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DESIGNING AS...: THINKING ABOUT WHAT DESIGNING MIGHT BE

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ABSTRACT

The issue of defining design is open in many quarters. Definitions abound, yet convergence, especially between different design disciplines, remains elusive. In this speculative paper, the authors consider what designing is *like*, rather than what it *is*. In particular, we consider some other activities that have been likened to designing (problem-solving, creativity, planning, synthesis, specification, and a natural human ability), and study the boundaries between designing and these other activities. These boundaries are not crisp, but may be analogous to boundary layers – grey areas in which certain, otherwise steady, characteristics change. While no clear answers result, we do believe we have shed some light on the nature of designing with respect to these other activities. In the end, we see designing as a *confluence* of other activities, each with their own existence, but combining uniquely to form the activity we call *designing*.

Keywords: defining design, planning, creativity, synthesis, evolution.

1 INTRODUCTION

> "Basic research is what I'm doing when I don't know what I'm doing."
> – Wernher von Braun (1912-1977)

One question that persists in design research, despite many vigorous and on-going research efforts, is "What is design?" All of us who practice, teach, or do research in design have an intuitive sense of what it must be. Still, disputes arise; proponents of one definition can become quite outspoken against the definitions of other groups – all the while happy to agree with the other groups that they are *all* "doing design." Some of the argument is centred on the difference between designing as a process in general and the particulars of designing as practiced by professional designers. Differences in disciplinary background (e.g. engineering design, architecture, industrial design, fashion design, etc.) give rise to other contentious issues.

Many definitions have been proposed. Hubka and Eder [1] collected a surprisingly diverse set of definitions. We list some here to show the breadth with which the matter has been considered.

- "Mechanical engineering design is the use of scientific principles, technical information and imagination in the definition of a mechanical structure, machine or system to perform pre-specified functions with the maximum economy and efficiency. The designer's responsibility covers the whole process from conception to the issue of detailed instructions for production and his interest continues throughout the designed life of the product in service." [2]
- "A goal-directed problem-solving activity." [3]
- "Design is the process of inventing physical things which display new physical order, organization, form, in response to function." [4]
- "... the creation of a synthesized solution in the form of products, processes or systems that satisfy perceived needs through mapping between the functional requirements (FRs) in the functional domain and the design parameters (DPs) of the physical domain, through proper selection of the DPs that satisfy the FRs." [5]

Other definitions of design that the authors have found interesting include:

- "Engineering design is the systematic, intelligent generation and evaluation of specifications for artifacts whose form and function achieve stated objectives and satisfy specified constraints." [6]
- "…the use of heuristics to cause the best change in a poorly understood situation within the available resources." [7]
- "Engineering design integrates mathematics, basic sciences, engineering sciences and complementary studies in developing elements, systems and processes to meet specific needs. It is a creative, iterative and often open-ended process subject to constraints which may be governed by standards or legislation to varying degrees depending upon the discipline. These constraints may relate to economic, health, safety, environmental, social or other pertinent interdisciplinary factors." [8]

Finally, however, and just to situate the presentation to follow, the authors prefer the broader definition of Herbert Simon [9], which we believe captures essential aspects of engineering design while also accommodating other kinds of designing too. Namely: *"Everyone designs who devises courses of action aimed at changing existing situations into preferred ones."*

We also note that many other authors, such as Kruger and Cross [10], have contributed substantively to the study of the essence of design. The authors' interest here is not to collate these admittedly important contributions. Instead, we chose to see how far we could go using a more common or vernacular base, on the premise that the most widely cast net will yield the most diverse catch.

Some may argue that asking the question "What is design?" is doomed to failure. After all, one can argue that it is just as difficult to define disciplines like *physics* or *chemistry* even though they have been studied vigorously for many years. Indeed, scientists have created an entire discipline to fit in the "grey" area between physics and chemistry – *physical chemistry*. Even *applied science* can be seen as filling in the grey areas between *pure science* and *engineering*.

