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Transformational practices: Aligning Governance and Design

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Abstract: This paper introduces the concept of ‘Transformational Practises’ as a prospective design-led integrative space to conduct multidisciplinary research aiming at exceptionally innovative and/or unconventional research aiming for a high transformational impact. Based on a range of selected examples, the authors underpin the fundamental principles of this new framework to propose a criteria to assess prospective and multidisciplinary design-led transformations. In the process, it places design as a distinctive and fundamental activity to develop transformational impact in research that aligns the applied arts (arts and design), with the prospective sciences (e.g., AI and synthetic biology), and prospective sociology (e.g., economics and policy). Finally, it combines the concepts of structured adversarial collaborations, knowledge vectors, and transformational practises metrics to integrate this area into established models of academic assessment.

Keywords: Prospective design; transformation; Governance; impact metrics

1. Introduction

As we have been transitioning from the industrial, to the digital, to the knowledge-based economy, the exponential acceleration of innovation is transforming reality and affecting the development of society. In this context, recent strategies in the social sphere are calling for anticipatory strategies. For instance, Guston introduced the idea of *anticipatory governance* defining it as “a broad-based capacity extended through society that can act on a variety of inputs to manage emerging knowledge-based technologies while such management is still possible” (Guston, 2014 p.218).

As the digital, biological, and knowledge paradigms, with their exponential development and uncertainty become more prevalent, research will need to focus on the preventive and prospective aspects of technological development including preparedness, readiness, and appropriateness. We define prospective in this context as a strategy of navigating innovation via concrete activities towards preferred futures (Hancock and Bezold, 1994) as opposed to



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the tradition anticipatory ‘forecast, plan and wait’ approach (Galdon & Hall, 2019). Anticipatory design was introduced by Buckminster Fuller in 1927, outlined for a course in 1950, and taught at MIT by Fuller in 1956 as part of the Creative Engineering Laboratory (BFI, n.d), however it failed to materialize as a reliable model due possibly due to its technocratic approach. Alternatively, the future-led preventive and prospective approach we propose presents a problematic situation for current knowledge ontologies which are limited by the present through measurement and observation. These perspectives limit the scope by which we access knowledge and prevents the transformational practitioner from prospecting for managing knowledge-led technological progress.

One of the most striking aspects of research into technological development is the broad range of agreement between designers, sociologists, lawyers, regulators, machine learning specialists, philosophers, or futurologists on the importance of addressing technological impact (Jasanoff, 2016). However, very few stop to check the technological impacts they are agreeing to, to find out what prospectivity or prevention means to people affected by the consequences. Under these constraints, it becomes an open question as to what form of practices could address these issues. In this context multidisciplinary is paramount where disciplinary perspectives may limit discussions and generate constraints potential leading to gaps in knowledge and capability. An example is provided by Lucy Kimbell and other policy researchers when they implemented the first ever multidisciplinary course in policy design. As they acknowledge; “when we design, develop and deliver policy and public services, we do a disservice to citizens if we don’t bring the best of our collective expertise and experience to the challenge” (Gov, 2022, n.d.). They follow their argument by explaining how;

“Working in a multidisciplinary way helps us operate as one team between those responsible for policy and delivery – bringing operational expertise into policy development at the outset, building trust between teams and accelerating collaboration and learning” (Gov, 2022, n.d.).

And conclude with “by taking a multidisciplinary approach, we collaborate better and deliver value for the citizen” (Gov, 2022, n.d.). We refer to the positive potential of exploring these gaps as ‘Transformational Practises’. This area, in line with Kimbell, is understood as a design-led multidisciplinary branch to address the implications of transformational processes in the context of governance. We do so by first reviewing what is a design-led transformational paradigm, then propose a definition and elements to underpin the fundamental concept of ‘Transformational Practises’ that differentiates it from other approaches including anticipatory. This is supported by examining examples in the fields of applied arts, sciences, and sociology. This exercise provides criteria by which to assess the types of disciplines that may be integrated into the model. Finally, building from the intrinsic multidisciplinary and prospective nature of the ‘Transformational Practises’, we combine the concepts of structured adversarial collaborations (Bateman et al. (2005), Cowan et al. (2020), Kerr et al. (2018), Mellers et al. (2001), & Rakow et al. (2014)), knowledge vectors (Hall & Galdon, 2023a; Hall & Galdon, 2023b), and potential transformational practice metrics (Staudt et al., 2018) to in-

tegrate this area into established models of assessment. This final part is of major importance as this area seems to be absent in current models (see Kimbell et al., (2023) Design and Policy Report for the AHRC section 5.2). If this argument holds true, it follows that the majority of currently available models seem to produce locally reliable incremental outputs, rather than leading transformational impact.

1.1 Transformational Practises: Hypothesis

A Design-led 'Transformational Practises' approach is different from the humanities and social science. The Humanities is a discipline that uses an analytical and accumulative approach to understand the world. To be more precise, Humanities is the subjective study of humans, our history, culture, and societies. On the other hand, the Social Science uses a scientific and evidence-based approach to understand the world. To be more precise, Social Science is the objective study of humanity and its past, present, and future (based on trends and predictions). Finally, Design is a field that combines abductive and critical reasoning. To be more precise, Design is the prospective practice that addresses issues between technology and society. During a Design study, we combine scientific, tacit, humanistic, and prospective insights to shape and transform the world (Galdon & Hall, 2022).

While we possess institutions for various purposes, we believe in line with Cross (1983), that the definition of *appropriateness* remains the exclusive domain of design. If philosophy is the main field for determining what is important, then, design is the main field for determining what is appropriate and its value. Aristotle's potentialities and actualities have shaped and focussed transformation over the last 2500 years. In this context a practitioner proposes what is appropriate, which then is determined a posteriori by the audience. This model operates with a type of knowledge that is neither theoretical or practical, but productive (Atwill, 2009). This type of knowledge was defined by Aristotle as not being either within the subject nor the object, but the audience (Galdon & Hall, 2019).

