Encouraging DfE in Design Education to promote Sustainable Medical Product Design

Pranay Arun Kumar
Department of Innovation Design Engineering, School of Design, Royal College of Art, London, pranay.arunkumar@network.rca.ac.uk
Stephen Jia Wang
Department of Innovation Design Engineering, School of Design, Royal College of Art, London, stephen.wang@rca.ac.uk

ABSTRACT

Without disputing the importance of eco-design and sustainability in design education, there is little evidence of work specifically targeting sustainable medical solutions. Developing medical devices is complex, financially risky, requires large upfront investment and involves long lead times to market. In global design education today, the rigour and necessary focus on safety and efficacy of medical devices has meant that efforts to minimize environmental impact are often deprioritized or postponed, but increasingly emphasising on providing guidance to firms.

This exploratory study aims at understanding how design education affects DfE implementation in the process of designing medical products. 54 healthcare and medical design programs were identified online and analysed based on the information they provide on their websites. The surveys and the following analysis of the data helped highlight some of the problems in design education and open the platform for future work in environment conscious design education.

Key Words: Design for Environment, Medical Design, Design Education

1. INTRODUCTION

As the understanding of design and its complexities increases, today we stand, a century after the birth of the Staatliches Bauhaus, with new challenges to the purpose and role of design in shaping the world around us. As eloquently put by Findeli, (2001) "..design could not only contribute to a sustainable natural world, but would adopt as a purpose something such as: "A balanced humankind in a balanced world,"...". Here, he refers to the need to use design to address the concerns of our biophysical, social and cultural environment, and in effect address the

human condition. To do this, the design curriculum should be developed using anthropology and cosmology as the two polar complementaries (Findeli, 2001).

The medical industry is highly wasteful in its processes and resource consumption. A study by Minoglou et al. (2017) observed the healthcare waste generated by 42 countries and their associated GDPs. The average amount of waste generated by a patient per hospital per day ranges from 0.44 kg in countries like Mauritius to 8.4 kg in the US. It was observed that countries with a higher GDP tended to produce higher quantities of health care waste (Minoglou et al., 2017). With the emergence of new markets and the rise of an ageing population, the industry is predicted to grow further (Deloitte, 2016). This may indicate a rise in health care waste, and associated problems. How does this waste impact the environment and human health? Apart from unregulated abuse of land, the toxic substances in the waste leach into the soil and the water table, and scavengers carry pathogens through the air. The poor ventilation of large piles of rubbish also leads to the production of Carbon di oxide and Methane, thus contributing to GHG emissions.

An exploratory study conducted by Moultrie et al. (2015) surveyed 34 medical device designers regarding the barriers to implementing Design for Environment (DfE) principles in the practice of designing medical devices. The survey indicated that one of the urgent issues to tackle in the medical device industry regarding this subject was the education of designers and clients to implement DfE (Moultrie et al., 2015). Although this does not indicate an absolute lack of sustainability education in design education for medical devices, it may indicate inconsistencies. According to the survey, currently the only institutes that are involved in educating the designers and manufacturers about sustainability are the regulatory bodies. Just like education in law and medicine is highly driven by the set protocols and regulations followed by the country, it may become important to educate students about regulations in manufacturing to ensure that students are up to speed with acceptable norms of practice in design for medical devices.

Back in 2007, Ramirez surveyed the inclusion of sustainability in design programs around the world (Ramirez, 2007). He concluded that although designers were well aware of the concept of sustainability, and it was actively taught in design programs at the higher education level, it did not have the importance and value that it needs (Ramirez, 2007).

In this study, we look at the emerging trend of specialised design programs catered towards healthcare and medical technology, and how they respond to the global need for sustainable solutions.

