

# Problems, Design Problems, and Designers: Decision-Making in Action

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While it is undeniable that both design and design education seek to engage with meaningful problems and to achieve desirable solutions, much of design education is still hostage to the twin notions (i) that problems constitute sets of external conditions presented to the designer for the most efficacious solution and (ii) that the potential problem-solver is somehow neutral in respect of the problems s/he engages with, 'merely' applying extant skills and knowledge to achieve their solution. This mindset can easily mistake design education for the provision of just such technical skills and knowledge, and fails to take due cognisance of the central role of the problem-solver in establishing just what problem is actually being solved in any particular case. In elucidating this the paper argues that meaningful problems are to a significant extent self-determined by the design problem-solver; that there is an intrinsic, and often under-acknowledged, link between problem-setting and the establishment of outcome possibilities; and that relevant criteria of outcome acceptability or desirability cannot be known, to either designer or client, in advance of both personal problem-setting and the advancement of solution-candidates.

## Introduction

For more than half a century now, from at least the 1950s, and across a range of design disciplines, from product and graphic design through to architecture and engineering, contributors to the body of design literature have committed themselves, either tacitly or explicitly, to the view that design is a problem-solving activity. While arguments may be advanced to refute or, at least, substantially qualify, this view, i.e. to establish that, in important respects, design is *different from* problem solving; and while a number of contemporary writers on design have sought to investigate the nature of design problems from a more sophisticated perspective – the writings of Dorst (2003), Dorst & Cross (2001), Jonas (1993), and Restrepo & Christiaans (2003) may be cited here – the 'design=problem-solving' equation nevertheless still tends to present itself as a self-evident given of design thinking.

This being the case it is usual that the tasks facing designers, both in practice and, perhaps more significantly for this paper, in the context of design education, are framed in the conventional language of problems and problem solving, with its attendant, and frequently unchallenged, assumptions about the rationality of problem solving, the nature of problem-solving techniques, and the relations between problems and solutions. This is not to suggest that the construal of design tasks as problems, and design responses as solutions to such problems, is not potentially useful in explaining certain issues pertaining to the design process, particularly in the context of the education of young designers, whether at tertiary or at secondary level, but rather that an unreflective and overly-simplistic acceptance of the problem/solution binary effectively masks a number of crucial aspects of the *relations between* problems, solutions and problem-solvers that are essential to understanding how the act of designing actually proceeds.

It is for this reason that the conventional nomenclature of 'design problems' and 'design problem solving' has been retained *pro tem*: to facilitate the argument that, in

significant ways, design 'problems' are not what they are taken for granted to be. Needless to say, in such a short presentation this issue can be addressed only briefly and, by way of establishing focus, the paper will contend that, while it is undeniable that both design and design education seek to engage with meaningful problems and to achieve desirable solutions, much of design education is still hostage to the twin notions, first, that problems constitute sets of external conditions presented to the designer for the most efficacious solution and, second, that the potential problem-solver is somehow neutral in respect of the problems s/he engages with, 'merely' applying extant skills and knowledge to achieve their solution. This mindset can easily mistake design education for the provision of just such technical skills and knowledge, and fails to take due cognisance of the central role of the problem-solver in establishing *just what problem is actually being solved* in any particular case.

On this basis, the paper argues: (i) that meaningful problems are to a significant extent self-determined by the design problem-solver; (ii) that there is an intrinsic, and often under-valued, link between designer-driven problem-setting and the establishment of outcome possibilities; (iii) that therefore relevant criteria of outcome acceptability or desirability cannot be known in advance of both personal problem-setting and the advancement of solution-candidates; and, finally, (iv) that these observations are of critical significance for design education.

### Determining Design Problems

When, in primary or secondary school, pupils are set simple mathematical problems – what are six sevens, or what is the square root of 144 – then we know in advance of their asking that, notwithstanding the range of answers that might be forthcoming from the novice problem-solvers, such problems can yield only *one*, or, in the second case, *two*, acceptable solutions. Basic mathematics is, in this sense, a closed system: specific and limited numbers of solution-finding methods are available to, and may be learned by, the problem-solver; and the problems themselves yield outcomes that can be classified as 'all-or-none' solutions that can be assessed as being either right or wrong.

