

Gifts to the Future: Design Reasoning, Design Research, and Critical Design Practitioners

Abstract Set in the context of a particular orthodoxy about the history of design research over the last 50 years, this opinion piece selectively surveys some of the significant findings from research into what expert design reasoning entails. Using the conceit of a pool of knowledge – which has come about from many different design research agendas, using multiple methods, and with differing foci of attention – it indicates some of what we know about design reasoning as a phenomenon by taking three “scoops” from the pool. These scoops, respectively characterize design reasoning as navigating the swamp; having negative capability; and being concerned with framing. This material is then used to contrast expert design reasoning with salient features of some popular characterizations of design thinking. The contribution concludes with some comments on designer formation, centered on the necessity of proficiency in *reflection* implied by any goal to nurture critical design practitioners.

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1 Ian Hacking, "'Style' for Historians and Philosophers," *Studies in History and Philosophy of Science Part A* 23, no. 1 (1992): 3.

2 Horst W. J. Rittel, "The Reasoning of Designers" (working paper, International Congress on Planning and Design Theory in Boston, August 1987), 2, also available at <http://www.cc.gatech.edu/fac/ellendo/rittel/rittel-reasoning.pdf>.

3 Rittel, "Reasoning of Designers," 2.

4 Stefan Wiltschnig, Bo T. Christensen, and Linden J. Ball, "Collaborative Problem-Solution Co-Evolution in Creative Design," *Design Studies* 34, no. 5 (2013): 515–42.

5 Herbert A. Simon, *The Sciences of the Artificial* (Cambridge, Mass.: MIT Press, 1969).

6 Nigel Cross, ed., *Developments in Design Methodology* (New York: John Wiley & Sons, 1984).

Preamble

I avoid using the term *design thinking* myself. Much of what is termed design thinking isn't restricted to thinking, and quite a bit of it isn't restricted to designing. I prefer the term reasoning because, in the words of Ian Hacking, "reasoning is done in public as well as in private by thinking, also by talking, by arguing and by showing."¹ Horst Rittel spoke about *design reasoning* in 1987 as follows: "[I]magine a designer thinking aloud, arguing and negotiating with himself (or with others), trying to explain or justify what he is proposing, speculating about future consequences of his plan, deciding the appropriate course of action ... the designer's reasoning is disorderly ... due to the nature of design problems."² He goes on to say, "[F]rom the beginning, the designer has an idea of the 'whole' resolution of his problem which changes with increasing understanding of the problem, and the image of its resolution develops from blurry to sharp and back again, frequently being revised, altered, detailed and modified."³

In design research, we have become accustomed to speak of the co-evolution of problem and solution;⁴ and use of the terms "problem," "solution," and "search space" still pervades much of design research reporting, even from those researchers who find restrictive Herbert Simon's characterization of a science of design.⁵ Language enables and constrains our perceptions; thus it is interesting to speculate on what the differences in our apprehension and interpretation of design activity might be if our notions about a developing design were more often conceived in terms of a process of successive blurring and sharpening of an image, and if we design researchers had become more accustomed to using more camera/lens inspired analogies like panning and zooming.

I am going to start with a bit of design research history, a history, just to set some context, and remind us of how far we have come in understanding design reasoning and the rich pool of knowledge that has been collected about designing as a phenomenon. I'm then going to poke around in this material and scoop out a selection of things we've learned about design reasoning over the last 50 or so years, then we can drop them back in the pool and let them settle on the bottom again – or perhaps some of you will want to take another look, or even a closer look, and turn them over and see if any of them are useful for your own purposes. I've had a difficult job deciding what to fish up, so I'm netting a few things together and taking three scoops. If I had my own manifesto for what comprises *design thinking*, I guess these components would feature in it. So the first Gifts to the Future of my title refer to these *findings from design research*.

After scooping from the pool, I'll finally, briefly, indicate what I think are one or two general principles for educational interventions that can encourage the development of *design reasoning* among novice designers and support them in developing a critical awareness of, and stance towards, their practice, so that they can move beyond inculcation in a discipline to contribute to its formation and reformulation. It is these resulting *critical practitioners* that are the second set of Gifts to the Future, the designers who will address the challenges we are facing and who will have a formative influence on all our futures.

A Bit of a Design Research History

A commonly held Western orthodoxy holds that research into design per se (design, designing, design processes, design expertise, design thinking, and so on) dates back about 50–60 years. In a landmark collection of papers, *Developments in Design Methodology*⁶ published as a reader just under halfway through this period, its editor, Nigel Cross, organized the selected contributions as a movement

through phases characterized by their prevailing foci of attention and ambition. He characterized the first three of these phases as *prescription* of an ideal design process, *description* of the intrinsic nature of design problems, and *observation* of the reality of design activity.⁷ This characterization also usefully points to an expansion of the objects of design researchers' investigations. Findings and issues raised from each phase influenced studies that followed, and each new emphasis led to a re-interpretation of the value and meaning of earlier work.