This may well be. However, we believe that *seeking* an answer may be more important than the answer itself. Though we may someday find that the question itself is flawed, it is hard to see how we might reach that point without at least trying, and not benefit substantively from the attempt – surely such a study will advance *some* aspects of our understanding of designing. Until that time arrives, we see will use this opportunity to introspect on an activity that is so often fixated on outward considerations.

Thus, armed with the knowledge that we are likely to do more good than harm, the authors will consider in this speculative paper, "What is Design?" from what we believe is a relatively unique perspective. (We note here that our focus will be exclusively on defining design *as an activity* – thus, per [1], we will use the term *designing* to denote this.)

Typically, as is evidenced from the many definitions of designing given above, these kinds of studies assume either a *(de)compositional* perspective, or a *specializational* perspective. In the (de)compositional perspective, designing is defined with respect to its constituent activities, domain knowledge elements, or internal characteristics. In the specializational perspective, design is defined as a qualified specialty of some other discipline or activity.

Instead of either of these perspectives, the authors will take a qualitative *relational* approach, of designing with respect to other activities, to illuminate the boundaries where designing becomes something else. This approach is not completely new; for one example, [1] do discuss designing as it relates to other phenomena (intuition, creativity, heuristics, etc.) We believe, however, our use of this approach is unique for two reasons. Firstly, we focus on the *boundaries* between designing and other phenomena – something we have not encountered elsewhere in the literature. Secondly, we have identified a set of other phenomena that, as far as we can tell, have not yet been studied in relation to designing in the manner in which we do here. The authors note that the set of phenomena we consider in this paper is *not* an exhaustive list; some phenomena have been omitted because we have not sorted out how best to compare them to designing, while other phenomena remain unidentified.

The notion of finding boundaries is particularly important.

Consider a paradox that arises in trying to distinguish between an organism and its environment. To identify the organism, one must know what constitutes the environment; that which is not-environment must be organism. However, the converse is also true: to identify the environment, one must know the organism, and that which is not-organism must be environment. So, which comes first, the organism or the environment?

To break the paradox, one must stop thinking of *only* the organism and the environment. In particular, one looks for boundaries *first*, and then distinguishes those things lying on either side of the boundaries.

A boundary is a region where some (basic) property changes value in some way. There is evidence (such as [11,12]) that suggests the brain operates by taking advantage of boundaries to compartmentalize its work. There are specific brain centres, for example, that treat colour, shape, and motion separately. In each area, it seems that the extent of the value in a field (e.g. a colour in the visual field) is found — that is, the boundaries of that property's value are found (e.g. where the colour stops being red). These boundaries are then used to build a (sometimes partial) model of a scene, which is then matched to memories of other things for identification. Thus, using boundaries to distinguish between different entities may be an *entirely* natural way of thinking.

Obviously, these design boundaries are not crisp. Indeed, they *ought* not be crisp so that there is enough flexibility to allow design as a discipline and a body of knowledge to evolve with humanity's understanding of the universe. Of course, boundaries themselves are not crisp in reality even if they might appear crisp to us. Engineers are well acquainted with the notion of a boundary *layer* – a region where change happens relatively smoothly, rather than some crisp, mathematical discontinuity. They occur in many situations. The zone of elastic/plastic transitional behaviour of materials can also be thought of as a boundary layer, as can the region inside a wire that actually carries an electric current. Even the extent of the human body is defined by a boundary layer: the amount of activity happening at the "surface" of our skin at the microscopic level is quite high, to the point where it is difficult to know where "skin" ends and "atmosphere" begins.

Thus, we expect the boundaries we find between designing and other activities to be boundary *layers*.