In marked contrast to this, design solutions are taken to epitomize what are known as *satisfying* or 'better-or-worse' solutions, i.e. solutions that can be assessed only relativistically according to the extent to which they satisfy some set of 'imposed' criteria. This is, of course, a long-standing 'given' for designers and design educators that brings with it not the implication but the fact that all design problems, properly-so-called, can result in a variety of different possible solutions. There is no 'right' answer, but judgments can be made on the design proposals offered – what we might call the 'solution-candidates' – on the basis of how *well* they 'solve', or, more accurately, resolve, the issues established by the problem. And as professional designers well know – and design students rapidly come to learn – 'how well' is determined not only by the fact *that* a solution has been reached, but on the designerly manner of that resolution.

Now, while this sounds both simple and commonsensical, it has a number of immediate implications. The first of these is the by now well-established understanding that the majority of design problems fall into that large class of problems variously identified as ill-defined (Reitman, 1964; Eastman, 1969), ill-structured (Newell, 1969; Simon, 1973; Voss and Post, 1988), or, more poetically, wicked (Churchman, 1967; Rittel,

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1972; Rittel and Webber, 1973). While we will return to the idea of wickedness in due course, it is sufficient, for the moment, to note that design problems are regarded as being ill-structured on the basis that design problem-solving is open-ended, that is to say: no definitive design solution can be reached; a variety of distinctly different outcomes are possible depending on the specific inputs; there is no algorithm for generating solutions; and there is no formalized way of knowing when to stop the process of solution-finding.

Of these conditions, the second, that each individual problem can, in principle, lead to multiple solutions, presents us with a number of further implications for design thinking. Conventional wisdom suggests that design problems are presented to designers by external agencies (clients, or, in the case, educational problem-setters) and with specific requirements (nominally represented by the brief). It is further taken as read, first, that the design process is thus *initiated by this external problem-setter*, who, on the basis of a set of extant requirements, 'commissions' the designer to produce an outcome that will satisfactorily meet such requirements; and, second, that, while this set of specific requirements does not provide, automatically and without further expert input, a direct specification of the outcome *per se* – to do so would suggest that the design is already to hand and thus make the role of the designer nugatory – the input required of the designer comprises a comprehensive and rational analysis of the brief, undertaken in the light of, and informed and augmented by, the expert knowledge of the designer, such that the most appropriate outcome for the given requirements may be determined (Harfield, 2007b, p.1).

This, in turn, is suggestive of two further presumptions about design outcomes. The first of these is the uncontentious claim that, based on the same brief, different designers will inevitably produce different outcomes. The second, again usually taken as read, is that the differences in such outcomes can be attributed to differences in the range and level of the skills, experience, professional competence, talent and imagination that the designer (or design team) can bring to bear on this common brief in preparing the design proposal. While this is undeniably accurate – differential skill sets are to be expected in both novice and professional designers alike – this account of outcome difference is, it will be argued, *incomplete*, and therefore *erroneous*, on the basis that it overlooks an essential and inescapable element in design problem solving: the self-determination by the problem-solver of the actual 'problem' to be solved.

That this is overlooked is hardly surprising. To talk about 'the design problem' at all – in educational terms, perhaps, the 'design problem as set' – tacitly endorses a well-established but conspicuously under-explored assumption, viz: that sharing a common brief means that designers engaging with this brief are, *therefore and necessarily*, sharing a common problem. Stated another way, this received view asserts that, in any given instance, the great variety of different 'satisficing' solutions that design problems allow emanate from a single shared problem identified by the requirements listed in the brief (to which, we might add, individual problem-solvers apply rational analysis and individuated skill sets).

Yet this, it will be contended, is *not* the case. As has been argued elsewhere (Harfield 2002, 2007a, 2007b), without either ignoring or wilfully deforming the requirements identified in the brief, it is *not* this 'problem-as-given' that the designer 'solves' but rather a substantially revised and personalized problem, titled here the '*problem-as-design-goal*', that

both subsumes the original problem and imposes upon it a range of designer preferences, prejudices and expectations. Hence, starting from the same brief, different designers will necessarily produce different outcomes not merely on the basis of differential skill sets but because, in substantial ways, *they are solving different problems*. Design problems are meaningful not just because they address technically meaningful requirements, but because they are to a significant extent self-determined by the design problem-solver, and cannot help being so-determined. To use a convenient shorthand: an architectural design competition, or a studio of architecture students, does not produce, as is conventionally thought, fifty different solutions to the same problem, but rather fifty different solutions to fifty different problems!