The development of ideas about design did not take place in isolation. Developments, emphases and insights in design research reflect and incorporate key contemporary developments in the evolving history of ideas more generally and the methods these have generated in the understanding of science,⁸ psychology and cognition,⁹ and the nature of social experience¹⁰ to name just three broad fields and to identify just a few examples of key contributions in each. It is not the intention here to explore in any detail these influences; but in passing over them, we must note that to account for and explain the description of design research below we would need to trace how ideas and methods evolving outside the design research community enabled its own trajectories.

In the era of *prescription*, then, the design methods movement looked to improve design through the development of systematic methods to encourage better attention to user needs and a broader range of contextual factors. These motivations had themselves come to the fore from observations of the limits of formal modeling for confronting complex problems, and a spreading understanding that the post-war promise of operational research might achieve much but was also limited in the scope of what it could render orderly. A desire to manage design activity, and to be able to systematically relate design methods to parts of the design process, demanded certain kinds of models of the design process, *prescriptions*, for what should take place as design occurs.

In its turn, the failure of the design methods movement to impact *practice* (among other reasons) led to the focus of effort shifting towards *description* – here the attention of researchers expanded to investigate the *nature* of design problems. From this era, we have the legacy of understanding better that design problems are poorly specified; goals are vague; what is relevant, for example in terms of constraints, is not completely knowable in advance; that designs are always amenable to improvement; and that all these characteristics are *inherent* to design. The implication of this characterization is that design problems have to be both *set* and *solved* by designers. The setting part was seen to be the locus of the *mysterious*, *intuitive* elements at the heart of what makes designing possible.¹¹

Researching design, conceived as “problem-solving,” led to some huge advances. But in terms of understanding how designs come about – designs in *complex* situations where divide and conquer cannot work, designs where *aesthetics* are fundamental, and the design of any socio-technic systems (where people are part of the system) – more and more dissection, and ever more mapping of the territory of the design “problem” with finer-grained sets of instructions for micro-managing design process stages, each with many steps, seemed not to yield a complete account of what was going on. It is not surprising, therefore, that researchers' attention turned to studying designers themselves – the era of *observation*.

So in comes the designer – initially of course always a *he* – always a heroic figure who works in mysterious ways, intuitive, aloof and unaccountable: in short, Ayn Rand's fictional architect, Howard Roark.¹² The focus in the era of *observation* has been on studying how it is, given the complexity of designing, that a designer is able to design anything at all. We have learned a great deal from observation of individual designers in experimental settings, from recording them at work, from studying the representations they produce for themselves and others, and from

7 Cross, *Developments in Design Methodology*, 52ff.

8 Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962); Karl R. Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge* (New York: Basic Books, 1965).

9 Daniel K. Kahneman, Paul Slovic, and Amos Tversky, eds., *Judgment Under Uncertainty: Heuristics and Biases* (New York: Cambridge University Press, 1982); Lucille A. Suchman, *Plans and Situated Actions: The Problem of Human-Machine Communication* (New York: Cambridge University Press, 1987); Edwin Hutchins, *Cognition in the Wild* (Cambridge, Mass.: MIT Press, 1995).

10 Peter L. Berger and Thomas Luckmann, *The Social Construction of Reality: A Treatise in the Sociology of Knowledge* (Garden City, NY: Anchor Books, 1966); Harold Garfinkel, *Studies in Ethnomethodology* (New York: Prentice Hall, 1967); Erving Goffman, *Frame Analysis: An Essay on the Organization of Experience* (Boston Mass.: Northeastern University Press, 1974).

11 Christopher J. Jones, *Designing Designing* (London: Architecture Design and Technology Press, 1991).

12 Ayn Rand, *The Fountainhead* (New York: Bobbs-Merrill Company, 1943; London: Penguin Books, 2007).

13 Dana Cuff, *Architecture: The Story of Practice* (Boston, Mass.: MIT Press, 1992).

14 Louis L. Bucciarelli, *Designing Engineers* (Cambridge, Mass.: MIT Press, 1994).

interviewing them. We now know that designers are solution-oriented – that they use ideas about potential interventions to formulate (set) and understand a “problem” that they will attend to; that they employ a range of strategies to impose order on a design situation and to generate solution ideas; that they can maintain mutually incompatible sets of beliefs (to support deferral of decisions, and the pursuit of parallel possibilities); and that expert designing is characterized by repeated movement between design detail and design overview and between modes of representation.