2. THE CURRENT STATE OF DESIGN EDUCATION IN HEALTHCARE

Today, there is a strong focus on design for healthcare and medical technology with many higher education institutes offering dedicated programs in this area. In this study, we have compiled a list of dedicated programs around the world offering design education for healthcare and medical technology. The list includes degree programs, certificate programs, and diploma programs. Multiple programs on bioengineering, bioinnovation and industrial design were found in which a part of the focus was on medical devices and healthcare, but these are not included in the scope of this paper. The list does not include short courses, courses within other programs or fellowship programs. The list also does not include programs that may be valid, but do not provide a relevant website for course information. This list was created by conducting google searches with the following four phrases ‘healthcare design program’, ‘healthcare design course’, ‘medical design program’, and ‘medical design course’. For the complete list, please refer to Appendix I.

The purpose of this list is to give the reader an idea of the emerging trend in design education catered towards healthcare and medical devices, and lay emphasis on how these programs pay attention to sustainability through their pedagogy. The purpose of this list is neither to exhaustively collate all healthcare-oriented design programs, nor is it to pin-point the triumphs and failures of specific programs in how they address the concept of ecological preservation. The course content of the identified programs was analysed and has been presented in this paper as a discussion.

The search resulted in the identification of 54 distinct programs. Out of the 54 programs identified, 26 programs were Masters level, 17 programs were certificate level, 7 bachelor's level, and 2 each doctoral and diploma level. Out of the 17 certificate programs, 7 were online courses. 10 programs used the word 'sustainable/sustainability' in their program description. 9 programs mentioned 'systems thinking' in their description of taught modules. Two programs mentioned that they focus on lean thinking and six sigma principles. Two other programs emphasized on efficient use of resources. There were three programs that broadly looked at solving real-world problems. 21 programs had no descriptions that even vaguely focused on sustainability as part of the learning provided to the students. University of Leeds adds education in sustainability through the ethics module. But sustainability is only one of six examples of topics covered on their website. A word search on the program description pages of most of the other programs showed that they did not use the word 'ethics/ethical'.

Most programs identified are based in English-speaking countries, with USA accounting for 22 programs and United Kingdom accounting for another 14. In figure 2, the size of the dots used to locate programs is directly proportional to the number of programs identified in the city. There were 4 programs identified running just from Dublin, while another 3 were found in London.

3. THE 5 ASPECTS OF SUSTAINABILITY IN DESIGN EDUCATION

A study by Ramirez et al., (2016) explores the role of sustainable product service systems in industrial design education in Australia. Through case studies of student projects on climate and resource scarcity, mobility and health, Ramirez et al. show the embedded understanding of sustainability in these projects, and thus the permeation of sustainability in industrial design education. One can argue that sustainability becomes an embedded value in design when the need is apparent (as exemplified by Australia's scarce water resources), and thus it is taught purely as an ex-post practice. But what about design as an ex-ante practice, preparing for future scenarios and as an attempt to minimize the impact of our consumption today?

Although the Talliores Declaration (ULSF, 1990) did set the precedence for universities to acknowledge and commit to environmental sustainability in higher education, it was not enough to convince the signatories to adopt and implement impactful measures in their curricula (Ramirez 2015). As Ramirez (2015) clarifies in his elaborate survey on industrial design programs offered by the Talloires Declaration signatories, even though 80% of the degree programs do cover, or intend to cover aspects of sustainability in their programs, there is very little evidence in the form of student projects to validate this learning.

With the concept of sustainability not yet realised in industrial design education, where does sustainability in design education fit with healthcare and medical products? An important aspect of medical devices is sterilization. Every product, before and after its use, must be sterilized to ensure that patients do not get infected by exposed devices, and pathogens are not released into the environment from non-sterile equipment. The stakes are also very high in the case of the healthcare industry because medical negligence has a high cost associated, often causing lawsuits which can be financially demanding, and degrading the reputation of the organization responsible. At the same time, the waste generated from healthcare industries is highly toxic and pollutive. How can complex issues such as these be understood and resolved through design education?