In this context, we must approach the inquiry towards *the appropriate* from a standpoint encompassing the entirety of life. Speaking from this entirety necessitates a discourse that transcends specialisation and impacts the entirety itself. In this vein, we propose that 'Transformational practices', enabled by design offers a means of intervention within complex situations where wicked problems prevail (Rittel & Webber, 1973). Wickedness holds paramount significance within this context; in societies characterised by a multiplicity of beliefs, races, genders, interests, and nationalities, the question of what is *appropriate* remains complex, as these contexts adhere to social, economic, and environmental norms and beliefs. However, inquiring into the *appropriate* becomes crucial, as it facilitates a reflective space for practices aiming for change.

We propose that in social landscapes marked by a dichotomy between local, (where a global perspective it is very challenging), and global, (where a local perspective it is very challenging), design emerges as a field capable of enquiring what is *the appropriate* by reflecting on what is suitable for life's entirety. It could be argued that design shapes, or aspires to shape,

an art of living in all its extension. While contemporary design may have lost this perspective, we have a wealth of experience emerging from the last decades to deal with these scenarios. This accumulation of knowledge enables us to adeptly develop an art of living that provides hope within humans and beyond. In this context, the nexus of design and governance emerges and the 'Transformational Practises' enable these fields to align in their shared exploration of liveability.

On this basis, the authors argue that, if the 'Transformational Practises' are to produce methods that make research systems more impactful and transformational, attention must shift to the development of mixed-methods strategies, emergent methodologies (Gaver, 2022), and post-hoc interpretation to integrate present-based insights to facilitate prospective transformational practises.

2. Methodology

We reviewed literature on current work to provide examples of transformative practices to support a theoretical foundation for the proposed study, substantiate the presence of the research problem, test the research contributes something new knowledge, and validate the methods and approaches for the proposed study (Hart, 1998; Levy & Ellis, 2006).

Examples enable the exploration and investigation of a real issue within a defined context by using a variety of data sources (Baxter et al., 2008). This method allows design researchers to develop and enhance;

“The capacity of comprehension and analysis of real problems, the capacity to propose and evaluate alternatives for the improvement of the problem considered, to work collaboratively, [and facilitate] their capacity of information management and synthesis of problems” (Herrera et al., 2016).

In this context, we will apply comparative studies to the examples in order to identify and underpin key characteristics. According to Bukhari (2011) a Comparative Study analyses and compares two or more objects or ideas to examine, compare and contrast them to show how two or more subjects are similar or different.

3. Exploring Transformative Practices

3.1 National Science Foundation

We can trace the notion of transformative research back to the National Science Foundation (NSF) and the National Science Board (NSB) in the USA. For the NSF transformative research is about “revolutionising entire disciplines; creating entirely new fields; or disrupting accepted theories and perspectives—in other words, those endeavours which have the potential to change the way we address challenges in science, engineering, and innovation” (NSF, 2007, p.1). For the NSB transformative research frequently crosses disciplinary lines, adding to the challenge of evaluating the work. Nonetheless, it views transformative research as being “of critical importance in the fast-paced, science and technology-intensive world of the 21st Century” (NSB, 2007). These concepts were further developed in 2015 by the National

Institutes of Health (NIH) and again, by the National Science Foundation (NSF) in USA. For the NHI transformative research is:

“...exceptionally innovative and/or unconventional research projects with the potential to create or overturn fundamental paradigms. These projects tend to be inherently risky and may not fare well in conventional NIH review... The primary emphasis of the Transformative Research Award is to support research on bold, paradigm-shifting but untested ideas” (NHI, 2015, n.d.).

Finally, for the NFS transformative research is about developing:

“...ideas, discoveries, or tools that radically change our understanding of an important existing scientific or engineering concept or educational practice or leads to the creation of a new paradigm or field of science, engineering, or education. Such research challenges current understanding or provides pathways to new frontiers” (NSF, 2015, n.d.)

From these documents Staudt et al. (2018) extracted seven fundamental elements of transformational practises; (1) generate important new ideas (radical generative), (2) make existing ideas obsolete or less salient (radical destructive), (3) be risky, (4) be multidisciplinary, (5) have a broad impact, (6) have an impact that builds over time, and (7) have a high impact.

These elements point towards the disruptive and multidisciplinary nature of the transformational paradigm. However, they also point towards concepts such as time, potentialities, risk or boldness. They link science, engineering, and innovation as fundamental variables to archive the desired outcome (Staudt et al., 2018).

From these accounts, it seems that managing the development of these processes and technologies will become important for government and governance. However, these variables and processes present a range of questions; how can practitioners and researchers access potentialities in research when they are limited by the present? Which are the most adequate disciplines to address the intended output? And finally, building for the NSB description, how can we evaluate *a posteriori* potential impact?

3.2 Defining design-led Transformational Practices

Building on our progress, we start by defining ‘Transformational Practices’ as a prospective design-led multidisciplinary endeavour building on productive knowledge with the fundamental characteristic that knowledge is known *a posteriori*. Its development is based on exchange and forever bounded to its context and dynamics (social, economic, and environmental). Intrinsically this indicates that knowledge is probabilistic in its nature. From this definition three fundamental elements emerge: Design-led, *a posteriori* and multidisciplinary, along with two variables: exchange and environment (See Fig. 3 for an integrated model, and the *a posteriori* subsection for examples to support the argument).

Design-led

The Oxford Dictionary presents seven entries to define design; Five as a noun and two as a verb. In this context, the word planning is present in five entries (Oxford, 2019). From this

perspective we would position design as a future-led prospective thinking activity in the context of abductive reasoning (making decisions without having all the information) focused on planning. Research by Dorst (2011) or more recently Cramer-Petersen et al. (2018) have concluded that design combines deductive and abductive reasoning, however, in both cases, abductive thinking plays a fundamental role as initiator of the design activity. Furthermore, as the current paradigm of exponential technological development drives context uncertainty to become more prevalent in society, design practice and research will need to focus more on the preventive-prospective aspects of design including preparedness, readiness and appropriateness. In this context, the deductive becomes limited by access and abductive reasoning becomes necessary.