But of course we can no more understand the richness of design reasoning by studying individual designers than we can understand it from micro analyzing design problems. Just as exhaustive inspection of the nature of a design problem renders some important contextual factors invisible – and no matter how detailed a description is arrived at, an understanding of designing as a phenomenon eludes us – so too attending exclusively to the designer limits comprehension. Without any contextualization, designers’ behavior appears, and has been characterized pejoratively, as disorderly (Rittel’s term), irrational, opportunistic, and so on.

Following on, perhaps as a natural development from studies of individual designers, came studies of design teams, design collaborations, multi- and interdisciplinary engagement, and studies to acknowledge, and then explore, the polyvocality and polysemy that characterize design challenges in which controversy is negotiated among disparate stakeholders’ interests. Research of this kind has opened up many more aspects of design to inspection. Dana Cuff’s ethnography of the *culture* of architectural practice¹³ was swiftly followed by the publication in 1994 of Louis Bucciarelli’s own landmark ethnographic study, *Designing Engineers*, which was able to claim to reveal significant mismatches between still current idealized notions of design as an instrumental process and its reality.¹⁴ In Bucciarelli’s work, the reality of engineering design was revealed as essentially a situated, *social* process concerned with coming to agreement through negotiating uncertainty and ambiguity, rather than (solely) a process of the pursuit of factual information for technical ends.

Cross’ organization in 1984 of some key contributions to design research according to their focus on prescription, description, or observation continues to be useful for structuring an account of what had been learned about designing. It was not suggested by Cross then, nor is a similar use of these themes here intended to imply that these researcher framings were each exhausted and superseded each other. All three foci continue to receive attention. However, it is now more widely accepted among design researchers than was the case 20 years ago that they need to inspect and declare their assumptions and the worldviews on which their findings rest. It is, perhaps, *this* development (as much as any new research findings) that signals the maturing of the field of design research, and is most promising for collaboration between researchers who have common interests in studying design but draw on different disciplinary practices.

Design Research Now

The study of design as a culturally embedded, social process broadened the scope and reach of design research into many new areas. Among many other topics of research these include: design team interactions; the roles and uses of objects and the functions of gestures in design and design communication; the influences of variations in the design setting on outcomes, e.g. the effects of the nature and form of design briefs on the course of the designing; how, and what kind of shared representations are developed during a design process, and what purposes they serve; what types of language, roles, and structures support or impede design; the

effect of evaluation of others' contributions and of types of appraisal on design; and the roles and uses of analogy during designing.¹⁵

What are the design researchers' methods and the objects of research? They are many and varied. Some researchers are still prescribing, testing and refining models and methods – models of the design process, shared mental models of teams, models of design functions, behaviors, and structures, and so on. Some are studying the practices of individual designers through interviews and archival research, some construct laboratory conditions in which design can take place in controlled and recorded environments from which data can be analyzed; some immerse themselves in design teams or follow large and long term projects.

For many researchers, research questions and hypotheses or areas of concern or issues of interest *drive* research design and thence the collection of empirical data to support very specific enquiries. However the sharing of datasets such as video recordings and transcripts from design activity, pioneered for design research in 1994¹⁶ has grown and expanded in scope. Here, it is empirical data that *prompts* researchers to construct plausible accounts of phenomena using methods and theories of their choosing which they must justify to others. The common dataset approach has led to new research findings but also has introduced scope for cross-comparison of similar findings arrived at through different methods and, most promisingly, across researchers whose conceptions are radically dissimilar.¹⁷ One exciting feature of this polyphony of objects of study and means of studying is that we are now very encouraged by some strong melodies or themes that have emerged; less poetically we might call this a triangulation of findings, all conspiring to help us better understand more about design reasoning and have more confidence in the contributions to knowledge which emerge.

First Dip into the Knowledge Pool: Design Reasoning Is About Navigating the Swamp

In 1975, Fred Brooks Jr. first published his advice on software systems design as a series of essays under the title *The Mythical Man-month*.¹⁸ One essay is entitled “The Tar Pit,” and begins, “[N]o scene from prehistory is quite so vivid as that of the struggles of great beasts in the tar pits. In the mind’s eye one sees dinosaurs, mammoths, and saber-toothed tigers struggling against the grip of the tar. The fiercer the struggle, the more entangling the tar, and no beast is so strong or so skillful but that he ultimately sinks.”¹⁹ And then he likens large-system programming to such an experience. The impact of Brooks’ essays has been immense (over a quarter of a million copies of the first edition were bought by practitioners, academics, and students). More ubiquitously cited in the design research community – if less widely circulating among design practitioners – are the writings of Donald Schön, who talks about the “varied topography of professional practice,” where “there is a high, hard ground where practitioners can make effective use of research-based theory and technique, and there is the swampy lowland where situations are confusing ‘messes’ incapable of technical solution. The difficulty is that the problems of the high ground, however great their technical interest, are often relatively unimportant ... while in the swamp are the problems of greatest human concern.”²⁰ He continues, “[S]hall the practitioner stay on the high ground where he can practice rigorously, as he understands rigor, but where he is constrained to deal with problems of relatively little social importance? Or shall he descend to the swamp where he can engage the most important and challenging problems if he is willing to forsake technical rigor?” And of those who choose the swampy lowlands he writes, “when asked to describe their methods of enquiry,

