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Abstract: *Design skills and methods have been at the conceptual foundation of the design discipline(s) for at least the past half century. Over this period, design has also changed, focusing on new outcomes, serving new goals, and addressing different scales and broader application areas. On the one hand, there is a large set of methods and tools; on the other hand, there is growing visibility with 'design thinking' both giving design greater appeal and a shallower message. Currently many design schools struggle with adapting their curricula to meet the new demands for sustainability, diversity, and incorporating new technologies such as AI or Biodesign (designing as, with and for nature). Several academic initiatives have produced visions giving direction to those efforts. This paper reports the outcomes of a series of discussions by experienced educators, attempting to produce a specification of the goals and detailed objectives of design methods education. We share these outcomes not as a definitive prescription for the incorporation of methods within a design curriculum, but as a reference point for further development.*

Keywords*: design methods; design education; curriculum development; critical thinking*

Introduction

With the maturing of design as a discipline, an overwhelming number of Design Methods have evolved. At the same time, our collective understanding has evolved that designers need to take more responsibility for the wider systemic consequences and impacts of design outcomes. Methods play a critical role in getting to desired outcomes, and in providing evidence if those outcomes have been reached.

Design Methods have been an integral part of most curricula and are actively developed in many institutions, but are often only seen as supporting, "something handy to use," with one method interchangeable with another. We argue that Design Methods are a crucial enabler to generate results—similar to how injection molding is indispensable in creating plastic parts—and posit that reliable and appropriate research methods are necessary to designing well. The Dutch sector for the Creative Industries similarly proposed that 'Key Enabling Methodologies' are an essential part of the innovation and technology agenda (Bruns Alonso et al, 2020). Descriptions of methodologies vary in the design literature include examples that can be found, e.g., in The UK Design Council (2007), and in Aulisio et al. (2021).

A renewed attention for methods in the curriculum is also needed because design is addressing a broader range of values than before:

- Impact: although design has contributed to quality of life improvement for many across the planet, design also contributes to landfill, social and economic inequalities, and environmental destruction. We need to become more systemic in understanding the consequences of design choices and therefore methods.
- Equality and inclusion: to take one example, the design and implementation of medical treatments are male dominated, we need to become better in understanding bias, accessibility and intersectionality when designing.
- Evidence: with the rapid rise in digital capabilities and the amount and quality of data available, it becomes easier to design for and understand particular outcomes. However, designers are not systematically linking the available data to outcomes or to the methods selected. This omission makes it extremely difficult to compare approaches, identify and continuously improve what is effective.

Selecting the right methods is important for designers to account for the impacts of their actions both in situated circumstances and systemically. Methods also serve as the glue in a design team: a shared understanding of how design methods function, as well as an understanding of their common characteristics, are critical for their description, selection, and use.

Background

The work that led to this paper started from the recognition that methods and their potential must be described accurately, be recognized as dynamic, and that method selection must be acknowledged as problematic in current practice. We identify three key challenges in current design practice, related to method selection and use: (i) the process for selecting methods is rarely obvious; (ii) there is little understanding of the consequences of specific methods and the biases they give rise to; and (iii) there seems to be little deliberate method selection or justification, to ensure that any methods utilized are fit for purpose, and the biases they bring forward are carefully attended to.

The content presented below is the outcome of the working group on design methods in the 'Future of Design Education Initiative' founded by Donald Norman and Karel Vredenburg (https://www.futureofdesigneducation.org). The initiative consisted of a large number of working groups. Some of its results were reported in Davis (2023). The Methods group withdrew from the FDE in 2022 and is presenting its output in this paper.

Here we have pooled our own experience with additions from design, social sciences, philosophy, and education literature. To consolidate the outcomes of these discussions, and share them with an impactful audience, we present our findings as a paper rather than a report. Within this paper, we make a first proposal towards a common vocabulary to enable this, and second provide suggestions for how to embed methods in design education. We acknowledge the limitations of our insights (for one, we are all professionals who can afford to donate our time, most of us employed by Western institutions). Our hope is that our insights provide a seed for the rich and pluriversal discussion towards a common understanding of methods fit for addressing twenty-first century concerns. The paper represents a snapshot in time, limited by the experience and lenses of the authors. It is intended as a resource not a prescription, elements of which can be adapted, modified for local situations, and superseded as further insights come up with better approaches.

Methodology

The work presented here is the result of a collaboration among a group of academics and design leadership practitioners, who have knowledge and experience in a variety of design disciplines. They met online more than 100 times for almost three years to discuss and brainstorm at both the philosophical and practical detail level regarding

teaching, selecting and applying design methods to achieve optimal results under various circumstances and constraints. Similar to most geographically distributed teams they employed standard collaborative digital tools such as Miro, Goggle doc and Zoom. Several of the authors began to integrate (and refine) the approach and recommendations contained in this article into their departments design teaching practices as this effort progressed.

Although the group had other members for short periods, the authors were the ones that consistently participated and continuously contributed to the conception, organization and writing of the work presented here. The reporting format grew over a number of iterations, partly based on formats pursued, then rejected, by the larger initiative. In the final run, the group decided for the hybrid form of general reflection in the main text and more detailed considerations in the appendix. The text was extended when some members identified topics or considerations that were missing. These topics were initially proposed and drafted by those whose expertise was greater concerning the topic in question. Nevertheless, every topic benefitted from group discussion and exchange of viewpoints, opinions, and references to research literature. A few shared principles framed the progression of the text, fundamentally, the notion that methods support the work of designers but do not provide solutions to the problems confronted; and that fundamental understanding of methods is generic (and therefore timeless), but current developments in the field and society in general demand attention for methods to support certain new efforts, e.g., in the areas of complexity, equality, and sustainability. To achieve good results, it is always the responsibility of the design team to select the appropriate set of methods and to use them with intelligence.

The paper consists of three parts. Part I gives a working understanding of what we mean by the key jargon around 'design'. Part II sketches the context of this effort regarding the development of the design field, and design education in particular. These two parts prepare the ground for the following overview of considerations for including design methods in design education. We split that discussion in two: a narrative which is Part III of the paper, and an operational detail level which is found in the appendix.