In significant ways, then, designers construct the problems that they seek to solve. "Design problems are...not just 'received' by the designer in the form of a set of extant and fixed requirements, nor are such problems merely augmented by the designer on the basis of professional expertise, to establish the problem-as-given. Rather, the collective requirements of the problem-as-given are synthesized and internalised by the designer, and are further augmented, incorporated and subsumed into a more specific and targeted and personal entity...the 'problem-as-design-goal'...The form and content of each design outcome is thus based not on answering the question 'how have you elected to solve the problem-as-given?' but rather on determining 'on the basis of the problem-as-given, what further and designer-specific problem has been generated and selected for solution?' The problem-as-design-goal thus constitutes the individual designer's overlay on the brief that determines what she or he wants to do with the general problem presented." (Harfield, 2007b, p.3).

Such personalization of design problems – what I have dubbed 'problematization' (Harfield, 2007a, pp.159ff) – stems from the fact that designers are clearly not objective and neutral in respect of design issues. They do act from personal self-interest, and they bring to bear on the problem-as-given not only a range of professional skills and knowledge (plus, one trusts, creativity and imagination), but also a set of personal and varied (and perhaps idiosyncratic) views about the nature of design itself. With this ostensive 'design world view', and different for each individual designer, comes a range of ideological or aesthetic or ethical or technological beliefs and commitments which determine not merely 'how is this problem-as-given to be solved?' in a pragmatic sense, but rather, on the basis of this initial problem specification, but substantially going beyond it, 'what is the problem that I as designer choose to adopt and solve?'

Now this, of course, is not, in any way, to suggest that the designer ignores the set of requirements established by the brief. What it does suggest, however, is that this brief is merely the starting point for the designer's thinking, and not, it should be added, merely the designer's thinking about how rationally to engage with this problem, but how to establish the nature of the personalized problem that this brief allows – perhaps, even, necessitates – and that will inform and constrain both the design activity and the final outcome in ways that are not dictated by the brief itself.

"For each designer each design is 'their' design, a personal exploration and statement that not only serves the clients' or users' interests, but does so *in a way that reflects the designing mind and designing personality that produces that outcome*." (Harfield, 2007b, p.3).

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### On Problem-setting

This imposition of 'self' onto 'problem' is a clear instance of what might be called designer-driven problem-setting. The issue, and the significance, of problem setting or problem finding – as opposed simply to problem solving – has evoked wide discussion across a range of disciplines. Within design circles Schön's (1983) work deserves attention, while useful perspectives on ideology and normative positions in design thinking, and on the idea of 'discovering' the design problem, are provided by Rowe (1987) and Lloyd & Scott (1994) respectively. Within the more general theoretical literature the work of Getzels (1975, 1979), Jay and Perkins (1997) and Runco and Dow (1999) provide useful insights.

What should be noted about this literature, however, is that it still tends to treat the problem in isolation from the potential solution and thus objectifies the problem, assuming that problem finding is essentially a rational and quasi-objective activity. Under this view problem finding is good because it identifies significant gaps in our knowledge; because it focuses attention on issues that have not previously been explored; in short, because it gives us new problems to work on. While this is undoubtedly important for design, as it is for a number of other disciplines, it signally fails to appreciate another and far more prevalent enactment of problem-setting – the imposition of self onto problem in design situations – which has significant implications for our understanding of the problem-solving process, the relations between problems and solutions, and the criteria used to assess design outcomes.

In saying this we are asserting not that design problem-setting occupies a space outside existing problems, nor that such 'new' problems are divorced from potential future solutions on the grounds that such solutions have not been considered yet, but rather (i) that such problem setting occurs within the context of, and in response to, extant problems on which the designer is already 'working', and (ii) that such problem setting is simultaneously a technique of problem solving (on the basis that such problem setting involves solution 'choosing', or, at least, conscious, if generalized, solution framing).

