image or idea that could stimulate more ambiguous conversations with an audience. The communicators or educators were interested to find a unique form that could discuss relationships between scientific fact and society and to interpret and translate knowledge to the general public as well as to generate interest in the art of learning. Then there were the scientists, who of course, valued the hypothetical understanding of how life forms work and needed to generate explicit knowledge about their results. Their aims were to solve problems that can create more questions in the future! I claim that although these are all still noble motivations, they constitute old linear analogies of difference and duality that are no longer applicable for the complex problems we now face in society.

This complexity needs cross-disciplinary teams with the skills to measure problems and to design an experiments that can deduce precise data and generate facts, and to be able to manufacture these experiments so that others can use them to recheck data and improve on the experiment. However, if we take Bono's potentials of lateral thinking, notes from others, comments and unrelated ideas are also inspirational for new approaches to the creation of discourses about complex problems. Perhaps one of the best examples of scientists who have used lateral thinking is the evolutionary theorist Charles Darwin. His notebooks are full of comments from other disciplines and seemingly unrelated ideas [5]. What inspires researchers like these is sheer curiosity and observation without any defined out comes in the mind. It is no surprise that like the scientists, the artist or architect is intrigued by the solid raw materials, pertinent debates and scientific tools that are found in the science lab itself.

Lateral and critical thinking in modern examples

Even in my own case, I have found the "hands on" natural science labs of neurobiology as a place to explore. This entails not only shadowing their basic scientific experiments about perception - a subject that is close to the arts in many respects. In audiology labs I also offered myself as a one of their subjects and added art to their existing communication experiments with the public. For AURALROOTS, an interactive tactile sculpture about the cultural relations of sound pitch and the behaviour of the Stereocilia (small hair cells in the inner ear), I extracted a cochlea in a guinea pig, learnt how to use electrophysiology and underwent all the hearing tests myself. The result was an interactive tactile sculpture about the cultural relations of sound pitch and the behaviour of the Stereocilia.

Although this work succeeds in transferring anatomical information to the public, the addition of cultural information may have been difficult for some people to digest. My scientific inspiration mostly came from the systematic and creative methods to measure human directional acuity, but I added a metaphor about the generational contract between aboriginal people. Through the method of oral roots, tacit knowledge that is handed down from generation to generation via storytelling [6]. I continue to build experiments that try to combine cultural messages with neuroscience and environmental science, as for me this investigation in interactive know-how transfer and learning challenges the edges of didactic and visceral experience.

1 - The Bauhaus Model was to reimagine the material world and to reflect the unity of all the arts through contextual workshops. Compare: [4].

In architecture similar experimental investigations explore the future of smart architecture. Is survival architecture smart architecture? While in architecture today the focus is about reducing the environmental impact of our human activity such a trajectory requires learning from other disciplines about material science including interaction with minimal amount of materials, energy and long term planning. For example, at MIT lab in Boston designers like Neri Oxmen invent their own scientific techniques that support structural loads with the same object's external skin [7]. Her experiment building requires the imbedding of materials with new software that is bio-inspired. These "art builders" aim to collaborate with scientists to lower the environmental load and at the same time enhance usability. Their creative goal is to make more than just a reduction of energy consumption. Instead they tend to take a lateral approach and build experiments with local climate in mind, consider the embodiment of the user or the voice of the local wind (ventilation) or the quality of the communities' water (moisture). This trajectory includes a focus on lighter materials and movement with the least effort. This can even take into consideration our current migration crisis to create nomadic and emergency design. American architect Denise Brown cites *the Shack Chic* Townships of South Africa as relevant lateral and visceral structures for her disciplinary colleagues to explore (picture in [8], Denise Brown 2010). These communities build their own architecture that can be adapted to various environments and nomadic life styles. This is design for an everyday context! When architects couple up with these community groups and bring in material and environmental scientists to share grand objectives, could they steer humanity towards new ways of thinking about nature and survival?

Over the last 20 years, we can see that this was a challenging question - one that tended to ignore a deep analysis of the failures of experiment building - and mostly value its successes. More comprehensive analysis has come from involving local communities right from the beginning of project or by designing open ended platforms for them to build upon. For example, although the recent "democratization" of technology with "open source" computer software seems to be a risky business that might or might not lead to deeper interaction with community groups it can be used to give them a "voice". One success can be found in the radical approaches that were led by the Exploratorium in San Francisco, where computer interaction with "impaired users" can be seen as a promotional form of learning[2]. As has been proven, some of

these science exhibits are much more successful than others, a factor that would never have been discovered without the inclusion of the failures in the study. While creative art and science workshops for science education might fill the gaps of these so called failures, the successful ones are combinations of pedagogic, inductive information with tacit and tangible interaction by the viewers. Creative experiment building will always generate knowledge even if the aim is only to provide others with the opportunity to share some food for thought.

In a related trajectory of experiment building it is interesting to note that community workshops themselves have not only become a way to democratize technology and recycle and re-adapt old technologies for other users becoming platforms for the exchange of local information. For example, Mexican programmer and poet, Eugenio Tiselli, writes open source software for farmers to be creative, swap information about climate change and interact with other communities. One of his experiments has lasted for six years and it is a collaboration with agro-ecologies from the Institute of Integrated Biology at the ETH Zürich, the Swiss Federal University[3]. However, when he tried to apply the same platform to Mexican farmers in Oxaca it failed miserably. Both scenarios were compared and evaluated in his own PhD Thesis at the Z-Node Zürich Program [12].

3 - The actual web site by the farming communities can be found at [10]. And some of the research analysis can be found about small scale and agricultural technologies – [11] Accessed 2016

Conclusion

"Building art is a synthesis of life in materialized form. We should try to bring in under the same hat, not a splintered way of thinking, but all in harmony together" (Alvar Aalto) [13].

In these team work examples, I have tried to show that there are benefits of experiment building in collaboration with researchers from neuroscience and environmental science. I chose these two sciences in particular because the interface potentials are clear. The borders of exploration with researchers from neuroscience and art are often based on the fact that perception lies at the heart of both disciplines. Both parties are interested to explore perceptual accuracy and ambiguity. The scientists want to encourage viewers to understand the complexity of perception and the artists are fascinated with the fact that our body often shapes the way we think. In the area of environmental science and the arts, a parallel and renewed interest in the redesigning of nature has led to bio-mimicry and a shared interest in material science. The potentials of recycling materials for experiment building are also shared. Although these environmental scientists are interested in human biology, there is often not much collaboration between these disciplines. This is a surprising fact because it is hard to discount the social, cultural and historical factors that will almost always affect the processes of obtaining knowledge. Tacit knowledge is almost always "situated" and therefore "embodied". This fact challenges us to communicate in new ways that traverse the spatial realm of peer to peer justification. In both, the tangible and non-tangible art, communication and science fields, we need more interspatial zones of creativity that travers these disciplines and facilitate change. But who is willing to be the black or orange dots in the middle of these interspatial zones?

Thus we have seen an enormous change in the roles of researchers and educators in the arts and the sciences, who feel responsible to help raise awareness about environmental issues or create access for communities to fab labs or form hacker groups that teach others how to build their own experiments in the hope to shift our ways of thinking and adapting[4]. It seems that in relation to environmental stewardship art can become a much more "useful," "appropriate" and "effective" activity, rather than be simply a contribution to any particular aesthetic or conceptual style or form. As French philosopher, Bruno Latour suggests, to address a complex problem like climate change, we may need to focus on teaching people "how to think" rather that "what to think" (Latour 2012) [15].

4 - See [14] for the following toolboxes of working methods, for artists, educators and communities.

Fig. 3. The interspatial zone of the creative commons featuring trans-disciplinary facilitation.

Source: Scott 2015.
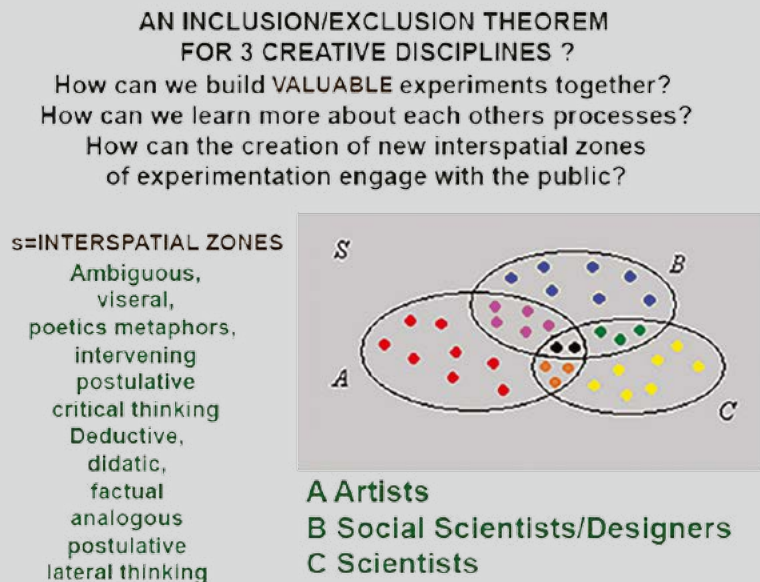
In this article I have focused on a combination of tacit knowledge and lateral thinking to bolster the hybrid creative attributes of experiment building. These approaches can not only encompass the material and the immaterial, but attempt to build up our interdependent relationship to the natural world which is also full of failures and successes. It seems that tacit and lateral experiences have more potential to be immersive, generate different layers of meaning and they may even result in unique outcomes. I also claim that these are new methods of communication that can humanize science by relating to today's social and ethical issues. Furthermore, trans-disciplinary art building between social scientists, philosophers and scientists needs to be encouraged by facilitators who construct incubators, salons and workshops for citizen science activities and community groups. Such activities might constitute a more harmonious creative commons that can sit under one hat: a hat that features the values of lateral and critical thinking as well as inductive and deductive methodologies.

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CREATIVE URBAN AREAS OR URBAN GARDENING AS A PROCESS OF CONTEMPORARY CITYSCAPE MAKING

The aim of the paper is to show changes in landscape of urban areas, and the role of urban gardening initiatives in it. At present, the role of urban greenery in the processes of social integration is more and more acknowledged as it is being used as a tool for participatory design of front yards and parks located in housing estates. However, greenery has one more task: to be used by residents in their grass-root activities aimed at creation of the place, it alters the paradigm of urban space changing it from expert to social paradigm.

INTRODUCTION

No person needs to be persuaded of the great role of urban greenery. For many years, the social role of greenery was deemed to be of the same great importance as the role of nature, however it was also perceived as stable since it had been determined by similar premises. At present, the role of urban greenery in the processes of social integration is more and more acknowledged as it is being used as a tool for participatory design of front yards and parks located in housing estates, thereby creating the identity of the place. However, greenery has one more task which seems to be the most significant though unnoticed so far. Being used by residents in their grass-root activities aimed at creation of the place, it alters the paradigm of urban space changing it from an expert-led to a social paradigm that is based on proactive bottom-up initiatives. Greenery also gives inhabitants a feeling of agency as well as allows them to realize their own impact on the space that surrounds them. A change in the urban image as a result of such initiatives is evident. However, it is hard not to notice that the social role of greenery which creates this image – an image of community gardens resembling private gardens of activities at the intersection of art and social actions – is also subject to alteration, just like any other element of urban architecture in the course of its history.

MATERIALS AND METHODS

The authors analysed different forms and locations of urban gardens in Warsaw: gardens at multifamily buildings sites: Ursynów Północny and Warsaw Housing Co-Operative in Żoliborz, community gardens in Jazdów housing area as well as garden installation in Pasaż Wiecha. The settlement in Warsaw Żoliborz, was example of modernistic social settlement, inspired by the ideas of The Athens Charter. Ursynów represented architecture of the late communist period, 70. and 80, XX c. Jazdów Settlement, localised in the centre of the city of Warsaw, close to parliament building, was green space, with over a dozen small wooden cottages, built in 1945. When municipality

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of Warsaw decided to remove them, NGO's, which represented interest of residents "took over" vacant houses, uniting grassroots cultural and educational initiatives, thus creating a unique park of participatory democracy initiatives. The installation in Pasaż Wiecha was an artistic project of temporary garden designed by Dallas Pierce Quintero office in 2010.

The basic method used was case study and its comparison. To study different cases visual ethnography and photographs have been used as a method to source information about the spatial configuration, main design idea and motivation of gardens creation of the sites. Furthermore, free participant observation and ethnographic interviews have been applied in the form of spontaneous, informal conversations. Data about the genus and species of plants grown on the plots and the spatial structure of the garden was gathered by conducting a conventional inventory. The authors have been collecting all the information during the time from 1996 until today, not only as researchers but also as active participants of some of described in presented text initiatives. Long period of research time was valuable in context of tracking the changes that have occurred in Warsaw public green spaces and its perceptions from user point of view.

ORIGINS OF THE PLANNED, SOCIAL ROLE OF URBAN GREENERY

While documenting the principles which Barbara Brukalska and her husband Stanisław followed when laying down the foundations for the first community housing estate of the Warsaw Housing Co-Operative in Żoliborz, Barbara Brukalska wrote that greenery has a profound impact on the urban life since it produces oxygen and constitutes an inseparable component of leisure areas (Brukalska, 1948). In the 1920s, Polish modernists paid great attention to the natural environment of the city and the structure of urban greenery. According to Barbara Brukalska's "Zasady społeczne projektowania osiedli mieszkaniowych" ["Social Principles in Designing Housing Estates"], greenery embraces not only housing estate parks but also public greenery. Differentiating such types of greenery, Brukalska called for continuity of the green areas used by city dwellers, from flower pots in the windows to open areas located outside the city. Nevertheless, such greenery, may be apart from the said flower pots, was planned and "arranged" in every single detail. Despite the fact that during the 1920s and 1930s no person could imagine existence of private domains in the common housing estate space, the designers of the housing estate in Żoliborz, inspired by social ideas of architecture promoted by the CIAM movement, understood the necessity to provide inhabitants with unrestrained use of their space. "We will try to convince the others that an architect should, as far as it is possible, arrange space in an approximate manner, that is by determining the lifestyle of its residents in broad terms solely at the same time not prejudging it in details" (Ibidem). But this form of freedom was conceived more as a freedom of use, not as user's design.

URBAN SPACE AS A GARDEN

A well designed courtyard space of the residential areas encourages a sense of community. This was proved by spontaneous structuring of the space into spatial domains whose indispensability for the purposes of creating a safe and favourable residential area was realised as early as in the 1960s. Oscar Newman [1966] claimed that consecutive order of the private (apartment), semi-private (front garden), semi-public (yard, housing estate greenery) and public domains determined public control thus ensuring safety of the space. This viewpoint was shared by Jan Gehl [2009] who spoke of the so called "soft borders" and small gardens located in front of the entrances to terraced houses which by turning residential roads into a bustling community space animated social relations. Owing to the existence of green spaces, the collectivity changed into a society, and the society turned into a community.

According to Jankowski [1888], the purpose of urban greenery is to provide poor urban residents with an access to the beauty of the nature and this purpose is to be served by parks and green areas. A memory of an urban landscape is a memory of a rural landscape. The greenery representing the interwar period includes the English Woodlands from the "Wild Garden" by William Robinson [Robinson, 1994] as well as the Alpine meadows from romantic poems. The Sady Żoliborskie (Żoliborz Orchards) by Halina Skibniewska, a housing estate built in 60-70' of XX c., constitute a direct adaptation of the image of a peaceful landscape with gardens and romantic orchards where children played. This is a frequently cited example of space that gives a false impression of the optimal human environment, that is an own garden, and constitutes the proof of urban planner's game with space that pretends to be rural landscape as well as with the inhabitant of this space who plays the role of its host.

HOUSING ESTATE INSTEAD OF THE GARDEN?

Warsaw Housing Co-Operative in Żoliborz as it was already mentioned above, was a project of Barbara Brukalska and Stanisław Brukalski in 1921-1955 inspired and based on CIAMs movement and their approach to green space of the housing estate. It was based on the assumption of the freedom of its users, allowed its inhabitants to build a structure of greenery that was extremely similar to the optimal one, which is a characteristic feature of gardens in detached houses. Small gardens which resembled front gardens were located under the windows of the housing estate residents and around the entrances to buildings. It was mainly a flower bed with decorative shrubs and perennials located between paths and buildings walls, rest of the area was covered by lawns (Gawryszewska 2013).

Northern Ursynów is a universally valued example of social architecture as well as the next attempt at creating an illusion of an apartment located in a house with a garden. This housing estate, designed by Marek Budzyński and his team, was carried out in the years 1978-1993. One of the primary assumptions underlying spatial arrangement of the estate was the idea of linear concentration in which green areas, namely housing estate parks and gardens, should be created in front of apartment windows, behind residential buildings and opposite to the entrances to staircases. The designers provided some space for private gardens of the dwellers, who this time played at the cost of the urban planners. The gardens were built on both sides of the buildings. The gardens located opposite entrances were of front garden nature (with low fences and predominance of perennial and seasonal plants [Gawryszewska 2013]) whereas the gardens situated on the other side, far from the pedestrian routes or entrances to staircases, were of leisure nature and their structure was deprived of the characteristic features of the front garden, namely the colour and openness to passers-by.

THE NEW GENERATION OF ACTORS, METAMORPHOSIS OF THE GADEN IDEA?

The generation of grandchildren of the first residents of multifamily housing areas as Żoliborz and Ursynów, who were brought up in the place where personalised gardens were built on the canvas of anonymous greenery, kept in their memory the image of a comfortable dwelling space in the community of neighbours where the garden constituted its inseparable component. As a result of it and inspiration of modern eco architecture movements nowadays, we can observe new generation of 'gardeners' and their gardens, which are currently being created on the courtyards of tenement houses and guerrilla gardening projects aimed at enlivenment of dysfunctional public areas are now being carried out. With reference to the concept of everyday urbanism that was proposed by American urban planners, such gardens constitute places that create a resilient and dynamic urban landscape which is subject to changes resulting from its inhabitation [Chase, Crawford, Kaliski 2008]. In line with the concept of everyday urbanism, the contemporary urban communities

are starting to battle with the anonymousness and lack of identity of public areas by creating flowerbeds with structure based on the image of the front garden, thus proving that the garden decides on the specific identity of the place with which the inhabitants may identify and where neighbour's ties may be built. Both of the aforementioned movements, that is community and guerrilla gardening, together with the front garden concept are inscribed into the mainstream of social architecture equally with Howard's garden city concept and similar theories [McKay, 2011]. This seems to be important in these times of rapid flow of trends leading to non-places creation (Augé, 2010).

A similar role of urban space design is played by multiple artistic activities based on the image of the garden. Steve Wheen builds small gardens in the most hostile urban spaces where greenery cannot be observed, e.g. in cracked surfaces. His gardens are an exact replica of miniature flowerbeds that can be found in home gardens [Wheen, 2012]. In 2010, on the pavement of the Pasaż Wiecha, the architects from Dallas Pierce Quintero created a garden using jute sacks in which there were herbs that are usually grown in home gardens. The inhabitants of Warsaw had an opportunity to "adopt" a sack with an herb, take care of it through the entire period of the project and then take it home. However, the adopted herbs were dying since their adoptive parents, though extremely enthusiastic in the beginning, did not find time to come and water their plants.

JAZDÓW – AN IMAGE OF THE URBAN GARDEN AS A SYMBOL OF FREEDOM

The final example is the Warsaw housing estate of Finnish houses in Jazdów. This area located in the city centre still remains a park-like place with its loose housing development of small Finnish houses that were constructed in 1945 for the employees of the Warsaw Reconstruction Office and their families. In the recent years the municipal government decided to dispose of the remainders of the substandard housing development and use the economic potential of the area in a totally different way. However, this decision met with great opposition on the part of the inhabitants and non-governmental institutions grouping community activists who cared about the unique character of this place and collective memory of dwellers as a base of local identity. The associations and foundations representing residents' interests "took over" the unoccupied vacant space. (Wilczyńska, 2015). The old home gardens were replaced by new community gardens based on the image of the home garden. There are now the same plants and vegetables growing there as those associated with the garden. The image of the garden has become a manifesto of the freedom of urban space management.

