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Sustainable Design as a Sustained Upstream Effort*

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A salmon swims upstream to its birthplace—renewing the cycle of its life. The tectonic rise against which it struggles is an unending cycle—of uplift and erosion, of heat and cold. Wishing to catch the fish, a human waits, breathing deeply, quietly—an unending cycle of expansion and contraction, of tension and release. The human's desire itself an unending cycle—of transforming what is to what might be and what might be to what is. This cycle—of certainty and curiosity, of wondering and knowing—we call 'design.' It is another form of breathing.

Keywords: problem-naming; design sensibilities; exploration; design-breathing; pre-expert design; whole systems; whole person

1. WE CHOOSE AND NAME THE THINGS WE WILL NOTICE

> . . . the problems of real-world practice do not present themselves to practitioners as well-formed structures. Indeed, they tend not to present themselves as problems at all but as messy, indeterminate situations. . . . When a practitioner sets a problem, he chooses and names the things he will notice. . . . Depending on our disciplinary backgrounds, and political/economic perspectives, we frame problematic situations in different ways. . . . Often situations are problematic in several ways at once. . . . These indeterminate zones of practice—uncertainty, uniqueness and value conflict—escape the canons of technical rationality.
>
> D.A. Schön [1]

2. IN CONVENTIONAL DESIGN WE CHOOSE

> . . . as engineers . . . we are always given the objectives. We design something for a reason and it would be unreasonable for us in the real world to not expect to have those requirements at the beginning of the project.
>
> Senior—M&AE

In *conventional discipline-focused design,* we apply ourselves in *'determinate zones of practice.'* We find familiar *'problems'* and use standard tools and techniques, *'the canons of technical rationality,'* to produce familiar *'answers.'* We afford ourselves the luxury of choosing what we will notice and what we will deem irrelevant. As a result, there is much we don't notice. In this realm, the *'problems'* we allow ourselves are simplified, bounded and, in their essence, routine. *Externalities* are neither actively sought nor rigorously addressed. Here, we approach as *experts* and intervene with narrowly-focused perception. Our basic concern is to *do the job right.*

We learn this behavior in school. In the architecture studio, we are given *architectural problems* and are expected to respond with *architectural solutions*—we are taught *to be architects*. In the engineering classroom, we are given *engineering problems* and are expected to respond with *engineering solutions*—we are taught *to be engineers*. In each, the emphasis is on *finding 'the answer'* to intentionally-constrained discipline-specific *'problems.'* In neither do we practice exploring the limits and nature of whole systems or reflect on the on-going adequacy of the models we propose as representing those systems. In neither do we truly learn *to be designers*.

In such surroundings, and with practice and time, we learn to see only familiar patterns and come to expect them. We learn to define ourselves by what we choose to see and we stop seeing everything else. We come to believe that *'problems'* actually exist as tidy packages that someone else—the boss, the client, the instructor—will deliver to us as specifications, as client requirements, as a design program. And we come to believe we are powerless until that package arrives.

Since we are expected to—and expect to—find familiar patterns, *certainty* and *narrow focus* are applauded and promoted. Their complements, *curiosity* and *broad awareness*—the foundations of creative engagement—are neglected and allowed to wither in the shadows.

3. IN SUSTAINABLE DESIGN WE CANNOT

The pursuit of *sustainable design*, however, derives from our over-arching but ambiguous desire, first, to *'do the right job'*—and then, to *'do*

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the right job right.' Our success depends on our ability to discover and understand the *'uncertainty, uniqueness and value conflict'* that underlie the elusive concept we call *'sustainability.'* In this realm, we strive to discover and engage externalities—to understand the hidden elements, subtle relationships, and uncertain dynamics of nebulous, far-reaching systems. We do not have the luxury of choosing—we must *notice everything* – and curiosity and broad awareness are precisely the skills needed to support us in doing so. We learn to be continuously circumspect of the perceptions and mental models that inform our fragile understanding. This is a realm for *creative explorers*—a special type of generalist—who are humble and circumspect and who manifest the *pre-expert* abilities to assess, translate, integrate and facilitate the critical effort to notice *everything*. The objective of this role is to catalyze the collective creativity needed for *naming problems* that are comprehensive and capable of producing truly effective responses to complex situations. In *sustainable design*, our basic concern is with how we find *'the problem.'*

4. DESIGN AS BREATHING

Design: The intentional transformation of an existing situation into a preferred situation.

We can consider truly creative design to be analogous to *conscious, deep-breathing*—a process of continuous and balanced cycling between complementary conditions of *expansive exploration* and *convergent resolution*. These phases are symbiotic—neither has enduring value without the other.