15 See, for example, Janet McDonnell and Peter Lloyd, eds., *About Designing: Analysing Design Meetings* (Oxon, UK: Taylor & Francis Group, 2009). This collection of work includes research findings related to each of these topics.

16 Nigel Cross, Henri Christians, and Kees Dorst, eds., *Analyzing Design Activity* (Chichester, England: John Wiley & Sons, 1996).

17 See, for example, McDonnell and Lloyd, *About Designing*; André van der Hoek and Marian Petre, eds., *Software Designers in Action: A Human-Centric Look at Design Work* (Boca Raton, FL: CRC Press/Taylor & Francis Group, 2014); Robin Adams and Junaid Siddiqui, eds., *Analyzing Design Review Conversations* (West Lafayette, IN: Purdue University Press, 2015).

18 Frederick P. Brooks, Jr., *The Mythical Man-Month: Essays on Software Engineering*, 2nd ed. (Boston, Mass.: Addison Wesley, 1995).

19 Brooks, *Mythical Man-Month*, 4.

20 Donald A. Schön, *The Reflective Practitioner: How Professionals Think in Action* (New York: Basic Books, 1983), 42.

21 Schön, *Reflective Practitioner*, 43.

22 Linden J. Ball and Thomas C. Ormerod, "Structured and Opportunistic Processing in Design: A Critical Discussion," *International Journal of Human-Computer Studies* 43, no. 1 (1995): 131–51.

23 Ömer Akin, "Variants in Design Cognition," in *Design Knowing and Learning: Cognition in Design Education*, ed. Charles Eastman, Mike McCracken, and Wendy Newstatter (Oxford, UK: Elsevier, 2001), 105–24; Nigel Cross, *Designerly Ways of Knowing* (Basel, Switzerland: Birkhauser, 2007), 97.

24 Ömer Akin and Chengtah Lin, "Design Protocol Data and Novel Design Decisions," *Design Studies* 16, no. 2 (1995): 211–36.

25 Cynthia J. Atman, Justin R. Chimka, Karen M. Bursic, and Heather L. Nachtmann, "A Comparison of Freshman and Senior Engineering Design Processes," *Design Studies* 20, no. 2 (1999): 131.

26 Willemien Visser, "Designers' Activities Examined at Three Levels: Organization, Strategies and Problem-Solving Processes," *Knowledge-Based Systems* 5, no. 1 (1992): 92–104; Ball and Ormerod, *Structured and Opportunistic Processing*.

27 Henri Christiaans and Kees Dorst, "Cognitive Models in Industrial Design Engineering: A Protocol Study," in *Design Theory and Methodology*, ed. D.L. Taylor and D.A. Stauffer (New York: ASME, 1992).

28 Cf. here again Rittel's image of something coming in and out of focus.

29 John Keats, *Selected Letters*, ed. Robert Gittings, revised with a new introduction and notes by John Mee (Oxford: Oxford University Press, 2002).

they speak of experience, trial and error, intuition, and muddling through."²¹ In Schön's swampy ground of designing, each new endeavor is unique in context and circumstance, unclearly defined in scope and parameters, and presenting multiple possible means of approach and multiple possible outcomes that will serve some interests at the expense of others.

Here is a rich metaphor which helps us make sense of our observations that experienced designers manifest a capacity for shifting between the *part* and the *whole*,²² sometimes characterized as tackling that "solution space" I have mentioned, breadth first, depth next;²³ the same movement of the subject of attention, between detail and overview, that Rittel refers to as movement in and out of focus.