CASE STUDY: COMPARISON AND CONCLUSIONS

The image and role of the garden has changed almost completely. The starting point for reflection about urban gardening should be the traditional, rural 'grandmother' type of garden which is existing in our memory as a model form of inhabited spaces. Presumably the first plants in home gardens were cooking and medicinal herbs, brought from natural landscape. There was a strong relation between gardener and garden. Plants, especially edible plants were basis of peoples' lives, without them they wouldn't have anything to eat, so they were doing everything to care about their garden in a right way. It was a form of mutual exchange of goods between nature and man. Usually, garden space was divided into two compositionally different parts - the front decorative and representative part and the main garden with places for recreation and for growing edible plants. Traditionally in home garden ornamental plants were localised in front before entrance the house and utilitarian edible – behind the building (Gawryszewska 2013).

After analysing case studies of Ursynów Północny and Warsaw Housing Co-Operative in Żoliborz, it can be said that garden plots at multifamily buildings clearly differ from urban greenery, repeating

Fig. 1. Garden in the
settlement of Jazdów in
the centre of Warsaw
Source: Anna Wilczyńska
2015

layout of composition and list of plants characteristic for home garden. In both examples, there can be seen more ornamental than edible plants, especially in front gardens under the window at block of flats in Żoliborz and Ursynów. They have representative, ornamental character. Edible plants appear on the backside of building, if they exists. Housing estate gardens, especially the front garden, are the effect and the symbol of freedom of the management of the inhabited urban space, but the relation between gardener and garden isn't as strong as in traditional model. Garden is more a sign of inhabitation than basis for life.

Gardens full of traditional, edible plants became popular among city residents and NGOs, but people try to remember them grown in contemporary gardens only as ornamental. A new generation of gardeners is brought up in a democratic reality, and for them garden associates with grandmas' garden, friendly space of childhood. The essence of the garden reminds them not only the image of a rural garden, but of togetherness as well. The image of informal space, associated with the safety of living is image of edible plants garden, as have been shown in shared gardens near the NGO's Jazdów houses, built as a manifesto of opposition against the monopolization and building up the space of the city. Thus garden secured not only food, but primarily image of garden environment, as a substitute of living in the "generous" landscape. So, the relation in this context still exists but a garden is more a monument for idea of new way of living. As one of initiators said, there is small group of people who feels somehow responsible for it, but mostly people come, stay few weeks and then, busy in the rush of their daily duties, they easily forget about garden.

The extreme example of almost completely lost of relation between human and garden is temporary garden or art installation in Pasaż Wiecha. Here the garden has lost its function of the base for life and symbol of inhabiting in landscape, thus becoming a simple decoration that improves the image of the city and brings back for a while the childhood memory of space.
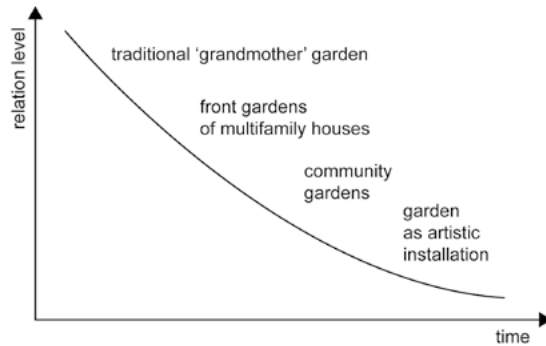
"UNPRODUCTIVE CREATION"

Chantal Mouffe created an idea of the new "vernacular forms of democracy" aimed at change the traditional contemporary forms (Miessen, 2013). The phytosanitary and decorative functions of the green urban interiors were dominated and substituted by the function of greenery, and rather the function of the garden, as means of vernacular democracy. As a result of this specific evolution, there is now a garden detached from the function and even from its structure; a garden that represents only an image, an "unproductive creation". However, this cannot be mistaken for the productive, from the market point of view, creation of the creative class (Krajewski, 2013; Florida 2002). Why there is no need for greenery but there is a need for a gardens? Since the garden guarantees freedom of creation and independence from architecture and urbanism, the unproductive freedom of space management even if this is only an illusory game. The city is better tolerated if it contains an illusion of the garden.

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SHOWCASING THE USE OF AVAILABLE OPEN DATA RESOURCES FOR URBAN DENSITY ANALYSIS

As urban consumption increases, the forms of production and reutilization of urban land are in constant analysis. There are many approaches to urban planning and design, which put density in the middle of the debate. The increasing availability of open spatial data creates an opportunity for analysis methods aided by GIS that can serve to relate urban form with its performance. Open Spatial Data has been supplemented with top-down and bottom-up initiatives, which can provide an ideal check of updated and accurate data. This paper presents a method that combines open SVG data with the Polish government's WMS data to produce density related analysis.

THEORETICAL BACKGROUND

The concept of density is still used in urban design and planning. Raymond Unwin, at the beginning of the 20th century proposed a concentration of 30 houses per hectare, Jane Jacobs [1] in the sixties suggested a minimum of 250 dwellings per hectare. Currently, hyper and high densities have become a trend in the discussion of the compact city, the new urbanism movement, transit-oriented development and urban sustainable growth. Density usually refers to a population size or number of units or, generally, entities per given area – people, inhabitants, built area, or number of dwellings per area. A density measurement doesn't imply a qualitative judgment - it is neutral. Seemingly simple and commonplace, it is far from being devoid of complexity.

Density is broadly used across science, not only in urban planning. Despite, or perhaps due to, its broad use there is no consensus concerning densities' definitions and it can vary considerably depending on the country and discipline. Due to the lack of standard, sometimes a comparison between areas becomes very difficult, according to Alexander [2]. The conversion of density measurements can only be made with some assumptions, sometimes statistical, such as dwelling size and occupancy rate, and other methodological ones, such as the area's plot or building measurement. Commonly, the definition of the boundary area is, according to Berghauser Pont and Haupt [4], one of the most problematic and important for density outcomes. Units of measure and the definition of net and gross area can also vary widely. Often, people reduce density to a measure of building typology, which can be a constituent determinant to density but is not the sole component of density. For example, it is not certain that high-rise buildings will necessarily

have a higher density than other dwellings – such high rises can have large units and therefore have a density comparable to a single-family detached-housing neighborhood. Without appropriate attention to differences in units of measure and density specifically, it is easy to make errors in the application of density as a concept.

Density, as a concept, has historically suffered criticism, partially due to the over usage of robust modernist planning methods. Some critics have argued that density does not have a direct correlation with quality of space or building typology, as stated by Alexander [2]. At some point it seemed that density had become purely descriptive, normative and programmatic, unrelated to physical properties. Population and dwelling density, along with its unfolding measurements, is still used in urban planning and design.

More recently, density is a trendy discussion topic related to environmental awareness and scarcity of current resources – on which urban land plays an important role. A growing number of advocates of urban concentration or even containment state that generally the current density of urban land is too low, there is a large amount of vacant land in the cities and that land non-urban peripheral land needs to be left undisturbed [7]. Urban containment may be applicable to some cities that are dealing with a decreased population number or are too disperse to make public transportation feasible, but it is probably not applicable to other cities that have substantial population growth and depend heavily on public transportation, for example.

Multiple case studies and comparative indexes can be found [7] [8] [9]. The known case of Medellin's successful restructuring while containing 700 dwellings per hectare managing to reduce carbon emissions and ameliorate its inhabitant's life quality is one of the case studies that catch the eye in the UN Habitat's selection [8]. However, studies relating the nominative density and the spatial properties of an urban area as in Berghauser Pont and Haupt are needed and more are required to fully understand the influence of density on the built environment. Whatever the situation might be, an adequate assessment of the empirical, realistic evidence, supported by facts and numbers, not based on ideological positions, is needed to support decision makers and government bodies.

DENSITY MEASUREMENTS

This section will address different measurements of density used in the application of the methodology used to compile data from sample areas in Warsaw for density and further urban form analysis. As described, density is widely used and has different applications. When dealing with urban density it is important to realize that it can be perceived differently per individual or as a technical index – in other words, perceived density and physical density. While these two concepts may be related, only the physical density measurements will be considered for now.

Various measurements of physical density have been used to describe space. There are many conventional methods used and only some will be used in the application and further study concerning the urban form. These calculations are briefly defined as follows.

Land Use Intensity is a purely physical measurement and is closely connected to physical density. Since mid-century this has become a standard in the European urban practice. It is one of the main indexes that supports density and can is also found in literature as the American FAR (Floor to Area Ratio) and the European FSI (the Floor Space Index). The relation of the built area (Gross Floor Area – GFA) to the plot area defines the Land Use Intensity (Equation 1). GFA is understood as the total amount of built area in a plot area and is usually calculated by the land use intensity multiplied by the plot area, as can be seen by Equation 1. Taking into account all land use, however, it is not enough to alone correlate Land Use Intensity directly to the density or to a certain urban form.

(1) $$FAR_x = \frac{GFA_x}{A_x}$$

There are other measures that can be used in tandem with Land Use Intensity to describe an urban form. Coverage is one such ratio that helps relate density to the urban form. Coverage (Equation 2) is the relation between the occupied (built) land and the non-occupied (non-built) land taking into account only the surface of the plot and the footprint of the building. This ratio has been used to guarantee good hygienic conditions of a plot (i.e. insolation, ventilation) and more recently has an added ecological goal of permitting natural rainwater drainage into permeable area.

(2) $$C_x = \frac{B_x}{A_x}$$

Yet another measure that can be used is spaciousness, the relation of the open space to the total floor area (its GFA), as seen in Equation 3. Spaciousness is meant to measure the quality of the urban settlement in relation to crowding. It is tempting to relate it to perceived density, but this paper focuses solely on physically measured densities. However, it will be an important index in future studies to infer the relation with the urban form. Crowding along with perceived density is too important to be added only as a detail; therefore it will not be addressed.

(3) $$S_x = \frac{(C_x - 1)}{FAR_x}$$

Land Use Intensity, coverage, and spaciousness are all measurements that add to the analysis of the built environment that are subject of this study. Alternatively, GFA can be calculated using the building footprint and its number of floors. For a theoretical assumption, where the precise GFA is not available, it can be assumed that each floor is whole and the building does not have any mezzanines or double height floors so that the GFA can be assumed by the following equation:

(4) $$GFA_y = B_y \times Fl_y$$

Collectively, there are a handful of indexes that are necessary to start analyzing density indexes: area of plot/parcel/district, building footprint and number of floors. These are the very basic indicators needed for an initial exploration on the subject. Many other measurements and indexes can also support an urban density calculation in combined for a correlation with urban form. However basic, these are the data that this paper will aim in acquiring to input in the analysis.

OPEN SPATIAL DATA

Another development occurring with urban studies that rely on concrete, measurable data is the increasing availability of open and free spatial data. Spatial data is often used interchangeably with geographic data and geospatial data. In this paper, spatial data will be considered in its scope related to geography and includes information about space – i.e. satellite imagery, scanned plans or CAD (computer aided design) based drawings of building footprints. The spatial data I focus on have real-world coordinates, in other words, a geographical reference, and I am especially interested in those that can be collected, manipulated and be used to produce information associated to a location.

The prominent growth of open data has been due to two main reasons: first, the restrictions of usage and availability of spatial information aligned with inexpensive technology (i.e. GPS receivers, among others); and second, an international growing trend of governments adopting open data policies and programs[1]. It is important to note that the allowance of spatial data usage – whenever documented or available – has become less restrictive for common civil along with the development of new spatial technologies.

Lia M. D. Bezerra_Showcasing the Use of Available Open Data Resources for Urban Density Analysis

Fundamentally, open spatial data has been accessible in two different, complementary ways: through crowdsourcing and government releases. Crowdsourcing is bottom-up and provides an updated map built through local knowledge. It is mainly based on voluntary work and, due to its simplicity, usually contains updated or almost real time spatial data. Government spatial data services are top-down resources. In order to provide the service, it organizes and gathers information once scattered around multiple agencies and departments. An example of these services would be the European Union's INSPIRE program.

The crowdsourcing program used to obtain the Scalable Vector Graphics – SVG - orginated from Open Street Maps – OSM. OSM is a collaborative project that creates and offers free editable spatial information. This open spatial data is created by volunteers who collect data manually, through GPS receivers, aerial photography and other inexpensive sources. Although the data can been considered a primary source of information, the data quality varies by location because it is so heavily user dependent.

The mentioned government service can be available in multiple formats. On of the possibilities is the a WMS – Web Mapping Service, which is defined and standardized by the Open Geospaitial Consortium – OGC [14]. WMS allows tranfers of geospatial data from servers to clients through raster images (jpg, png and others) that can be displayed in browsers or provided through a service inside a geospatial processing program. The data is not stored locally and does not support traditional GIS processing methods. Despite WMS's availability, it is relatively new and the number of service providers are growing. Due to the facility to access and visualize the information, WMS is a practial and accurate form of checking user generated data against official information.

One can say that urban scale analysis no longer depends solely on availability, individual authorization to use governmental information or large investments to obtain proper documentation and sufficient accuracy. Spatial data can be produced in a variety of ways, can be obtained for free and can be checked by official information from inside the laboratory.

METHODOLOGY AND CASE STUDY DESCRIPTION

The compilation of data is an explorative research project in itself. The acquired spatial data of the built environment is input into a databank and is analyzed through formulas and variables. In this sense, the methodology can be described as research by design as in de Jong and van der Voordt [15]. There are many variables included in this research project, but it is possible to include more. The subject of study is a description and analysis of the built environment in its context.

The methodology applied for data compilation for the density measurements combines the uses of both bottom-up graphic data from local volunteers and top-down governmental data. First, Open Street Maps provide data containing building footprints that is converted to Scalable Vector Graphic and then manipulated in Geographic Information System - GIS - software. Later, governmental spatial data is provided through Web Mapping Services - WMS, as sets of raster layers containing information such as cadaster data and plot boundaries (among other themes). WMS provided by the Polish national authorities are loaded directly into the GIS software which makes it possible to compile data into a shapefile and start the measuring processes that will compile the three basic elements of data needed for the processing of density measurements: plot area, building footprint and number of floors. There is a need to describe these spatial properties accurately.

The use of spatial data to provide information, solve problems and base analysis is not new. Maps aiding in decisions date back thousands of years ago, as is the case of the Egyptian Turin Papyrus Map of 1160 BC. The novelty in this study is that it is designed to solely use freely available open

source data and GIS software [16]. Therefore, no additional contact was made with any government agency to receive official or extra data.

In order to illustrate the accuracy of the available data for Warsaw, Figure 1 shows the layering of the shapefile originated from OSM layered onto the WMS basemap from the Polish government.

FUTURE STUDIES AND USES

Density is a powerful tool capable of grasping the micro-scale of urban design and macro-scale of urban planning. Density, when appropriately defined and correlated, is capable of relating to the quality of the built environment. In applying the density measurements, several sample areas of Warsaw had their data collected for comparison and evaluation. The districts are settlements of different occupation periods, but the main prerequisite is to have both single family and multi-family buildings of similar scale. This allows the comparison of two building typologies areas, or two urban forms. I use the multivariable definition of density found in Berghauser Pont and Haupt's Space Matrix in combination with my own calculation method using open data and GIS. The results are now being complied and the results will be the subject of a future publication.

The applications of open spatial data as in my study has a wide application on teaching and understanding the many underlying themes of space and place. GIS tools and software allows for new technologies and real-time information to enter classrooms in a very simple yet visually attractive way. It also allows for the introduction of research methodology from the data acquisition to modeling and simulation of the real built environment passing through analyzing and effective representation. Open spatial data adds value to the lessons through innovative methods of research, stimulates students, integrates and facilitates the already ubiquitous spatial information.

Fig. 1. Over layering of OSM and WMS spatial data for a sample area in Warsaw

Source: Author's own work.

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ARCHITECTURAL FEATURES OF A BUILDING ENVELOPE. WORLD EXPOSITIONS EXAMPLE

Shaping the exterior image of the building is one of the most important problems of contemporary architecture. It is characterized by numerous aesthetic, technical and technological directions. The article outlines primary trends in the development of building envelopes, understood as a building's skin or an enclosure. The problem is presented on world exposition pavilions between 1850 - 2012, that introduced numerous innovative solutions in architecture. The formal, material and functional experiments of temporary exposition objects result from aesthetic motivations and the practical needs of modern construction industry. The primary building envelope objective concerns aesthetic unconventionality in geometry, structure or material. Besides the visual attitude, the building envelope also takes responsibility for supplementary solutions: resource-efficiency, energy-efficiency and user-related comfort.

INTRODUCTION

Since the Industrial Revolution architecture has been dependent on novel building techniques and technological inventions. Pioneering solutions require experimentations. World expositions, nominally used for self-presentation of national achievements, have become a laboratory for architectural innovations. Since The Crystal Palace exposition objects have focused on novel forms, structures and materials. At present, pavilions promote the implementation of sustainable materials, energy efficiency and user-related comfort [1]. This article aims to present positive architectural achievements of world expositions, each justified by appropriate pavilion.

The undertaken problem concerns mainly an envelope or an external *building skin,* understood as the "packaging" of the interior usable space [2]. The concept of an envelope is synonymous with the terminology: *elevation, external wall, outer shell, façade, curtain wall, building skin, enclosure or cover.* An envelope applies to both vertical (façade) and horizontal partitions (roof/covering) as well as a three-dimensional form that can surround the entire building. The metaphor of the building skin in the architectural context is recalled by Wigginton and Harris as applies to a skin's complex functions related to bodily protection, temperature and humidity control as well as response to external stimuli [3].

This article relates to the PhD thesis entitled "Architectural Features of the Building Envelope. World Exposition Pavilions", under preparation in the Department of Civil Engineering, Architecture and Environmental Engineering, Technical University of Lodz, guided by Prof. Eng. Arch. Nina Juzwa. The object of the research concerns evolution of a large scale building's envelope. The investigation was separated into two parts. The first part describes the problem in terms of historical and contemporary solutions. It presents an envelope's attributes - form, structure and materials. The topic is fulfilled with ecological and functional solutions. The second part of the research analyzes world exposition pavilions. The research collects all important pavilions, highlights significant historical developments (1850-1980) and examines 120 envelopes (1980-2012) with reference to their geometry, materials, structure and incorporated technologies that have a positive impact on the environment.

ARCHITECTURE OF WORLD EXPOSITION PAVILIONS 1850 - 1980

In the long history of world expositions pavilions have introduced a number of innovations related to an envelope's form, structure and materials. The golden period of historical fairs was the second half of the nineteenth century. Expositions presented large exhibition halls with structures that eliminated internal columns. The first official Expo object - The Crystal Palace (Paxton, 1851), completely changed the approach to the building design, due to its non-structural and prefabricated outer wall built up with glass and iron. The Galerie des Machines (Dutert, Contamin, 1889) opened a new era for large-scale objects, by introducing the engineering construction system into architecture.

The second important period started in 1920's and concentrated on the concrete skeleton structure and external attractiveness based on the glass façade . The world expositions contributed the well-known L'Esprit Nouveau Pavilion (Le Corbusier, 1925) and The German Reich Pavilion (van der Rohe, 1929). Both used modern concrete structures filled with light and non-structural walls. In addition, the Finnish Pavilion (Aalto 1935), the Czechoslovakian Pavilion (Krejcar, Bolivka, 1935) and the Brazilian Pavilion (Nemeyer, Costa, 1939) implemented materials innovations. Out of the three, the Scandinavian building skillfully integrated traditional cover material with modernism proportions. The two others responded to the inadequate glass properties, concerned energy and comfort, by introducing thermal glass and *brise-soleil.*

The third culmination point was reached in the 1960's with innovations associated with structure, form and a new aesthetics. The Philips Pavilion (Le Corbusier, 1958) for the first time presented a unified three-dimensionally curved envelope. The Biosphere (Buckminster Fuller, 1967, fig.1) introduced a division between the occupational core of the pavilion and the independent envelope. At the same time it tried to isolate the indoor climate conditions by using steel-and-glass dome. Furthermore, the pavilion applied a novel digital optimization to the structure and innovative self-regulating sun shades. Now it is claimed to be the first responsive envelope. The experimental impact of world expositions was recognized in grid structures (Festival Plaza, 1970, Tange), tension skins (West German Pavilion, 1967, Frei) and air supported roofs (USA Pavilion 1967, Davis, Chermayeff) [4].