In the expansive, exploratory phase of this design cycle, we strive to understand the actual scope and dynamic of the situation we wish to transform—and we imagine the condition to which we hope that situation can be transformed. We embody our understanding of these when we (take a deep breath and) *'name the problem.'*

In the convergent phase, we apply known strategies and techniques—or invent new ones—to resolve *'the problem.'*

Together, these form is an unending cycle that is present in every conscious thing we do. This cycle exists as countless cycles-within-cycles—it is a fractal.

In this cycle, our most critical act is *'naming the problem.'* This *'name'* is our explanation of the space that separates where we are from where we hope to be. In effect, it is the essence of our *map* for getting from *here* to *there*. How we arrive at this *'name'*—and how long and how tightly we cling to its appropriateness—determine the effectiveness of all our subsequent efforts. Our desired *'solution'* can be no better than this *'problem'*—our potential *solution space* can be no bigger than the *problem space* we create through this *'name.'*

In *conventional design* we remain in familiar terrain that demands little exploration. We don't have to design *'the problem.'* In the world of *sustainable design* we do. We constantly struggle to understand things far beyond our own current knowledge and experience. Our success in doing this is highly dependent on the range of perspectives and the range of *knowing* that we are able to engage in the explorations that inform our *'naming'* effort.

These *expansive sensibilities* are inextricable linked with *creativity* and, in their nature, very different from the technical abilities we rely on in the convergent phase of the design cycle. Encouraging the engagement of these *creative sensibilities* is the essence of sustaining *sustainable design*. In practice, this means overcoming two substantial inertias in existing technical education—the pervasive disregard of the exploratory phase of design and the general absence of substantive creative

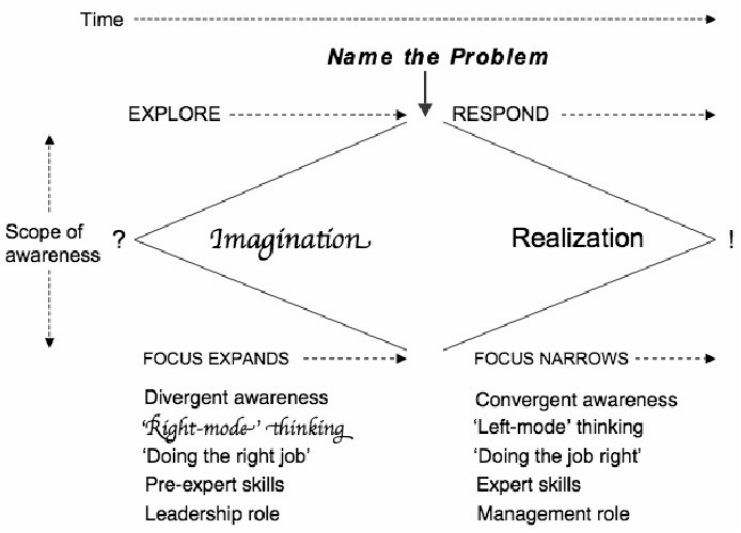

Fig. 1. Design as a breathing cycle.

engagement. In our *conventional design* experience, we don't learn to breathe—we only learn to exhale. To sustain *sustainable design*, we must encourage creative engagement in order to effectively integrate the expansive exploratory phase and the convergent resolution phase of a whole design process. We must learn to breathe—deeply and consciously.

5. SUSTAINING CREATIVITY

> The key lesson . . . is . . . that I do not need to be anyone special to be creative.
>
> Senior—M&AE

> *Creativity*: *The joining of will and ability to discover and productively engage opportunity spaces beyond our prior awareness.*

In the design process, there are countless ways for engaging *creativity*—and countess ways for suppressing it. While the concerns of *sustainable design* most certainly require *creative problem-solving*, at a much more basic level, they require *creative problem-naming*. As we have discussed, *creative problem-naming* depends on the creativity we bring to imagining, exploring and finding meaning in the circumstances we wish to transform. This creative engagement, although foreign in most traditional engineering curricula, can be explicitly integrated and effectively supported in a technical curriculum.