Design's intrinsically prospective approach is based on planning, solution-based problem solving, problem shaping, synthesis, preparedness, readiness and appropriateness in the technological environment determining a different way of knowing. In this epistemological scenario the designer is accessing areas yet-to-be or not fully formed. Therefore, knowledge cannot be empirical nor observational, but prospective and transformational. Consequently, the output is based on potentialities rather than certainties. As Glanville proposed, 'knowledge for' future action and possibilities rather than 'knowledge of' past actions and events (Glanville, 2005). These cybernetic perspectives place design as the most relevant discipline to approach transformational practice potentialities.

A posteriori

In this context, the life of a design intervention is placed into the future with time to assess the impact of the design extended during its lifetime and forever bounded to its environment. In this scenario, validation is always a posteriori, and the proposed output becomes the main element to be assessed.

The iPhone is a paradigmatic case for understanding how we grasp the *a posteriori* impact of design as time evolves. In the first 2 years we discovered that it had transformed the mobile industry. After 5 years we discovered that it had transformed the manufacturing system. Over 10 years, we are discovering that it has transformed society. Scientific extrapolations could never have predicted the social implications of having a tracking device in your pocket capable of monitoring everything you do and everywhere you go where various actors can, if they choose, use this information to trigger new behaviours and beliefs. Neither science nor sociology could approach this *a posteriori* reality as they are limited by what we do or have done and how we have achieved it. In other words an ontology of the past. As Glanville suggested, we are limited by knowledge of the past (Glanville, 2005). However, the intrinsic prospective approach of design, based on planning, solution-based problem solving, problem shaping, synthesis, preparedness, readiness and appropriateness can provide a suitable framework to access these future spaces for knowledge. By positioning design in this manner, we position design as a transformational epistemology to develop transformational impact from a probabilistic ontological position.

In another example - due to the impact of climate change in the future of our cities - the government of Sweden decided to investigate future housing typologies. They selected a plot of land and invited a range of architects to present proposals. Some of these proposals were completed by 2018 (Mallet, 2018). The experiment was finished but we don't know whether these new typologies are appropriate or not. We need to wait 10, 20 or 30 years to discover. Transformational knowledge is always knowing *a posteriori* and is based on exchange bounded to its temporal context. We see 'Transformational Practices' as applied research. By applied the authors mean disciplines aiming to go beyond personal practice to deliver tangible interventions for transforming society. This implies exchange beyond oneself involving social, environmental and, or economic activities. This exchange intrinsically means it is always *a posteriori* and forever bounded to its environment.

In the applied arts, for example, when you finish a fashion collection, or a song, or a theatre play, or a movie, or a book, you do not know whether it will transform society or not. It will be known *a posteriori* and will be based on whether there is exchange or not and this exchange is forever bounded to its context, which is determined by social, economic, and environmental factors that we cannot control.

Beyond design, art and architecture, the authors have included examples in AI and synthetic biology. These two disciplines are referred in this article as prospective sciences, which means scientific outputs that evolve by themselves by interacting with the environment after the experiment has been completed without a clear understanding of where they may lead.

Recent research in the area of robustness in Highly Autonomous Systems shows 0% adversarial accuracy when evaluating a deep network against stronger adversaries (Athalye et al., 2018; Uesato et al., 2018). In order to address this problem, the researchers used interval bound propagation to great success (Ehlers, R., 2017; Katz et al., 2017; Mirman et al., 2018). However, as the researchers acknowledge;

“...no amount of testing can formally guarantee that a system will behave as we want. In large-scale models, enumerating all possible outputs for a given set of inputs...is intractable due to the astronomical number of choices for the input perturbation” (Kohli et al., 2019, n.d.).

With reinforcement learning the artificial system keeps developing by interacting with its environment. Therefore, the knowledge generated is always probabilistic and forever bounded by *a posteriori* exchange to its environment. The same can be stated to describe synthetic biology. A recent example presents the case of Dr. He Jiankui of Southern University of Science and Technology in Shenzhen, China. He claims to have created the world's first genetically edited babies, in a potentially ground-breaking and controversial medical first (Cyrnosky, 2018). In this case we do not know what impact this experiment entails for future humankind. We will know *a posteriori* and its development will be forever bounded to that time-based environment. These two cases differ radically from other models of scientific research where we know *a priori* when the experiment is completed (see Figure 1).

Finally, in the social sciences the authors have included politics and economics. These two disciplines are referred in this article as prospective sociology, which mean social activities and disciplines based on prospective planning where their impact is always known *a posteriori* and forever bounded to their environments by exchange. They are radically different from other disciplines in the social sciences such as psychology, history, archaeology, geography or linguistics. In these late cases, we know by performing an experiment based on observation, interpretation or measurement.

In terms of politics, we may review Operation Yellowhammer. This is the codename used by the UK Treasury for cross-government civil contingency planning for the possibility of a “no-deal” Brexit. This strategy was intended to mitigate disruptive developments. It was developed by the Civil Contingencies Secretariat (CCS), a department of the Cabinet Office responsible for emergency planning. This document embodies the preventive/prospective aspects of design (preparedness, readiness and appropriateness) and its development is a posteriori process bounded to its environment (Merrick, 2018; O’Carroll, 2019; BBC, 2019).

In terms of economics, economic forecasting is the process of making predictions about the economy. Many institutions such as the International Monetary Fund (IMF), World Bank, the Organisation for Economic Cooperation and Development (OECD), national governments, central banks, and private sector entities, including think-tanks, banks, consultants and companies use economic forecasting as a planning technique. Economists use statistical analysis of historical data to determine the forecast. Normally, formal forecasts are produced once a year, however, quarterly updates or corrections are implemented to fine-tune the projection. The fundamental function of the economist is to anticipate future risks (i.e., events or conditions that can cause the result to vary from their initial estimates). These forecasts are continuously updated as the conditions of the environment evolve. These evolutions determine whether the adjustments will get tighter or looser, how interest rates vary affecting a wide range of factors from loan repayments to employment levels.