While some have argued [13] that humanity will someday soon know "everything" that is knowable – at which time a definitive and crisp set of boundaries may be possible, it is unclear that this is a reasonable assumption for the foreseeable future. In any case, such boundaries are finally human constructs, and as humanity's sensibilities evolve, so will our notions of the boundaries of designing. Indeed, this kind of evolution may be in the very nature of definitions and categories [14]. So the best we can say, we believe, at this time, is that any set of boundaries must be meaningful in the present *and* be able to evolve in time.

In summary, then, there appears to be good reason to struggle with the notion of defining design, even if we know any such definition will (and should) change with time. In the following, the authors will look for boundaries (or, more precisely, boundary layers) between designing and other phenomena, in the hope that finding some of these boundaries will help us understand what designing is.

2 DESIGNING AS....

The question the authors pose is: can some sense of what designing is be found at its boundaries with other phenomena? This section will study some of those boundaries.

For each phenomenon considered in this section, we will use typical, "common sense" definitions, from the Oxford American Dictionary and Thesaurus [15], to keep the arguments as broadly relevant as possible and hopefully to avoid the misunderstandings that can arise when terms are used in specialized, discipline-specific ways.

We will then consider how designing is like, and unlike, the phenomenon. In so doing, the authors seek to illuminate the nature of the boundary between designing and these other phenomena. We will also try to define the boundary in terms of a quality or characteristic the value of which changes at the boundary.

We intend, in the end, to suggest that designing may be thought of as the confluence of these other phenomena – not just a superposition of them, rather a whole that is greater than the sum of the parts.

2.1 ...Problem solving

Designing is often described as a kind of problem solving [16,17].

The dictionary [15] defines a *problem* as *"a matter or situation regarded as unwelcome or harmful and needing to be dealt with and overcome; a thing that is difficult to achieve or accomplish."* Synonyms from the thesaurus include *"difficulty, trouble, worry, complication, difficult situation; snag, hitch, drawback, stumbling block, obstacle, hurdle, hiccup, setback, catch; predicament, plight; misfortune, mishap, misadventure; dilemma, quandary."*

Wikipedia, the online encyclopedia [18], includes this definition. *"Problem solving forms part of thinking. Considered the most complex of all intellectual functions, problem solving has been defined as higher-order cognitive process that requires the modulation and control of more routine or fundamental skills. It occurs if an organism or an artificial intelligence system does not know how to proceed from a given state to a desired goal state. It is part of the larger problem process that includes problem finding and problem shaping."* The Wikipedia entry also refers to a number of problem solving techniques that include many methods commonly associated with designing: means-end analysis, brainstorming, morphological boxes, lateral thinking, analogy, abductive reasoning, etc.

Based on this information, the authors propose that designing may be a specialized sort of problem solving. That is, by the definitions above, we cannot think of a situation where designing occurs but problem solving does not occur. It is easy to think of Simon's *seeking of preferred situations* as equivalent to problem solving: the problem is to find the preferred situation. Problem solving can also include discovering or deciding how to solve the problem; this is consistent with Simon's *devising courses of action*. Even in the non-engineering design disciplines, one can argue that problem solving is fundamental: for instance, the artist's problem is to create a form or expression that appropriately captures the emotion, idea, or thought that the artist feels the need to express.

On the other hand, we also believe that not all problem solving is designing. For instance, one would typically consider finding the roots of a quadratic equation a *problem* that students have to solve, although there is clearly no designing happening. Therefore, the authors believe there is no designing that is not also problem solving.

Based on this, then, we believe that designing is a kind of problem solving that applies only to certain kinds of problems. While there may be others, the authors think that one of these kinds is typically known as the *wicked* problem. A wicked problem has the following four key features [19]:

1. The problem is not understood until after formulation of a solution.
2. Stakeholders have radically different worldviews and different frames for understanding the problem.
3. Constraints and resources to solve the problem change over time.
4. The problem is never solved.

It seems quite clear from the definition above that problems typically considered "design problems" could be called wicked.