PART I
Key terms: 'design', 'method', and more

Design as a discipline is continually evolving. As a professional activity, design consists of making or shaping 'things' (Binder et al., 2011) for different peoples, purposes, and contexts of use. These things may include physical artifacts, processes, protocols, structures, organizations, digital experiences, conditions for living, tangible or intangible products, systems, services, and more. Whatever the desired outcome, the work of design and designers reshapes and gives rise to new relationships and possibilities. In each design activity, the context of the work may seem specific. However, the designer's considerations must be expansive; consider the breadth of human diversity, more-than-human and multi-species experience (Wakkary, 2021), global concerns (Wilde, 2020) and situated challenges in order to better understand unintended consequences and outcomes. Throughout the design process, the social responsibility of the designer must be held at the forefront. This is not a new concept. In 1955, Tomás Maldonado flagged social responsibility as a key concern, shortly after his arrival to the Ulm HfG, stating emphatically that: "On no occasion the commitment (of design) to serve industry can be found in conflict with its commitment to serve society." (Maldonado 1974, p. 54. Translated from the Italian by J. Frascara).

Historically, design education and practice have been dominated by short-term business goals and have not attended well to these broader societal and planetary issues. And while progress has been made, for example with the development of participatory design and its commitments to democratic processes and inclusion (e.g. Björgvinsson Ehn & Hilgren, 2010, 2012; Binder et al., 2011, 2015), and increasingly in design education programmes (Noël 2020a, 2020b), this progress is uneven and requires more attention to gain better adoption.

We therefore posit that new approaches are needed for design education and practice if design processes and outcomes are to effectively contribute to social, cultural, environmental, political and economic flourishing. The intention is not only that design does no harm, which in itself would be an advance, but that design processes and outcomes work in support of rebalancing relationships between humans, and with non-human stakeholders, to support justice and dignity for all, and regenerate the damaged ecosystems that we are part of. This move finds resonance in Maldonado's 1970 proposal of design (*la progettazione*) as an activity that could offer a systemic and methodical way to address the crises created by late capitalist society (Maldonado 1970, p. 128-129). In a similar vein, Victor Papanek (1971 p. ix) attacked designers for "designing criminally unsafe automobiles … by creating whole new species of permanent garbage… designers have become a dangerous breed." The pathway we propose here connects with calls to reposition the role of design in human endeavours as relational (Dindler & Iversen, 2014) and ontological (Nold, 2018); fundamental to how we live. This positioning stands in contrast to the still common understandings of

design as a discipline that merely contributes to how things look and function in narrow and isolated contexts of engagement, solving problems at hand with little regard to surrounding systems and societal context.

Purpose of methods in design

Design methods facilitate activities conducted within the (full or partial) life cycle of a **design process**. The most common objectives of a design project are to understand context and inquiry into what is going on (Park et al., 2022, p. 439), and to invent, improve or modify what Binder et al. (2015) call a design 'thing' (e.g., a product, service, process, situation, organization, or system). Methods are critical for achieving successful results within a reasonable amount of time and effort. Design methods, thus, form the keys to open our understanding of the world to new perspectives and dimensions. In this sense methods serve these goals of designing: framing, learning, doing and validating.

Design methods exist to support activities related to commonly understood working step-categories such as: discovery of realities and needs, engagement, analysis, synthesis, domain understanding, prioritization, economics, modelling, concept generation, communication, prototyping, evaluation and more. Critically, these categories, the work done in them, and the design methods themselves are not fixed. Existing methods continue to be adapted and evolve in response to new circumstances and constraints which may be of a technical, political, social, educational, cultural, commercial, environmental or financial nature. Furthermore, new methods are invented to fill gaps where current ones prove insufficient in any dimension. In brief, new situations often need new methods. Jones identified this need back in 1970 (Jones 1970, 1980, p. 27-42). As Martin and Hanington explain, methods and techniques "provide an opportunity to structure conversations that can help us better understand and empathize with people," (2012 p. 6). Historically, design methods have been segmented into those particular to generative activities (e.g., sketching and rapid prototyping) versus research activities involving measurements and observations whether quantitative, qualitative or mixed. However, in practice this distinction is often blurred, for example when a speculative UX prototype is used as a research probe in studies to elicit user needs and goals. Therefore, we do not carry this formal separation of "design versus research" any further in this paper. In the past decade several overview books have listed and described dozens of methods, typically about one hundred per book (e.g., Kumar, 2012; Martin & Hanington, 2012; van Boeijen et al, 2014, 2020). These books indicate a position of use, and carry pointers to the literature, but do not provide detailed instructions or background. Discussions of the evolution of design methods can be found in Gray (2022, p. 2) and Daalhuizen & Cash (2021, p. 3). For Gray (2021, p. 1),

> "Design methods have been integral to design studies research, with initial goals of bringing rationality and objectivity to design activities, later shifting to the creation and provision of methods as tools to encourage more reflective, meaningful, and socially responsible design practices."

For Edgar Morin, "that which helps understand how to learn, that is the method… I do not offer the method, I go in search of the method." (Morin 1977, p. 28. Translation from the Italian by J. Frascara)

He is opposed to methods as rigid structures and to any form of simplification. Methods should help face reality in all its complexity. John Chris Jones (1970) proposes a very brief definition: "A design method is any action one may take while designing." (1980 p. xix) Nigel Cross and Robin Roy propose that "design methods are tools or techniques for conducting design projects. They are separate design activities that a skilled designer will select and combine into an overall design process." (Cross & Roy 1975, p. 4)

As design expands its focus—from the shaping of artifacts, to collaborating with people, towards organizational change, to addressing systemic challenges—the number and range of methods also expands, making design methods as dynamic as the discipline itself, its educators, and practitioners. The turn to systems prompted an expansion of design methods to deepen understanding of contexts, relations, interdependencies, and collaboration, in response to the need to integrate methods and expertise from many more disciplines into design processes; and to support very different ways of working.