ARCHITECTURE OF WORLD EXPOSITION PAVILIONS 1980 - 2012

After accomplishing many of the utopian projects at Expo '70 Osaka, the world has changed drastically. The oil crisis ended an optimistic race aimed at extending the size and volume. The publication *Limits to the Growth* by the Club of Rome warned about thetoo intense use of natural resources. There was no sense of competing any longer. The construction industry began to search for energy-efficient, resource-efficient and later ecological solutions. As a consequence, modern

structures and enclosure materials were developed. New techniques and technologies allowed greater freedom of form types and a new envelope aesthetics [1].

Recently, architects have shaped the contemporary envelope searching for a compromise between aesthetics, economy and practicality. First of all, a modern envelope tends to uniqueness. Its task is to break through and distinguish among a wide variety of objects. Visual appeal results from the individual approach and unconventional attempts to surprise the viewer. To be remembered it tries to strongly affect observers emotions. Second, an important role in shaping the envelope is put into the structure. Particularly, architects tend to minimize the amount and weight of materials in forming the structure. Also modern cladding become lightweight and while the new materials provides the same properties as traditional load bearing solutions [5]. Thirdly, the concept of the envelope changed towards technology, ecology and function. The outer skin is responsible for a number of complex functions, such as savings and energy production, as well as ensuring user comfort. Results benefit the environment and determine the architecture's attractiveness [6]. Following Velikov and Thun, thanks to functional solutions, envelope does not concentrate only on aesthetics but also has a specific goal to achieve [7].

Among many design directions, envelope shaping is dependent on four significant trends: unconventionality, resource-efficiency, energy efficiency and user-related comfort.

INNOVATIVE ENVELOPE DIRECTIONS

Unconventionality

The architecture of the contemporary exhibition object is strongly motivated by visual qualities. It aims to be exclusive, unique and exceptional. The task is to identify and distinguish the object among many other interesting solutions. The attractiveness of the envelope can be achieved by a non-schematic approach to form (Japan Pavilion, 2010), material (Pavilion of Christ, 2000) or structure (Trade Fair Hall 26, 2010). Each of these solutions involves an individual solution. Implementation of an unique envelope is often an experiment, the results of which may prove to be an exceptional success or a spectacular failure. Nowadays, the most common solution in achieving a unique and expressive envelope is a three-dimensional curvature of the enclosure (Pavilion of Spain, 2010) or an experimental material (UBPA B3 Pavilion, 2010). Simple geometry of the envelope is often combined with expressive materials. Under opposite conditions, a multi curved surface is combined with uniform surface, keeping attention rather to the geometry, not to the detail. Unconventional form is created by complete building skin - multi curved envelope that eliminates the difference between the roof and the façade, like a "package" of the building (Israel Pavilion, 2010). All the unique forms and structures are appealing, especially the unobvious and 'impossible' to build ones (Kuwait, 1992). Furthermore, innovative materials are introduced (Cyclebowl, 2000). In opposition, the demand for traditional materials has risen, changing the common attitude to creative application (Spanish Pavilion, 2005), recreating vernacular direction and ornamentation (Polish Pavilion, 2010).

An example of an unconventional aesthetic approach to the envelope was presented by the UK pavilion in Shanghai in 2010 (arch. Thomas Heatherwick). The object took advantage of a simple form and eccentric materials. It used the surprise factor. In the first contact the envelope was soft and uniform. It used geometry of the rectangular prism with rounded edges and corners. The uniqueness of the pavilion was result of surprising visual lightness and vanishing of the edges. This effect was created by acrylic rods placed perpendicular to the envelope. Slender rods disappeared in sky the farther from the inner core. Moreover, their low weight made it possible to be gently vibrated by the wind blows. The outside image was created by identical rods. In contrast the interior

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was made by variable rods in length. The indoor element cut the external wall causing smooth curvature of the inner plane. The envelope appeared structureless, visually carried by numerous soft rods. Although engineers had approved such a support alone, it was strengthened with steel pipes. As noted by Heatherwick, the envelope caused surprise effect, by unique design and experimental material.

Resource-Efficiency

The lightweight and resource-efficient trend in envelope design results from the attitude to reduce the consumption of raw materials and to encourage the use of renewable, recycled and reused substances. Lightness is the result of the opportunities introduced by a skeletal structure of the external wall and its infill. Reducing the weight of the envelope is an effect of structure optimization and the use of thin cladding materials. The most popular method of this resource strategy is associated with highly efficient steel structure connected with lightweight glass façades (UK Pavilion, 1992). Further lightness is achieved through independent self supported skins - a combination of structure and envelope in one element, for example, a single-layer grid shell constructed from triangular modules (Israel Pavilion, 2010). Resource-efficiency applies tension structures combined with membrane cover. Such materials are high strength and practically weightless, for example an ETFE film (La Sed Pavilion, 2008). An equally light envelope is possible to obtained through low-tech construction techniques and the use of simple materials.

This research distinguished the Japan Pavilion at Expo 2000 Hanover (arch. Shiguru Ban, fig.4). It maximized ecological solutions and low technologies toward resource-efficiency. The three-dimensional barrel vault envelope was made exclusively from natural materials like bamboo tubes, rope, cardboard, steel fasteners, and covered by a paper membrane to provide water resistance. The experimental skin was the lightest self-supported structure, have been constructed with such a small amount of material. In addition, only recycled materials and reusable components were used. In the case of demolition all the elements could have been reused, as the intension was to produce little waste as possible.

Energy-Efficiency

The envelope is a key element in the energy-efficient building. It enables positive effects from cyclically changing climatic factors. Modern solutions operate on two backgrounds: savings and energy production. Both are mainly associated with solar radiation and modern technologies for the processing of renewable energy into usable form. Solar radiation determine the buildings geometry and transparency according to variable daylight strategies and seasonal differences. The process of savings in cold periods of the year concentrates on increasing profits from sun energy and reducing heat losses (Italy Pavilion, 2010). In summer, energy-efficiency refers to reducing excessive impact of the sun on the building's interior (United Arab Emirates Pavilion, 2010). The passive methods of solar energy are primarily concerned with glass façades. Active methods on the envelope focus on producing energy. Modern solar panels allow the incorporation of photovoltaic cells in the vertical walls to increase surface area capable of producing energy (Switzerland Pavilion, 2010). They are the first energy-efficient systems aimed to express the technology through specific aesthetics. Currently, saving and energy production systems enable full integration of solar technologies with basic construction techniques such as glass BIPV façades (Alsace Pavilion, 2010), semi translucent BIPV foils (Japan Pavilion, 2010) or opaque components, like roof tiles. In this context energy-efficient envelope has unlimited aesthetic solutions.

The most advanced energy-efficient envelope was incorporated in the UK pavilion at the Expo 1992 Seville (arch. Nicolas Grimshaw, fig.2-3). Due to the high temperature and solar isolation it was

necessary to use innovative methods that avoided overheating. The shading solutions were chosen depending on the orientation of the façade s and the degree of solar radiation. The southern façade applied stretched PVC material. The west side was indicated as a thermal buffer constructed by containers filled with sand and water, delaying the impact of sun radiation. In addition, the roof was covered with photovoltaic panels placed on special V-shaped supported components. At the same time panels enabled the electricity production, shaded the roof eliminating the possibility of overheating and ventilated warm PV cells. The electricity was used to cool the innovative east glass façade that was chilled with water circulating on its outer surface. The innovative solution allowed to limit sunlight penetration into the pavilion in the morning hours and provided a unique aesthetical effect. As a result of special solutions used to maintain the pavilion, the internal temperature was kept below 26°C (up to 40°C outside), without any additional mechanical devices.

User-Related Comfort

The comfort of users refers is one of the most important features of the architecture is necessary to ensure satisfactory conditions and protection against abnormal weather conditions. Achieving an appropriate comfort through envelope results from controlling natural lighting, emphasizing natural ventilation and providing acoustics. Adjusting comfortable lighting is achieved by appropriate types of façade blinds (Kinetic Pavilion, 2012) and semi-transparent cladding materials (Japan Pavilion, 2000). Natural ventilation is the result of double glass façades (Expo Building, 2008), buffer façades with an open-work exterior layer (Canada Pavilion, 2010), atriums (Italy Pavilion, 2010) and solar chimneys (Japan Pavilion, 2010). The sound protection follows geometry, double façades and special windows (Madrid Case Pavilion, 2010). Comfort focused solutions are often similar and even identical to energy-efficient methods. However, even the most efficient building may be impossible to operate, if it does not provide satisfactory conditions for everyday use.

A number of user-related solutions were implemented in Madrid Case Pavilion in Expo 2010 Shanghai (Alejandro Zaera-Polo, fig.5). The principle strategy concerned a buffer façade made of inner glass façade and open-work bamboo coating layer. The solution was used on the south, east and west façade. The aim of the system was to reduce excess solar radiation that reached the interior of the pavilion and to provide ventilation space in front of the glass layer. Bamboo exterior panels were individually operated, providing adequate daylight where required. The north, double glass curtain wall provided natural reflected light without the risk of excessive overheating. Between the glass layers a shaft ventilation system eliminated the heat from the interior. Warm air circulated naturally to the top and was extracted through the openings in the upper part of the façade. Additional energy benefits were generated by a vegetation roof, that limited overheating of the horizontal plane. The atrium was designed as a core of the interior discharge heated air by gravity principle as well as double glass façade. The pavilion used wind turbines and solar panels integrated with the air conditioning system. It was also ecological, by using natural and biodegradable façade materials - bamboo and highly efficient steel structure that is possible to reuse.

CONCLUSIONS

The World Exposition example was evaluated as a positive group of interest to conduct a study on the building envelope. Over the years pavilions perform as a laboratory to initiate experimental solutions. Temporary objects enable testing innovative techniques and technologies, too risky for permanent architecture. After proving positive effects solutions are adapted to everyday architecture. It was confirmed on a great number of examples [8].

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Among many different trends in shaping contemporary envelope unconventional aesthetic is not the only important direction. Besides visual attractiveness the building envelope has grown in importance in environmental solutions associated with resource-efficiency, energy-efficiency and user-related comfort. If one considers different goals, each trend is an individual approach. In most cases the solutions are comparable but sometimes can exclude each other. Selecting appropriate strategy requires establishing priorities, otherwise all the positive efforts could be worthless.

Fig.1. From top left to lower right: Biosphere 1967, British Pavilion 1992, Japan Pavilion 2000, Madrid Case Pavilion 2010.

Source: From top left to lower right: wikipedia.org, grimshaw-architects.com, expomuseum.com and author's picture.

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THE ROLE AND RESPONSIBILITY OF AN ARCHITECT IN A SMALL TOWN

During the last 100 years, changes of the architectural paradigm turned over vernacular construction process in small towns, devastating their spatial consistency and identity. In this paper, I argue that to invert those negative phenomena, a specific approach is needed in which the architect takes new role and responsibility. To take this role he will need specific soft skills apart from his professional knowledge, which will create a challenge to the process of academic formation of architects. This paper is based on case of Monte Carasso, small town in Switzerland, which is the scene of long-lasting architectural experiment led by architect Luigi Snozzi.

THEMES

The traditional building process in European small towns has been working without the presence of the professional architect. This has led those settlements to have an impressively consistent spatial character. But during last 100 years, changes of architectural paradigm (simplifying – the consequences of modern movement) have turned over this vernacular process, strongly embedding the person of architect into it. Implications of this shift proved to be devastating for the space of small towns causing the loss of their spatial consistency and identity. In this paper, I argue that to invert those negative phenomena a specific approach is needed in which the architect takes new role and responsibility, becoming not so much an individual designer as an independent expert engaged in formation of the totality of a town space. To take this role he will need specific soft skills apart from his professional knowledge, which will create a challenge toward the whole process of academic formation of architects.

This paper is based on the case of Monte Carasso, a small town in the Ticino region of Switzerland, which is the scene of long-lasting architectural and urban experiment led by architect Luigi Snozzi. This example proved that the desirable spatial transformations of a small town are possible with the engagement of an architect not only within individual designs but also in other fields such as spatial policy, urban planning and education. The subject context has been explored by the author during research held in summer 2015. This work refers also to other research led by author in European small towns, and to the research on contemporary academic learning methods.

CONTEXT - BUILDING PROCESS IN SMALL TOWN

The construction process outside big cities had been always rooted into local tradition, not being subject to any significant influence of an individual designer or the customer. The modernism movement caused an essential shift by undermining this tradition. This fact may seem a paradox because the modernism was born in cities and even though it looked to the countryside as a source of inspiration, it was focused mainly on the environment of a big city. Yet, the ideological charge that modernism liberated hit the ex-urban with great force, which resulted in a break with the local architectural traditions. The main issue was the introduction of professional architect and in empowerment of the „project" – giving it independence and necessity. Before modernism the architecture was shaped according to the rules of tradition and common sense. The final form of the building depended on functional needs and the budget of the owner, but its essential architecture (understood as typology, main relations, construction techniques and details) was independent. After the modern shift, each project gained individuality and thus it needed to be designed, or even „invented" from scratch.

The original idea behind this was to convert traditional process of just „building" into „designing" and thus to appreciate architecture. In reality, however, such assumptions, did not work. We did manage to significantly erase the traditional architectural patterns but we failed to replace them with valuable works of individual talented architects. Cases of such outstanding architecture remain the exception, while the majority of new construction is poor quality. In small towns, the emptiness left after historical patterns have been replaced by pop-culture ones.

These patterns are foreign to traditional European towns and in its typological aspect they follow the idea of detached single family house with a garage and a yard that was popularized by American mass-media. In the architectural layer, they are characterized by wide variety of forms, styles and materials, and they are being applied according to individual taste of an owner – without the regard for the local tradition. Architects are somehow compelled to support this practice. These new patterns are particularly dangerous because they undermine not only the stylistic aspects but also typological ones and consequently affect the very structure of towns. Detached, extensively distributed, buildings are changing the landscape, functions and whole ecosystems of whole territories.

In that situation, the question raises: What could the (responsible and ethical) architect do? The obvious answer today, (natural for the modernist-formed architect) is: „Try to approach each project with due care so as to ensure its highest quality, hoping that the urban regulation will solve the big problem.". However, as already mentioned, it is doubtful that this approach could be a basis for creation of a consistent urban space (to the level of consistency natural for typical pre-modern townscape). Even outstanding examples of architecture when put together are likely to create a spatial disorder, because they are using different stylistic and typological language. Similarly, urban regulations alone will fail to ensure harmonious spatial development because it could seem too oppressive and will cause a resistance.

Traditional small towns were consistent also through the lack of an architect and urban planner. But today, it is difficult to imagine such situation, being aware of complicated technology and bureaucratic procedures that need to be faced. So, if the architect is necessary but his role of a designer of single buildings is insufficient, it becomes clear that we should reconsider his role and responsibility. I assert that he needs to become a kind of engaged local expert, or even a leader. I will try to illustrate this thesis describing briefly the Monte Carasso case, which will concern the activities of Luigi Snozzi in this town in the Swiss region of Ticino.

LUIGI SNOZZI IN MONTE CARASSO

Architect Luigi Snozzi commenced its activity in Monte Carasso in 1979 and it continues to this day. As he describes, the starting point of his work was a commission for the design of new elementary school from the town mayor.

At that time, the town was applying a recently adopted urban plan developed by ETHZ Professor Dolf Schnabli. Approaching his task, Snozzi criticized the location of the school (on the outskirts of town, close to the highway) provided by this plan, instead proposing to place the school in the very centre of Monte Carasso. While working, he noticed, favourable to him, conscious and "enlightened" approach of the municipal authorities, so "going with the flow", he proposed the rejection of the entire plan and replacing it with brand new principles of urban planning. In opposition to the functionalist and "suburban" regulations, he puts forward his own proposals aimed to restore the density and urban character of municipality.

This proposal is a reaction to the processes of urban development that are being observed at that time in many similar settlements of Ticino: Towns are being extensively developed by single-family detached houses, what leads them to the loss of urbanity and individuality of their centres turning them into suburbs of larger cities (Lugano, Locarno, Bellinzona). Snozzi identifies the need restore, or rather to create a new urbanity of Monte Carasso. He believes that only in this manner it can maintain its autonomy.

The whole of his activities can be divided into two main phases:

1. Project of the centre (so-called. Centro Monumentale or Monumental Centre)

2. Other projects, mainly single-family homes scattered throughout the town, following the new rules of urban planning.

The first step in reaching the final objective is just the realization of the school in the adapted former convent of Augustinian in the centre of the town. The result of this project was also a whole range of accompanying public spaces – most important being a central square raised from the monastic cloister. Another important step was the clear definition of the town centre through a tree-lined avenue loop that delimited the downtown area and allowed the romoval of a traffic within this zone. Then, the centre was filled with further public (gymnasium, cemetery, multi-purpose hall) and semi-public facilities (home of the mayor, bank facility). In this manner, a valid downtown zone was created and along with it, social awareness of the community was growing.

Being aware that the direct intervention in the town centre is a good starting point, but does not guarantee the proper development of the whole town, he decided to use other methods of shaping space. Apart from architectural intervention, Snozzi proposed new construction rules (as he claims 7 instead of the previously existing 250) for the entire area of the municipality. Their main goal was to force the proper density of the urban fabric and a definition of public and private spaces. New rules are fairly liberal on one hand – they allow for considerable flexibility (colours, shapes, angles of roofs ...), on the other hand, however, they remain hard at several key points – such as the indication for aligning the building to the street, or the obligation for putting up high walls (min. 0,8 m) on border of the property. The new rules also recommended relatively high buildings (up to 3 storeys) and they cancelled the obligatory distances between the buildings in adjacent plots. These indications directed new urban tissue towards traditional urban structure while allowing stylistic variety (underlining only that the object should "fit" to its urban setting).

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Additionally, Snozzi proposed the setting up of a committee of architecture (in which he sits himself) whose functions is to indicate proper directions, give opinions and approve the submitted projects. In such conditions, the architects (including Snozzi himself) created new projects (mostly single family) with the objective set not only to satisfy the customer needs, but also to build clearly public space of Monte Carasso.

The entire process of transformation entered in the traditional urban paradigm, representing at the same time uncompromisingly avant-garde architecture of the individual objects (minimal forms, raw materials). The effect of this experiment (lasting over 30 years) is outstanding. The space of Monte Carasso stands out clearly from the surrounding villages – as the only one it upheld its compact urban character typical for the historical settlement, while delighting with plenty of high-quality modern architecture. It remained a traditional mountain town with winding streets and alleys, but it is build out of modern architecture: minimalist solids with raw concrete.
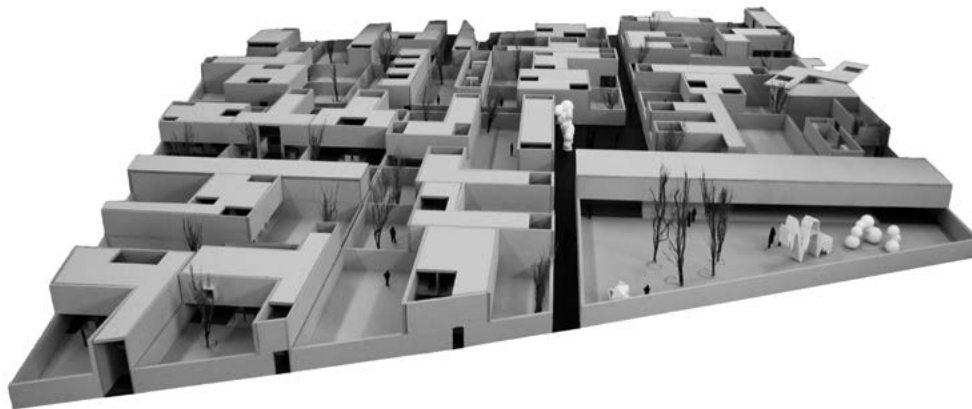

Fig. 1.: Innovative space made by innovative typologies. Residential neighborhood inspired by Monte Carasso urban rules – a result of design laboratory of Roberto Briccola at Accademia di Architettura di Mendriso

Source: Roberto Briccola

THREE DIMENSIONS OF TRANSFORMATION

Monte Carasso is a unique case of an urban process in which the space of a small town is being consequently transformed by a set of urban regulation and architectonic actions. Those transformations are directed toward „urbanization" of a town, which is understood mainly as densification and the clear definition of public and private space.