Here we discuss five ways of strengthening the value of sustainability in design education, each bearing its own merits and implications.

3.1 Pedagogy of design in higher education

When looking at it from a pedagogical point of view, we must question how teaching can be structured in an undergraduate program of three years, or a postgraduate program of 2 years. It is also important to question the essentials of design education, what they should comprise of, and where does sustainability play a role. Is sustainability one aspect of the education, or is it fundamental to design as a subject? Is it an over-arching theme, or is it an essential part of the process? One way to encourage a holistic understanding of the context is to introduce systems thinking in design education. To encourage students to look beyond their skillset, and appreciate the complexity of the systems they live in, has shown to bring in concepts of sustainability and holistic decision making in the process. Of course, while design students and design teachers do acknowledge the role of sustainability in

industrial forms of production and consumption, the reason it gets left simply as a keyword is that the subject in itself is far more complex than a lecture or seminar. It requires conscious practice, and imbibing it as part of the factors that impact its use and the context in which it is positioned. As Findeli (2001) mentions in his article, designers should be interested in the origin and destination of their project, and in doing so, be interested in the complexities of the end and the beginning. Only then will they get a glimpse of their impact and their thinking on a seemingly simple concept.

One way of introducing sustainability in design education is by creating relevant project briefs for students. Ramirez (2018) documents a Circular Economy Challenge that he had floated for third year Industrial Design students at UNSW. A survey questionnaire answered by the students at the end of the project showed that they were now more aware about the broader aspects of sustainability. The survey also showed that many students were motivated by this project to imbibe principles of sustainability in their own lives.

The 7 online courses identified in the study catered towards a theoretical understanding of the topic, and relied on the self-motivation of the students to apply the theory in practice. It is also important to mention here that each of these courses were offered by highly credible institutes and universities. More and more we see that students are less reliant on classroom teaching to understand theoretical concepts, and use their time at university to gain access to facilities that they may not get once they graduate from these institutes. In the case of design, especially in healthcare, online courses can be leveraged significantly, since healthcare and medicine are tremendously theory-driven, and require a good understanding of the regulations, healthcare systems, and the human physiology before attempting to find solutions.

3.2 Praxis, not limited to Poeisis

One of the many concerns of design education today is that, the teaching is focussed on the design process from idea generation to solution making. This covers essential concepts in the area of innovation and making, but it fails to address the role of the solution beyond its own use. Even the core definition of sustainability is not embedded in design education today, because otherwise there would be a much stronger focus on how to sustain solutions. As the concept of value shifts from the product as an entity, to the agency it provides, the role of the designer must shift to finding a solution with or without making an object. “Making” is an important part of the job of a designer, but not the only part. “Not making” is an equally important part of a designer’s responsibility, if not more important sometimes (Findeli, (2001)).

3.3 Explicit or implicit

As observed with the course contents and program overview of the programs identified in the survey, most courses do not explicitly mention ‘sustainability’ in any form in their program. So the question here is, “should sustainability be made explicit in the course content of a program?”. Ideally, sustainability of solutions, be it social, environmental or technological, should be implicit in the designs produced. Sustainability is not a specialization or a silo of design education. It is a scientifically proven requirement in society and an ethical stance. Thus it, could be implicit in design education. But it is still not valued, as it involves rigour, time and money to create sustainable solutions. This dichotomy of making sustainability implicit or explicit in design education needs to be addressed. If sustainability is not a core focus of design, then it must be made explicit, to reiterate its importance.

3.4 The gap between design education and practice

One reason why sustainability in design education fails to follow through with professional practice is that the current industrial requirements do not emphasize on sustainable practices. There is a disconnect between the ethics of design practice and the industrial requirement. As the use-and-throw culture grows, there is less of a need for products to be easy to repair or recycle, and the focus remains purely on instant gratification and user satisfaction. Here, it is important to question the role of ethics in design education, and the transfer of design ethics to practice. It is important to emphasize the role of the consumer in wanting responsible and ethical practices in product design and manufacturing for it to seep into the requirements of clients and designers. As Moultrie et al. (2015) explain, the regulations are not stringent enough with medical devices when it comes to environmental impact, and result is that many devices use harmful quantities of toxic materials that degrade our environment after their use.