Meaningfulness and relevance have always been core values in design practice. Methods have traditionally focused on designing the design process, performance, innovation, differentiation, and risk management. In contrast, methods for systems focus on avoiding the simplification of reality, the disjoining of parts, with the aim of assisting the designer in conceiving the complexity of phenomena. Methods for systems focus on discovering what makes sense in the collaboration between a specific context and its ecosystem. Previously, methods were largely discipline specific. Today, with the understanding of the importance of working systemically, designers need to be better equipped to

consider the possibilities of cross-disciplinary methods. In this new landscape, traditional design methods remain relevant but making a conscious decision in selecting the appropriate method becomes an even more critical skill.

To address complex systems, methods are pivoting towards evidence-based understanding of the impact of design in creating positive outcomes. This reorientation generates a need to formalize methods more specifically, so that their role in evidence creation can be better understood and transferred. The use of evidence thus requires an awareness of the paradigm on which the knowledge or theory is based.

A vast body of literature exists with regards to design methods and these resources are distributed across multiple specialized design disciplines. Designers must understand how each method can contribute to the eventual outcome, why to use a particular method, when to use it, and how to use it, including in combination with other methods. To assist in this process, we find it is first necessary to define a common vocabulary to frame the pedagogical recommendations that follow. The key definitions offered below are intended to clarify and are applied consistently throughout this article.

Other key terms

Besides the main terms 'design' and 'method', several related concepts return in the narrative. For each of these, we call upon fairly basic understood terms, each of which has a deeper academic base, but more precision would distract from what we are trying to achieve here.

Approach is an overarching perspective when facing a reality, model of practice, and perceived scale of action. For example, applying People & Planet-Centred Design when designing products as part of a service ecology or regenerative system approach that guides the overall decision and trade-off making process, to develop capacity within a community and create conditions conducive to life (Wahl, 2016, p. 43).

Design actors: various people, professionals and others, including stakeholders, who have agency in the activity of designing.

Design practitioners: actors that work in design, with or without education and training.

Design professionals: actors deeply educated and trained in design competencies.

Design methods: structured protocols that support all stages of doing design and are critical for achieving successful results.

Model is "... to provide a language sufficiently schematic and precise so that relations within the subject that is being modelled can be examined by comparing them with relations within the model… It is above all the tool of *abduction*, drawing from phenomena in different fields that which is shared among them…" (Bateson, 1987, p. 37). This is particularly relevant in contexts dominated by occidental languages, which "do not lend themselves to the discussion of relations" (Ibid.). Once a vocabulary of relations has been established, a model can be useful to generate questions.

Process is the structuring over time and actors of the design activities.

Situation-Intervention is used in this document to indicate what design starts from and works toward; several other terms are in frequent use, but we do not use them often here, e.g., *problem, challenge, solution*; when we do, it is without intended philosophical implications.

Technique is a way of carrying out a method. Interviews, for example, can be structured or unstructured; one-on-one or with groups; and coded or simply transcribed (Sanders & Stappers 2012, p. 65).

Tools are devices used to collect data, represent findings or propose and envision possible interventions and futures. Video recordings and sensors are data collection tools. Models, maps, and simulations are tools for representing a view of the situation, research and findings. Prototypes are a popular tool for articulating a potential intervention or possible future direction.

Methods have two functions: recipe and language

As a recipe (algorithm, prescription), methods can be executed in the hope of achieving a specific result or experience. This is valuable for the beginner, but too narrow for the competent design practitioner or professional.

As *language*, methods provide a means to frame, discuss, argue, and specify the nature of the situation that the designers are facing and what could be done by whom, how, and why. As a language, methods support teams to achieve an effective division of tasks. When practitioners or professionals rebel against methods, it is usually against *recipe*. We mainly focus on *language,* although *recipe* has its place.

Additionally, methods can function as learning aids: they assist in user research and in learning through action, as in the use of prototypes and other evaluation, observation, interaction and testing methods. Along Morin's lines, Jones writes: "choose whatever method will tell you what you don't know, but need to know, in order to proceed." (1980 p. xix)

PART II

Context: developments in society, the design field, and education

Here we position our effort in the current moment in time, discuss beliefs and assumptions around educational competencies, principles, and some caveats; goals for student understanding and behaviour; required characteristics of teachers; and propose a list of topics.

The table below is provided only as "a point in time reference" and it will of course continue to evolve through the participation of design professionals globally as new and more challenging situations emerge which demand our collective talent to drive innovation, intervention, and regeneration.

The beliefs and assumptions are based on the experience of the authors, but also on our view on how the design discipline is evolving. To that extent we have used a historical perspective of shifting that broadly follows the model as proposed by Brand R. & Rocchi, S. (2011) "Rethinking value in a changing landscape". For this discussion we have collapsed the knowledge and transformation paradigm in one (see table 1).

To clarify how design changes across phases, the rows distinguish a set of design competencies modeled after those presented by Conley (2011). The competence "Modeling as analytic tool" has been split into a set of activities focusing on supporting creativity, and a set supporting envisioning, as a core competence of design. Likewise, "Integration" is reviewed from an aesthetic perspective (integration of different design elements) and from a concrete perspective (integration of different disciplines).

The table summarizes a historical perspective regarding the generational transformation of design methods, tools, and techniques. It is important to note that the shifts or paradigms are cumulative, not mutually exclusive. For instance, prototyping is still an important activity, but in the new paradigms it is not only executed by the designer, but might be supported by generative algorithms and evidence from data.

Table 1. Development of design 'generations' over the last decades (phases after Brand & Rocchi, 2011; competencies after Conley, 2011). It should be understood as marking the point in time from which we review the recent past.