The authors therefore propose that wickedness is a characteristic that can distinguish designing from problem solving in general. Furthermore, since it is possible to imagine problems that are obviously design problems but that do not satisfy all four of the features of wickedness, we suggest that *degree of wickedness* is the metric used to establish a boundary layer between designing and problem solving. If designing involves wicked problems, then as one eliminates each of the features above, one moves further away from designing and towards conventional problem solving.

Of course, a great deal has been written about the nature of wicked problems; what the authors have presented here is just an overview. It may be that in time, the notion of degree of wickedness will have to be amended. Nonetheless, we believe this is a good start.

2.2 ...Planning

Per [15], planning is to *"decide on and arrange in advance; make preparations for an anticipated event or time."* The term *design* is also mentioned in the dictionary definition. An alternative definition [20] is *"a process to determine goals and objectives and to devise the means by which they can be accomplished."* Thesaurus entries for planning include: *"preparations, organization, arrangement, design; forethought, groundwork."*

The authors note with interest how close these definitions are to Simon's definition of designing (see Section 1). Especially in light of the above discussion about problem solving and designing, one might reasonably ask whether designing is also just a kind of planning.

We do not think so because we believe the underlying perspective of designing is different from that of planning generally. While one usually plans *for* an eventuality, one designs to *cause* an eventuality. Designing is therefore different from planning in its intent, its expectations for the future, and the extent of its conditional nature.

This is best demonstrated by example. Consider the occurrence of an influenza pandemic. In the *planning* perspective, the plan is implemented only if the pandemic occurs; that is, the plan's

implementation is contingent on (or an effect of) an eventually. From the point of view of the plan, the pandemic's occurrence is a *certainty*.
In the *designing* perspective, on the other hand, the design is implemented to *cause* an eventuality – for example, to prevent the pandemic, or to limit deaths. In this case, neither the occurrence of the pandemic nor the designers' intent is a certainty.
Of course, these two perspectives have a great deal in common. The result is the same: the design is the plan, and the overall processes used under both perspectives will likely be very similar. It is easy to see how planning and designing could be confounded given these similarities.
The difference – and what we think distinguishes the "designerly" perspective from the planning perspective – is the nature of the assumptions underlying them. In designing, there is more and different uncertainty of the eventualities on which the act is focused. In other words, one is entirely focused on getting as close to the desired end-point as possible.
We note here that "a design as a plan" highlights that the design is more than just a rendering, a CAD model, or a market study. If the designed product is a vehicle of beneficial change, then the design must account for all this information and more. Indeed, it must include *everything* needed to implement the intended change, not *only* the artifact to be used to bring the change about.
In the authors' experience, this is not a perspective that is widely assumed, especially in North American engineering and product development. (There are of course exceptions.) We see, instead, a general sense that a design is some kind of rendering, or a collection of renderings and models, that capture only the artifact. This is especially common in the work of engineering students, who tend to render their designs as floating in space rather than *in situ*.
The difference between planning and designing impacts on the certainty of the process by which planning (or designing) occurs. Given the assumed certainty of the eventuality, planning processes can be more definitely specified. Design processes, on the other hand, must be more adaptable and flexible, because one is only increasingly sure of the target as one takes successful steps toward it [21].
The authors therefore propose that an appropriate characteristic to distinguish between planning and designing is the degree of certainty assumed of the outcome, target, or eventuality for which it is being planned/designed.