3.5 Sustainability of design education

So far we have discussed, how sustainability can be addressed in design education. But what about the sustainability of design education. While the concept of evaluations in most schools is still driven by individual efforts of the students, most designers end up working professionally in collaborative and team environments. The ability to use the individual's voice for co-creation and constructive criticism is not developed when the focus of the education is on the individual. This lack of knowledge exchange between the students often means that the knowledge gained or created by an individual resides within the individual, restricting the transfer of knowledge to others in their environment. This could also be a reflection of society today, where the individual's achievements are glorified over the team efforts to achieve mastery. To put designers on a pedestal of out-of-the-box thinking and masters of creativity is to isolate them and stifle the potential holistic development of a group. We are now beyond the age of silos of fields and disciplines, and well into the age of co-creation and inter-disciplinary value creation. The only way to encourage holistic thinking and include multiple perspectives is to encourage teamwork and interdisciplinary activities in design education.

4. DISCUSSION AND CONCLUSION

Sustainability is not an elective course or a hobby-subject. It is embedded in our concept of "living". The term health is synonymous with sustenance. We can only sustain our lifestyle, our work, our activities and our thoughts while we sustain the physical and emotional manifestation of our individual identity. When health degrades, it affects everything we do and live for. This study not only indicates a growing focus in the role of design in healthcare, but also the need to relook at education in design, and how it affects us in different timescales.

We are the only species on this planet to have prolonged our individual lives, and hence our civilization by ensuring the sustained healthcare received by each individual. The same concepts apply to the products we build, the environment we live in, the people we cherish and the systems we create. While some things are inanimate, their sustenance, affects the larger consumption patterns we create, and these patterns have drastic effects on the delicate balance of the environment around us called Earth. To build sustainable solutions to our everyday problems is to build a sustainable future.

BIBLIOGRAPHY

Deloitte (2016) 2016 Global health care outlook: Battling costs while improving care. 2016 pp: 1-28

Findeli, A. (2001) Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion. *Design Issues*, Vol. 17, No. 1 (Winter, 2001), pp. 5-17 https://www.jstor.org/stable/1511905

Minoglou M., Gerassimidou S., Komilis D., (2017) Healthcare waste generation worldwide and its dependence on socio-economic and environmental factors. *Sustainability* 2017 vol:9 (2), 220.

Moultrie, J., Sutcliffe, L., Maier A., (2015) Exploratory study of the state of environmentally conscious design in the medical device industry. *Journal of Cleaner Production* Volume 108, Part A, pp. 363-376.

Ramirez M. (2007), Sustainability in industrial design education: a worldwide survey. *Connected 2007 International Conference on Design Education*, 9-12 July 2007

Ramirez, M. (2015), Commitments of University Leaders to the Talloires Declaration: Are They Evidenced in Industrial Design Teaching and Learning? *Integrative Approaches to Sustainable Development at University Level- Making the Links* 2015, pp. 225-244.

Ramirez, M., (2016), Building capacity for sustainable product service systems in Australian industrial design education: a reflection upon contemporary practice. *Sustainable energy for all by design* 2016, pp. 379-391.