The urban process of the town is based on two "pillars":

1. Introduction of unique urban rules which are inspired by the traditional townscape;

2. Direct architectural interventions (design of most important public buildings as well as numerous houses according to mentioned rules).

Those actions are being constantly supported and evaluated by the third class of actions: theoretical research and promoting events. The most important of them is the annual Design Seminar held in summer in Monte Carasso – during this event, students and young architecture apprentices get acquainted with Snozzi's design methods and ethic approach.

The described range of undertaken activities resulted from Snozzi's experience as well as from his specific moral and philosophical attitude. During several decades of his professional activity he found out that the capabilities of architects working on single plot in influencing the larger

urban scale are limited. On the other hand, he believes that it is a duty of an architect to take responsibility of the whole city in which he operates. Hence, the choice of multi-track intervention as a method of action: architectural projects, urban regulations and theoretical research. We can assume that this massive action was aimed to create new local construction culture – as we can observe in examples of houses designed by Snozzi himself and by other architects in Monte Carasso. A specific local style has emerged, based on traditional typological principles but using modern (or even avant-garde) means of expressions and ways of shaping interior spaces. Once this local culture is created, it becomes easier to develop it further. People start to understand it and are ready to adopt it. But to get to this moment, a lot of effort is necessary, so an architect willing to do it must not limit himself to "doing his job" but he needs to try to influence the space where he operates by all possible means.

Social responsibility is another important theme. Snozzi's understanding of this term, however, is very far away from the term "participation". He admits that he never designs "with" the people, because the architect is the expert who knows his art and matter and who should be trusted. This does not mean that he is not aware of the needs of society – he only understands them to be wider: he assumes that only an architect, as a spatial professional, is able to interpret today's culture and shape it in architectural matter. That is why he appreciates deep humanistic reflection more than simple "listening to what people say". It may seem controversial, but it is undoubtedly worth thinking of, because it shows the potential perspective of our profession.

ACCLAMATIONS, CONTINUATION AND IMPORTANCE

The case of urban transformation of Monte Carasso has been widely recognized throughout Europe – the town received several urban prizes, and it has been chosen to represent Switzerland in the Venice Biennale of 1996. However, there are surprisingly few followers of this model – it overturns the traditional investment and construction process that is rooted deeply in the mentality of officials and it proposes alternative urban patterns which are not familiar to town inhabitants. To implement the Monte Carasso model in any town it is necessary to overcome the bureaucracy and the initial resistance of population. In these conditions only few towns expressed the will to go this path and even they are not very advanced on it.

Another problem lies in the architects' attitude: as it was shown the responsible and charismatic personality of and architect is necessary to lead this process. Nowadays it is hard to find one that would "accept this quest". One of the reasons is the academic formation of architect which does not underline the social responsibility of architect and does not provide him with essential soft sills.

But the Monte Carasso phenomena found some appreciation in academic world, being an inspiration for several research projects and design laboratories, the most important of which is probably the work of Roberto Briccola. He is another member of architectural committee of Monte Carasso; he may be considered as a "pupil" of Snozzi. This is another interesting aspect of Snozzi's activity: an effort in formation of "successors" that would continue his work.

In summarizing the Monte Carasso case for the needs of our considerations, the most important aspects seem to be:

– the architect understands the global urban trends with its reasons and possible consequences
– the architect takes responsibility for preventing those dangerous spatial phenomena
– the architect has a vision of a town (dense, compact, "urban")
– the architects collaborate closely with the local authority
– in order to reach their objective, the architect acts on various disciplinary fields: advising,

urban planning, architectural design.

- to ensure sustained growth of the town, constant theoretical research is being made
- the architect tries to create (or recreate) a local building culture
- developing a valid centre with public space and monumental building is essential
- to obtain the proper spatial character of small town, typological issues are more important than the stylistic ones

Therefore, conclusions about the role of an architect operating in small town are:

- should be versatile and proficient in all spatial disciplinary fields
- should have humanistic knowledge and an understanding of contemporary cultural processes
- need to take responsibility for the space of a town where he operates.
- should be provided with essential soft skills (leadership, group work, presentations) that would allow him to actively participate in shaping the space of the town.

This paper indicates the need to rethink the role of an architect in the small town by presenting the example of Luigi Snozzi activities in Monte Carasso. This example suggests that the broad activity of an architect, exceeding his traditional tasks, may lead to the successful and spatially-consistent character of a town. Studying this case in detail could provide us with many useful methods and procedures.

However helpful it may be, it is not universal – there are still a lot of questions that are raised out of it. One of the most important is how to form future architects in academia to prepare them to the extended role of local experts. Probably the most fair starting point would be implementing one of the innovative education standards, such as for example 21st Century Learning Design, which would prepare students for the real conditions of the contemporary world. Another important direction is the emphasis put on humanities during architectural studies. That would allow future professionals to understand the reasons of negative spatial phenomena and efficiently prevent them. Finally, the most important issue is to underline the meaning of ethics and responsibility in everyday architectural practice.

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DISPLACING ARCHITECTURE? FROM FLOATING HOUSES TO OCEAN HABITATS: EXPANDING THE BUILDING TYPOLOGY

The current research on the amphibious architecture lacks a proper, commonly shared vocabulary and typology of water-placed structures. In this paper, the state of typological works is described and a new typology based on three main distinguishing factors (relation to water, buoyancy and mobility) is given. Thanks to the different perspectives of civil- and naval architecture that are taken into consideration, this new typology encompasses the architectural objects of all sizes, functions and movability, built both in the water and on the water, divided into six types: overwater, waterside and amphibious buildings, floating structures and residential and facility vessels.

INTRODUCTION

Since the beginning of the 21st century we have seen a dynamic growth of amphibious architecture. This water boom has its roots in the old call for living by the water, but it would not be possible without a couple of very specific circumstances that came into being in the last 15 years. The first reason for the interest in amphibious architecture is fear. The threat of a flood caused by the sea level rise, hurricanes or heavy rains – all correlated with the climate change – has become a fact and many flood mitigation strategies now incorporate some amphibious building techniques. The second reason is economy. The shortage of land available for development in the largest metropolises and the smallest states has pushed architects and engineers to reclaim the seabed or to build floating structures. At the same time, the shortage of energy resources – mostly the fossil fuels like gas and oil but also the renewables like strong and steady winds – has created a large sector of offshore research, mining and energy industry which seeks for the new types of the ocean structures and vessels. The third reason for substantial amphibious architecture growth is technology. Although building on the water is not a new idea, today, thanks to new materials and construction methods, waterside and floating structures are as durable and as comfortable as their land-based counterparts. They are as affordable, too.

When we recall the history of building in and on the water [1] or when we look on the number of its contemporary realizations, we certainly can call the amphibious architecture a mature discipline. But, if we try – for research or teaching purposes – to describe this phenomenon we experience major difficulties with defining the basic terms and classifying them all under the label of the amphibious architecture. The aim of this paper is to overcome these semantic and typological

problems by analyzing the current state of research of the typology of water-placed architecture and proposing a new multidisciplinary approach to this problem.

COMMON DEFINITIONS AND TYPOLOGIES

The literature review showcases that the problem of water architecture vocabulary has at least three main causes. The first is the ambiguity of the main terms. *Amphibious* is a term coming from the Greek *amphi-bios* that means the potential of living both on the land and in the sea. In architecture and urban design practice, it is used in two meanings: as the general description for *aquatecture* [2][3], which is the architecture shaped in the water context [4][5]; and as the precise definition of the otherwise-ordinary building capable of floating on a flood waters [6]. Another popular term, *the houseboat*, may refer to at least three different types of amphibious dwellings: to a small motor yacht with a very high level of comfort, to a boat or a barge rebuilt into a stationary residence [7] and, especially in American literature, to a *floating house* [8–16].

The second reason is the metaphorical approach of some authors who focus on the ideology and perception of the building surrounded by water regardless of its other functional and technical features. It may results in using quite clear terms like *island buildings* [17] but also happens to be confusing when *floating architecture* [18] or *buildings on water* [19][20] are being proposed for describing the ground-based structures.

The third reason is the multidisciplinary nature of amphibious architecture, which results in double terminology proposed by architects and naval engineers - *a floating system* [21] is an example of architectural equivalent for the well-known marine hull. This overlap results in merging civil and naval building rules in the new legislation [19, 21, 22, 22 –25].

Some efforts to propose the typology of the amphibious architecture have been already made. Grau, Ryan, Zevendingen and Kekez in 'Building with Water. Concepts, Typology, Design' presented the functional (arts and culture, recreation, living, industry and infrastructure) and natural (like, river, sea) typology [26]. Baker in 'Built on Water. Floating Architecture + Design' despite the metaphorical title gave a hint of aquatic structural concepts (pillars support, stilts elevation, pontoon floatation) [19].

Probably the most comprehensive study of the problem was given by Flesche and Burchard in 'Water House' in which they distinguished between ground-supported, floating, submerged and frozen architecture [1]. A more detailed picture taken from the Dutch flood-mitigation perspective was presented by Nillesen and Singelenberg in 'Amphibious Housing in the Netherlands' where the floating dwelling, the amphibious house, the pile house, the dyke house, the terp house and the waterside house were all described [25].

THE ANALYSIS OF THE COMMON TYPOLOGY

In the first phase of the research the most popular types of aquatic structures – two with flood resilience origin, three allowing living by the water, and one vessel – were selected as the most representative amphibious forms and defined as follows:

– *static elevation building* - a building located out of a water basin that is supported by an openwork structure high enough to allow the flood water to flow under the building without any damage;
– *amphibious building* – a building located out of a water basin and set on the ground but capable of floating on the rising flood water thanks to its low weight and special structural

elements like the buoyant foundation [27] or a watertight basement that displaces surrounding water, held in place by two or more vertical piles along which it can vertically regulate;

– *waterside building (building in the water)* – a building located in direct proximity, partly or entirely in a water basin, and erected on a waterproof foundations*;*

– *pile building*, *stilt building* - a building located partly or entirely in the water basin that is supported by a ground-based openwork structure rising it over water for a designed height*;*

– *floating building (building on the water, boathouse)* – a building located in a water basin, partly submerged, floating on the water surface thanks to its low weight and special structural elements like the buoyant foundation or the watertight basement that displaces surrounding water, that is held in place by variety of systems like mooring piles (dolphins), stopping piles, anchors, mooring lines and combination of those;

– *houseboat* – a small watercraft designed *with no concessions to quality of living aboard which usually hampers the nautical and the aesthetical value of the craft.*

In the next step, six selected types were analyzed in terms of ten basic aquatic features. The results are compiled in the Table 1.

	static elevation buildings	amphibious buildings	waterside buildings	pile buildings	floating buildings, boathouses	houseboats
relation to water	*elevation*	*floating*	*delimiting*	*elevated*	*floating*	*cruising*
application	*flood-prone land*		*water banks*	*water*		
context	*land*				*water*	
legal definitions	*real-estate*				*mobility - watercraft*	
buoyancy	*non-buoyant*	*buoyant*	*non-buoyant*		*buoyant*	
supporting substance	*ground*				*water*	
		water				
mobility	*static*	*kinetic*	*static*		*portable*	*transient*
propulsion	*unpowered*					*self-powered*
base type	*piles/stilts / columns*	*pontoon / float/raft*	*waterproof foundation*	*piles/stilts / columns*	*pontoon / float/raft*	*hull(s)*
discipline	*civil architecture*				*naval architecture*	
		naval arch.				*industrial design*

Table 1:

The compilation of current typologies of amphibious architecture.

The current typologies are based on the context of the building. The watercrafts are excluded except for the houseboats.

The compilation shows that a common typology is based on the context of the building – the main distinguishing factor due to its evident character. The following disadvantages of this approach were observed:

– there is no clear connection between the structures of three different origins: the flood-resilient house, the water dwelling and the watercraft;

– the technical features seem to be irrelevant to the typology;

– despite the fact that watercrafts were the first amphibious structures, they are hardly represented in the typology.

THE PROPOSAL OF A NEW TYPOLOGY

After showcasing some disadvantages of the common classification of the amphibious architecture, research for a new better typology was started with special regard to the following guidelines:

– design approach - it should reflect different design concepts, methods and tools that are being used for water-related structures;

– emphasizing mobility – it should not only distinguish fixed and mobile objects, but also organize them by the level of mobility;

– emphasizing the space relation to water – it should indicate how the structure is located in relation to water with the special regard to the fact that both the aquatecture and the water may change their position over time.

An important element of the new multidisciplinary approach was extending the field of amphibious architecture to the marine structures. This is not a new problem: Le Corbusier [28], Fuller [29] and the Japanese Metabolists had already explored it in their manifestos and projects. Today architects like Norman Foster and authors like Quartermaine [30] continue the idea of including watercrafts to the scope of architecture. In this paper, a moderate attitude to this problem has been taken: vessels are accepted as a form of the aquatic architecture only if their purpose goes beyond the simple function of as a mode of transportation.

As a result of expanding the scope of analysis and redefining typological objectives, the following types of amphibious structures were proposed:

– *overwater building* (*pile building, stilt building, static elevation building)* – elevated, static and non-buoyant building supported by the ground-based (or bottom-based) openwork structure raising it for a designed height over any kind of permanent or temporary water.

– *waterside building (waterfront building, building in the water)* – water-boundary, static and non-buoyant building located in direct proximity to, partly or entirely in the water basin, erected on waterproof foundations not intended to float*;*

– *amphibious building*s – floatable, kinetic and buoyant building located out of the water basin set on the ground but capable of floating on the rising flood water thanks to its low weight and watertight base;

– *floating structure* – floating, portable and buoyant, partly submerged structure resting on the water surface thanks to its low weight and special structural elements like buoyant foundation or watertight body (the hull) that displaces surrounding water, kept in place by variety of systems like mooring piles (dolphins), stopping piles, anchors, mooring lines and combination of those; includes structures of different functions, applications and sizes like *floating building (building on the water, boathouse), living barge, offshore floating platform, Very Large Floating Structure (VLFS), floating habitat, floating city,* as well as the ships that require a fixed position to fulfill their purposes like *lighthouse ship, botel, floatel and museum-ship;*

Table 2 — Proposal for the new typology of amphibious architecture.

	overwater buildings	waterside buildings	amphibious buildings	floating structures	residential vessels	facility vessels
sub-type			buoyant architecture			
examples	static elevation buildings, pile/stilt buildings	shore- and land based buildings incapable to float	shore- and land based buildings capable to float	floating dwellings, VLFS, offshore platforms, sea-habitats, lightships, botels, ship-museums	houseboats, mega yachts, cruisers	aircraft carriers, hospital ships, prison ships, power plant ships
relation to water	elevation	delimiting	floating		cruising	navigating
application	flood-prone land		flood-prone land	water		
	water banks					
context	water			water		
	land					
legal definitions	real-estate					
				mobility - watercraft		
buoyancy	non-buoyant		buoyant			
supporting substance	ground			water		
mobility	static		kinetic	portable	transient	
propulsion	unpowered					
					self-powered	
base type	pilles/stilts / columns	waterproof foundation	pontoon /float/raft			
				hull(s)		
discipline	civil architecture					
			naval architecture			
						industrial design

- *residential vessels* – cruising, transient and buoyant watercraft designed especially for living onboard, used as 'a place to be in' and not as a mean of transportation – like *houseboat, mega yacht, cruising ship;*
- *facility vessels* – navigating, transient and buoyant watercraft designed to combine water mobility with the function of the land facility that needs to be substituted offshore – like *aircraft carrier, hospital ship, prison ship or power plant ship.*

To test the new typology, six selected types were analyzed in terms of ten basic aquatic features in the same way as the former typology was examined. The results are compiled in the Table 2. What can be noticed is that in all categories except for the context, the gradual change of the features

between the types was achieved. As an evidence of the validity of the proposed approach, several continuums of properties were shown in the key typological categories:

– relation to water: elevation – delimiting – floating – cruising – navigating
– mobility: static – kinetic – portable – transient
– buoyancy: not buoyant – buoyant

BUOYANT ARCHITECTURE

The general definitions should also be reformulated on the basis of the proposed typology. Amphibious architecture should be expanded to encompass watercrafts of strong architectural characteristics, like residential and facility vessels. Additionally, thanks to the clear division between non-buoyant and buoyant objects, a new subcategory of *buoyant architecture* may be introduced. It will be defined as the part of *amphibious architecture referring to the buoyant (floatable) elements of the built environment*. Buoyant architecture must be seen in two very promising perspectives of sustainability and mobility.

The idea of sustainability is embodied in the very nature of buoyant architecture: a floating building cooperates with water rather than opposing it [31][27]. It undergoes water level fluctuations and it reacts to water's movement so it is adaptive and kinetic by definition. The initial problem of buoyant architecture – infrastructural isolation – is now an advantage as new autonomous technologies of energy production, rainwater collection, seawater desalination and wastewater purification may be harvest. [18, 32, 33].

The second advantage of the buoyant architecture – the level of mobility [34] – is overwhelming in comparison to land-based buildings. Either portable or transient, these floating structures can be easily reconfigured or moved (or they can move themselves) despite their often enormous sizes and without detriment of the comfort of their users.

CONCLUSION

The author believes that the proposed multidisciplinary typology has following advantages:

– modern structure – focuses on sustainability and mobility;
– openness and inclusiveness – may be detailed or extended to encompass more types of buildings, vessels or water engineering structures;
– interdisciplinarity – enables cooperation and technology transfer;
– activating potential – invites architects to explore new design territories;
– cohesion and clarity.

The obtained typology is clearly functional – but not in the terms of the structure's purposes. Here an architectural object is being classified on the basis of how it interacts with its eternal adversary – water [20] and what technical means does it take. Therefore, this typology may became a useful tool in the hands of designers of all disciplines who want their architecture to cross, delimit, float, cruise or navigate the vast expanse of water.

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FROM AR TO ARCHITECTURE: SEARCHING FOR NEW WAYS OF GRASPING THE DIGITAL

In my opinion, the traditional human-computer interaction based on mouse, keyboard and screen is inadequate for three-dimensional modeling and architectural creative process. The article covers my intent to propose alternative means of transmitting information between the architect and CAD software: ways that allow for more immersive interaction and give more direct access to signals that can be perceived by the user. I hypothesize Augmented Reality (AR) to be one of possible solutions. To prove that, I present experiments involving three mobile applications of my authorship along with recent studies on Augmented Reality and its implementation in architectural and education processes, showing the emerging need for innovation and experimentation in this field.

Augmented Reality (AR) – as defined by Ronald T. Azuma – is a variation of Virtual Reality (VR) that allows users to immerse in digital space while seeing the real world with virtual content superimposed upon physical objects. Therefore, AR supplements reality instead of completely replacing it, and it provides users with additional data as well as it allows for three-dimensional navigation. [1] Contemporarily, AR is understood as the use of mobile devices (smartphones, tablets) or HMD (Head-Mounted Devices) to render digital content embedded in real world. This technology uses device's camera and trackers (elements of reality such as three-dimensional objects or images) to recognize spatial configurations (perspective, viewing angle, illumination) and display digital content like images, movies or digital models on the screen. Other methods are also available, such as using GPS data and a built-in accelerometer to recognize user's position in space to render digital augmentation. [2]

Originally used in military application (flight simulators) – AR was eventually adapted in medicine, industry, entertainment (computer games) and advertising (leaflets and posters supplemented with additional information). Architecture is also one of the areas where it is emerging – especially for three-dimensional visualization and as a tool for virtual reconstruction of non-existing buildings in real context, such as in Colonia 3D Project. [3]

Billinghurst [4][5] distinguishes four groups of AR interfaces. The first group includes instruments for displaying additional information in form of media – such as text, image or video. The second

group consists of interfaces used for interaction with three-dimensional digital models. As the third type Billinghurst defines 'Tangible Interfaces' that extend physical models and combine access to digital information with intuitive physical-model interaction. The last category is 'Tangible Augmented Reality', where the real world is augmented with no additional instruments like phones or VR glasses but by projecting content directly onto physical objects.

The article covers experiments involving three mobile applications that I created with the objective to combine Augmented Reality technology with architectural presentation, physical model-based urban design and free-form modeling.