Indeed, the two are effectively one: in considering the problem established by the brief the designer both restricts and reconfigures the problem space by imposing on it what might be called a proto-solution, informed by the aesthetic, formal, technological, and/or ideological preferences of the individual designer. This reframing of the problem effectively 'writes the language' of the future solution, restricting its possibilities to a particular design set with which the designer is familiar and comfortable or towards which the designer feels some obligation, and to which the future solution will conform. This, it should be noted, is *not* the unreflective adoption of a preconceived solution for a predetermined problem. It is, rather, the utilisation, by the designer, of a particular solution type – or perhaps a solution mode – as a means not to solve the 'original' problem-as-given, but to interrogate that problem, to set it within the designer's particular working universe, and to develop the 'new' problem, hence determining 'what will be done'. In this sense design 'problem solving' is not the objective and dispassionate analysis of some external set of requirements, nor the 'mere' rational deconstruction of needs and wants and their impartial reconfiguration into a coherent but neutral solution package, but rather the passionate and entirely partial imposition of the designer onto the problem-as-

given, such that *that* designer's problem – which already *de facto* contains the language and impetus of its own solution – is drawn out and concretized as a specific, and now individually circumscribed, design goal.

This proposition returns us to our earlier reference to wicked problems, a descriptor that, as Lloyd and Scott usefully remind us, does not suggest *just* a problem's lack of structure, but asserts that "a design problem and its solution are linked in such a way that *in order to think about the problem the designer has to commit themselves to some sort of solution*" (1994, p.125, my emphasis). This constant interrelation between problem and solution – discussed under the rubric of 'co-evolution' by Dorst and Cross (2001; see also Dorst, 2003), but perhaps implying considerably more in this current context than the 'feedback loop' informing of the problem by reference to developing generations of solution-candidates (and vice versa) – has a number of significant implications for our understanding of design thinking and for design education.

### Implications for Design Thinking

First, we might reiterate the earlier point that the proto-solution imposed on the problem by the designer at an early stage of the process is not just *any* solution, used as a convenient test case; nor is it a solution derived by apparent deduction from analysis of the problem as given. Rather it is a conceptual schema, a solution 'framework', which has the effect of interpreting and delimiting the original problem in a manner consistent with the personal preferences and ideological position of the individual designer.

To this we should immediately add, second, that this imposition of self on problem, this reconfiguration of the original problem in the light of personal preferences and ideological commitments, is not necessarily a *conscious* imposition. It is not necessarily a decision, nor an intention, but perhaps an inevitability. Our experience of the everyday should confirm this: how we – and others – 'see' the world, and how we act within it; what we do and what we wouldn't consider doing; are, to a significant extent, determined by our beliefs, our preferences and our prejudices, even if we are unaware that we have them, and even if they are simply 'taken for granted' and are thus effectively both commonsensical and/or invisible. So too with the act of designing, and, to use a simple example, we should all recognise that "the imposition of a minimalist 'style' onto a problem brief is not inescapably an act of *choice*" (Harfield 2007a, p.171). Our belief systems often do not allow us to think otherwise, and our design problematizations – and thus our effective 'pre-selection' of our design language, and the formal and aesthetic imperatives that flow from it – often could not have been otherwise! Perhaps this is another reason why design problems are 'wicked': they do not allow of neutrality, and always speak of – and to – the designer!

Third, and on the basis of this, we should reiterate the central contention of this paper: viz, that it is no longer the problem-as-given that is being 'solved' but a 'new' and more precisely and more personally focused one. Consciously or otherwise, this is what the introduction of the proto-solution at such an early stage of the process *does*: it shifts and frames the 'new' designer-driven problem, and it is *this* problem which establishes the goal state, and against which the increasingly developed solution candidates are judged.

This in turn suggests, fourth, that design problems and design solutions are more than co-evolutionary, more than simply mutually informative, and are, in fact, co-extensive, i.e.