Rapid movement between *modes* of activities such as drawing, thinking, and examining²⁴ has been found to be associated with critical and novel design decisions (as contrasted with routine ones). Additionally, frequent transitions between *types* of activity such as generating ideas, gathering information, modeling, and evaluating characterizes processes which lead to better quality outcomes – and distinguishes expert behavior.²⁵ Close attention to the contexts in which apparent opportunism takes place shows it can be accounted for as efficiency gains, and attunement and responsiveness to what is taking shape rather than signaling something chaotic or undisciplined.²⁶

To navigate the swamp, we have learned that fixation is an effective coping strategy, as well as a potential pitfall. Experts, it turns out, *seldom* consider a wide range of possibilities, but quickly latch onto parts of a problem that are critical issues to resolve, sometimes working on these aspects in some detail before stepping back to appraise, evaluate, consolidate, expand and move the design on. Novice designers tend to suggest solutions (too) quickly and have poorer, more limited characterization of the design task and converge (too) rapidly to limit its scope. Those with a little experience sometimes retain this strategy or, equally unsatisfactorily, they err on the side of remaining uncommitted, manifested as expending too much resource on problem formulation and failing to develop well-resolved outcomes.²⁷ Experienced designers "reason forwards," developing more richly conceptualized notion and representations of the design "problem" as they construct and evaluate aspects of their design proposals. Divergence is thus *interwoven* with convergence – experienced designers use what is discovered dynamically to control the expansion and contraction of what is receiving attention.²⁸

Second Dip into the Knowledge Pool: Design Reasoning Is About Having Negative Capability

Negative capability is a term attributed to the English poet John Keats. It is the ability to be at ease with working in a state of uncertainty, since it is such a state of partial knowledge, says Keats, that makes creation possible at all.²⁹ Uncertainties, of many origins, are intrinsic to any non-trivial design task, even if, unlike for Keat's context (poetry, literature) we might not be able to entertain the idea that this state can endure indefinitely in the case of designing.

Scott Minemann has pointed to how designers *conserve* ambiguity, and that this very ability plays a critical role in allowing meaning to coalesce. As part of the process of coalescing meaning, it is *ambiguity* that gives a space for collaborators to share ideas that are not coincident and mold them into something effective. We know from studies of the way design progresses that design ideas and the details of any particular design are not developed monotonically. In the journey to arrival at a final design, progression can be characterized as simultaneously pursued, parallel lines of enquiry – even in the case of design by a solitary designer. The parallel

lines of development include pursuit of conjectures that can be mutually inconsistent, and therefore during design, designers are able to maintain simultaneously incommensurate sets of “truths” to support different assumptions or lines of enquiry. It appears that, even to be modestly successful at designing, a designer must be at ease with uncertainties, contradictions and with partial knowledge.

S/he must be able to defer commitment *at times* to keep design options open, and sometimes to keep collaboration moving along effectively. Fine-grained analyses of conversations between designers and between designers and clients have shown how vagueness in language grants openings for others to make contributions so that a developing design may benefit from differing contributing bodies of expertise. At other times, early commitment is an expert’s strategy to impose order or to generate something that can be evaluated. Schön speaks of sensitivity to “talk-back” from the emerging design,³⁰ and Christopher Alexander, back in the era of prescription, wrote of using misfit to understand what is needed, by testing the effects of “solution” proposals up against an evolving understanding of what might be required or possible.³¹ It is important to see that when to commit, what to commit to, and when to defer is a matter of the expert judgment of a skilled designer.

Many researchers have worked with, and contributed to, the characterization of designing as co-evolution of problem and solution.³² However, as I have indicated earlier, researchers perhaps do themselves and the practitioner community no favors by using the terms “problem” and “solution” at all, as their meanings – in the rarified atmosphere of design research – are now richer and far more nuanced than their everyday meanings. Faced with complexity, analysis is of very little value, we can intervene or make conjectural excursions, observe what happens, assess the effect, and do all this iteratively. Here is the impetus for drawing heavily on *prototyping* and the so-called *bias to action* in the collection of activities popularly referred to as *design thinking*.

Getting away from the notion of a “problem” to be comprehensively specified (as though it is somehow objectively “there” in the world to be found), and looking rather at designing as a process of effectuation³³ where the task is oriented towards what can be done with the resources available in an unpredictable setting makes it easier for us to see how a designer with design reasoning skills can play an important role in situations where there are multiple legitimate interpretations of what is going on. And where the challenge is to collaborate to establish how a more acceptable state of affairs might be devised with the means at hand.³⁴

Third Dip into the Knowledge Pool: Design Reasoning Is About Framing

In this scoop I touch on some of what design research tells us about the designer’s set of resources and skills to create a productively bounded design task, to set its scope, to impose order on it, and to guide progress with it.