ARCHITECTURAL PRESENTATION AND AUGMENTED REALITY

The application prepared for the course of 'Computer Aided Modeling' held at the faculty of architecture (the first year of bachelor studies) is an example of AR-support for architectural presentation. The course focuses on modeling historical and contemporary projects that had a major contribution to the evolution of single-family houses. There are three main objectives of the process. Firstly, students are supposed to gain skills in architectural and free form modeling software. Secondly, they get to understand how specific building's elements (such as walls, columns and slabs) work. Finally, during the process they gather information on the building they model and thus learn well-known examples of structural, functional and aesthetic solutions.

At the end of the modeling process, students present their work on printed panels. This medium often results to be less powerful than a digital model complemented with additional information. The message resulting from the modeling process is supposed to meet the criteria of a new medium as described by Lev Manovich, i.e. numerical representation, modularity, automation, variability and transcoding [6]. Augmented Reality provides students with the possibility of adding media to their panels. It gives more flexibility in presenting an architectural model and may facilitate understanding of such presentation for potential spectators.

The panel can be augmented with text, image, sound, video or a digital model. [7] Text accessible through an Augmented Reality application can either provide users with extra information or it can become hypertext allowing access to external resources such us online website that contains more information on the model. Images provide better understanding of the modeled object by e.g. showing historical photographs of its context or focusing on real-life details that were not included in the model itself. Sound may be used to address multiple senses. It can also provide access to a musical piece that was an inspiration to the architectural form. Videos combine the characteristics of both image and sound and are useful when presenting the work through a flythrough animation, physical simulation of kinetic elements or a more personal, graphical analysis of the project. An interactive model accessible through Augmented Reality allows free and intuitive perception from different angles and distances and can be easily altered by turning on and off particular layers of information, such as architectural elements (external walls, roof) or hierarchical organization (floors, functions). Such a model can be further supplemented with other media, such as sound or text rendered when zoomed on a point of interest. A wider explanation of student work along with examples is available in [8].

At the beginning of the procedure of implementing Augmented Reality in a modeling course, a set of freeware digital tools providing an easy-to-use AR functionality was used. However, in later stages those solutions were replaced with a custom application in order to provide greater flexibility in interaction programming and for the school to become independent from third-party software. The application was created using Unity 3d – a videogame development platform – and Vuforia plugin that provides programmable elements for AR functionality. Models prepared by the students are

imported to Unity as part of application development process. User interface and all interaction are programmed in C# language using a dedicated IDE. Unity provides a ready to use real time rendering engine and compiles software for a chosen platform.

The Augmented Reality application provides students and spectators with intuitive interaction through a tactile screen and facilitates three-dimensional navigation by giving them direct control on the camera. Such interface seems to increase efficiency of browsing and communicating architectural ideas in comparison to standard navigation techniques.

AR-CRAFT FREEFORM MODELER

Computational representation of space based on abstract geometrical entities is just one way of digitally portraying reality. Although the simplification of architectural forms and everyday objects to basic solids (a computer screen – a flat cuboid, a roof – a triangular prism, a round table – cylinder) facilitates describing and understanding such objects, it also limits the accuracy of their representation by omitting small differences and imprecisions. Mathematical description of geometrical elements is a theoretical base for NURBS models (non-uniform rational basis spline) that are supported by many modeling programs (Rhinoceros 3D, Camera 4D, IGES, STEP and ACIS standards). Such software enables defining geometrical forms by editing control points and their sequences and thus affecting shape of curves and surfaces. [9]

Instead of representing a model with abstract figures (points, curves, surfaces), one can subdivide it using a three-dimensional grid composed of cubes ({4,3,4} in Schlaefli's symbol) and assign properties to each of the resulting cubes. In the most basic configuration this can be a binary value (a cube is solid or hollow) and thus describe matter and vacuum for any partition of space. Such cube used as a unit of spatial representation is called a voxel. [10]

A voxel is a sample of space – a point complemented with data. It can store simple information like transparency, or more complex, such as color or physical properties. 4D voxels – or doxels – are dynamic units that can alter their properties in time. This means that, with sufficient resolution, such representation can be used to describe complex spatial organization and phenomena as well as to visualize objects using volume-rendering technique. With today's technological progress it still seems challenging to compute big sets of three-dimensional data. However, when reviewing the evolution of raster graphics (based on pixels – two-dimensional points representing color values of an image) and digital photography in particular, one may notice how quickly technological advancement provided us with two-dimensional resolutions that exceed eye-sight capabilities of distinguishing component pixels in an image. Therefore, it is likely that managing three-dimensional grids describing relatively large partition of space, with resolution that does not distort human perception, will be possible in the close future.

Bauke de Vries (ETH Zurich and Eindhoven University of Technology) in 1999-2000 started working on a program called DDDoolz – later developed with Henri Achten and Jordan Jesserun. DDDoolz is a tool for creating conceptual architectural forms using Virtual Reality technology. The authors of this application responded to an emerging necessity to be able to model geometry with the same facility as one has while sketching with a pencil on a piece of paper. Research on this way of 3D sketching dates back to 1990's and is associated with fast development of computational tools. DDDoolz offered *a sketch-like environment in VR with an unobtrusive interface*, where forms where created by 'painting' with a computer mouse (copy-while-drag). The results were rendered in real time through VR WorldUp engine. An additional enhancement was a possibility of multi-user cooperation. [11]

A Swedish design group FRONT investigated the concept of sketching in three dimensions with immediate materialization of ideas in a project called 'Sketch Furniture'. It was an experimental process of furniture design in one-to-one scale. Using motion-capture technology, movement of a physical pen-like tool was tracked and saved as a three-dimensional path with a defined thickness. It was then converted to a G-code (numerical control programming language) and manufactured on an SLA machine (a type of a 3D-printer). [12]

I implemented voxel operations as a basis for a freeform modeler with a working title AR-Craft. It is a mobile device application that allows for intuitive modeling using both voxel modeling and an Augmented Reality interface. The user defines forms in one-to-one scale by operating with a mobile device (smartphone or tablet) that has a dual role in the process. On one hand, the device is a virtual camera allowing for three-dimensional navigation around the user. On the other hand, it is a virtual drawing tool – a brush or a chisel – used for adding or removing voxels in space. Operational area for the process of creation is user's surrounding, which is scanned and digitalized by the program.

To start working with AR-Craft, the user places a tracker in his or her surrounding (on a table or on the floor). The tracker is a printed image that remains static during the entire process and it is used for orientation reference. Once scanned with a mobile device, the tracker is interpreted by AR-Craft as the origin plane of coordinate system of the operational area. The program can also recognize certain elements of the user's surrounding and use them as reference when the tracker is not visible by the camera.

The virtual drawing tool's center point is defined in front of the camera (30 cm from the lenses) and is visible on the screen as a cursor. The tool is of spherical shape and its radius can be defined by the user. The orientation of both the tool and the virtual camera is defined by moving and rotating the mobile device. Implementation of other shapes and the possibility of defining tool-camera distance are planned for later stages.

The modeling task is performed by adding and removing voxels. Whenever the mobile device's screen is touched, cubes are created in all points whose distance to the tool's center point is smaller or equal to the radius of the tool. No duplicate cubes are added. Similarly, cubes are removed whenever the screen is touched with two fingers. The user is able to see all the modifications on the screen. Augmented Reality provides intuitive navigation similar to viewing physical object in real world: one can change their position in virtual space and watch virtual objects by moving and rotating the device. One of the major differences between navigating through the real world and the digital one is the lack of awareness of collisions between the user and the digitally defined objects (walking through walls). In order to simulate this awareness the application was broadened with simple force feedback functionality: whenever the user comes in contact with the digital model, the device vibrates. This solution facilitates erasing voxels, as it is easier to estimate whether the virtual chisel is intersecting with existing mass.

Further extensions to the program are planned to provide users with the possibility to cooperate while working on one model. The method chosen to achieve it is Photon Unity Networking – a platform providing multiplayer functionality in games. All model modifications can be saved on Photon Cloud server and shared live among users working in one operational area (space defined with the same tracker). This will enable a user to track changes introduced by others and see the results live on his or her device, regardless whether all users are physically in the same place or use the same tracker in different places.

CITY-AR: AN URBAN DESIGN GAME

City-AR (which I developed in collaboration with Łukasz Piątek) is an application that allows for the use of Augmented Reality technology in urban design. The workflow consists of using physical elements – graphical symbols representing urban blocks such as housing, services and infrastructure – to create a model of a city. Such models can be scanned with a mobile device and thus each element can be complemented with digital model that changes depending on its surrounding.

The program combines live analytical feedback typical for digital working environment with the intuitiveness of a physical model interaction. A few case studies are worth mentioning as examples of research on merging physical and digital world in creative work. The first project is 'Bricks' developed in 1995 by George Fitzmaurice, Hiroshi Ishii and Bill Buxton at MIT's Tangible Media Group. The project focuses on manipulation of physical elements (bricks), which by being rotated, moved or shifted affect the position and attributes of digitally defined objects [13][14]. The second example is 'Triangles' – also conceived at the same leading institution by Matt Gorbet, Maggie Orth, Emily Cooper, James Hsiao and Hiroshi Ishii – that investigates modeling mesh-like surfaces using simple geometrical shapes (triangles). Each triangle is equipped with electronic circuit and sensors that allow for recognition of contact between elements. By analyzing connections, the surface is reconstructed live in computer software. 'Projections of Reality' is an outcome of Smartgeometry workshop [15]. It is a physical urban scale model augmented with real-time data analysis. The model consisting of cuboidal boxes is manipulated manually by adding, removing and displacing elements; it is scanned by a set of Kinect devices, analyzed by computer software (CFD wind analysis, agent-based people movement simulation) and the results of such analyses are projected directly on the model using video mapping.

Architectural presentation with Augmented Reality application.

Voxel modeling with AR-Craft.

City-AR complementing physical model with digital data.

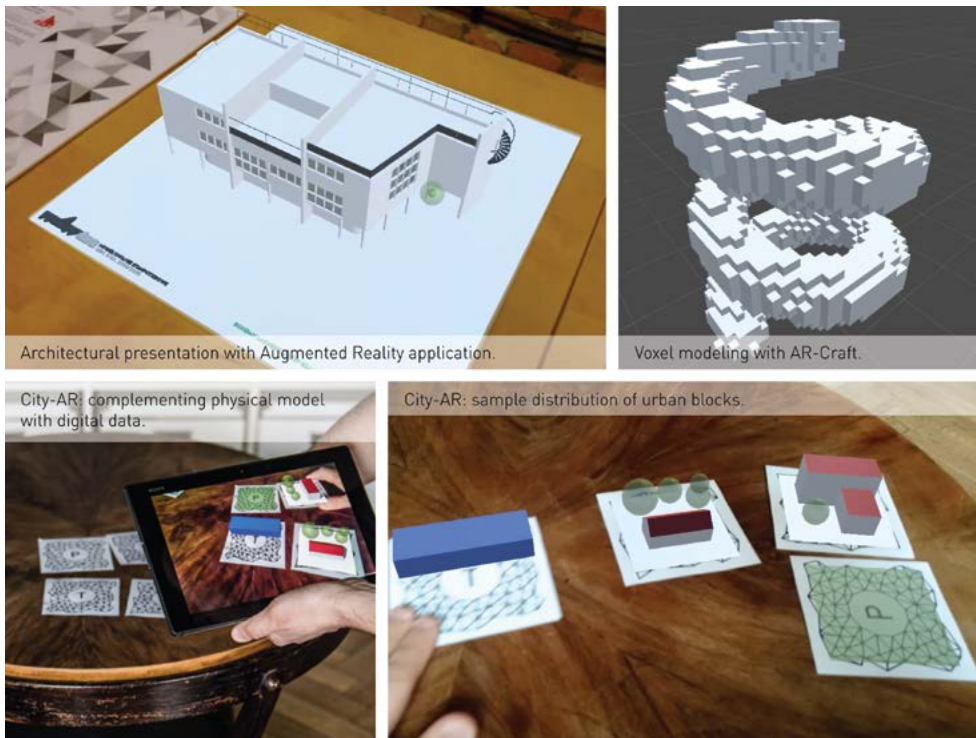City-AR: sample distribution of urban blocks.

Fig. 1. Developed AR applications.
Source: Author's own work

Another inspiration for creating an urban design tool such as City-AR is a genre of city-building videogames, where players interact with an open world and focus on limited resources, human behavior and ecological aspects. A milestone in this genre is SimCity: a game series created by Will Wright that defined directions for similar titles, such as Cities in Motion, Cities XL or City Skyline. All these titles take advantage of a simplified representation of reality, based on simulation models that approximate car traffic, energy production and consumption, as well as multilayer functional organization in cities. [16] Vermeer even finds in SimCity the logic of CIAM manifests: rational resources investment, sustainable growth and function zones. [17]

The functionality of City-AR is provided by Unity's extension Vuforia. Image trackers used for augmentation are physical symbols of urban blocks. Virtual content consists of digital models that represent these blocks. The software is still a work-in-progress version and there are three types of city areas: housing, park and retail. Block models are dynamic and they consist of different potential arrangements and scales: from a single-family house to a high-rise apartment building. Only one arrangement can be visualized at a time and which depends on the block's surroundings: number of neighbors, distance to a park or a retail unit. The larger the number of neighbors and the closer the block is to a park, the more successful it is considered and thus the bigger the scale of arrangement is visualized. Additionally, some fringe conditions have to be met for a block to be upgraded, like the vicinity to retail. In the further development of the application, more complex conditions will be introduced (as a growing demand for retail for high-end apartments, additional functions and relations between them, resources management, etc.). As an experimental project, City-AR at its current stage of development focuses on the technical aspects of human-computer interaction. The parametric model rules are not based on any urban design theory. Implementing such theory is planned in the future in collaboration with experts in the area.

CONCLUSIONS

Software solutions that are available today along with computers' increasing calculation capabilities provide users with mechanisms to easily model, edit, analyze, present and share architectural projects. However, it is still difficult for many architects and students to intuitively handle CAD tools. In my opinion, the reason for that is the use of inadequate peripheral devices in the process of modeling, complex information management and browsing. Human-computer interaction based on mouse, keyboard and screen may be a proper solution for two-dimensional operations such us typing, drafting and desktop organization. Yet, adapting it to three-dimensional navigation leads to imprecision and latency.

One of the reasons to that is what Słyk [18] calls a double projection effect. Standard computer mouse navigation is by definition two-dimensional. Thus, all three-dimensional operations such as zooming, panning and orbiting have to be projected from the three-dimensional imagination of the user onto a two-dimensional plane on which a mouse can operate. The actions performed with a mouse have to be then reinterpreted by software and applied in three-dimensional coordinate system. In the paper 'From Shaping to Information Modeling in Architectural Education: Implementation of Augmented Reality Technology in Computer-Aided Modeling', I also point out that three-dimensional navigation in computer software is much less intuitive than object manipulation in real life, where looking at an object from different angles consists of moving and rotating one's head or the object itself. Mouse operations convert these simple tasks into complex transformations that have to be defined by the user, which results in shifting user's focus from the content to tool management.

Augmented Reality seems to be able to at least partially solve these issues by viewing digital objects in three dimensions using a mobile device that works through direct manipulation of the

virtual camera through the device's movements – as if one had a video camera in their hands. Interaction takes place by touching specific elements on the screen as one would touch them in real life. Implementing AR also allows for targeting multiple senses when communicating information increasing effectiveness of a message. Caillois' ideas on games point towards immersion as one of the key conditions to involve a player [19] – or in case of my experiments, a user or creator. AR applications – through their multilayer structure and data hierarchy, their organization in terms of user preferences and space awareness – give users the ability to better connect aspects of digital space with the real world. In comparison to other forms of digital media presentation, Augmented Reality – with its interactive functionality – involves the user in a more direct and substantial way. [2]

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PROCESSING FOR ARCHITECTURE

The Processing language was created to simplify the learning of programming by designers and architects. Due to its pedagogical and graphical capabilities, the Processing language has spread among the electronic arts and design communities. Unfortunately, it is much less used in architecture, which relies on CAD and BIM applications that cannot be programmed using this language. To overcome this situation, we propose a solution that joins Processing with these tools. In this paper, we develop a complex architectural example using the Processing language, whose results are visible and editable in different supported CAD and BIM applications.

INTRODUCTION

In the past, programming was considered a highly specialized task in the design and architectural fields. However, nowadays, many designers are already aware of the potential of programming, thus introducing it in their design practices (Burry, 2011). This increasing use of algorithms in the field of architecture allowed the automation of tedious methods, the exploration of generative processes, and the simulation of complex solutions that would be impossible to generate manually. Therefore, algorithms have become extensions of human thinking, overcoming its potential limitations by allowing the exploration and experimentation in an alternative realm (Terzidis, 2003). This algorithmic and rule-based process defines the concept of Generative Design (GD), wherein a wide variety of solutions can be created in a short period of time (Fasoulaki, 2008).

Unfortunately, programming is not trivial (Burry, 2011). If architects and designers have the necessity or interest in learning programming, they have to spend some of their time studying it. This learning process can take more or less time according to the language being studied. In order to facilitate the use of GD, some programming languages were carefully designed with the aim of teaching programming skills to designers and architects. Such is the case of the Processing language (Reas & Fry, 2007).

Processing was inspired by the Design by Numbers project (Maeda, 1999) and it was created especially for designers, although it has also been used in the architectural field. This programming language balances between simple and more advanced features, and is considered a pedagogical language. In fact, Processing was designed mainly to teach computer science and programming to designers without programming experience. With the support of an academic community, this

language has grown over the years, and it is already being used in several courses due to its simplicity and to the excellent documentation available (Fricker, et al., 2008).

PROBLEM

Generative Design is extending the role of the architect to also become a programmer, thus requiring not only algorithmic, mathematical, and abstract thinking, but also programming skills. Programming is increasingly being used in architecture and, therefore, creating a methodological shift in architecture's practice by introducing an intermediate step in the architectural work. In this step, architects develop a program that reproduces and generates the idea they have in mind, instead of modelling it manually as they were accustomed to do.

CAD tool manufacturers are already aware of this methodological shift and they have adapted their tools to this emerging reality. Therefore, they have already made available the possibility to program their tools with a variety of programming languages, such as Python, Grasshopper, AutoLISP, and VisualBasic.

Processing, however, is much less used in the architectural practice, despite its attractive pedagogical capabilities. The main reasons for this unfortunate situation are (1) the inability of Processing to interact with the Computer-Aided Design (CAD) and Building Information Modeling (BIM) tools that are typically used by architects, such as AutoCAD, Rhinoceros 3D, and Revit, and (2) its shortcomings in 3D modeling operations and transformations, such as sweeping or lofting.

This is not surprising, because Processing was originally intended for 2D drawings and animations, running in its own programming environment, completely isolated from other applications. It was only recently that Processing was extended with simple 3D operations and ways of exporting the generated designs. However, these are very limited in their capabilities. As a result, although architects can easily learn and use Processing, this knowledge cannot be easily and directly applied in the field of architecture.

In order to overcome this situation, we first need to augment Processing to deal with a wider range of 3D modeling primitives (*cylinder, sphere, cone, etc.)* and transformations *(extrusion, loft, sweep, Boolean operations, etc.)* that are essential in the architectural daily practice. Secondly, we need to enable the users of Processing to generate their results directly into a CAD or BIM tool.

SOLUTION

We proposed a solution that joins CAD and BIM tools with the Processing language (Correia & Leitão, 2015) and allows architects to (1) develop new designs using this programming language and (2) generate their results directly into a CAD or BIM application. This solution was implemented in Rosetta (Lopes & Leitão, 2011), an Integrated Development Environment (IDE) for generative design. One main advantage of Rosetta is its emphasis on portability and, unlike other development environments, Rosetta supports scripts using different languages (AutoLISP, JavaScript, Python, Racket, and Scheme) and generates identical models in all supported CAD and BIM applications (AutoCAD, Rhinoceros 3D, SketchUp, Revit, and ArchiCAD).

In order to make Processing more suitable for the needs of architects, 3D modeling extensions to the Processing language were also implemented in the Rosetta IDE. These extensions include several operations for basic 3D modeling, such as boxes, spheres, cylinders, etc., as well as shape forming operations, such as lofting and sweeping.