2.3 ...a Creative Act

The verb *create* means to *"bring into existence."* Thesaurus entries include: *"produce, generate, bring into being, make, fabricate, fashion, build, construct; design, devise, originate, frame, develop, shape, form, forge."* Creativity is defined as *"the use of the imagination or original ideas, esp. in the production of an artistic work."* In the dictionary [15], the term is described as applying to persons with *"active, exploratory minds,"* as in having a "creative approach to problem-solving." The entry for *creative* also includes a distinction between the *inventive* mind that *"comes up with solutions to problems it has posed for itself"* and the *resourceful* mind that *"deals successfully with externally imposed problems or limitations."* Finally, an *ingenious* mind is one that is both inventive and resourceful. Thesaurus entries for *creativity* include: *"inventiveness, imagination, innovation, innovativeness, originality, individuality; artistry, inspiration, vision; enterprise, initiative, resourcefulness."*
It is a safe assumption that one does not knowingly design things that already exist, at least in the context in which the designing act occurs. Although many new designs are only marginally different from existent ones, there is (presumably) at least something new about every design. As such, designing usually involves generating ideas cognitively that one would not have generated otherwise. One may say, then, that designers create "from nothing," as it were. This creativity is usually marked as an essential characteristic of design.
Dym [6] recognizes three classes of designing: creative, variant, and routine. They map very well to the inventiveness/resourcefulness spectrum noted in the definitions of "creative" minds given above. In this way, design activities cover the whole spectrum of creative requirements. Indeed, most would agree that some creativity is required in all design.
Beyond this, however, the authors believe that design creativity is distinct from artistic creativity by having to address the needs of others. That is, a purely artistic creation is a *self*-expression – an expression of the artist's self – even if the act is motivated by external forces or experiences. The artist interprets things, depicting what he himself "sees," and then renders that for others to "see." (For example, the author William Gibson once advised Salustri to "write only if it hurts not to [22].") A

designer, however, must find an expression common to many people, driven in large part by what the others "see." A designer must render something that captures the visions of others. This is not to say that designers do not imbue their designs with their own sensibilities – of course, they do. But the thing imbued by the designer's sensibilities is fundamentally motivated by the vision of others.
This outward-looking sense of designerly activity also seems similar to Donald Norman's notion of design affordance [23], in which an object suggests its own uses to a human, mitigated by the human's experience. The designer, then, needs to understand the affordances of a target user community, and create with respect to those affordances.
In this case, the boundary layer between designing and creativity involves the degree to which the creator expresses the vision of, and affordances for, others. In designing, others matter more than the designer does; in art, they matter less.

2.4 ...Synthesis

Synthesis is the building of complexity from simplicity. In the dictionary, this notion is described in terms of philosophy, chemistry, grammar, and linguistics. Its thesaurus entry includes: *"combination, union, amalgam, blend, mixture, compound, fusion, composite, alloy; unification, amalgamation, marrying."* It is a process commonly associated with designing.
Synthesis is more than just assembly or superposition, because the desired functions of the whole often only emerge from the combination of the whole's parts rather than from the parts themselves.
Synthesis is not quite the same as creativity, but there is (or, at least, can be) creativity in synthesis because the complexity itself is created "from nothing." The emergent characteristics of a synthesized thing are usually described in functional terms that capture how the whole is used in context. So synthesis is a kind of creativity of function or affordance, but not a creativity of structure.
Synthesis is not necessarily an activity only of human designers. Synthesis occurs frequently in nature as well, and examples abound, including most obviously the evolution of life. However, there is no evidence of *intent* in synthesis as it occurs in nature. The authors believe *intent* is the key distinction between natural and artificial synthesis. Designing is inherently intentional, and synthesis is part of designing. So intent, it would appear, is an optional aspect of synthesis.
We note, however, that synthesis is not *necessary* for design. For instance, barring the availability of other tools, one might use a paper clip as a tool to press a recessed reset button on certain kinds of electronics. This is done by straightening part of the paper clip, which *lowers* its geometric complexity – one has made something simple from something (slightly) more complex. While there is admittedly little designing in this case, it does satisfy Simon's general definition. And there is no synthesis at all because complexity is decreased, not increased.
Therefore, designing may include synthesis, synthesis may be intentional, but designing is always intentional.
The key characteristic here appears to be intent. Intent appears implicit in Simon's definition, as it is in every other definition of designing of which the authors are aware. Thus we propose that the boundary layer between designing and synthesis occurs where the degree of intent underlying the designerly or synthetic act changes. It is not clear to the authors at this time how intent can be measured to provide *degrees* of intent.