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in meaningful senses *they are one and the same*. The very suggestion of a proto-solution – and the sequence of developing solution-candidates that follows from it – establishes the ongoing sequence of problems that are being ‘solved’. The solution *becomes* the problem. From a designer’s perspective, every decision that is made about the ongoing development of the potential ‘final’ solution itself frames a problem state. A design (solution) decision to ‘do x’ evokes a range of considerations or questions – effectively a range of ‘problems’ – about ‘how to do x’ or ‘precisely what x should be like’, considerations that, while they might – or equally might not – be compared to the original problem specification, do not emanate from that specification but from the designer’s own problem/solution matrix. Effectively the question ‘what will make me, as a designer, satisfied with the ‘solution’ I am now working towards?’ has already been incorporated into the design process as requirements and criteria specified in the new and evolving problem.

Finally, and of key concern, is the question of how the imposition of this designerly self-interest impacts on the client. To the extent that the client (or, in this case, the educator) might be considered the initial brief-setter, then it must be assumed that s/he has both ‘something’ in mind at the beginning of the process, and certain criteria against which this potential ‘something’ can be assessed or measured. At the same time, and as with any design, it is taken as read that neither the client nor the designer can specify, in advance of its attainment, the precise nature of the final outcome. But between these two lies the contentious terrain of the design process, and if our current argument is accepted, then it suggests that, if the final design *outcome* cannot be specified in advance, then neither can (i) the ‘final’ *problem statement* (of which the design is an outcome); nor (ii) the final list of *desirable requirements* (which inform this problem statement); nor (iii) the final *outcome criteria* (upon which the ‘solution’ is judged).

Irrespective of the starting point all three of these remain in a state of flux. As the design is developed – as tentative solution proposals emerge and are vetted by both designer and client – then so too emerge additional and different requirements and criteria generated in response to such solution-candidates. In other words, as designing proceeds both designer *and client* come to understand what it is they ‘want’ from this design. And these wants – and the criteria that are harnessed to assess them – have not been retained, simply and without change, from the initial list of requirements that established the problem-as-given, but have emerged, for both designer and client alike, from the designer’s ongoing engagement with and transmutation of this problem into a specific and often more sophisticated design goal.

### And Education?

If the idea of design is conventionally tied to problems and problem-solving, then it is also inescapably tied to *expectations*, expectations that are, for students, designers and clients alike, informed by, influenced by, and, to large degree, controlled by, a universe of preferences, prejudices, beliefs and assumptions. And if this universe of influences is too often less than conscious to our design thinking, or if certain of these assumptions are actually embedded in the minds of students by virtue of their design education, then perhaps it is time that we looked at such education more critically.

In doing so, and in the light of this paper, four strongly interconnected issues are paramount.

First, the received view of design as a rational and effectively neutral problem solving-process must be seriously re-examined by design educators. This suggests not only that educators themselves must re-think and take a critical stance on the presumption that externally-delivered design briefs, and, more importantly, the intelligent and 'distanced' analysis of such, constitute the central motivator of design, but that design *students* must be alerted to this. Design outcomes are not 'simply' the result of thorough and quasi-objective analysis of the brief as provided.

Second, and following from this, both students and educators must be made aware of the often less than rational inputs and influences that condition, not to say control, define and limit, their thinking about and enactment of the design process. Without necessarily being able to identify them definitively, the presence and the effect(s) of specific theoretical and ideological commitments, and of particular preferences and prejudices, tastes and desires, must be recognised and understood as inescapable contributors to both the analysis of, and the determination of, design problems.

Hence, third, the central role of the individual designer – not merely as the 'doer' who solves the problem but as the active agent who, in any given instance, and in key ways, albeit potentially unconsciously, initiates, develops, personalizes and concretizes the actual problems that are to be solved – must be recognized and premiated. Contrary to the received view, it is not only design solutions that emanate from the individual designing agent but, in major respects, the design problems themselves, a causative effect that in turn effectively pre-determines the range and nature of the solution possibilities open to the agent, and that educators must be at pains to convey to their students. Designers effectively construct the problems that they seek to solve.

Finally, and in conjunction with all of the above, it is important that the potentially negative and restricting effects of any such predetermined assumptions, views and commitments, on both student problem solvers and educational problems setters must be explored and revealed. While theoretical, formal and aesthetic 'blinkers' might usefully sharpen focus, and certainly aid and inform solution development, they simultaneously limit scope and reinforce preconceived expectations.