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In addition to supporting the traditional syntax and semantics of the Processing language, our solution extends Processing in three directions:

(1) Interactive evaluation, which allows designers to evaluate small fragments of Processing programs in a Read-Eval-Print-Loop (REPL), thus enabling a quick experimentation of the scripts being developed;

(2) 3D modeling, an essential extension in order to improve the use of Processing in CAD and BIM tools;

(3) Professional CAD, a connection between Processing and CAD or BIM tools, supporting the generation of designs in those tools, without suffering from the problems that typically occur when designs are imported from different applications.

EVALUATION

Our solution is intended for architects that learned the Processing language and want to use it in their architectural practice, more precisely, in the production of 3D models. Due to the large number of Processing tutorials available, it is natural to expect that architects will try to use and adapt some of the material presented in those tutorials as a starting point for more advanced modeling efforts. This situation was taken in consideration and, in this section, we explore a complex architectural example that starts from one simple trigonometry tutorial available in the Processing web site. This trigonometry tutorial explains the generation of a sine curve using Processing primitive operations running on the Processing Development Environment (PDE). Although it presents a trivial example of the use of sine curves, it only produces results aimed for a 2D visualization.

Marriott Hotel in Anaheim

It is noteworthy that there are several buildings and facades inspired by sine curves and, indeed, sine curves have large applicability in the architectural practice. Therefore, it becomes relevant to extend Processing's sine curve example to 3D modeling and, in particular, to generate a more architectonic result. In order to provide a more realistic evaluation of our solution, we developed a model based on a real building, the facade of the Marriott Hotel in Anaheim, using the Processing language running in the Rosetta IDE.

The facade of the Marriot Hotel in Anaheim is composed by several sinusoidal balconies with opposite phases. This produces an offset between sine curves, which creates a complex visual effect. The relevance of the sine curve in the development of this example becomes evident when we notice that it is needed to model almost all the facade elements, including the slabs, guards and handrails, and the vertical walls.

In this section we describe, step-by-step, the generation of the 3D model of this facade. To this end, we combined the original features of Processing with our proposed extensions, enabling a more expressive modeling approach, whose results are visible (and editable) in any of the supported CAD and BIM applications, such as Rhino5, AutoCAD, SketchUp, and Revit.

In order to generate the 3D model of the Hotel's balconies, we started by developing the sine curve in the tutorial, since it was then required for most of the following operations. After the implementation of the sine curve we proceeded with the development of the facade elements.

Balconies Slabs and Guards

First of all, we developed the slabs that compose each level of balconies. To this end, we used operations such as lines and splines to define the contours of the slabs: the lines were used to create the regular faces of the slabs, whereas the spline was used to define the sinusoidal contour. Then, we used the operation Surface to create a surface between the contours previously defined and, after that, we applied the operation Extrusion to the obtained surface in order to give a certain thickness to it. As a final result, the resulting volume of the previous operations (Fig1.a) corresponds to one slab.

The next stage was defining each balcony's handrail and guard (Fig1.b). For that we also used a sine curve defined by a spline, but this time to work as a path for a sweep operation. As a result, the sweeping of a circular section or surface along this sinusoidal path created the sinusoidal handrails.

After that, this same sine curve was used to place the vertical elements of the guards as well. More precisely, we used the curve to compute a list of points to then control the placement of these elements. In practical terms, their distribution is done along the sine curve and the distance between each element depends on the number of vertical elements of the guard. In practical terms, a higher number of elements originates smaller spacings and vice-versa. These elements were generated using the *cylinder* operation, in which the starting point parameter corresponds to the previous list of points, the height parameter depends on the handrail's height value, and the radius parameter is controlled by the size selected by us.

Facade Walls and Levels

As already mentioned, the sinusoidal movement of the balconies alternates between two phase values, 0 and ϖ, which results in a sequence of intercalated undulations along the Hotel's facade. Consequently, this alternation conditions the geometry of the division walls belonging to each level, since their definition is made according to the limits of both upper and lower slabs.

In order to generate the division-walls belonging to each level of balconies we used the *cuboid* operation, which produces an irregular parallelepiped shape. As in the previous examples, the sine curve was also necessary to control the limits of these walls and, thus, defining their shape. As these elements are connected to the upper and lower slabs, they follow two sine curves with alternated movements (Fig1.c). As a result, we defined the shape of these walls using two different sets of points, where each one corresponds to one of the sine curves.

In practical terms, the set of points of the upper curve was used to control the top geometry of the walls, and the points of the lower curve defined the shape of their bottoms. In the end, the generated walls follow the alternated movement of the corresponding upper and lower slabs (Fig.1d).

After the previous steps, we have all the elements that compose one single balcony. Now, we just need to repeat this process to create the Hotel's facade, which is composed by several balconies. For this, we implemented a loop within the method *draw*, which repeated the process multiple times until the stop condition was reached (Fig. 1 - right image).

Note that none of the 3D elements of this example could have been done using the features provided by the original Processing language because it did not provide (1) extrusions, (2) sweeps, and (3) cylinders. In addition, this model was created directly in Rhinoceros 5, but it could also be generated in any of the CAD and BIM tools supported by Rosetta.

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To sum up, this example illustrates the extension and adaptation of Processing to the architectural practice, not only by enabling the use of the most required 3D operations and transformations, but also by allowing a direct interactivity with the most used CAD and BIM applications.
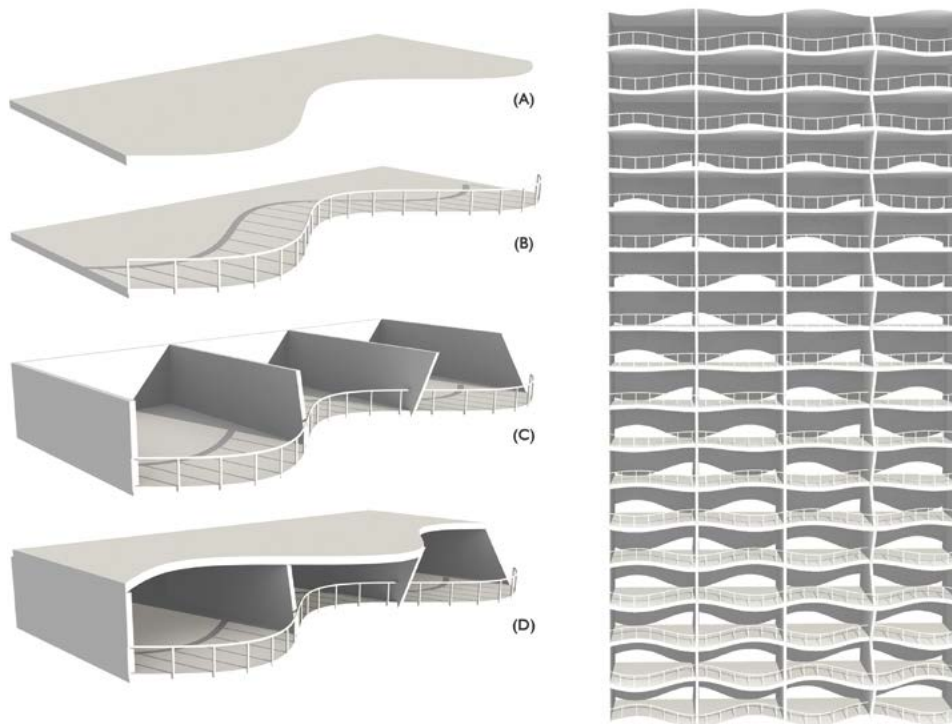
CONCLUSION

Generative Design has been changing the way architects work. In fact, it promoted the introduction of an intermediate step in the architects' daily practice, which corresponds to the development of a program capable of reproducing the ideas they have in mind. Therefore, in order to use GD, architects need to learn programming.

Processing is a simple and pedagogical programming language and, hence, easy to learn by designers with no previous programming experience. Therefore, it empowers the creativity and design exploration of its users. However, when it comes to the architects' work, processing shows its limitations. The main reasons for this situation are (1) its lack of 3D modeling operations and (2) the difficult combination and interaction of Processing with the most used tools in the architectural practice. Our solution overcomes these two barriers, by augmenting Processing with new design abstractions and operations, and by connecting it with several CAD and BIM tools.

In this paper, we explained how we combined the Processing language and the Rosetta IDE, and we demonstrated how the use of this combination supports the generation of more complex design solutions by using a practical example. In addition, we also demonstrated that it would be much harder to implement a similar solution in the original Processing environment.

Using our solution, it is now possible to explore 3D architectural models using the Processing programming language, since the modeling operations required are already available, and the model generation can be directed to several CAD or BIM tools that are essential for architects.

A final advantage of our solution is that it also allows architects to combine Processing with the different programming languages provided by Rosetta IDE, such as Python and Scheme. This allows Processing to move from its comfort zone - the design environment – into the more complex architectural environment.

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DESIGN PROCESS AND BUILDING PRACTICE

One of the most important and oldest problems that architectural education is facing is the schism between the design process and building practice. This division was strengthened in the seventeenth and nineteenth centuries. But it seems that it was the past three decades that completely changed the dynamics of this relation. At the same time, attention was diverted from objects to their digital representation. The article describes attempts to solve the issue researched at the TUL Institute of Architecture and Urban Panning. It provides a solution, which can be called: design and build, but strongly based on modern technologies.

INTRODUCTION

One of the most important and oldest problems that architectural education faces is the schism between the design process and building practice. It was Leon Battista Alberti that separated the architect (as an artist) from the contractor (as craftsman) for the very first time (Alberti, 1960:14). And thus the link between the conceptual work and its implementation was broken. This division was strengthened in the seventeenth and nineteenth centuries. But it seems that it was the past three decades that completely changed the dynamics of this relation.

At the same time, much was done, in terms of teaching, to overcome this duality – most of them based on the educational ideas of Bauhaus (Carpenter, 2014). But the introduction of digital tools in both education and practice has inevitably altered the very essence of design. Attention has been diverted away from objects to their digital representation. The apparent ease of the manufacturing process hides from the designer's eyes the real complexity of the mechanisms leading to implementation. As Nicholas Carr underlines, there is no requirement for understanding the process, because, to some extent, it is controlled by algorithms (Carr, 2015). Finally, architects lost contact with the processes of construction. Thus, they are doomed to focus on virtual tools, neither knowing, nor willing to know, their real impact on the design process.

The answer to those problems seems to lie in the design-build studio. The method of learning by doing, can, in our view, serve as a cornerstone for the synthesis, integration, and transformation of knowledge gained through teaching and execution (Hinson, 2007). According to Robert M.

Diamond, it is suggested that such an activity can be considered scholarly only if it meets the following criteria (Diamond, 2006):

– Clear Goals
– Adequate preparation
– Appropriate methods
– Significant results
– Effective presentation
– Reflective critique

Responding to this situation, as patrons of the student academic association "KĄT", we recognised the need to implement new types of activities into the syllabus. We advocated a solution, which might be called design and build, strongly based on modern technologies. It seemed important, as the existing syllabus did not take into account both classes with the use of parametric design tools, and the realisation of their own projects by the students. Due to the large institutional inertia, there was little possibility for rapid changes in the course. Therefore, we decided to adopt the formula of designing a series of workshops outside the curriculum and in a wider time span. This decision seemed correct, because of the greater freedom this form of activity gives its participants. The assumption was to combine several independent undertakings into a logical system. Starting with teaching students the investment and organisational process, through the use of modern methods of fabrication (CNC, 3D printing) as far as allowing participants to use the knowledge gained to create their own prototypes.

DESIGN AND BUILD

The aim of the first workshop was to indicate the importance of the materialisation of a parametric project and problems related to that process. The pretext for the action was the creation of a pavilion, which was to be built on campus to show the commitment of students to developing their own space. And since this need was expressed by students themselves, it seems reasonable to assume that they will be strongly connected to this idea. On the other hand, it was also a response to demands for incorporating the parametric design process into the curriculum. Consciously, we handed over the whole organisation to students, trying to teach them not only modern design tools, but also the entire organisational and investment process. The final group involved in the project consisted of four organisers: stud. Piotr Adamski, stud. Olga Chrzanowska, stud. Rafał Jóźwiak, stud. Ewelina Stawowy; foreign tutors: Sebastian Białkowski, Tudor Cosmatu, Alexander Kalachev; and twenty-three participants. Some of them were also responsible for the preparation of webinars, on-line tutorials and assisted tutors during the second stage (stud. Aleksander Dynarek, stud. Piotr Kluszczyński, stud. Łukasz Stawiński).

The whole event lasted from the 23rd of September until the 20th of October 2013, taking place mainly at Lodz University of Technology.

The project was divided into four phases. In the first stage, the students identified the principles of the design, the tasks to be executed and proposed a timeframe. In this stage, the students faced two very important problems. The first was quite obvious – organising funds. This challenge was handled extremely well. The students acquired sponsors both from the University and from outside. Of the many firms that agreed to support the idea, the most important were: Orzechowskie Zakłady Przemysłu Sklejek Orzechowo, Arcylab.pl Prot Haładaj, GeoTkacz, CTA, SARP Łódź. The help provided by them was not only a significant amount of money, but also discount prices on materials, and this influenced the decision in equipping computer stations with the required programs. This provided the opportunity not only to design, but also to realise an object of considerable size. The

Fig. 1. P^3 Pavilion
Source: SK KĄT archive

second challenge was to develop a common scheme for the project. A human-scale parametric pavilion demanded the necessity of creating new design tools and experimenting with new working methodologies.

At this point, a further plan of action was prepared. It included software training and design workshops dedicated to the creation of the ultimate form of the pavilion. At first, the webinars and tutorials were prepared by students organising the event. Thanks to them, the interface and basic Rhino and Grasshopper functions were presented to the future participants. Tutorials allowed students to learn and somewhat prepared them for the upcoming, intensive workshops. At the same time, applications were collected, and with them potential participants submitted their projects. The twenty-six best entries were chosen by a workshop committee. At this time, 30 Rhino licenses were purchased for the event and the material for the pavilion was bought – namely 200 sq.m. of 15 cm thick plywood. The amount of material ultimately determined the size of the pavilion.

In the next step, a week-long workshop was led by tutors from the Dessau Institute of Architecture. It was to explain the parametric design methodology and the basics of a designing procedure. Then, intense training on Rhino and Grasshopper software commenced. The exploration of specific design solutions played an important role at this stage. Various shapes of the construction panels and ways of combining them were considered. These studies were carried out using cardboard models and test panels made of plywood. Students were subdivided into five design groups. Each one of them was required to present a different concept of the pavilion. The five different models that were created were a result of the diverse ideas developed by these groups. They differed in the terms of forms, patterns, details and assembly. Then, the decision was made to prepare the final pavilion out of all of these concepts. So, with the combined forces of all the groups, a pavilion resembling a dome was defined. Using the same methodology that Gaudi used to create his work, a self-bearing structure was designed through application of "anti-gravity".

The last stage was a fabrication of the whole pavilion. The students have participated in the entire process, from cutting out the elements to their installation on site. At this point there were still some problems to solve – for example the method of constructing the three-meters-high construction, or methodology of connecting the wooden elements to temporary foundations while maintaining

the required margin for error. Problems that seemed very simple while designing, in real life were highly challenging and demanding. This part was very important for students to become aware of the problem of transferring the computer-designed idea into reality. It took an extra week, after the workshops, to prepare the documentation. This time was also used for consulting the structural design with Civil Engineers. Only after that was it possible to finally prepare all the pieces for fabrication. The distribution of all the wooden elements on the surface of the plywood boards alone proved to be a hard and important problem. Solving this particular issue led to downsizing the pavilion – and so to a very important change in the design. The manufacturing process was observed by the workshop participants. They also helped to operate the machines preparing fragments of the pavilion.

Altogether, there were 570 unique panels, 1,008 connectors corresponding to 806 different angles in between the panels, and 2,016 wedges produced. The pavilion consisted of 3,500 elements – which had to be hand mounted on site.

To manage such a large amount of elements during the building process, each part had an individual number engraved on it. Secondly, an efficient and organised working strategy was developed. It was based on the proper distribution of responsibilities. Again, all the participants were divided into three-person constructing teams. One person in the team checked the numbers of the panels and connectors on the 3D model, while another pair of students brought them to the construction site, where they were assembled in the correct position.

The finished project was crowned with the ceremonial inauguration of the pavilion prepared by the participants as part of the international Lodz Design Festival. The grand opening took place on the 20th of October, as part of the international Lodz Design Festival 2013.

The main aim of the workshop was to make students aware of the many problems associated with the process of materialisation of an idea. Proof that this goal was achieved was the opinion of the majority of the participants. Most of them admitted that thanks to this experience, they had gained a new approach to the design process, based on practical issues (i.e. materials, structure, size, joints).

The success of the workshop ensured us of the necessity of a second edition, which was held a year after (organisers: stud. M. Wróblewska, stud. A. Giełzak, stud. A. Świątek). This time, the aim was to manufacture a set of furniture for the Institute of Architecture and Urban Planning at TUL. The results of the second edition of the workshops, called P ^ 3.2, are three, fully-developed, numerically parametric furniture designs.

"The Tree" is the first of the projects. In addition to its decorative function, it may serve as a place of rest, for meetings or work. Its eye-catching, soaring and spreading form, enriches and divides the space. It also offers the possibility of serving as a presentation space for student projects.

The spatial sculpture, called the "Spiral form," takes the form of a spiral, which can serve as a seat, a couch and a place to present student theses. The furniture is made up of sections of plywood with increased density on the seat and back.

The third project developed - "Geco" - features the concept of a set: a table and benches in rounded, organic shapes. Interesting, surprising and elegant in its simplicity of form, combined with functionality (wide, long table and comfortable seating benches) it constitutes a piece of furniture that serves as not only an object of daily use, but also as a modern parametric sculpture.

During the first stage of the project, the part including the by now well-known webinars and tutorials, a series of lectures on furniture design were held. Practical information from the field of ergonomics was presented by tutors from TUL and the Academy of Fine Art. Full-scale furniture is being prepared at this moment.

RESEARCH AND BUILD

As a complement to the previously described workshop was a new project called "Nieistniejące/ Non-existent" (stud. Aleksander Dynarek, stud. Piotr Kluszczyński, stud. Łukasz Stawiński). The goal was to prepare a project devoted to restoring non-existent historic buildings using 3D printing technology. As previously constituted, it was just an excuse to pass on more general truths about the design process and to show the opportunities offered by the progressive digitisation of the architect's workshop. Again, the participants were entrusted with all the preparations – actions considered as a part of an important pedagogical value.

As it was said, the intention was to re-create demolished buildings, or ones that were never built, using the technology of the 3D printing process. Due to the local nature of the association, it dealt with non-existing buildings of Lodz. The project combined historical flashbacks, a debate about the past and future of the city, and brand new, contemporary forms of prototyping.

The practical approach from the P^3 workshop was changed into a research based project. This time, art historian research was used to support digital design. To provide a certain level of professionalism, help from the tutors and students of the Faculty of History of Lodz University was required. After completion of a list of objects, students were expected to search for information in the archives and literature. Fabrication of chosen buildings (in scale) with the use of 3D printing was partly completed on a device especially constructed by participants. The rest of the 3D prints were made by professional enterprises, who enthusiastically joined the project.

The results were presented at three exhibitions - including one, prepared in cooperation with the Association of Polish Architects, called The Architecture Week, the second as a part of an exhibition during the International Lodz Design Festival. Currently, there are ongoing preparations to develop further objects and create a database.

EXPERIMENT AND PROTOTYPING

The last step of our educational experiment was to create a workshop based on the knowledge gained by the students during the previous editions (Hinson, 2007). This time, the problems were related to the individual concerns of the participants, and the result was the preparation of a prototype. As previously, it was based on the interest shown by students and was, in fact, a response to their demands and requests.

The research LAB, or experimental design workshops as they were called, were planned to deal with the exploration of new technologies and approaches to design. The goal was to conduct research and the creation of a project by each participant (or group) on a chosen topic. This was intended to go one step further than previous activities, by revealing the architect's role, which lies in the search for new solutions - both in reality and in design and exposing, at the same time, issues which broaden our understanding of reality, and of things that are not necessarily more feasible today, but offer a deeper insight into the future.