				III: Since 2000
			II: Since 1980	
Core Competencies of Design		**I: Since 1950**		
1a	(Re)framing	Program of Requirements, Quality Function Deployment (QFD), third person perspective	Design thinking, Design Sprints, End user insights, Reformulating the question	Interventions (always in beta), growing systems, first person perspective
1b	Research for Design	Safety	Usability Testing	Contextual Research to generate insight leading the design cycle
2	Developing multiple solution directions	Challenge the starting point (challenge the brief)	Knowledge from different fields (e.g., other disciplines)	Integrating different values & ethical considerations, design for inclusiveness, reduce bias
3a	Modelling as analytic tool (creativity)	Sketching, model making	Experience journeys, context mapping, behavioural change models	System maps, solutions created on existing products or building blocks
3b	Modelling as analytic tool (envisioning)	Personal insights or quest of the designer	Trend research, speculative design, concept cars	Creation of shared values, back mapping, sustainability brokering
4	Generate alternatives (& testing)	Prototyping to evaluate alternatives	Focus groups, persona definition to describe behaviours and aspirations and guide design work	Generative design (AI), datamining, evidence based, personalized solutions. Engaging in participation to understand the story of place.
5a	Integration (aesthetics)	Aesthetics principles, integrity of the concept in the final result	Total touchpoint experience, aesthetics of interaction	Focus on outcomes and quality of life, of aesthetics, and of intelligence
5b	Integration (multi-disciplinary)	Multi-disciplinary within an organization	Cocreate sessions with clients, solution partners, etc.	Cocreate sessions with eco-system partners, enabling non-designers to do "design doing"
6	Holistic (user focused)	User focus, usability (UX)	Customer experience (CX)	Total experience, planet focused, purpose & values, systems perspective, regenerative design
7	Create form, experience & value	Stylistic, a personal style	Branding, design language systems	Experience models and heuristics as input for co-creation with AI, biomimicry and nature-inspired design

Educational competence: beliefs and assumptions

***Design competencies require critical thinking*:** Knowledge of and rehearsal with design methods alone does not guarantee attainment of design competencies. Attainment of the desired competencies incorporates knowledge, critical thinking (understood not only as questioning, being curious and analytical, but also as principled thinking) at every stage of the process, and practice skills.

***Teaching and learning*:** From a pedagogical point of view the most important objective of a course is not what *the instructor must teach*, but what *the students must learn*. Therefore, it is essential to determine:

a. which concepts the students must know and use;
b. which ones should only be learned when required by a field of specialization; and
c. which ones students need only be familiar with.

Competency-based curriculum: Best practices in design curriculum development will first define the program's competency model (or adopt an existing one), before finalizing the subset of design classes that will be taught within the degree program. Specific types of projects should be planned to help students develop the competencies pursued, including expanding their capacity to learn (Claxton, 2007).

Evidence based practice: Designers can no longer rely on the intuitive nature of human creativity alone to design appropriate responses to problems. Design methods education and deployment must evolve to embody an Evidence Based Practice (EBP) operational model, sensitive to both global and local concerns and contexts. For Rousseau et al (2016, p. 668), "Evidence-based practice (EBP) is a disciplined approach to decision making and action…Its goals are to improve the results of professional decisions and to increase the use of practices that lead to desired outcomes." They explain that

> "(…) EBP is not limited to scientific evidence, but also incorporates local or situational information, stakeholder concerns, and practitioner judgment and experience. Rather than a narrow focus on scientific research, a focus on evidence directs attention to the quality of the available information and knowledge, the various forms it can take, and the way people use it in decision making and action." (2016, p 669)

The use of evidence thus requires an awareness of the paradigm on which the knowledge or theory is based.

Design is a team sport: The challenges of the 21st century require a multidisciplinary approach between designers, researchers, and many other professions, like engineering, in addition to collaboration with end stakeholders (Sanders & Stappers 2012, p. 25; Sanders & Stappers, 2014). For this reason, we articulate competence 5 in table 1 as two rows instead of one. Project practice and rehearsal in multidisciplinary teams is a foundational element in design education and opportunities for it should be embedded into the curriculum.

Everything is a System: High value equitable design responses require maintaining a systems perspective that accounts for all stakeholders, including the biosphere, and side effects. A systems perspective should constitute a key aspect within all projects. Bateson (1979, p. 7) adds emphasis to the need to see the patterns of connection in education: "Break the pattern which connects the items of learning and you necessarily destroy all quality."

Models are important but always incomplete: To comprehend complex systems, big data, and human interaction trends, both system and behavioural models are required to understand phenomena and respond to them. Models are appropriate to both research and design activities. However, the real world is always more complex than the model which, while useful, is inherently a simplification of reality. As Bateson said, citing Korzybski: "The map is not the territory" (Bateson 1979, p. 27). Wilden refers to the cybernetic notion of requisite diversity, asserting that the system that represents another system must have at least the same range of variety as the system represented: i.e., a simple method cannot be used to represent a complex reality. (Wilden 1987, p. 192)

Embed ethics and sustainability: Holistic topics such as ethics, sustainability, regeneration, safety and universal design should be embedded into most research and design topical courses to frame the appropriate contexts, decisions and responsibilities. It is no longer suitable for 21st century design education to treat these holistic topics from a standalone perspective.

Delivering AI supported design solutions (embedded AI usage): Numerous products and services today use AI technologies for recommender systems, natural language understanding and other functional implementations.

Designers and researchers need to be skilled in the designing and deployment of embedded AI to ensure they deliver fair, accurate and equitable outcomes and to minimize bias induced by underlying training sets and algorithms.

Designing with artificial intelligence (AI): Automation has been creeping into the designer's toolkit for decades, with software for constraint-based layout, simulation, and other functions. AI today has already demonstrated the ability to produce generative outputs (in both art and UX design) previously believed to be the sole provenance of people. Designers and researchers need to become skilled in collaboration with these tools through the educational process, part of which is understanding that they must retain social and ethical responsibility for the outcome of joint human/AI inventions.

Critical understanding of past, current, and emerging design cases: Design is an integrative discipline, with a rich history of innovations, shifts of perspective, and discovery of new ingredients. Designers need to understand how those changes happened, why previous "best practices" needed to be replaced, in order to deal with current changes and not repeat old mistakes.