Ramirez, M., (2018), Industrial design education and the circular economy: experiences from UNSW Sydney. *Unmaking Waste 2018 September 2018.*

ULSF (1990), http://ulsf.org/talloires-declaration/

APPENDIX I - Google Search results based on keywords used

1. ‘healthcare design program’ (first 20 pages)
1.1 Imperial College London (MSc Healthcare and Design)
1.2 Royal College of Art (MRes Healthcare & Design)
1.3 Kent State University (Master of Health Care Design)
1.4 University College London (Healthcare Facilities MSc)
1.5 New York School of Interior Design (Healthcare Interior Design)
1.6 University of Minnesota (Health Care Design and Innovation Post-Baccalaureate Certificate)
1.7 OCAD University (MDes Design for Health)
1.8 University of Miami (Healthcare Design)
1.9 University of Nevada (Master of Healthcare Interior Design)
1.11 TU Eindhoven (PDEng Healthcare Systems Design)
1.12 Ball State University (Graduate Certificate in Planning Design of Healthcare)
1.13 John Hopkins University (Design for Health)
1.14 TU Delft/edX (Design in Healthcare)
1.15 The New School (Human-Centered Healthcare)
1.16 Texas Tech University (Health Care Facilities Design)
1.17 Cornell University (Healthcare Facilities Planning and Design)
1.18 University of Twente/Ahti/AMC (Healthcare Design)
2. ‘healthcare design course’ (first 20 pages)
2.1 University of Dundee (MSc Design for Healthcare & Assistive Technologies)
2.2 Staffordshire University (Graphic Design For Health Care PgCert)
2.3 University of Nottingham/Future Learn (Designing E-Learning for Health)
2.4 Harvard University/edX (Innovating in Health Care)
2.5 Manchester Metropolitan University (Simulation and Technology Enhanced Learning in Healthcare)
2.6 Clemson University (Architecture + Health)
2.7 Muthesius University (Master’s in Medical Design)
2.8 University of Plymouth (MSc Healthcare Management, Leadership and Innovation)
3. ‘medical design program’ (first 20 pages)
3.1 Johns Hopkins University (MS Medical Device Design)
3.2 Keck Graduate Institute (Medical Device Engineering)
3.3 University of Michigan- Biomedical Engineering
3.4 University of Michigan- Biomedical Engineering (Graduate Design Program)
3.5 UC San Diego (MAS in Medical Device Engineering)
3.6 UCSC Silicon Valley Extension (Medical Devices Certificate Program)
3.7 University of St. Thomas (Graduate Certificate in Medical Device Development)
3.8 University College Dublin (Medical Device Design)
3.9 UNC/NC State (Medical Devices)
3.10 Ferris State University (BFA in Medical Illustration)
3.11 UC Irvine Division of Continuing Education (Medical Product Development)
3.12 University of Alberta (MSc Rehab Science-Specialism in Surgical Design and Simulation)
3.13 Princeton University (Innovation and Design Application)
3.14 University of Auckland (Master of Engineering Studies in Medical Devices and Technologies)
3.15 TU Dublin (Medical Device Innovation)
3.16 University of Southern California (Master of Science in Medical Device and Diagnostic Engineering)
3.17 University of Newcastle Australia (Bachelor of Medical Engineering (Honours))
3.18 Temple University (Graduate Certificate in Healthcare Innovation Management)
4. ‘medical design course’ (first 20 pages)
4.1 Keele University (MSc Medical Engineering Design)
4.2 Swansea University (BEng Hons. Medical Engineering)
4.3 NUI Galway (Medical Device Science)
4.4 Cardiff University (Medical Engineering MEng)
4.5 University of Bolton (BEng Hons Medical Engineering)
4.6 University of Dublin (M.Sc. Bioengineering with specialization in Medical Device Design)
4.7 Glasgow School of Art (MSc Medical Visualization and Human Anatomy)
4.8 University of Leeds (MSc BSc Medical Engineering)
4.9 Cork Institute of Technology (Biomedical Device Manufacture Part-time Certificate)
4.10 Osaka University (Medical Device Design Course)
4.11 University of Hertfordshire (MSc Health and Medical Simulation)
4.12 Griffith College (Postgraduate Diploma in Medical Device Technology and Business)
4.13 TU Delft/edX (Product Design and Health)