CONCLUSIONS

Our method seems to meet all expectations imposed on it, and all of the stages have developed further. Going beyond the accepted framework of education triggered the enormous interest and commitment of students. Many of the participants have returned in second editions as tutors. The team building aspect of those actions is not to be underestimated. An important role in the process was assessing student needs in the construction of every step. This assured not only a high level of commitment of the participants, but also gave them a feeling of power over the course of their education - a quality that has to be underlined. But above all, it seems that the project achieved the most important goal that we set. It has shown the correct use of digital methods in architectural design - as a tool to achieve goals, rather than a goal in itself. It is very important for students to realise that those are not purposes in themselves, but utilities that should serve ideas and the objects designed. So, the workshops can be a kind of zipper (Cross, 1988) between theory, practice and digital design.

Up to this point, we can draw the following conclusions from the whole process:

– Work that includes not only the design process, but also execution is seen as more satisfying by students. That results in higher involvement and willingness to put in a stronger effort by the participants.

– As failure is an important part of educational process, it is crucial to allow the students to search for their own way. The role of academic teachers is limited to supervising the process and helping to find the proper sources of solutions, rather than providing the solutions themselves.

– One of the most commonly underlined assets of this activity is the relatively large freedom to decide when and what should be done. That feeling of responsibility is perceived by the student as very important. It also provides a space for creativity.

– The fabrication of ideas in full-scale is connected with a vast amount of problems. Solving them requires from students to be open to ideas and to search critically for solutions. This broadens not only their knowledge but also teaches them to work in teams, and to cope with such a workflow – one closely related to reality.

– It also shows that, due to a strong dependence on automation, sometimes even simple problems can in reality be challenging. This shows students that apart from the skills required to use such tools, they are still limited by the knowledge and ingenuity of the person using them.

– The opportunity to present the work to a wider public is also good training in presentation skills and an opportunity to confront different opinions.

– In all cases, the success of the whole depended on:

    – Clear Goals – set as soon as possible. This was proven in all cases.

    – Proper preparation – a key issue in all enterprises, preferably as a responsibility of the participants (or selected group). It is important to build a bond between them and the topic at a very early stage.

    – Appropriate methods – as for educational methodology, aspects of PBL education were used. This was especially in terms of the role of the tutor and student, co-working in teams and the need for the student to describe all the problems, not the tutor.

    – Significant results – all the projects were designed as operations, which created an important deal of different results, from academic to educational. The scale of project was always bigger than the tasks set in the curriculum.

    – Effective presentation - in all cases the finished works were presented, either at international or local exhibitions and widely discussed in the press.

–   Reflective critique – All the projects required the participants to sum up their experiences during a meeting after the end of the project. The results were taken into consideration in preparing the next workshop.

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1:1, A TRANSDISCIPLINARY PROTOTYPING STUDIO

The main author is using transdisciplinary studio courses as a research tool in the field of performative wood. Through sharing the knowledge between architectural, environmental design, and wood science researchers and students, we managed to develop complex 1:1 scale prototypes. The course process is a learning arena for students, teachers and researchers and the skills, competences and insights are being developed through experimental practice. The second prototype of the Environmental Summer Pavilion II course was created from reflection upon the first one while both serve as complex material-environment interaction studies for the development of responsive envelopes.

INTRODUCTION

The theme of this paper is to present and discuss the experiences of working in a transdisciplinary prototyping studio forming a learning framework for a collaboration between two different university level institutions, working with full scale prototypes. The research guest studios have been led parallel at architectural schools, the Architectural Institute in Prague [1]and the Faculty of Art and Architecture at the Czech Technical University in Liberec [2]in 2013 and 2014, respectively and at the Faculty of Forestry and Wood Sciences at the Czech University of Life Sciences in Prague [3].In both of the cases, there were three guest tutors, the first author, being the project leader and being responsible for the material and architectural performance of wood, Martin Gsandtner/ Šimon Prokop, responsible for coding and Martin Šichman/Martin Kloda, responsible for structure, detailing and realisation. In addition, different specialists from both of the faculties were available for the consultations and prototypes testing.

The work conducted in the presented collaboration is based on material research by design on the dynamic features of wood. Following the work of Hensel [4] and others in using the performative material features of wood, for example shrinking and warping, as a dynamic material feature from which one could benefit, the research ought to further develop this approach.

The methodology for the research is based on Research by Design (Research through Design) as described by Frayling [5] and others and developed in more detail by e.g. Sevaldson [6], [7].

Research by Design is in the process of being established as a solid approach and a more effective version of the practice of Research in Design, [8] where uniqueness, reflexivity, discourse and generalization are addressed.

All modes of modelling in physical materials and digital models are applied during the experimental design work. Full-scale prototyping is central to this method. The models and prototypes work as a dialogic platform for interdisciplinary inquiry. This way of design research had been common during the Renaissance times, for example in the work of Leonardo da Vinci. Highlighted by the most advanced structural experiments by the end of 19th and the duration of the 20th century, prototyping became a key method for material research and is used by the academy as well as by the industry.

Michael Hensel explains it as follows:

'…. The findings of the material experiments are the basis for computational modelling and analysis, which serves to further elaborate the design as it gains in complexity. In most cases, the design experiments culminate in full-scale constructions that can be further examined in order to empirically derive reliable data for the further development of the specific material system, working methods and approach to design.' [9]

From the philosophical point of view, the method is argued for by Wallner:

'We understand what we have constructed. We cannot understand anything else.' [10]

We could add that only when our experiments are finalized can we fully understand what we have constructed and what its implications will be.

Schön is describing the design process as reflection in action, explaining the reflective conversation within the situation, while gaining the skills by experience [11]. Reflection in action has been

central to the research process, beginning with sample observations and concluding with the built prototypes. The success or failure of design actions has been central in building a body of methodological and technological knowledge. Numerous failures were unavoidable due to the lack of particularly developed methods suitable for the case. Samples, prototypes, and measuring had to be repeated because of the utilization of methods that in hindsight proved to be inappropriate. As Sevaldson stated in reference to designing with digital tools: 'clear models and methodologies do not yet exist – these are being developed through practice' [12]. The same can be applied to material research by design, using digital tools and prototyping in 1:1 scale. The design problems we are discussing here are of a nature that confronts the designer with wicked problems [13]. There is no right or wrong answer, each problem is to a certain degree unique and it is only possible to base a resolution on prior experience to a limited degree. Therefore, the researcher needs to base her or his learning on practice, reflecting the failures that also bring the new findings. This process develops in iterations, which makes every new prototype more complex.

THE PROJECT: WOOD AS A PRIMARY MEDIUM TO ARCHITECTURAL PERFORMANCE

The introduced prototyping studios are part of the first author's PhD research project, Wood as a Primary Medium to Architectural Performance, where the key interest is the development of environment responsive screens/envelopes. During the spring semesters of 2013 and 2014, the courses Environmental Summer Pavilion I [14] or II [15] were conducted at the Architectural Institute Prague and the Faculty of Art and Architecture at the Technical University of Liberec, respectively, both in cooperation with the Faculty of Forestry and Wood Sciences at the Czech University of Life Sciences in Prague. Prior to the start of the first course, various theoretical studies, speculations, and sample observations were conducted by the first author and research questions for the first course were established in the paper for the 33rd eCAADe conference as follows:

– 'The main area of our investigation lies in the material performance of solid wood: Wood - Humidity - Temperature Interaction (see section 'Material Performance').
– A second topic is the question of how to create parametric models of the design and produce CNC fabrication data, leading to the question: Can parametric design cover all the design tasks? (See section 'Design Process in Grasshopper for Rhino 5'.)
– Finally, we discuss the structural possibilities of CNC fabricated design (see section 'Structural Design').' [16]

The course lead by the author, Šichman and Gsandtner lasted only a half semester, so much of the production data and industry negotiations had to be finalized by the tutors until the students returned to physical prototyping when their school duties finished in ARCHIP's students case, or in FLD CZU students' case it was their new course of professional practice. This situation was not ideal, but it was the only possible option. However the main focus on material performance was maintained in the course. The observation of warping of the panels and structure from torqued greenwood planks locked in a triangular structure was described as follows:

'...The pavilion designed for reSITE festival, is a möbius shaped structure, built from torsed pine wood planks in triangular grid with half cm thin pine wood triangular sheets that provide shadow and evaporate moisture in dry weather. The sheets, cut in a tangential section, interact with humidity by warping themselves, allowing air circulation for the evaporation in arid conditions.' [17]

Along with this project, mapping the overall performance from worldwide orientations mainly focused on sample measuring, the speculation of particular application in the building industry was investigated on prototype Ray 2. The prototype developed further the combination of design with material science. This was published in 33rd eCAADe proceedings:

Marie Davidová, Birger Sevaldson_**1:1, A Transdisciplinary Prototyping Studio**

'Ray 2 is a wooden environmental responsive screen system that reacts to changes in relative humidity. Based on the material properties of wood, cut in the tangential section, the system opens in dry weather thus airing the construction. Whilst in the humid conditions it closes, not allowing the moisture into the structure.

Ray 2 was developed from the concept of Ray with the fact that it resists to sudden rain. Based on the properties of tangential cuts from different position of the tree trunk, the plates are combined in diagonal directions…' [18] Both of the prototypes were observed and analysed and reflected upon and the findings were used as a starting point for the next pavilion course, led by Davidová, Prokop and Kloda. This time, a full semester was provided for the course so the schedule was not as tight. The resulting Loop pavilion utilised and developed further the gained knowledge to its fullest potential and increased the performance by design. The panelling was laid not only in combination of the left and right side of the tangential section, but also in spatial organisation into the structure. In this case, as it was observed on the prototype, the circulation of humid air was better. The team work was organized in a much more efficient way by arranging regular meetings with GIGA-mapping [19] for team work, an online file-sharing offered by *Copy cloud service and a private Face Book group. This was especially useful because the two participating faculties were located in different cities* [20]. The GIGA-mapping method proved to be a perfect tool for interdisciplinary communication both, within the team as well as with the invited specialists. The performed sampling, as well as parametric analyses of joints, wood extension or FEM simulation, was more promising in the end than the final full-scale prototype. This speaks to the fact that full scale prototyping is necessary within architectural research.

In both cases, the pavilions were designed by the entire team-the students as well as by the tutors-, after the initial concept sketch was selected through a competition. In the second case, the responsibilities within the design tasks were more clearly outlined after being discussed by the entire team over a GIGA-map. In both cases, the students followed up observations of the prototype originally made by the first author. The students with backgrounds from different disciplines were initially not assigned to particular tasks but all were coping with design, engineering or environmental issues. Later in the process, the responsibilities were assigned according to particular interests relating to the profession that they were studying. In addition, the researchers from both of the faculties were engaged to assist with particular design questions.

THE TRANSDISCIPLINARY PROTOTYPING

The cooperation between the disciplines proved to be smooth while each of the professions followed their particular missions. The cooperation between the Architectural Institute in Prague (ARCHIP) and the Faculty of Forestry and Wood Sciences at the Czech University of Life Sciences in Prague (FLD CZU) worked well as continual prototyping and designing were interchanging. Students from both institutions cooperated well during the overall process, exchanging their skills and using their institution's facilities and studios and competences e.g. structural engineer of ARCHIP and wood workshops and wood technologists of FLD CZU. The mature and experienced students of FLD CZU, many of them with architectural background, organized the prototyping and fabrication as well as helped with digital data.

The Faculty of Art and Architecture at the Technical University of Liberec (FUA TUL) was well-suited for concept design and this part of the project was performed there, including regular meetings over one common GIGA-map that also served for the organisation of the team work. The Faculty of Forestry and Wood Science at the Czech University of Life Sciences is well-equipped with wood workshops and testing machines. Therefore the prototyping, as well as the final fabrication, took place here. This time, we had few students from FLD CZU following the overall process but we

had also a student with building engineering background in the architectural team, who could be involved full time.

The skills of the students perfectly complimented the equipment of the school. The wood engineering students had much better practical experiences with machines as well as with the materials and the architectural and environmental design students were learning such skills from them. On the other side, the architectural and environmental design students were better in following the complexity of the overall project while still maintaining responsibility for certain tasks.

Due to the different missions of the faculties, architectural and environmental students possessed a time advantage in having the studio as the main subject. This changed when it came to the building phase, when wood engineering students were given the task as their full time exercise in professional practice.

Though we believe it would be ideal if both teams could have participated equally, the division of the work intensity according to the different professions worked well. The wood engineering students focused on material and prototyping consultancy or small tasks within the concept design phase, which was mainly executed by architectural and environmental design students. The architectural students had a perfect overview of the design and fabrication data and could organise the building process when the wood engineering students were engaged in the workshop.

CONCLUSIONS

The 1;1 scale prototyping is necessary for Research by Design development when it comes to material-design experimentations. Though the sample observations and digital simulations are helpful, they are not fully representative for the overall situation. So, despite that constant learning was achieved through action and analysis throughout the whole design process, the main learning input was obtained from the full scale prototype. And thus the loop pavilion gained the most from the previous prototypes and studio experiences while it brought forth new questions for further consideration. New experiences, successes as well as errors were recognized.

The transdisciplinarity of the project played a crucial role within the process. While the wood engineering students proved to have the best experience with physical prototyping, the architectural students were better equipped for design tasks, using digital tools and handling fabrication data. At the same time, the environmental design students had the best understanding of implementing the local conditions. One of the students had a graphic design background, which was of great assistance, when deciding the organisation of the GIGA-map, as well as its finalization for print. GIGA-mapping turned out to be an ideal tool to bridge differences between the groups and for coordinating the work.

The full scale prototype generates a distinct and clear transdisciplinary understanding because all team members focus on one common product while implementing their professional background and observing and analysing the common result at the end.

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CONTEMPORARY ARCHITECTURAL PRESENTATION IN THE CONTEXT OF THE "MEMEX" IDEA

The paper is based on direct experiences with some available presentation tools in both the commercial and academic fields. State-of the art architectural presentation methods are confronted with the "memex" idea. This confrontation aims to help with imagining future development of the field of architecture in this area. At the same time, it compares architectural production methods with presentation standards showing the detachment of these two actions and expressing the need of its integration.

THEORETICAL INTRODUCTION

Definition of Design and Design Tools Characteristics

According to Prof. Gasparski, design is a conceptual preparation of a relevant change [1]. This approach emphasizes the environmental and economic relevance of a design decision for future society. Sometimes architecture combines design with art/culture. This second subjective aspect of architecture is difficult to quantify. Therefore, design tools should have the capacity of expressing objective and subjective aspects of change. Change can be expressed by making a clear schematic comparison between the state before and after the design intervention. On the other hand, a tool should be able to express the atmospheric quality of change. These opposite requirements led to the necessity of using a different media, mixing them in process of design creation and design presentation.

Architectural Design Presentation

Based on Gasparski's definition of design, architectural design presentation is kind of presentation which appropriately codes the conceptual preparation of architectural change. Appropriate code is adjusted to the subject of the presentation and to the ability of the audience to decode it.

Having this approach in mind, media that is involved in design presentations should be orchestrated with design nature. That becomes an unusual problem in spectrum of fine arts and science. Other disciplines work directly with its final product. Writers work with words, painters with "paint", theoretical physicist with theory, etc, even car designers can have a hands on approach and control of final outcome. Maybe the composer's position in most similar to architectural designer, if he limits himself to just the music composition project without its execution.

This detachment between architectural design and architectural product leads to the need for specific coding methods. A classical solution consists of set of various types of drawings and models. While architectural drawings are simple and become natural for people from the industry, they demand a certain level of architectural literacy. Although it is not a problem for the industry itself, it is a large problem for people who are responsible for communication with others who do not have this kind of background.

Relevance of the Memex Idea.

Memex is a theoretical computer concept introduce by Vannevar Bush in text "As We May Think" in 1945 [3]. Memex is used for extending user memory throughout lifetime. It was theoretically constructed using outdated technological components, but the strength and relevance of the memex idea can be observed on its meta level fertility. It has a strong bond with the hypertext concept and its user-oriented component can be traced back to many internet services. Thanks to applications like Evernote [2], Vannevar Bush's idea of Memex was realised with help of contemporary technology already available. Some ongoing research projects like MyLifeBits [4] investigate the problem of life long data storage. On the other hand, the internet serves as form of memex for society. By now the active form of saving data is needed while links between elements are able to emerge as a resolution of a script's activity. Even the border between a personal memex (like Evernote) and a public one is broken already. It is still present with Google products, but Facebook and Pinterest are following the same path. The strong presence and success of this direction of development should justify the relevance of the memex idea in context of future development.

The Memex Idea: How to Turn It into a Presentation

Hyper-presentation is a method of introducing interactivity into presentations using the memex concept. In this kind of presentation, multimedia can be linked together in various configurations. Problems with the compatibility of media appear also in the relation between hyperpresentation and other memex systems. We can think about contemporary memex as a well linked database with almost unlimited possibility of extension. This flexibility and lack of limitations has weaknesses when it comes to communication. Mieczysław Porębski in his essay "Art vs. Information" explains how rapid is the growth of simple information. Information, and therefore presentation of it, need to be cleaned of noise in order to be understandable. The conflict between the richness of available data and noise appear.

Coding Strategies - Choosing the Best Media

Joseph Kosuth's One and Three Chairs (1965) showed that using different media does not necessary lead to increased richness of a message. It even can have opposite effect. One of the communication strategies can be focused on choosing the best media for the project. In Kosuth's case, it would probably be by a model. While another strategy could be to keep all media available but to express different attributes by different media. Models cannot tell a history which text can and pictures cannot express kinaesthetic. Text is most capacious and elastic medium. It is also one of least direct. On the other side of the spectrum, there are models that are very direct and interactive but also very demanding to produce.

The memex style of presentation should be able integrate the properties of all media.

CASE STUDIES

Case studies present recent experiences with new (for the author) possibilities of architectural presentation both in terms of media and presentation formats.

Educational experience

A 3d Visualisation techniques seminar conducted in the ASK studies programme investigated the possibility of using Augmented Reality (AR) and Virtual Reality (VR) in architectural presentations. Core exercises are based around the unity game engine. AR and VR exercises are done in the context of fundamental knowledge from the photo and video realm.

Unity is a free game engine , which requires no scripting knowledge to perform basic tasks. Thanks to the growing popularity of the engine, 3rd party components and prefabs are available for Unity. Communication between android/OS mobile devices and PCs, however, can be tricky and sometimes even overwhelming for people without a background in computer science. Despite this difficulties AR presentation was never so available and easy to reach. It takes two days to present the whole process of AR production. After this initial introduction and proper hardware set up, producing AR takes several minutes. There are commercial or even free apps whose learning curve is flatter then Unity, but they are limited to AR only. Moreover, they are full of limitations. Vuforia for Unity, on the other hand, gives a lot of possibility for application personalization.

The second part of this class was concentrated on VR. The reappearance of virtual reality on the market can be seen influencing the gaming industry. The Oculus project has its SDK available for Unity developers. The entry level for the device can be still a problem if somebody wants to just give VR a try. Google Cardboard makes virtual reality available for home use. Every smart-phone that can track position in 3 axis can become a VR device just by inserting it in a simple casing. Thanks to Google Cardboard SDK for Unity, students were able to export simple virtual reality applications and experience their models in VR. So far applications had a form of 360 movie with no extra interactivity. External controllers were not used, which leaves a huge space for future improvements of the class.

Game engines can operate with new media and are interactive. They utilized hyper-media with ease. Some games are in fact hyper-presentation with a additional component of competition. While teaching architects game engine seem a little bit unnatural it is a easiest way to experience new media now. We can observe some startups that target their services in changing architectural models in to VR tours. It is expected that this kind of functionality will be integrated with software dedicated for architects. Should it be a part of education programme? Should education be involved with developing skills which have short time of relevance?

Practical Experience

While AR and VR are not an industry standard yet, movies, animations and iconography definitely are. Standard presentation formats are pdf, Powerpoint and Keynote - usually used with live commentary. Additional movies are made which can explain project by themselves – typically with voice over. The presentation software can handle animations but typically do so poorly. Even if a designer owns (or plan to finally produce) a fully independent movie, it is difficult to use it as a part of the presentation. There are options for playing and looping a movie available. The smooth connection between two looped clips is not an option. There is no option of playing video clips on demand and doing it with background music synchronisation.