2.5 ...Specification

Designing usually starts with broad qualitative problem elements that need to be reduced to structured, solvable elements (i.e. a problem specification). Designing also results in a set of artifacts that specify how to implement something that will cause a (presumably beneficial) change in each dimension of the problem (i.e. a solution specification). Thus, designing is (partly) specifying. The dictionary gives this general definition: *"an act of describing or identifying something precisely or of stating a precise requirement."* Thesaurus entries include: *"statement, identification, definition, description, setting out, framing, designation, detailing, enumeration; stipulation, prescription."*
A design is, however, rarely as antiseptic as what is commonly thought of as a "specification." A design is just a model of something else, and thus imperfect by definition. Therefore, the design specification will also be imperfect. By capturing the qualitative as well as the technical aspects of a design, a specification provides a better sense of the design intent to the agents who will have to manifest/implement/manufacture it. The authors note here that we mean *qualitative* in the sense of a thing having certain recognizable qualities. Strictly speaking, such qualities are not subject to the

"hard" quantifications that engineers prefer. However, at a coarse level, some kind of quantification is possible. For instance, many users have commented favorably on the aesthetics of the new Apple *iPhone*; though its aesthetic cannot be quantified in the usual scientific way, there are relative measures that can be applied (e.g. as when significantly large groups say that the device is the "most beautiful" of all similar products).
Indeed, depending on the nature of the design problem, the qualitative design information may more accurately capture the spirit and intent of the design than might the technical information. If errors in the technical specification are found, they might be addressed by changes that bring them more in line with the qualitative specifications.
However, the qualitative information that must be captured to truly specify a design cannot *just* be specified. There is no method of which the authors are aware that can accurately and reliably capture this sometimes ethereal sense of a particular design. Nonetheless, if we could specify this kind of information, it seems quite certain to result in better manifestations of those designs.
Therefore, reconciling the dry and technical notion of specification with the broader and more informal articulation of qualities would be an important achievement.
In this regard, the technical aspects of specification might be used as grounding for other kinds of specification. Compared to the broader kinds of design specification, technical specification is quite well understood, and there is no doubt of the necessity of technical specifications for the sake of implementing designs. At very least, methods of technical specification allow one to identify those aspects of a design for which implementation is relatively well understood. Knowing this allows us to focus, by elimination, on those aspects of a design not otherwise covered and that go beyond the technical.
What information is missing from the technical specification of a design that is necessary nonetheless to convey the design *in toto* to others? How can one organize the non-technical specification in relation to the (relatively) well-understood technical information? What mismatches or apparent contradictions arise from such a categorization? How does non-technical information help to capture the "spirit" of a design for the sake of better implementing it? These are all open research questions.
In this case, the authors suggest that a boundary layer occurs between designing and specifying with respect to the amount of qualitative information that must be captured to represent the design accurately and completely. In this view, specifications that have no qualitative elements were not an artifact of a design process.

2.6 ...Natural Human Ability

As so many activities of human beings can be explained from an evolutionary point of view, one may consider whether design may be the result of evolution and natural selection. The authors were unable to find a suitable "dictionary definition" for this phenomenon, but we believe that this perspective is worthy of study, and so include it using our own experience to guide us. By *natural human ability*, the authors mean a human capacity to do something that is essentially innate.
An ability to design can give an organism an evolutionary advantage. If designing brings about beneficial change, then a designerly organism could anticipate the need to proactively change its environment, to plan that change, and then to execute that plan. If pitted against other organisms without such a capability, then it follows that natural selection favors organisms that design well, *ceteris paribus*.
Of course, designing in any conventional sense (e.g. in art and in engineering) has a history of "mere" millennia from an evolutionary point of view. Evolution of complex life forms does not act on such short time scales. However, with respect to activities like farming and hunting, it is not unreasonable to think that some sort of planning, creativity, synthesis, etc. could have been used tens or even hundreds of thousands of years ago. We can go even further back in time: humanity has existed in one form or another for at least 2.5 million years; many activities of early hominids as evidenced by the archaeological record, such as tool-making, imply the features of designing we have mentioned above. One can even find evidence of some phenomena described in previous sections exhibited in surprising ways by certain animals (e.g. octopi that open screw-top jars to get at food [24]).
So, if design is a natural behaviour that emerged through evolution, then the first proto-designerly organisms must have been quite primitive by modern standards. If this is the case, then some of the natural/neurological foundations of designing may predate all modern notions of aesthetics, function,