A posteriori is a fundamental quality of transformational processes. This notion aligns the Prospective Arts, The Prospective sciences, and Prospective Sociology (Figure 2).

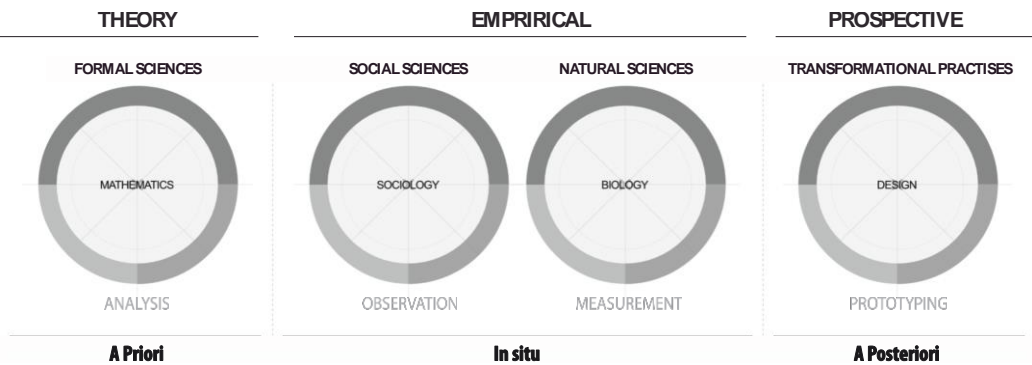


Figure 1 Comparating the Transformational Practices and the Social, Formal, and Natural Sciences. Galdon & Hall, 2024

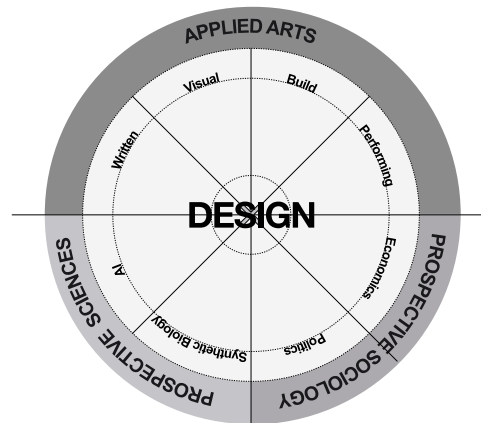


Figure 2 Transformational Practices; a Design-led, a posteriori and multidisciplinary model. This diagrammatic model integrates different disciplines aligned in their ontological nature.

Multidisciplinary

Multidisciplinary research, a fundamental element for enabling policy design (Kimbell, 2023), involves a coordinated effort that brings together several disciplines to provide complementary contributions in the service of a common goal (Fiore and Salas 2007). However, as Cuevas points out, the main challenges this perspective entails are; meeting the constraints of different stakeholders with different agendas, and conflicting data collection requirements. For the researcher it “may hinder the project team’s ability to meet all their members’ different research objectives” (Cuevas, 2012, p.63). As a solution he proposes to:

“Establishing a systematic process by which the project team can objectively agree to a primary goal while still permitting stakeholders to determine their specific research objectives and carefully prioritise their data collection requirements for meeting this goal” (Cuevas, 2012, p.63).

This insight points towards structured adversarial collaborations as a model to construct reliable collaborations. However, the fundamental characteristic of the ‘Transformational Practices’ implies a design-led approach, probabilistic knowledge and a posteriori validation. These elements demand an adaptation of this model which currently focuses on present-based models. In addition, a fundamental question arises on how to combine different types of knowledges coming from different disciplines involved in the process. Here we present a diagrammatic model for integration based on ontological nature (see Figure 3).

Finally, innovation expert Marianna Mazzucato, identified a range of cases studies from Apple to government-led institutions such as DARPA in *The entrepreneurial state*, making the case for the long-term nature of innovation (around 10 years). Innovation is a high impact, high risk, failure-encouraging process based on challenges, economic support (especially at the beginning), milestones, and patience. (Mazzucato, 2013). These elements introduced by Mazzucato imply the integration of a new set of variables to address the a posteriori nature of transformations. At this point two fundamental questions arises; What are these variables and how can we assess something which is probabilistic and will develop in the future by interacting with its environment? In the next section we will explore this in detail.