***A commitment to the decolonisation of design*.** Decolonising design requires destabilizing the certainties of design as an activity that can be applied to diverse contexts to improve them. It requires pushing for understanding the diverse histories, locations, experiences and relations within design and designing; moving beyond Anglo-Euro-centric epistemologies to not only create space for situated knowledges, but to allow these to change design action in fundamental ways (Schultz et al., 2018). Designed artifacts configure meaning and possibility; designers must acknowledge this, and approach their tasks with humility. At its foundation, Decolonized Design is pluriversal in its understanding of and engagement with the world (c.f. Escobar, 2018). It emphasizes relations (Liboiron, 2021), with the land and the biosphere that we depend on and are defined through. "Colonialism is the disavowal of that debt and responsibility" (Mbembe, 2020).

In summary, it is important to note that these paradigms are integrative and interactive, not exclusive. For instance, prototyping is still an important activity, but in the new paradigms it is not only executed by the designer, but is for instance supported by generative algorithms and evidence from local or situational information.

> "Every knowledge, whatever that could be, presupposes a knowing mind whose possibilities and limits are those of the human brain, whose logic, linguistic and informational subtract comes from a culture, that is, from a specific society, real and current" (Morin 1977, p. 113. Translated from the Italian by J. Frascara).

Maturana and Varela continue along this line:

> "...when we examine closely how we get to know this world, we invariably find that we cannot separate our history of actions – biological and social – from how this world appears to us. It is so obvious and close that it is very hard to see" (Maturana & Varela 1987, p. 23).

Principles

Design methods require critical thinking and critical discourse. Designers' need for critical thinking involves a high ability to search, observe, collect, analyse, synthesise, understand, compare, select, doubt, consult, defend, argue, describe, communicate and evaluate to reject partiality and arbitrariness, validate, learn, and perhaps even change the designer's ways of knowing. Intelligent use of methods requires a developed and shared vocabulary.

Design methods cover the entire range of activities, along the whole design process, and involve creativity for conceiving and developing research, decision-making, analysis and requirements synthesis, creativity for generating ideas, conceptualising, visualising, prototyping, implementing, reasoning, reflecting of the process of thought, and evaluating at various points. Design involves managing the process and integrating the activities, often involving teams of design professionals and other stakeholders with essential domain expertise and agency.

Caveats

The field sails between two polar myths of simplification: that *individual intuition* suffices, and that *prescriptive methods* by themselves ensure results**.**

The myth of intuitive mastery. The last decades show the acceptance of **design as a generic ability**, the 'democratisation of design', a 21st century skill (Voogt & Pareja Roblin, 2012) to be held by all citizens, as matter for

the curriculum of even primary education. Elements of design are successfully ported to isolated workshop formats as in 'Design Thinking' or 'Design Sprints.'

But there is a different need for **design at a professional level**, that goes beyond the myth of universal creativity and require higher abilities. It is similar to mathematics: everyone must be able to count, but it takes professionals to solve differential equations. Therefore, training in relevant (e.g., technical, social science) domains combined with mastery in the selection and deployment of contextually appropriate knowledge and methods is a requirement for the design professional.

The myth of self-sufficient methods. Design is not magic. Its methods can be learned and taught. And they need to be instantiated and adjusted to the situation where they are applied. Methods do not provide solutions; they propose processes and strategies to obtain information or support action. They provide a framework through which to shape responses (to challenges / issues / areas of interest or concern). Methods require a capable designer. You can tell a master by his tools, but tools do not make a master. It wasn't Michelangelo's chisel that made the *David*.

Goals for student understanding and behaviour

Upon completion of a future design degree program students will realise that there is a range of methods to be drawn upon, each of which can potentially improve both the quality of their responses as practitioners and the efficiency with which they can research, comprehend, and envision possible futures through scenarios and prototypes. They will also be cognisant of the value that methods can provide to enhance visualisation, presentation, and communication effectiveness.

They will also recognise the supplemental benefit of improving communication and teamwork when methods are utilised as language in addition to recipe.

Specifically, graduating students will embody both in knowledge and in action that:

- Many methods exist for every phase of the design process (regardless of how a design sub-discipline categorises those phases/steps)
- Many methods are cross-disciplinary
- Many methods are applicable to more than one design phase, but they must generally be adapted to the phase, and the goals for the method may vary within the phase
- There is always a trade-off between time, participants' availability, resources and accuracy in the deployment of any method
- Blindly following any method will not lead to a high-quality result
- Selecting an inappropriate method and/or executing it poorly can lead to damaging results
- Selecting and executing a design method (what, when, with whom and how) must be done with critical concern for the method's appropriateness within the context of deployment:
- The local culture where it will be deployed must be considered
- All stakeholders' privacy and security must be protected
- The execution and the reporting of results must be Ethically conducted
- The project should not generate artifacts or outcomes detrimental to people and planet
- An IRB (Institutional Review Board/Ethics Board) review process must be utilized if there is a potential risk to research subjects
- The budget and schedule needs of the client/project must be met (e.g., business, government, NGO, etc.)
- The inherent bias embedded in a method's underlying assumptions and processes with regard to the capabilities and rights of living things, cultural hierarchies and belief systems must be recognized (e.g., Hofstede's, 1991)

Required characteristics of the teachers

Teachers of design methods must be extra cognisant of the same issues and dimensions as students. In addition, they must be keenly aware of their own bias with regard to how they present the pros and cons of method selection regarding the *what, when, with whom* and *how* decisions and trade-offs with regard to both their field of specialisation and in other related specialisations with which they collaborate. They should have practical experience using the most common methods.