Rittel talks of epistemic freedom, which manifests as a freedom from a prescribed set of steps to follow, leaving the designer to judge how design proceeds. “Nothing has to be or to remain as it is or as it appears to be.”³⁵ We might say designers’ epistemic freedom condemns them to taking responsibility for their actions/decisions. Here lies the cause of the fundamental necessity for designers to have learned the skills of justification, giving and taking critical feedback, and understanding how design proposals operate rhetorically. Nelson and Stolterman approach this condition by writing of first intentions, the designer’s choice of which way to set out. “Any design process can unfold in an infinite number of directions ... the design process is not about approaching the design situation with the ambition to ‘uncover’ the right problem or ‘discover’ the right solution ... things will be made to become real because of the path the design journey sets out on.”³⁶

30 Schön, *Reflective Practitioner*, 79.

31 Christopher Alexander, *Notes on the Synthesis of Form* (Cambridge, Mass.: Harvard University Press, 1964).

32 See in particular Mary Lou Maher, “A Model of Co-Evolutionary Design,” *Engineering with Computers* 16, no. 3 (2000): 195–208; and Kees Dorst and Nigel Cross, “Creativity in the Design Process: Co-Evolution of Problem-Solution,” *Design Studies* 22, no. 5 (2001): 425–37.

33 Saras D. Sarasvathy, *Effectuation: Elements of Entrepreneurial Expertise* (Gloucester, UK: Edward Elgar Publishing, 2008).

34 For example, see Adam Thorpe and Lorraine Gammon, “Design with Society: Why Socially Responsive Design is Good Enough,” *CoDesign* 7, no. 3–4 (2011): 217–30.

35 Rittel, *Reasoning of Designers*, 5.

36 Harold G. Nelson and Erik Stolterman, *The Design Way: Intentional Change in an Unpredictable World*, 2nd ed. (Cambridge, Mass.: MIT Press, 2012), 245.

37 Jane Darke, "The Primary Generator and the Design Process," *Design Studies* 1, no. 1 (1979): 36.

38 Kees Dorst, "The Core of 'Design Thinking' and Its Application," *Design Studies* 32, no. 6 (2011): 521–32.

39 Cameron Tonkinwise, "A Taste for Practices: Un-repressing Style in Design Thinking," *Design Studies* 32, no. 6 (2011): 533–45.

40 Bryan Lawson, *Design in Mind* (Oxford, UK: Butterworth Architecture, 1994).

41 Lawson, *Design in Mind*.

42 UK Design Council, *A Study of the Design Process* (London: Design Council, 2005), accessed January 20, 2016, [http://www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons_Design_Council%20\(2\).pdf](http://www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons_Design_Council%20(2).pdf).

43 "Design Thinking Resources," IDEO, accessed January 8, 2016, <http://www.ideo.com/pages/design-thinking-resources>; Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation* (New York: Harper Business, 2009).

44 Simon, *The Sciences of the Artificial*, 133.

45 "Our Way of Working," Stanford University, accessed January 8, 2016, <http://dschool.stanford.edu/our-point-of-view/#design-thinking>.

Enabling constraints that shape a design task that is tractable are designer-imposed and not implied, logical, or uncovered necessities. One of the earliest articulations of a mechanism for imposing order is that of Jane Darke, who identified a phenomenon – titled primary generator³⁷ – that serves variously to give structure and direction or order and form to design enquiry. Other researchers' work has looked at the finer nuances of imposed constraints and how some serve and endure through creative processes and manifest in the designed outcome, whilst others function as scaffolding to be discarded once their job is done.

Experienced designers establish a repertoire to enable them to quickly shape or frame the design task they will tackle. Dorst writes of *frame repertoires* that characterize the preferred practices of particular designers or design partnerships.³⁸ Tonkinwise has written in terms of *stylistic predilections* in a polemic in which he claims that much design research has so far ignored the aesthetic inculcation of designers into traditions of practice in which particular value judgments shape what is designed,³⁹ and Lawson has examined architectural design in particular in some detail for how *guiding principles* shape what is attended to.⁴⁰

Some designers, we might say the privileged ones, who have established reputations, are seen to take on design projects which serve their own pre-occupations, or "intellectual programme" (to use Lawson's term)⁴¹ and we notice that although these repertoires – as preferences – make designing tractable, they can also be a cause for criticism when the extent to which they shape outcomes compromises the interests of other stakeholders.

Expert Design Reasoning and Design Thinking

The popular characterization of *design thinking* has a number of salient features, which include: generating large numbers of ideas through variations on "brainstorming"; obtaining permission to engage in trial and error, so as to make and learn from mistakes, and take risks; trying things out particularly through varieties of "prototyping"; and preferring to intervene and observe, rather than describe and analyze. Often these practices are framed by a process model with a succession of stages that are alternately divergent and convergent. The double-diamond design process model propagated by the UK's Design Council offers such a model.⁴² Internationally, the best known characterization of design thinking is that of IDEO,⁴³ which advocates using "designers' methods" in a process which addresses a series of tasks including empathizing; generating ideas; and synthesizing of findings, ideas, and different perspectives, with an overall aim of moving from some less satisfactory state of affairs to a more preferred one. (Here we can note a direct association back to Herbert Simon's definition of the scope of design as being "concerned with how things *ought* to be, with devising artifacts to attain goals.")⁴⁴ Stanford University's d.school, whose characterization of design thinking stems from the same origins as that of IDEO, exhorts to "go innovate" those who have experienced its design thinking principles embodied as a five-stage process which entails empathizing, defining a problem, ideating/brainstorming, prototyping, and testing.⁴⁵ It refers to those who so engage, unambiguously, as designers.