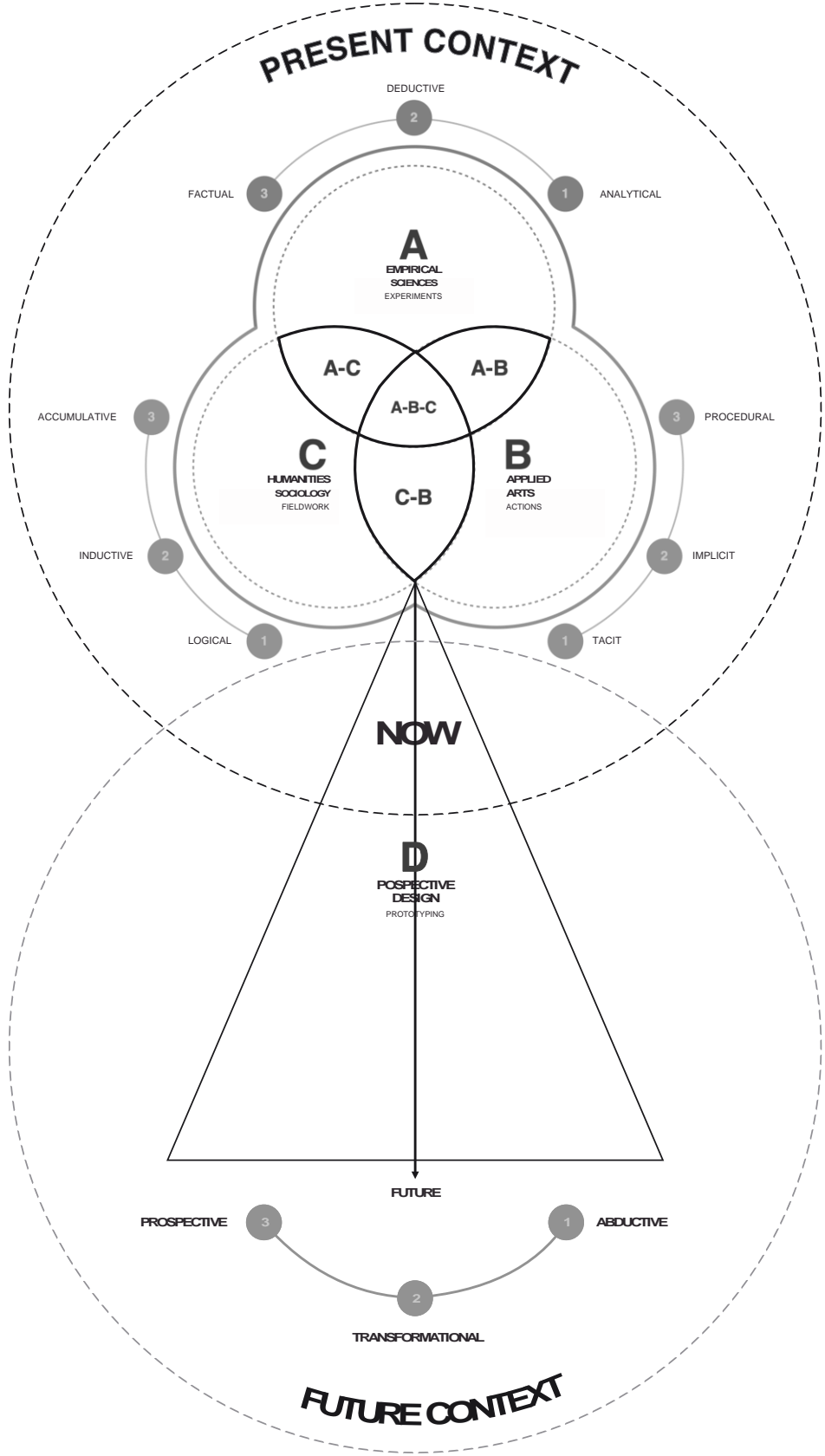


Figure 3 Transformational Practices; a Design-led, a posteriori and multidisciplinary model. Diagram integrates different types of knowledge to nurture transformational governance via prospective structured adversarial collaborations. Galdon & Hall, 2024

3.3 Assessing ‘Transformational Practises’: A methodological approach

Metrics

Staudt et al. (2018) developed a framework to measure transformational practises. Their work introduces a novel set of text and citation-based metrics that can be used to assess high-impact and transformative research. In the process they developed five fundamental variables to address the implications of *a posteriori* transformational impact: “F” refers to “forward citations” that a focal article receives in future works. “B” refers to the past works or “backward citations” that a focal work cites. “T” is a variable to identify time windows. *T* indicates the number of years (0, 3, 5, 10, ∞). “Age” metrics for Age using. And “Herf” metrics for dispersion to indicate Herfindahl indices, a common dispersion measure in economics. From these variables seven categories emerge: Radical-Generative, Radical-Destructive, Risky, Multidisciplinary, Wide Impact, Growing Impact, and Impact (overall) (Tab. 1).

Table 1 Seven categories of transformation. from Staudt et al. (2018).

Radical-Generative	Transformative research is viewed as critical because it generates radical new paradigms, theories, perspectives, and fields.	BMentT Metric called Concepts
Radical-Destructive	In creating radical new paradigms, transformative research is seen to render large portions of existing knowledge obsolete (or at least less salient).	BCiteAge Backward citation
Risky	Represents a substantial departure from prior work, the existing conceptualizations view transformative work as risky	FCiteVar. variance in forward citations
Multidisciplinary	Transformative work is viewed as more likely to draw on knowledge from many fields.	BHerfMentT Herfindahl indices of the range of fields
Wide Impact	Transformative work is viewed as more likely to draw on a wide range of knowledge, it is seen to be more likely to have a wide impact.	FHerfCite Herfindahl indices of the range of fields
Growing Impact	Because it is radical, the impact of transformative work is seen to take a while to accumulate.	FCiteAge forward citation
Impact	In order for a radical work to be transformative, it must be impactful, so we view this aspect of transformative work as somewhat definitional	FCiteMean forward citation

Vectors and Factors

Two recent publications by the authors (Hall & Galdon, 2023a; Hall & Galdon, 2023b) make a claim for building on the foundations of a prospective design ontology diverting it away from efforts to align with scientific models and use an ontological mirror to challenge concepts of repeatability. This leads to an *a posteriori* model where transferability becomes the desired outcome. We propose transferability vectors (Hall & Galdon, 2023b) as a strategy for recognising the quality of prospective knowledge and how it provides confidence in a ‘good enough for now’ model to develop and implement transformational initiatives.

The concept of vectors we described above facilitates the spatialisation of knowledge transferability and impact. We introduced five factors for delivering transferability which are; synthesis, Flexibility, Contextuality, Adaptability, and Comprehensibility (Tab. 2).

Table 2 Five factors of transformation. F. Galdon & A. Hall, 2023.

Synthesis	Synthesis is viewed as critical because it generates easiness and clarity when transferring new paradigms, theories, perspectives, and fields.
Flexibility	Flexibility is seen in transferability to render portions of existing knowledge obsolete (or at least less salient).
Contextuality	represents a substantial departure from prior work, the impossibility of controlling contextual factors renders existing work as risky
Adaptability	Adaptability is viewed as more likely to be implemented in many contexts.
Comprehensibility	Comprehensibility is viewed as more likely to be understood by many people, it is seen to be more likely to have a wide impact.