Teachers of methods must also embody both in knowledge and in action that:

- No method is neutral (all may be used for good or weaponised)
- Clear communication of the best practices for use of the methods within their own area of specialisation is necessary
- They implement effective communication of the relationship between a given method and the phases of the design process model they are communicating as best practice (and which will be different across institutions and subdisciplines)
- Preferably be qualified to serve as IRB (Institutional Review Board) reviewers for methods involving human or animal subjects
- Have the ability to invent new methods or modify existing ones to meet new situations, requirements and constraints while consciously incorporating the white bullets above that regard the context of deployment

PART III
Topical curriculum development recommendations that apply to all methods

Here we identify two overarching principles that we consider essential foundations for design that is *just, pluriversal, and caring* for human and planetary concerns; and lay out a range of topics that consider foundational comprehension, practical execution and planning, and emerging technical developments in the discipline of design. For each topic, we provide operationalisable – and customisable – **lists of things that students should know and be able to do** (see appendix). We complement these propositions with Table 1, which shows historically cumulative shifts in core competencies of design, recognising that the proposed view is only one of many possible perspectives on design histories.

Overarching Principles

At the very basis of design there should be an equivalent to the Hippocratic Oath:
First, do no harm. Methods are used by people toward purposes and affecting values. Designers must be aware of this, take responsibility, and proceed with care and caution. But we ought to 'do better';

Second, do good. Methods can be selected to support the regeneration, repair, and care of social and planetary ecosystems beyond the limits of a project. Designers must aim to extend their work to yield such positive value.

Practical Execution & Planning Topics

Approach, Method, Technique, and Tools. These are 4 levels of practice that require detailed consideration for successful execution. They are uniquely distinguished but also interconnected**.** They are defined at the beginning of this text.

- *Approach*: e.g., Participatory Design
- *Method*: e.g., Contextual Inquiry
- *Technique*: e.g., Ride along study (shadowing)
- *Tool*: e.g., Video recorder with transcription service

Methods support competencies. For each of the competencies listed in table 1, there are methods/etc. There are several overview methods books (e.g., Kumar, 2012; Martin & Hanington, 2012; van Boeijen et al, 2014, 2020) which position them relative to design processes, and give general descriptions and references to relevant publications.

Methods need to be critically selected. The designer should be aware of warnings coming from cognitive psychology, be critical when it comes to understanding the particularities of a situation confronted, and choose the most appropriate method to confront it. (Margolis 1985, p. 27)

Methods can be adjusted in real time and should be evaluated afterwards. "Every method should be constantly under critical review…Even the most appropriate one, however, will need to be modified according to the specific characteristics of the task at hand." (Frascara 1997, p. 35)

Teamwork. Complex challenges require teamwork, often relying on expertise from other disciplines and sharing design ownership with stakeholders. Collaborative design and research methods facilitate the negotiation of values, concepts, and processes. One of the roles of Methods is to foster participation through dialogue, reflection and action. Design methods are typically executed as team activities which require positive dynamics to function effectively with regard to roles, planning and alignment.

Ethics. Students should be familiar with ethical considerations in using methods that involve living subjects (humans, animals, plants, etc.) as participants. Attention to good ethical practices for such studies is often required by organisations' Internal Review Boards (IRBs). Students should be familiar with both theory and practice of complying with ethical guidelines.

Scale. Design method selection and execution must correspond to such shifts in scale. The complexity of systems grows substantially with the addition of each new element or actor. So does the size of the design team and stakeholder network.

Sensors. Contemporary tools and technologies expand design and research methods and allow designers' access to real time continuous feedback of products and systems during their use. This contrasts with the limitations of single point in time discovery and evaluation methods. The introduction of real time data streams brings with it new risks for misuse and misinterpretation. Ethics become a sensitive point here.

Designing *as, with* and *for* Nature. Increasingly, designers are working directly with natural systems to develop design outcomes. According to Collet (2020), there are three broad approaches currently recognised for designing as, with and for Nature. These are: approaching nature as a model, employing biomimicry principles; approaching nature as a co-worker, employing husbandry principles; and approaching nature as a 'hackable system', employing bioengineering principles. These three approaches are evolving rapidly. A number of organisations support their development with resources, events, competitions and community-building for educators, students and practitioners (e.g., https://www.biodesignchallenge.org and https://igem.org). Biodesign involves designing with living systems, for example, growing mycelium, kombucha or bacteria to develop or treat materials in new ways; shepherding slime mould's growth to design pathways for metros, railways and roads; designing for cohabitation with plants and critters, in the built environment; or in collaboration with the inhabitants of complex ecosystems such as forests, prairies, mountainscapes, waterways or oceans, so that human practices might better support more-than-human flourishing.

Conclusion

The paper highlights the inseparable connection between a practitioner's methods and their outcomes, and the need to bring this relationship to the forefront in design education. More than '*doing no harm'*, designers need to foster justice and dignity for all and repair damaged socio-cultural, technical, environmental, and planetary ecosystems. To be coherent and effective in this work, we argue, requires (re)consideration and (re)formalisation of methods to ensure that decision-making is grounded in empathetic, evidence driven and principled thinking-in-action.

To assist designers and educators in engaging with methods anew, we discuss the context, values and goals that we believe must underpin transformative design practice; observe how to learn and teach methods; provide recommendations for topical curriculum development; and overview core design competencies, to assist educators in developing their materials. We propose what students must learn, know, and do, at basic and specialised level. We argue that skills to collect and validate evidence must be accompanied by skills to identify the paradigm that informed the evidence. Throughout, we recognise that living, learning, and designing take place in systems where the in-between is what matters, and advocate for building relationships to learn collectively. We caution against simplifying realities to avoid unknown distortion of issues and contexts, and thence harm, and advocate for embracing other ways of knowing to move beyond restricted epistemologies and build capacities for new possibilities.

Design methods enable and support the development of particular ways of knowing and doing. Methods are continually evolving to meet changing needs in a landscape of socio-cultural, technical, environmental and planetary flux. The challenge for designers is to keep pace with this flux and to develop methods, strategies and tools that enable responsible action, while continually reassessing what responsible might look like from varying perspectives in the context of action. We hope that our reflections on the use and teaching of design methods might enhance educators' capacity for teaching, and practitioners' capacities for engaging with methods, in ways that make space for uncertainty and not knowing, avoiding oversimplification through reduction. We believe that critical engagement with methods can support transformation. We hope this paper makes a productive contribution to that process.