Studies of very highly regarded designers have shown us some interesting patterns: these suggest that they are able to make use of apparently conflicting requirements and aspirations – their own and their clients' – and use the tension as a focus to stimulate design innovation. It is this attention to the scope and context which is perhaps the "breadth first" behavior which laboratory studies first

uncovered. The next move is to work on a challenge identified as promising in some detail, “depth next,” before sweeping back to embrace aspects of the brief or more prosaic functional necessities. So they start broad, frame what they will tackle, and work at some level of abstraction. These findings largely come from a small number of studies of outstanding designers, from their introspection and retrospection. However even more “routine” experts are shown repeatedly (in empirical studies and analyses of design processes) not to consider a huge range of design ideas – where does this leave brainstorming? It leaves it in a good and useful place, but it is not a strong characteristic of expert design reasoning.

In my pool dipping, I have already mentioned – in passing at least – some of the ways designers control the scope of what they have to deal with – the navigation of the swamp, the use of negative capability, and the framing – to move to and fro, co-evolving a design task and its resolution. These practices support the management of the scope of the designs. Designers’ domain expertise, we might say designers’ *prepared minds*, come into play to attend to the “gap” between the situation framed and a future situation in which that which is being designed will be in play. Focusing, zooming in and out, and even panning are oriented to the “gap”, the between, the relationship: to differences. Expert designers are attuned *not* to a “problem” or a “solution,” but to the *relationship* between (a) possible future state of affairs, and that which is currently the case. Their movement of attention is fluid to the point where it is questionable whether separation of practices for divergence and convergence can be meaningful as abstractions because whether, at a given moment, a designer will open out or close in is determined as a localized response to what their most recent “moves” have led to – what “talk-back” they have sensed from the developing design. For non-experts, there may be value in following a prescribed routine, a discipline which forces attention on convergent and divergent activities, but again there is little evidence from studies of experts that this is what they do when they reason about their designing.

Like literacy and numeracy, the life skills of design thinking, as characterized popularly, have transformative capacity for those who acquire them. However, it seems important to me to make clear that whilst there is a relationship between design thinking and what domain-specific expert design reasoning entails: a crash course in the former⁴⁶ does not equate to the latter. At a time when there is a great deal of debate about the roles of designers in social, technical and service innovation, and the uses of their abilities to frame problems in ways that make it possible to address creatively major economic, societal, and environmental issues⁴⁷ it seems to be important to make some clear distinctions about what “life-skill” design thinking is, and to have a more critical debate about its limitations based on a better sharing of what the findings from design research are. The stakes are high as those responsible for formal higher education in design seek to help students prepare for their futures as designers.

Supporting Designer Formation

Proficiency in designing – acquiring the repertoire and qualities we have found characterize expert design performance – comes from experience, so to acquire expertise experientially, carefully crafted educational and early career experiences play an important part. Opportunities for experiential learning themselves do not guarantee that learning will take place: as the saying goes “experience is not enough.” Experiences need to be surrounded by apparatus so that learning can ensue, and reflection can take place. And if our ambitions are to nurture *critical* practitioners – ones that can not only reflect on the tasks they attempt but develop an awareness of their learning from them and thence a critical view on the

46 “Welcome to the Virtual Crash Course in Design Thinking,” Stanford University, accessed January 8, 2016, <http://dschool.stanford.edu/dgift/>.

47 For example, see Kees Dorst, *Frame Innovation: Create New Thinking by Design* (Cambridge, Mass.: MIT Press, 2015); Pelle Ehn, Elisabet Nilsson, and Richard Topgaard, eds., *Making Futures: Marginal Notes on Innovation, Design, and Democracy* (Cambridge, Mass.: MIT Press, 2015); and Ezio Manzini, *Design, When Everybody Designs: An Introduction to Design for Social Innovation* (Cambridge, Mass.: MIT Press, 2015).

48 David P. Ausubel, "In Defense of Advance Organizers: A Reply to the Critics," *Review of Educational Research* 48, no. 2 (Spring 1978): 251–57.

49 Cynthia Atman and her colleagues at the University of Washington originally devised these timelines for research purposes. See Cynthia Atman et al., "A Comparison of Freshman and Senior Engineering."