And when the often unconscious preconceptions of the educational problem-setter, and, perhaps more importantly, of the educational *solution-assessor*, are used, without appropriate realization, reflection and explanation, to vet – either positively *or* negatively – the individual proposals of the student problem solver, then 'education' is (again, potentially unconsciously) effectively replaced by 'the acceptable meeting – or otherwise – of prior expectations'.

## References

- Churchman, C.W. (1967). Wicked problems. *Management Science*, 14, B-141-142.
- Dorst, K. (2003). The problem of design problems. In N. Cross & E. Edmonds (Eds.), *Expertise in Design: Proceedings of the 6th Design Thinking Research Symposium* (pp. 135-147). Sydney: University of Technology Sydney.
- Dorst, K. & Cross, N. (2001). Creativity in the design process: co-evolution of problem-solution. *Design Studies*, 22(5), 425-437.

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- Eastman, C.M. (1969). Cognitive processes and ill-defined problems: A case study from design. In D.E. Walker & L.M. Norton (Eds.), *Proceedings of the International Joint Conference on Artificial Intelligence* (pp. 669-675). Washington DC.
- Getzels, J.W. (1975). Problem-finding and the inventiveness of solutions. *Journal of Creative Behavior*, 9(1), 12-18.
- Getzels, J.W. (1979). Problem-finding: A theoretical note. *Cognitive Science*, 3(2), 167-171.
- Harfield, S.J. (2002). How buildings come to be the way they are. In R. Best & G. DeValence (Eds.), *Building in value* (pp.17-32). Oxford: Butterworth Heinemann.
- Harfield, S.J. (2007a). On design 'problematization': Theorising differences in designed outcomes. *Design Studies*, 28(2), 159-173.
- Harfield, S.J. (2007b). On the self-construction of design problems. *Proceedings: ConnectEd 2007 International Conference on Design Education* (pp. 1-5). Sydney: University of New South Wales.
- Jay, E.S. & Perkins, D.N. (1997). Problem finding: The search for mechanism. In M.A. Runco (Ed.), *The creativity research handbook, Vol.1* (pp. 257-293). Cresskill, NJ: Hampton Press.
- Jonas, W. (1993). Design as problem-solving? Or: here is the solution – what was the problem? *Design Studies*, 14(2), 157-170.
- Lloyd, P. & Scott, P. (1994). Discovering the design problem. *Design Studies*, (15)2, 125-140.
- Newell, A. (1969). Heuristic programming: Ill-structured problems. In J.S. Aronofsky (Ed.), *Progress in operations research* (pp. 361-414). London: Wiley.
- Reitman, W.R. (1964). Heuristic decision procedures, open constraints, and the structure of ill-defined problems. In M.W. Shelly & G.L. Bryan (Eds.), *Human judgements and optimality* (pp. 282-315). New York: Wiley.
- Restrepo, J. & Christiaans, H. (2003). Problem structuring and information access in design. In N. Cross and E. Edmonds (Eds.), *Expertise in Design: Proceedings of the 6th Design Thinking Research Symposium* (pp. 149-162). Sydney: UTS
- Rowe, P.G. (1987). *Design thinking*. Cambridge, MA: MIT Press.
- Rittel, H.W.J. (1972). On the planning crisis: systems analysis of the first and second generations. *Bedrijfsökonomie*, 8, 390-396.
- Rittel, H.W.J. & Webber, M.M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4, 155-169.
- Runco, M.A. & Dow, G. (1999). Problem finding. In M.A. Runco & S.R. Pritzker (Eds.), *Encyclopedia of Creativity, Vol.2* (pp. 433-435). San Diego: Academic Press.
- Schön, D. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.
- Simon, H.A. (1973). The structure of ill-structured problems. *Artificial Intelligence*, 4, 181-200.
- Voss, J.F. & Post, T.A. (1988). On the solving of ill-structured problems. In M. Chi, R. Glaser & M.J. Farr (Eds.), *The nature of expertise* (pp. 261-285). Hillsdale, NJ: Lawrence Erlbaum.