Eventually, when designers use supporting methods: accepting uncertainty, not knowing, avoiding the simplification of realities; what should emerge is a transformation, not only of the reality confronted, but of designers themselves.

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Appendix – Detailed actionable tables supporting section 3

Design methods are structured protocols	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● Methods are deployed within a ***design process*** ● Methods are associated with specific ***tools, purposes and activities*** ● Methods are selected to address a problem/challenge/goal ● Methods do not solve design problems by themselves ● Methods help the design actors participating in the design activities to respond to them coherently ● Methods help to understand human circumstances that require change ● No method can be better than the skill level of the people using it	● Plan and conduct a ***design process*** ● Identify criteria to support selecting appropriate methods for the project at hand ● Select methods and support choices with defensible arguments ● Use methods with care and questioning their appropriateness to study the circumstances

Design methods serve both as language and as instructions	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● As language, methods support all actors in the design activities to structure, plan, coordinate, and justify design work (especially when collaborating in teams) ● As instructions methods are algorithms or recipes that can be followed (especially by novices, in early training) ● Teamwork relies on positive group dynamics, roles, planning, and agreement	● Competently apply the most common methods specific to their design sub-discipline area ● Practice and rehearse methods via projects ● Learn systems theory and how it applies end to end within the relevant context ● Set up, conduct, present, and lead projects (solo and teamwork) ● Perform different team roles ● Develop skill in evolving methods in response to the specific circumstances

Contextual sensitivity	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● Design methods must be matched to the contexts, goals, and conditions surrounding the problem domain and organizational dynamics ● Methods require constant evaluation during their use, monitoring the quality of the information obtained and being conscious of all the variables affecting the information obtained in order to be aware of limits to generalization, and minimize possible biases ● Methods must fit within project constraints (including budget) ● Methods can be replaced/changed during a project depending on its progress, however, changing methods in the middle can make longitudinal comparison of research results difficult	● Engage critically with the assumptions in the brief (problem statement), by doing background research to determine if the problem statement is desirable, rational and ethical ● Conduct a stakeholder bias assessment (including the design team members) ● Conduct a sustainability audit ● Adapt expressions, such as verbal, visual and tangible, to the people involved in the design process and the (more-than-human) public affected ● Design research methods help avoid inappropriate contextualization resulting in the distortion of issues

Evidence Based Practice and Creativity	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● Evidence includes scientific knowledge ● Various sources of information carry different weight as evidence ● General knowledge needs translation and embedding for specific situations ● Evidence includes local or situational information, stakeholder concerns and lived experience that can be understood from a plurality of perspectives ● Creativity can be defined as the conception of original ideas that have value ● Creativity can exist in situations with demanding constraints. The more constraints a situation has, the higher the value of creativity.	● Generate alternative framings of the challenge as presented ● Generate stakeholder maps ● Define the intersection of the “common good” for all stakeholders ● Conduct a literature/data review to assess the State of the Art with regard to general theories, analogous case studies, and specific context/situation ● Conduct research when knowledge gaps are identified in existing information required for the project, include user research to discover the plurality of needs and goals, and determine which must be satisfied ● Prototype, test and validate to create understanding early in the design process, develop ideas, and later evidence, to ensure that the solution is satisfactory and sustainable

Approach, Method, Technique, and Tools	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● Methods are keys to open our understanding of the world to new perspectives and dimensions. In this sense methods serve both learning and validation ● Methods foster teamwork, sharing and collective sense making ● Methods both facilitate and constrain thinking and action. This is done in order to avoid errors, and limit the solution space explored in pursuit of effectiveness and efficiency ● Design methods help hold various possible ways of knowing the world, and to embody a transformative praxis, leading not only to creating responses to situations, but also to knowledge creation	● Maintain a safe space for mutual exchange and learning. Consciously managing power balance dynamics and foster purposeful interaction

Methods support competencies	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● There are general methods/etc for each competency, and *specialist* methods/etc particular to sectors/domains (e.g., *automotive* sketching, *digital* prototyping) ● Beyond instructions, methods serve as language for more advanced practice (see Part I, Methods have two functions: recipe and language)	● Have experience with methods/etc for each competency ● Preferably in multiple domains/sectors/scales

Methods need to be critically selected	
Things to know Students should recognize that:	***Things to do*** Students should be able to:

● There are always time-quality-cost trade-offs to be made
● Approach, method, technique and tool must be appropriate to:
  ○ The circumstances to study
  ○ The question to be answered
● There can be significant emotional burdens placed on all actors in certain domain areas (e.g. designing for terminal illness)
	● Identify a set of possible choices of approach, method, technique and tools and explore their appropriate combinations
	● Perform a pro/con analysis for potential accuracy, cost effectiveness, efficiency, cultural appropriateness and potential bias
	● Argue why the method selections are the most suitable for the project
	● Explicitly document what was assumed and what was outside the scope of consideration
	● Embrace “Other(ed)” perspectives and enable reciprocal relationships between actors
	● Unlearn, relearn and go beyond capturing views

Methods need to be critically selected	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● Methods can rarely be used ‘from the book’ or repeated ‘exactly like last time’ ● Fitting them to the context requires appropriating, scaling, adopting, adapting them, or possibly creating new methods or variations ● Using methods requires ongoing management of both stakeholders and processing (i.e., for terminal illness)	● Continue to evaluate, as they execute a project, if the choices they have made are meeting the goals and remain the best option ● Iteratively collect and assess evidence on whether the methods and tools are effective as the project progresses ● Substitute an alternative method decision if there is evidence that it is not meeting the goal or causing harm ● Perform a multi-stakeholder retrospective analysis at the end of every project on how it could have been done better and what unanticipated side effects resulted from the methods choices, considering both positive and negative impacts