Indicators

In their quest to underpin truly transformative practises, Staudt et al. (2018) wonder on the citation system they should apply. In their model they sought to address what they see as deficiencies in standard citation methods to address transformational practises. Building from (Wang, 2013; Hutchins, 2016; Acemoglu, 2014; Wang, 2017; Funk, 2016; Evans, 2016) they generate a system to identify novel research from a unique combination of citations and shifts in citation patterns to identify relevant work. They are based on; publications, authors, references and contextual related concepts (downloads, recommendations, blog posts, and tweets). In the process they aim for a mix-method of established and current indicators. Here, based on the fundamental variable of exchange to determine the value and impact of an intervention, we have added a new variable (Exchange), and a set of sub-variables to address monitoring capabilities in the context of Monitoring exchange strategies (Surveys, Longitudinal studies, and Anecdotal evidences) (Tab. 3).

Table 3 Mixed-citation model to measure transformational Practises. From Staudt et al. (2018), and Galdon & Hall, 2023.

Publications	Text
Authors	Acknowledgements
References	Endorsements
Related concepts	Downloads Recommendations Blog posts Tweets
Exchange	Monitoring change strategies <ul style="list-style-type: none"> • Surveys • Longitudinal studies • Anecdotal evidences

Integrated Model

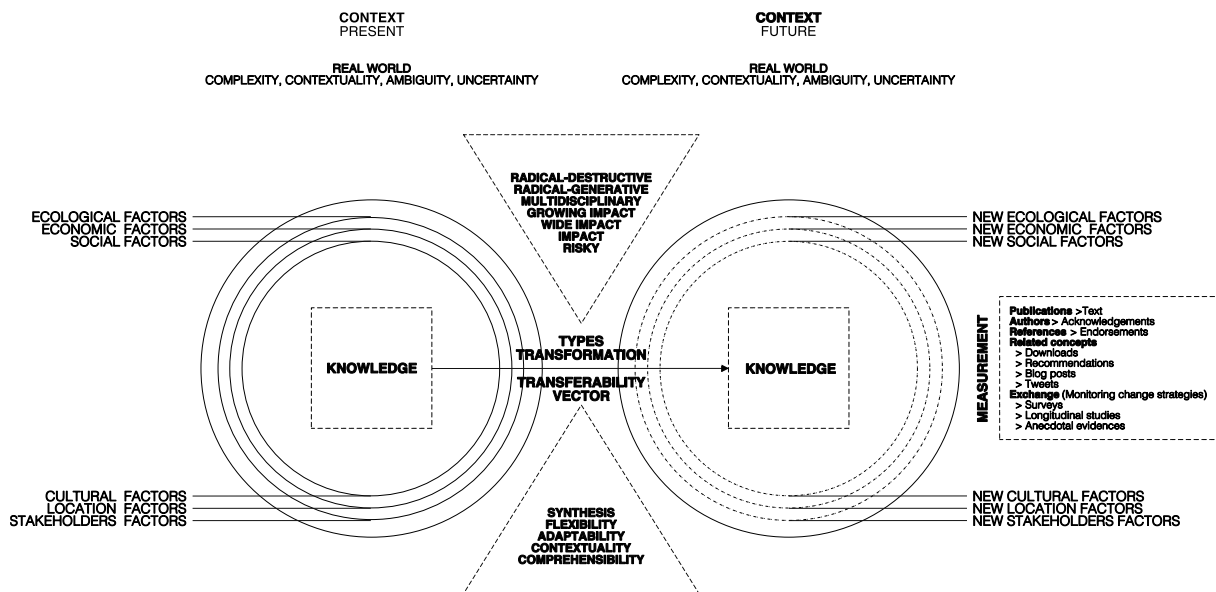


Figure 4 Assessing ‘Transformational Practises’; a methodological approach. This diagrammatic model integrates Seven categories of transformation and its corresponding metrics, vectors & factors, and assessment indicators based on a mixed-citation model to measure transformational Practises. Galdon & Hall, 2024

4. Conclusions

In In this paper, the authors introduce the ‘Transformational Practices’ as a prospective design-led integrative space to conduct multidisciplinary research aiming for exceptionally innovative and/or unconventional outputs with a high social or economic transformational im-

pace at the intersection of design, policy, and innovation governance. This area, as acknowledged by Kimbell (2023), lacks proper prospective evaluation mechanisms, which limits the process to present-based enquiry. This aspect is important for policy design and design practices as we move further into exponential technological development where research and practises will need to focus more in the preventive aspects of preparedness, readiness and appropriateness.

It positions design as the epicentre of transformational practises. In the process the authors position design as a transformational epistemology to generate impact from a probabilistic ontological position. With this initiative, the authors, in line with Kimbell, aim to position design as a discipline concerned with generating prospective future-led translational and transformational technological developments to enhance governance and facilitate knowledge-based technological potentialities and reduce future risks.

By selecting interdisciplinary examples we define the entangled fundamental elements that deliver transformational outputs and generate a criterion to define what kind of disciplines can naturally align a shared ontological aim where design-led interventions generate *a posteriori* knowledge perpetually changing and forever bounded to their environment by exchange. In addition, we provide a model to operationalise multidisciplinary based on different knowledge ontologies.

Finally, the framework aims for mixed-methodologies to develop and assess transformational outputs. It combines prospective structured adversarial collaborations, and transformative research metrics to develop and assess the impact of the intervention *a posteriori* to facilitate the design of novel strategies in prospective technological developments. This is achieved by integrating the seven types of outputs, the five factors of transformation, and a mixed-citation model as a method to deal with the probabilistic nature of the knowledge generated. It includes established indicators (authors, references and related concepts) and the aforementioned novel indicators to measure the impact of proposed outputs in extended timeframes to underpin work that consolidates or destabilises existing technologies. With this metric system addressing *a posteriori* transformational impact, design-led research activities can be integrated into current modes of academic assessment.