and even utility. The design research community should discuss then what a primitive notion of utility/function or aesthetics might entail.
Even if we accept Simon's broad definition of designing, it is difficult to imagine an animal doing it; but it does appear that proto-designerly behaviours (e.g. problem-solving, synthesis, etc.) do occur in animals, albeit in limited ways. It might then be that designing as a human ability evolved "on top of" these more primitive phenomena. Perhaps regarding designing as a confluence of these phenomena under evolutionary pressures may be a key to understanding the origin of designerly behaviours.
Given the evolutionary argument, designerly ability emerges from the moment when it produced a reproductive/survival advantage. This would be when the proto-human could see far enough ahead to regularly and effectively improve its fate. This would have meant, for example, selecting or modifying improved shelter, understanding fire management, and creating hunting tools that augment the performance of hunters (remember that the human is a comparatively weak, slow animal among the zoology of the African grasslands). Consider then how we currently decide that a shelter is a good place to be or that one stone (a most primitive hunting tool) will do more damage to prey than another will. One expression for knowing something without really reasoning about it is *instinct*.
Instinct is still very important today. People use it constantly to assess each other in social interactions, and it informs our sense of aesthetic about a thing, even if it is something about which we have no prior or detailed knowledge. That aesthetic is what product developers attempt to manipulate when creating external features. Unfortunately, it is hard to reprogram and it is sometimes wrong. Devices can look great but have rather awful usability. Hence, not all aesthetics, and certainly not all instinct can qualify as designerly behaviour.
The authors do not intend to denigrate the importance of aesthetic or other matters here, nor do we seek to minimize the uniqueness of designing in general. Instead, we suggest that designing is a perfectly natural, and therefore inherently sentient (and human), behaviour. In our view, these natural abilities and sensibilities exist because, on the balance, they improve survival. Indeed, our "sense" of other people is probably more reliable than our sense of a painting or a vase, but that is a good thing because other humans are more beneficial or potentially harmful than the latter.
All this discussion of evolution and design is, of course, not a scientific argument. It is not even clear which parts of the hypothesis (that designing is rooted in evolutionary processes) are testable; however, we would like to think that there is merit in pursuing the matter.
Beyond this, it is interesting to consider the differences between designing as executed by professional designers versus designing as executed by the lay population. Whether one argues for evolutionary roots of designing, or merely accepts Simon's definition, designing is something that everyone does. Professional designers, however, seem to design in different ways than the lay population. Professional designers bring to bear their training, their experience, and a body of knowledge – things to which lay designers do not necessarily have access. To use all this material, the professional designer must be aware of it, and so must *intentionally* act at a meta-level as well as a designerly level, by reflecting on his design activities, selecting tools and methods, and adapting his personal design process to suit the needs of the moment.
Both professional and lay designer intend to design, but only the professional designer is *necessarily* aware of it. The lay designer may not even know that he is designing whilst doing it, and rarely reflects on the designerly aspects of his activities. Put another way, the lay designer designs using only design as a natural human ability, while the professional designer has modified and augmented his natural design abilities with training and experience.
The essential characteristic here is a *conscious awareness* that one is designing. This awareness is present in professional designers, but not present in the lay designer. Thus, the authors propose that *awareness* be the metric that determines a boundary layer between *natural* design acts – of which the designer would not be aware – and the *intentional* acts of the professional design. We note that this way of thinking about designing offers an alternative definition of professional design: design conducted with conscious awareness, intent, reflection, and access to an external body of knowledge.