50 Janet McDonnell and Cynthia Atman, "Paying Attention to the Design Process: Critically Examining Personal Design Practice," in *Proceedings of the 3rd International Conference for Design Education Researchers*, Aalto University, ed. Robin Vande Zande, Erik Bohemia, and Ingvild Digranes (Helsinki: Aalto University Press, 2015), 1498–1517.

51 McDonnell and Atman, "Paying Attention."

conditions that have shaped their experiences – then we have to supplement occasions for learning with a variety of means for reflection of which the learner *can become aware*, so that they can consciously and comfortably call upon them on their own initiative.

To develop an awareness of what designing entails then, let alone a critical awareness of it as a practice, first we have to create experiences where the *processes themselves* are the focus of attention. In my own experience, although the scale of studies has been small, I have seen some remarkable value (as reported by participants) when reflection on experiences of designing is based not on ad hoc recall but when we have designed in means of capturing processes so that they can be inspected. What is captured or recorded is open to interpretation and draws attention to some phenomena, and enables those phenomena to be examined.

The first requirement, then, for effective reflection on what designing entails is a body of material that accurately records what has occurred. Reflection which is not based on such a resource is weak and in danger of reinforcing rather than surfacing assumptions. The second requirement is for some sort of apparatus that offers a framework for ordering and thence inviting a distancing of oneself from an experience. Some form of lens to let us make sense of the record we have gathered which supports assessment of it for some useful purposes. Maybe advance organizers⁴⁸ have a place here.

In the past I have used video story making – using footage from recording the design process – to help early career designers confront apparent conflicts *they* have perceived between the theory they have been taught (and respect) and their actual, practical experiences of designing with others. More recently, I have also used design timeline representations as bridging representations to prepare students to live-audit their own design working. They are shown how video recordings and transcripts of design activity can be interpreted and visualized as a series of activities through which a designer transitions over the course of designing.⁴⁹ The students collect data about how they themselves design, and then are invited to devise their own representations of what they have captured; so effectively they devise design process models of their own.⁵⁰

The third requirement for effective reflection is a means to confront one's own views. This is done readily by designing into the reflection experience a means of comparing our own interpretations of events with the perspectives of others. In video story work, if novice designers are asked to make stories collaboratively which "tell the tale" of what designing entails, the creation of a single account requires participants to marshal arguments for what they believe to be important, at the same time that it confronts them with the differing perspectives of others. In work where students design their own process representations to visualize data they have captured from their own design activities, we have, likewise, designed in extensive opportunities for participants to share and justify their own perceptions with each other.⁵¹

Gifts to the Future: Reprise

In the first part of this paper I reminded you of the history of design research framed as the expansion of the range of foci of attention. Next I drew from the pool of knowledge from design research, organizing the very selective account around three themes conceived as "scoops from the pool." This allowed me to expose just some of what we have learned about design reasoning by researching into it. I have deliberately drawn on what we have learned about expert performance – so situations where command of a domain and extensive experience within a discipline

are factors. The contents of the “scoops” are insights into how designing gets done; these are design researchers *gifts to the future*.

None of these insights can be passed on to practitioners or learned by telling what they are. My understanding of experiential knowledge is that it can only come about from experiences. Getting better at design reasoning – moving from novice to expert, to use the language I have been using here – requires not only opportunities to exercise design reasoning, but also opportunities to inspect and introspect about behavior, perspectives, worldviews – the provision of sets of apparatus to make them strange through distances – to make them present to hand so that they can be confronted and questioned.

It turns out that some of the very best designers – those highly regarded by peers and audiences beyond the profession, those who can tackle the most challenging situations, and those who can innovate radically when business as normal cannot cope – have in common that they continually challenge themselves through the ways they construct (that is, frame) the design tasks they attend to.⁵²

Erik Stolterman, writing in 1994, observed, “[D]esign learning should not be a process of conservation where an existing practice is taken for granted as the only answer....Design learning should strive towards the situation where new designers constantly reflect upon and critically examine their design practice.”⁵³

Such a body of individuals will be our salvation perhaps, *gifts to the future* of designers who not only bravely “descend into the swamp” but who are highly skilled in reasoning critically, and who can credibly and competently question their own, their discipline’s and societal assumptions. It is more in this latter spirit that Tony Fry uses the phrase, *gifts to the future* at the end of his polemic text, *Design as Politics*,⁵⁴ which I have appropriated here for more modest purposes.

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52 Dorst and Cross, “Creativity in the Design Process”: 68–70.

53 Erik Stolterman, “Guidelines or Aesthetics: Design Learning Strategies,” *Design Studies* 15, no. 4 (1994): 448.

54 Tony Fry, *Design as Politics* (Oxford, UK: Berg, 2011).