Teamwork	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● Teamwork requires practice in positive behaviors that facilitate productive work. ● Your stakeholders are "part of the team." ● Collaborative methods provide opportunities for others to engage in the design process; they create a safe space for mutual exchange, consciously overcoming unequal power over outcomes and building a collective sense of ideas to bring forward. ● Methods reveal stakeholder assumptions and biases. They seek accounts of lived experiences and a plurality of perspectives. They navigate language differences in reaching shared conceptualizations of the situation, and interventions possible, often through visualization to overcome discipline-specific concepts.	● Create stakeholder maps defining the collective set of interests and goals at the beginning of each project. Agree on roles and responsibilities in the team. Iterate the maps, and the implications of the changes, during the design process. ● Maintain a safe space for mutual exchange and learning. Consciously manage power balance dynamics and foster purposeful stakeholder interaction. ● Take on various roles in design teams and practice the application of methods, including leading projects and presenting both process and results. Their performance as team members and execution of methods are at least as important as the qualities of proposed interventions. ● Undertake some interdisciplinary projects that require expertise/participation from other fields. They should use design methods to facilitate and negotiate these collaborations. ● Students should engage in projects that include stakeholders in the design process. Using participatory methods and argument, they should develop iterative models of the situation and potential interventions with respect for what stakeholders know, can do, and can afford.

Ethics	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● The application of design methods can have undesirable effects on stakeholders and research subjects if not conducted properly. ● Most organizations have guidelines for research involving living creatures, not just humans. ● The design team is responsible for its conduct during methods execution to ensure that ethical guidelines such as subject privacy and respect are followed. ● The introduction of embedded sensors and user surveillance introduces an additional set of obligations regarding the privacy and real-time inference uses of user data.	● Show that the method has scientific, practical, and/or educational value. ● Be conscious of multiple roles as researchers and avoid conflicts of interest. ● Practice fair participant selection ● Take explicit measures to minimize any risk to participants and team members; place their health, safety, and welfare at the front of considerations. ● Avoid deceptive practices, and protect participant anonymity and confidentiality. ● Obtain participants' informed consents and provide them the right to ask questions and withdraw from the study at any time. ● Accurately and fully report findings and acknowledge contributors in presentations, reports, and publications.

Scale	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● Systems theory underpins contemporary work and should be reflected in methods selection and execution. Open systems (as compared with isolated products) have greater variety, volatility, and velocity of change. ● Framing the design investigation in conjunction with the approach, determines the level and scale at which design action can take place. ● When working at system scale, a plurality of methods that complement each other is required to provide different multidisciplinary and cultural perspectives and identify alternative possibilities.	● Prototype the intervention at the highest fidelity possible and breadth of scale. ● Use appropriate sample sizes for testing, and evaluate variation of profiles within a group when scaling up projects from a small to a large population segment. ● Make appropriate qualitative and quantitative adjustments when scaling up a prototype to a working intervention. ● Make, and learn from, many local prototyping efforts at different places in the system. Do iterations.

Sensors	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● Sensors record individual and social behaviour, environmental conditions, and interactions among parts of systems. These data inform design decisions. They also represent a potential intrusion of people's privacy. ● In addition to larger sample sizes, it is as important to acquire real time data that help to get closer to the actual moment of interaction and therefore more accurately informs design decisions. ● Data mining examines the traces of digital interactions, and data sets can be sorted for insights. Artificial intelligence learns from these interactions, increasing over time the nuance in questions that can be asked of these data or the recommendations a system provides via a real time interaction. ● Big data surveillance techniques allow designers to scale research methods to larger sample sizes and to display and analyse results in real time. Computer analytics also sort data under different queries that reveal and contrast relevant patterns. ● Available data biases understanding and action, as in the management saying 'what gets measured gets done.' ● Correlation within big data does not imply causality! (Refer to *Evidence based practice* under "Educational competence: beliefs and assumptions").	● Become familiar with and propose applications of new technologies in their design research. They should make critical judgments regarding privacy and the ethical use of these invasive technologies. ● Use available technologies in prototypes and presentations, especially in analysing dynamic system level challenges. For example, virtual reality for testing service environments. ● Reflect on what the blind spots and biases of available data are, e.g., where these concern human and environmental values. ● Undertake design projects where the intervention must adjust its behaviour in response to real time use of data streams.

Designing *as, with* and *for* Nature	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● All living systems, including humans, are part of nature. ● Nature demonstrates the ability to adopt and adapt to changing circumstances in rich and diverse ways. There is much to learn there for designers. ● Nature can never be fully controlled or predicted. ● Nature's search for balance may not always be beneficial for human survival or flourishing. ● Designing with nature is an intentional designing process with living entities whose language may not be accessible to humans. ● Designing with nature to develop materials, products, systems or services changes the role of the designer in the overall process from exploiter of resources to steward of the living systems. ● It is important to evaluate risks, safety codes, and ethical issues when designing with nature.	● Identify and consider the impact of your design process and what you intend to produce on human and non-human elements of nature. ● Design with nature as a partner, and approach the 'uncontrollability' of nature as an attribute to be explored, rather than as a problem to be conquered. ● Generate designs that respect living entities impacted by the design process; this holds both when intentionally or consciously collaborating with them, and when incidentally impacting them with your designing. ● Design with respectful caution and fully informed of all safety protocols.

Generative Artificial Intelligence	
Things to know Students should recognize that:	***Things to do*** Students should be able to:
● AI can be used as both a medium embedded in solutions (UX for AI) and in the context of smart tools for design creation (AI for UX). ● Using AI to support generative design activities changes the role of the designer in the overall process to focus on higher level tasks and user goals/requirements definition. ● AI is built on models and assumptions that have the potential to introduce bias and do harm. ● Reasoning models, training data sets and algorithmic logic always have limitations and side effects. ● All training sets have a potential bias (none is neutral)	● Be cognizant of how the underlying assumptions (and biases) coded into any automation within the tools sets you use affect the generative creation of the artifacts you are producing. ● Take responsibility to mitigate any negative consequences observed. Do not leave it to the technology to "fix itself over time." ● Conduct an open bias assessment on the training data set and expert systems rules to determine their accuracy and fairness BEFORE deploying them beyond the prototyping phase when designing interventions that incorporate embedded AI (e.g., recommender or recognition services). ● Design all intelligent systems to be explainable and transparent.