This paper presents a preliminary output to define, establish and position the 'Transformational Practices' as a fundamental nexus for policy design and design practice. In the process, it sets the foundation to develop the 'Transformational Practices' as a constitutive major branch to enable governments and citizens to participate and prepare for future changes via prospective transformation.

5. References

Acemoglu D, Akcigit U, Celik MA. (2014). Young, restless and creative: Openness to disruption and creative innovations. National Bureau of Economic Research. Available from: <http://www.nber.org/papers/w19894>

- Athalye, A., Carlini, N., Wagner, D. (2018). Obfuscated Gradients Give a False Sense of Security: Circumventing Defenses to Adversarial Examples. Proceedings of the 35th International Conference on Machine Learning, Stockholm, Sweden, PMLR 80, 2018.
- Atwill, J. (2009). Rhetoric reclaimed: Aristotle and the liberal arts tradition. Ed. Cornell University Press. First published, 1998. BBC (2019). "MoD hosts no-deal planning in bunker". BBC News. 21 March 2019. Retrieved 22 March 2019. <https://www.bbc.co.uk/news/uk-47658403>
- Ball, P. (2019). Neuroscience Readies for a Showdown Over Consciousness Ideas. Quanta magazine. <https://www.quantamagazine.org/neuroscience-readies-for-a-showdown-over-consciousness-ideas-20190306/>
- Bateman, I., Kahneman, D., Munro, A., Starmer, C., & Sugden, R. (2005). Testing competing models of loss aversion: An adversarial collaboration. *Journal of Public Economics*, 89, 1561–1580.
- Buckminster Fuller Institute. (n.d.). Eight strategies for comprehensive anticipatory design science. Retrieved from <https://www.bfi.org/about-fuller/big-ideas/design-science/design-science-primer/eight-strategies-for-comprehensive-anticipatory-design-science>
- Cramer-Petersen, C. L., Christensen, B. T., & Ahmed-Kristensen, S. (2019). Empirically Analysing Design Reasoning Patterns: Abductive-deductive Reasoning Patterns Dominate Design Idea Generation. *Design Studies*, 60, 39-70. DOI: 10.1016/j.destud.2018.10.001
- Cowan, N., Belletier, C., Doherty, J. M., Jaroslawska, A. J., Rhodes, S., Forsberg, A., Naveh-Benjamin, M., Barrouillet, P., Camos, V., & Logie, R. H. (2020). How do scientific views change? Notes from an extended adversarial collaboration. *Perspectives on Psychological Science*, 15(4), 1011–1025.
- Cuevas, H. M., Bolstad, C. A., Oberbreckling, R., LaVoie, N., Mitchell, D. K., Fielder, J., & Foltz, P. W. (2012). Benefits and Challenges of Multidisciplinary Project Teams: "Lessons Learned" for Researchers and Practitioners. *The ITEA Journal (International Test and Evaluation Association)*, 33(1). Retrieved from <https://commons.erau.edu/publication/108>.
- Cyranoski, D. (2018). CRISPR-baby scientist fails to satisfy critics, Nature News: 30 Nov 2018 [online]. <https://www.nature.com/articles/d41586-018-07573-w>
- Dorst, K., (2011) The Core of "Design Thinking" and Its Application. *Design Studies*, 32, 521-532. <https://doi.org/10.1016/j.destud.2011.07.006>
- Ehlers, R. (2017). Formal Verification of Piece-Wise Linear Feed-Forward Neural Networks. BT - Automated Technology for Verification and Analysis - 15th International Symposium, ATVA 2017, Pune, India, October 3-6, 2017, Proceedings
- Evans J., E., and Foster J. G. (2016). "Measuring Novelty by Simulating Discovery." Working Paper.
- Fiore, S. M., and Salas, E. (2007). Problems and possibilities: Strategically pursuing a science of learning in distributed environments. In *Toward a science of distributed learning*, ed. S. M. Fiore and E. Salas, 237-264. Washington, D.C.: American Psychological Association
- Funk RJ, Owen-Smith J. A (2016). Dynamic network measure of technological change. *Manage Sci.*; 63(3):791–817.
- Galdon, F., Hall, A. & Wang, S. J. (2019). Prospective design: A future-led mixed- methodology to mitigate unintended consequences. Proceedings of the International Association of Societies of Design Research Conference IASDR2019, The University of Manchester, UK.
- Galdon, F. & Hall, A. (2022) (Un)Frayling design research in design education for the 21st, *The Design Journal*. DOI: 10.1080/14606925.2022.2112861
- Galdon, F., Hall, A. (2019b). The ontological nature of design; prospecting new futures through probabilistic knowledge. Design Research for Change Symposium. Design Museum, London. ISBN 978-1-86220-369-3
- Gaver, B., Krogh, P.G, Boucher, A., Chatting, D. (2022) Emergence as a Feature of Practice-based