We can find tools that help us to play different music pieces in random order and length while still keeping smooth connection between them. Even some electronic toys are based on this principal. Unfortunately, there is no tool on the market that allows us to navigate smoothly between different formats and keep continuity of audio-visual experience. Interestingly enough, ProPresenter is maybe as close as it gets. It is a software dedicated for conducting religious meetings or popular music concerts. Unfortunately, it was found after our "in house tool" was developed.

By using action script we have created a player, which can smooth transitions between one looped clip to another one. Actions are triggered by events and clip behaviour is predefined in a text document. This application is already outdated – HTML5 is a superior language. Now I see two paths of further development. First one, developing custom non-linear multimedia player. Second, integrating office production pipeline closely with environment like Unity.

FUTURE EXPECTATIONS

It was expected that the personal computer would become more present within our life; That we would have contact with it not only in particular place but everywhere around us. Augmented Reality is an old concept but maybe we are now on the technological level to make it present in our life. Microsoft advertises "Holo lens" as a part of future of their system development. Augmented reality may become a primary environment for interaction with computers.

BIM in Production and in Presentation

BIM is a memex of architectural model creation. One can argue that the creation method has a rather linear structure but maybe we should not transcribe rules of hyper-fiction into engineering field without dramatically changing construction methods. After the conceptual phase BIM projects can be worked with in a non-linear style. BIM is already heading towards multidisciplinary communication. Platforms enable us to get complex data from the model. New updates of the software enable more elaborate 3d representation of the model. Other representations of the model can be customized for presentation needs. So far, BIM's focus is on communication inside the industry and in addition the production of some elements of the classical project presentation. Schemes and diagrams are now detached from the model. There are no tools to break the scale or to show process in time. The software enables user to add self made customized tool. The tool can link "project isotype" with project model. The result can be use during presentation process. Unfortunately not applying this logic to the program core will demand unreasonable amount of work.

Until now the BIM software industry is detaching presentation from design. Another aspect that is missing in contemporary BIM software is the possibility to control the narrative. Narrative can, by proper connection, change data into information.

Why we do not have a tool which enables designers to create custom made multilayer presentation with bespoke narratives which would be design tools as well? Probably the crucial reason lays in market demand. But we know today that this kind of tool is possible to build and when industry will get to next level of BIM collaboration, software providers will enrich their products with this kind of integrated tool set.

Final remarks

Being an innovator or even early adaptor of the concept is not an efficient strategy. Usually, it takes a relatively large amount of time and the results are unstable. Nevertheless, I think VR, even in this early stage, gives a new experience incomparable with any other experience of the project. The VR experience can help with the decision-making process. I think this tool should become more present in architects' workshop.

As far as hyper-presentations are concerned, this is a tool of persuasion. It may have an impact on communication and marketing of the project but so far I don't see a direct link between architectural work and hyper-presentation model.

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REDUCING THE ENVIRONMENTAL IMPACT OF THE PUBLIC WATER TRANSPORTATION SYSTEMS BY PARAMETRIC DESIGN AND OPTIMIZATION OF VESSELS' HULLS. STUDY OF THE GDAŃSK'S ELECTRIC PASSENGER FERRY (2015-2016)

This paper presents the potential and risks of utilizing Rhinoceros and Grasshopper software for parametric design and multi-varietal optimization of the hull of a small sustainable ferry. The sustainability criteria, parametric design flowchart and optimizing methods are described. As the result, the advantages and disadvantages of this approach obtained in the research-by-design process conducted by an intercollegiate team at the Gdańsk University of Technology are given.

INTRODUCTION

The history of the passenger ferry route between the Gdańsk's Main City and the Ołowianka Island goes back until the Middle Ages. From the 15th century, the upper banks of the Motława River have been used as a mooring wharf, which prevented the community from building a fixed bridge on the west side of the island. Today, this 85-meter-long ferry connection is maintained by the National Maritime Museum (NMM) which has its buildings on the both banks of the river. The motor ferry 'Motława' transits daily to the island every 15 minutes[1], which makes pedestrians' 1-kilometer-long way between the Old Crane and the granaries of Ołowianka twenty times shorter. The importance of the ferry grew after the Polish Baltic Philharmonic was relocated to the revitalized buildings on the Ołowianka Island.

As the existing ferry 'Motława', in service from 1975, is reaching her retirement age, NMM plans to replace it with a modern vessel capable of meeting growing expectations of the passengers and crews and following today's EU environmental regulations [2]. Design work on 'Motława II' started in March 2015 as a collaboration of the NMM and the Gdańsk University of Technology (PG)[2]. The goal of the project was to create a feasible proposal for a new sustainable [4] ferry. The research objective was to explore the potential of different design tools and methods with special regard to two of them: the physical hull model testing and the low-end modelling software.

The aim of this specific paper is to present how parametric design and multi-varietal optimization may be utilized for shaping more sustainable vessel. In our work we will:

– define what is a sustainable ship
– diagnose what makes it impossible building more green vessels
– describe the process of designing the sustainable ship on the example of „Motława II"

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As the design process is currently in progress, we present only the closed parts of the design that refer to the propulsion system and the hull shaping.

DEFINING THE SUSTAINABLE VESSEL

The main function of ships so far was to transport goods or people in order to obtain the highest possible profit. But, today, it is clear that the ship should not only fulfill traditional functional criteria but also meet certain ecological requirements. The latest Swedish research [3] shows that in the coastal areas almost half of hazardous nanoparticles in the air come from sea traffic. According to the INCOWATRANS project [6], the most difficult and important environmental problem of ship operation is air pollution from internal combustion engines. Reducing this is especially important where passenger vessels operate in the city centers, especially those where many citizens are already exposed to the different types of air pollutants.

The idea of such "green" vessel slowly finds its way into ship building branch. AIR-ECO+ and ECO BWM are examples of eco-friendly sea-going ship classes proposed by Polish Register of Shipping. An example of such definition for inland vessel was proposed by the INCOWATRANS project:

> *"Environmentally friendly inland or coastal vessel is characterized by the lowest environmental impact for the entire period of its life with regard to the fact, that it will not operate forever"* *(Kruszewski, W., 2006:7).*

According to the above, throughout its life cycle the sustainable ship should:

– use renewable energy and materials
– save materials,
– save energy,
– not pollute.

Among many problems of introducing the concept of sustainability in the naval design we focused on two major issues especially related to small vessels: the process of optimizing the design and the choice of propulsion type.

PROPULSION

Currently approximately 90% of inland vessels [6] are equipped with internal combustion piston engines. Most of the city ferries use high-speed diesel motors characterized by their low weight and compact dimensions but high noise. They use fossil fuels and emit following groups of pollutants:

– fuel, oils, coolants, shaft sealing polluting water during operation or damage;
– products of combustion [6] and hydrocarbon vapors from the fuel tanks;
– combustion, operation and vibration noise.

A partial solution to the problem is the hybrid system called "Diesel-electric". It consists of the diesel engine driving the generator, which, in turn, powers the electric motor that moves the propeller. "Diesel-electric" system his more fuel efficient and has lower noise emission. However, it still consumes fossil fuels and is not entirely exhaust free.

New technical capabilities of electric energy management and propulsion bring two alternative concepts. The first is the fuel cell engine, where electricity is produced in the electrochemical reaction. Exhausts are water, carbon dioxide and nitrogen - the harmful emissions are extremely low [4]. The second is the electric motor powered by the battery, photovoltaic cells or multi-source power supply. It produces no exhaust, no operation noise and does not use the fossil fuels. A

relatively low price, small size and the possibility of using renewable sources of energy makes this solution popular in the sector of inland ferries [1, 5].

Both concepts have the following advantages:

– elimination of exhausts;
– no pollution from leakages of fuel, oils or cooling agents;
– no risk of contamination during refueling;
– possible use of renewable energy;
– low noise emission.

Taking into account the cost and reliability of two described systems, the electrical battery powered propulsion system was chosen to be implemented on 'Motława II'.

DESIGN OPTIMIZATION

As building a full-scale prototype of a ship is almost impossible, uncertainty becomes the essence of naval design. Before launching the crucial design, features of the new vessel like stability or trim are very difficult to precisely predict. Theory describes two classical methods of overcoming this difficulty: basing a design on the parent ship or using the statistical empirical data [7], [10]. In these methods, the design starts from the general approximation of the vessel that is then developed in a long series of successive adjustments and corrections – the iterative process called the design spiral.

As the designer has to go from one iteration to another – manually or even using CAD – this approach is restricted by the limited time and cost of the design works. So, the main disadvantages of traditional methods are the inefficiency and the inaccuracy. According to Chądzyński [9] and Cepowski [10], the need for changing the traditional design process results from the need to:

– shorten the project cycle;
– reduce the number of iterative operations and move them to the earliest stages of the project;
– design new types of ships that are not covered by statistical databases;
– allow for changing the main design parameters of the ship in later design phases.

They propose the methodology of integrated and synchronous design process, which means:

– simultaneous consideration of all the elements of the object's function and its systems'
– definition of attributes of individual object's systems and subsystems (like mass, volume, energy, etc.),
– designation of the architecture functional-spatial scheme and volumes.

According to Michalski [7], the first step of the project is a phase of parametric design. It identifies the ship's parameters that determine the qualities of the whole project. In the classical approach, the main problem of this phase is the need to anticipate the multiple characteristics of the vessel without knowing the shape of the hull. Therefore, an important advantage of synchronous design is the possibility of connection of subsequent phases at the same time. The algorithmization of this process allows for testing of many possible variants of solutions.

The integrated and synchronous design requires using advanced software that allows the achievement of the highest level of detail [10] in the preliminary phase. Examples of such tools are: SHIPFLOW and NAPA [7]. These programs are expensive and require highly skilled and multidisciplinary teams, therefore, they are often unattainable for solo designers who usually work

in the sector of small ships. However, thanks to the wide access to computers and the Internet, even small design groups can use shared libraries, numerical methods and computer graphics. Refined visualization techniques and software systems engineering coupled with a significant increase in computing power make it possible to create modern design tools at low costs [7]. Even affordable modelling software like Rhinoceros 3D, Grasshopper or naval architecture programs like Orca 3D allow for algorithmization of the design process and the creation of tools for integrated and synchronous work.

Therefore, the design proposal for the "Motława II" combines two quite new concept of naval architecture: electric propulsion and dedicated parametric design methods.

DESIGN PROCESS

From the very beginning of the process – generating the preliminary geometry of the hull – we used generative algorithms software (Grasshopper for Rhinoceros) instead of the traditional modeling CAD systems. The overall project guidelines were:

– length of hull - 12,0m, beam - 5,0m;

– number of passengers: 50 persons;

– crew: 3 persons;

– construction material: steel;

– equal forward and backward manoeuvring properties.

– propulsion: electric, powered by batteries charged from the shore grid and photovoltaic panels;

In the first phase, nine different hulls were created in Grasshopper and visualized in Rhino. All of them were longitudinally and transversely symmetrical and had no appendages, as two azimuthal propellers were planned for the vessel. They were based on the following traditional hull types:

– flat-bottom;

– spheroidal;

– with a keel ('yacht shape');

– with a cruiser stern.

These hulls were then tested in Grasshopper for meeting the criteria of sufficient stability calculated as the heeling angle caused by the side wind and the passengers and crew placed on leeward (not exceeding 12 degrees) [8]. The minimum wetted areas that corresponded with the minimum frictional resistance were calculated as well. Simultaneously, rechecking resistance calculations were made using the Leningrad Design Office method [11] in MS Excel and with Holtrop analysis in Orca3D[3].

The results from Grasshopper, Excel and Orca turned out to be qualitatively correlated. The research showed that the optimal hull shape lies between a simple cuboid (highest stability) and part of spheroid (lowest resistance). This type was selected for further work.

To obtain better control of the form, the new hull topology was programmed in Grasshopper from scratch. The new bottom shape was a part of spheroid capable of changing its longitudinal and transverse curvatures. The former was determined by setting the stems height and the maximum draft. The latter was dependent on the amidships chine height. The topology of scantlings inside the hull was pre-programmed[4]. This allowed the calculation of the mass and the center of gravity of the hull based on the areas of the main elements (empirical correction factor for minor stiffeners

3 - total resistance for the speed of 10km/h.

4 - Scantling of construction details may be based on the requirements of classification societies, based on many years of seamanship and often containing restrictions not allowing for innovative solutions for the construction. They can be also an outcome of the direct numerical methods of structural mechanics. In this case the scantling were determined in accordance with the requirements of PRS. The further work on the project will also include the structure design using FEM methods, allowing for further optimization.

were applied). The obtained algorithm allowed to instantly update the hull after a manual input change.
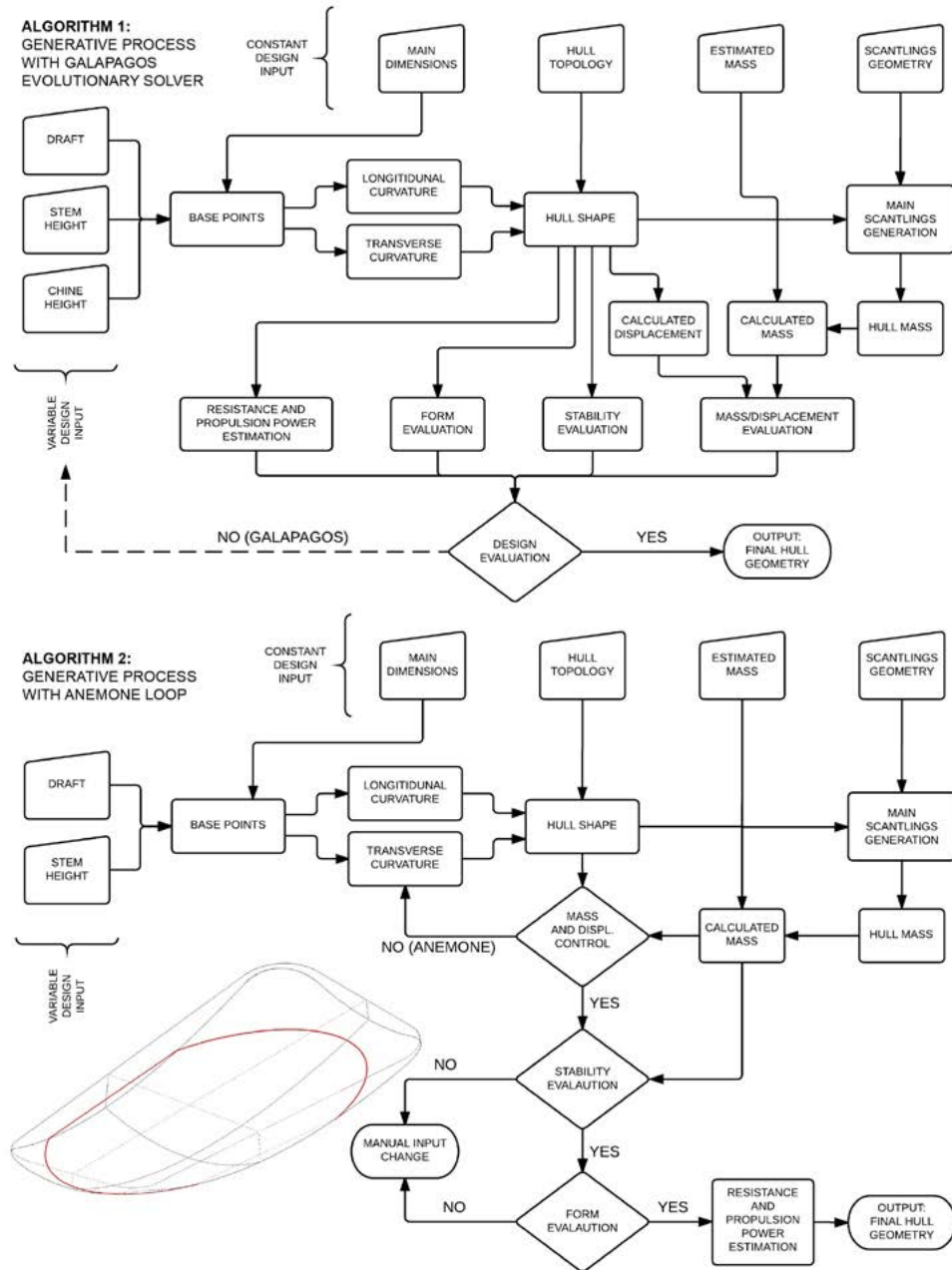
The next step was to optimize the form. To achieve an eco-friendly hull we searched for a shape parameter that corresponds to its lowest environmental impact. As our optimizing method allowed for only one parameter we decided to focus on the propulsion power which may be considered as inversely proportional to the vessel's sustainability.

This decision was based on two reasons:

– there are many available methods of power calculation based on a different number and precision of data;
– all of the methods bounds the single parameter of propulsion power with three out of four previously defined sustainability criteria: low mass, low energy consumption and low pollution emission.

Therefore, preliminary hull was optimized to find its lowest propulsion power and to meet the stability and the feasibility[5] requirements at the same time. For this purpose, we used a genetic solver (Galapagos for Grasshopper) to simulate a process of the natural selection of the best sets of the variable inputs like draft, stem and chine heights (see Fig. 1, algorithm 1).

Evolutionary computing gave very good results, but it turned out to be very slow which was inconvenient when it came to changing the input parameters for examining different versions of the design. Therefore, to develop a quicker and more responsive tool in the final phase of hull design we replaced evolutionary solver with an iterative process (Anemone loop), which allowed for us to quickly finding the proper transverse curvature giving the displacement volume that matches the total mass of the vessel. The number of input factors was limited to two (draft and stem height) and the stability and shape evaluation had to be done manually. Despite the lack of the optimizing component, this approach turned out to be very useful as it provided instant results (see Fig. 1, algorithm 2). The problem of selecting the best pair of inputs was solved by the 3-dimensional chart.

RESULTS

We obtained two systems that generate hull geometry capable of fulfilling the stability requirements with the smallest request for the propulsion power. The evolutionary algorithm was useful to establish the basic parameters of the hull with no restrictions to the number of variable input data but was too slow to allow for the examination of different sets of assumptions and different versions of the structure in the design process. The iterative algorithm was less flexible but much quicker which makes it a good tool for refining the final shape. Both systems are open for development and modification of input parameters.

CONCLUSION

Parametric design and multi-varietal optimization of a small vessel's hull may be conducted in low-end modelling CAD software like Rhinoceros and Grasshopper with very good results. The power of the real-time modification of design inputs is a very valuable asset, especially for teams in which coordination between different professionals is important. Considering the costs of the CAD naval architecture systems, this may be the only option for developing satisfying solutions for small crafts, especially when sustainability is a determining factor.

The advantages of presented approach of parametric design and optimization are:

– flexibility – all input numeric parameters, such as the main particulars, detailed dimensions and classification limitations may be changed in each phase of the design, resulting in an immediate model update;
– holistic approach - this generative method may cover the whole design process including the workshop files for CAM;
– resource saving – the automation of the process lets the designer focus on the crucial aspects

5 - "feasible hull" means the geometry characterized by mass equal to displacement and details that allow for manufacturing.

of the project or to test more solutions in shorter time without fatigue or mistakes,

- easy optimization – thanks to evolutionary algorithms, solution of very complex problems may be found in relatively easy way,
- low cost - Rhinoceros (around 1000 EUR), Grasshopper (free).

In the course of research, we defined the following limitations of the examined tools:

- the topology of the model cannot be easily changed without modifying the generative chain which restricts the flexibility to the topological limits;
- except for a few modules, such as the propulsion power or displacement control component, the algorithm is strongly related to certain topology and may not be utilized in other designs;
- despite the very unusual simplicity of the desired form (longitudinal and transverse symmetry), the algorithm is quite complex, which may be an obstacle in more complicated shapes;
- the time required for solving the problem by the evolutionary algorithm may disrupt the workflow.

SUSTAINABLE VESSEL – THE CONNECTION TO THE FUTURE

Thanks to the proposed innovative design concept, the city of Gdańsk has a chance to get a connection between the Main City and the Ołowianka – a connection of Gdansk's heritage to the sustainable future.

We hope that 'Motława II' will not only shorten the pedestrians way between the Old Crane and Ołowianka but will be attractive, modern and sustainable. Thanks to the collaboration of the NMM and PG, the new ferry will be an example of an sustainable inland vessel with the lowest environmental impact in the entire period of her life.

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