3 DISCUSSION

In the foregoing, the authors have identified six phenomena that are not designing, but that are entangled with designing in one way or another. For each phenomenon, we have sought to examine the nature of the boundary layer, that region of activity where it is difficult to distinguish designing from the other thing. Having identified the boundary layers, we have proposed metrics – albeit largely

qualitative ones only – that can help one recognize when a particular activity is wholly, largely, slightly, or entirely not a designing activity.
We note that the six phenomena we have identified are not all the phenomena that bound designing. Among the phenomena that the authors were unable to examine in this paper are: management, communication, decision-making, and social interaction. There are likely others too, that we have not yet even thought of.
It is quite evident, upon reviewing the material in Section 2, that no one phenomenon clearly distinguishes design. For example, designing involves a kind of creativity, but is at the same time more than just a kind of creativity. Similar arguments can be made for all the phenomena we examined. It is also evident that there is significant interplay between the phenomena when they occur within the boundaries of designing.
Designing, it would appear, is only designing *because* of the confluence of all these phenomena. Remove even one of these and what is left is no longer designing. Assuming one accepts the definitions of the phenomena as provided above, for example, what is designing without its creative element? It is difficult to imagine *un*creative designing. On the other hand, the kind of creativity that we believe occurs in designing – creativity that accounts for the vision of others – can also occur elsewhere (e.g. teaching, game-playing). Thus, the authors believe that it is not sensible to talk about or study designing without admitting and treating equally all the phenomena with which it borders and shares so much.
In exploring the six phenomena, we identified a characteristic for each phenomenon that changes at the boundary between it and designing. To summarize, these characteristics are:

- degree of problem wickedness (for problem solving),
- degree of certainty in the target eventuality (for planning),
- degree of expression of others (for creativity),
- degree of intent (for synthesis),
- amount of qualitative information to completely capture a design (for specification), and
- degree of conscious, reflective awareness of design activities (for natural ability).

This set of characteristics can be thought of as axes in an abstract space, a region of which is marked "designing." Along each axis, there is a boundary layer separating designing from other phenomena. The analogy is, however, imperfect because we have not identified the coupling between the other phenomena (e.g. the boundary layer between creativity and planning). Without knowing this, we cannot determine the adjacency of all the phenomena in this space. We hope to pursue these matters and develop a visualization of sorts of this space, at some future time.
The authors also find it interesting that this particular set of characteristics appears unique in the literature we have reviewed. Does this mean that we have identified a substantively new perspective on designing? We do not yet know. Whether it is new or not, however, is not really the point. It is more important that we find a use for this perspective. We can see implications for cross-disciplinary design methods here, as well as a potentially significant impact on design education. However, much more work must be done before we can expect results that can be evaluated pragmatically.
Finally, it is obvious that the perspectives and proposals written in this paper are skewed by the experiences and biases of the authors. As such, we believe we would be doing the discipline a disservice by arguing for our approach without also trying to get as many other individuals involved as possible. To that end, the authors will be setting up a collaborative web site, which will be open to any design practitioner or researcher, and that will be devoted expressly to discuss matters such as those examined in this paper. Any interested reader should contact the corresponding author by email to get further details.

4 CONCLUSION

In this speculative paper, the authors have considered designing *as* other phenomena, and considered the boundaries between designing and those other phenomena. It would certainly appear that design is the messy construct of world views arrived at through creation, synthesis, problem solving, and other activities, by people with some marginally coherent set of goals. Many questions have been raised; none have been answered. The authors hope, however, that the landscape of designing has been illuminated in a new and hopefully interesting and useful way, and that as a result we will eventually deepen our understanding of what it means to design.

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