- Design Research. In: Designing Interactive Systems Conference. ACM, New York, USA, pp. 517-526. ISBN 9781450393584
- Glanville, R., 2005, *The Unthinkable Doctorate: Brussels, Design Prepositions*. Cyberethics Research. American Society of Cybernetics, UK and Australia.
- Government UK (2022). Launching Government's First Ever Multidisciplinary Course. Public Policy Design Blog. Retrieved from <https://publicpolicydesign.blog.gov.uk/2022/11/03/launching-governments-first-ever-multidisciplinary-course/>
- Guston, D. H. (2014). Understanding 'anticipatory governance.' *Social Studies of Science*, 44(2), 218–242. <https://doi.org/10.1177/0306312713508669>.
- Hall, A., Galdon, F. (2023). Transferability vs. Repeatability: Consolidating the Ontological Nature of Design Research. Cumulus CAFA Conference Beijing November 22-24, 2023. <https://researchonline.rca.ac.uk/5603/>
- Hall, A., Galdon, F. (2023b). Transferability: Exploring ontological properties for design knowing at CUMULUS CAFA Beijing 2023, Beijing, China, 22-24 Nov 2023. <https://researchonline.rca.ac.uk/5600/>
- Hart C. (1998). *Doing a literature review: Releasing the social science research imagination*. London: SAGE Publications.
- Hutchins BI, Yuan X, Anderson JM, Santangelo GM. (2016). Relative Citation Ratio (RCR): A new metric that uses citation rates to measure influence at the article level. *PLoS Biol.*; 14(9):e1002541. <https://doi.org/10.1371/journal.pbio.1002541> PMID: 27599104
- Jasanoff, S. (2016). *The ethics of invention: technology and the human future (First)*. W.W. Norton & Company.
- Katz, G., Barrett, C. W., Dill, D. L., Julian, K. And Kochenderfer, M. J. (2017). Reluplex: An Efficient SMT Solver for Verifying Deep Neural Networks. BT - Computer Aided Verification - 29th International Conference, CAV 2017, Heidelberg, Germany, July 24-28, 2017, Proceedings, Part I
- Kerr, N. L., Xiang, A., Hogg, M. A., & Zhang, J. (2018). Addressing replicability concerns via adversarial collaboration: Discovering hidden moderators of the minimal intergroup discrimination effect. *Journal of Experimental Social Psychology*, 78, 66–76.
- Kimbell, L., Durose, C., Mazé, R. and Richardson, L. (2023) *Design and Policy: Current Debates and Future Directions for Research in the UK: Report of the AHRC Design|Policy Research Network*. London: University of the Arts London
- Kohli, P., Gowal, S., Dvijotham, K., and Uesato, J. (2019). Towards Robust and Verified AI: Specification Testing, Robust Training, and Formal Verification. Deepmind. Medium 28 March 2019. <https://deepmind.com/blog/robust-and-verified-ai/>. Accessed; 29/03/2019.
- Levy Y., Ellis T.J. (2006). A systems approach to conduct an effective literature review in support of information systems research. *Informing Science*; 9:181–211
- Mallet, L. (2018). Creating quality living:the new Swedish town offering innovative solutions to London's housing crisis. Evening standard. <https://www.homesandproperty.co.uk/property-news/the-new-swedish-town-offering-innovative-solutions-to-londons-housing-crisis-a116751.html>
- Mazzucato, M (2013) *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*, London: Anthem Press (Kindle Edition).
- Mellers, B., Hertwig, R., & Kahneman, D. (2001). Do frequency representations eliminate conjunction effects? *Psychological Science*, 12, 269–275.
- Merrick, R. (2018). "Operation Yellowhammer: Photo of secret government no-deal Brexit papers reveals questions over 'rail access to the EU'". *The Independent*. 6 September 2018. Archived from

- the original on 6 September 2018. Retrieved 6 September 2018. <https://www.independent.co.uk/news/uk/politics/operation-yellowhammer-brexit-photo-eu-rail-access-nodeal-secret-paper-latest-document-a8525506.html>
- Mirman, M., Gehr, T. & Vechev, M.. (2018). Differentiable Abstract Interpretation for Provably Robust Neural Networks. Proceedings of the 35th International Conference on Machine Learning, in PMLR 80:3578-3586
- NSB (2007). National Science Board (NSB). Enhancing Support of Transformative Research at the National Science Foundation. 2007. Retrieved: 25 April 2019. Available from: https://www.nsf.gov/nsb/documents/2007/tr_report.pdf.
- NSF, (2007). National Science Foundation, Office of the Directorate. Notice No. 130. 2007. Retrieved: 25 April 2019. Available from: <https://www.nsf.gov/pubs/issuances/in130.pdf>.
- NFS, (2015). National Science Foundation. Definition of Transformative Research. 2015. Retrieved: 25 April 2019. Available from: http://www.nsf.gov/about/transformative_research/definition.jsp.
- NIH, (2015). National Institutes of Health. Transformative Research Award Program. 2015. Retrieved: 25 April 2019. Available from: <https://commonfund.nih.gov/tra/description>.
- O'Carroll, L. and Campbell, D. (2019). "UK's emergency plans for no-deal Brexit begin to be put into action". The Guardian. ISSN 0261-3077. Archived from the original on 20 March 2019. Retrieved 20 March 2019. <https://www.theguardian.com/politics/2019/mar/20/uks-emergency-plans-for-no-deal-brexit-begin-to-be-put-into-action>
- Oxford, (2019). Definition: Design. Retrieved: 3 May 2019. [online] <https://en.oxforddictionaries.com/definition/design>
- Rakow, T., Thompson, V., Ball, L., & Markovits, H. (2014). Rationale and guidelines for empirical adversarial collaboration: A *Thinking & Reasoning* initiative. *Thinking & Reasoning*, 21(2), 167–175. <https://doi.org/10.1080/13546783.2015.975405>
- Staudt, J., Yu, H., Light, R.P., Marschke, G., Börner, K., Weinberg, B.A. (2018) High-impact and transformative science (HITS) metrics: Definition, exemplification, and comparison. PLoS ONE 13(7): e0200597. <https://doi.org/10.1371/journal.pone.0200597>
- Uesato, J., O'Donoghue, B., van den Oord, A., and Kohli, P. (2018). Adversarial Risk and the Dangers of Evaluating Against Weak Attacks. Proceedings of the 35th International Conference on Machine Learning, Stockholm, Sweden, PMLR 80, 2018.
- Wang D, Song C, Barabási A-L. (2013). Quantifying Long-Term Scientific Impact. *Science*; 342(6154):127–32. <https://doi.org/10.1126/science.1237825> PMID: 24092745
- Wang J, Veugelers R, Stephan P. (2017). Bias against novelty in science: A cautionary tale for users of bibliometric indicators. *Res Policy*. <https://doi.org/10.1016/j.respol.2017.01.002> PMID: 29058845

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