An extensive study has documented a common set of sensibilities—ways of *'knowing'* and *'thinking'*—that define *creative engagement* and underlie the creative accomplishments of many noted artists, musicians, and scientists. These are: *Observing, Imaging, Abstracting, Recognizing Patterns, Forming Patterns, Analogizing, Body Thinking, Empathizing, Dimensional Thinking, Modeling, Playing, Transforming, and Synthesizing.* [2] These *creative sensibilities* are universally applicable and transferable. They are also most effectively developed in the absence of constraining domain boundaries. They represent human capabilities far more extensive—and far more powerful—than those typically identified as the *'skills'* and *'intelligence'* required for (engineering) *'design thinking.'* [3] We were born with these capabilities and exercised them tirelessly in our childhood. As our formal education progressed, most of us saw these capabilities marginalized—deemed irrelevant to our rote technical development. We came to believe that *'being creative'* was a rarified condition beyond our reach and that creativity and technical accomplishment could not co-exist within us. Although these constructs continue to permeate contemporary education, they are simply not true.

Fortunately, we know how to design *'art'* education to serve as a vehicle for developing generalized creative capacity that is completely applicable in *'non-art'* environments. [4] Fundamental lessons from such programs have been successfully adapted to technical environments. [5] The objectives of these *'art'* interventions—comfort with risk-taking, stimulation by uncertainty, perceptual acuity, perceptual agility, fluidity in moving between *'right-mode'* and *'left-mode knowing,'* analogue awareness, anticipation of multiple *'answers'*, reflective self-knowledge, etc.—are central components of the creative engagement we need for the expansive phase of *sustainable design*. These objectives can be met with a surprisingly condensed effort—*creativity* can be effectively addressed without jeopardizing the otherwise overburdened technical curriculum we depend on for developing our convergent-phase design skills. The experience with *art-derived* education confirms *creativity* to be a universal condition that can co-exist with—and stunningly augment—technical accomplishment. To sustain *sustainable design*, this experience must be suffused through the technical curriculum.

6. SUSTAINING THE CONDITION OF 'NOT KNOWING'

> The map is not the territory.
>
> G. Pahl

A fundamental dilemma of *sustainable design* is our generally- limited grasp of *'the problem.'* As we try to understand and address systems whose nature and extent are unclear, we routinely discover our models for understanding them are insufficient. In fact, with disconcerting regularity, we discover they are clearly wrong. We must live in an uncomfortable state of chronic uncertainty. To be effective explorers, we must have the courage to accept that our *'maps'* may well be wrong.

In *conventional design*, this rarely happens—we are accustomed to *'knowing'* and we can limit our exposure to assure that we generally do *know*. With each passing year spent in such circumstances—where the overwhelming emphasis is on *'the answer'*—we become less and less able to *'not know.'* This is poor preparation for sustaining *sustainable design*—where the fundamental condition of creative process is *'not knowing.'*

An educational effort to sustain *sustainable design* must include an on-going practice of *'not knowing'*—of having the will to not know, of being comfortable not knowing, of knowing how to not know, and of being circumspect of what we believe we do know. The same *art-derived* experiences described above provide this practice. Rather than holding our breathe, we can learn to breathe though our *'not knowing.'*

7. ELEGANCE

> From time to time . . . I am briefed . . . in a way that prompts me to ask the questions:

> That's fine, but is it a good system? . . . Do you like it? Is it harmonious? Is it an elegant solution to a real problem?
>
> For an answer, I usually get a blank stare and a facial expression that suggests I have just said something really obscene.
>
> Robert Frosch

Elegance: Richness and polish in harmonious simplicity.

Elegance—the capacity for doing the most with the least—is a characteristic of the natural systems we wish to protect and emulate in *sustainable design.* It can also be viewed as an over-arching value to be pursued in all aspects of *sustainable design*—in the purpose, in the process, and in the resultant outputs of *design*.

Conventional design, in its discipline-centric concern for familiar *'problems'* and familiar *'answers'*, is by definition unconcerned with and, therefore, incapable of *elegance*.

To be *elegant in design* we must be *elegant by design*. This requires us to search for, be aware of, and understand relationships and impacts far beyond the boundaries of our own experience and responsibilities. Our commitment to *creative engagement* can lead us to discover many such opportunities for *elegance*. Our appreciation of *elegance* can become a central strategy for sustaining our capacity for *sustainable design.*

8. WHOLE PEOPLE AND WHOLE SYSTEMS

> We must stop acting as though nature were organized into disciplines in the same way that universities are.
>
> Russell Lincoln Ackoff

Sustainable design is concerned with *whole systems* that are characterized by tremendously complex and, often, incredibly subtle patterns and relationships. Regardless of the ambiguity implicit in a system's economic, environmental or social dimensions, the designer can not pick and choose what they will notice nor limit what they will attempt to understand. They must strive to notice and understand everything. The awareness and ability to do this depends on the integrated use of the full range of human creative sensibilities and intelligences. To design *whole systems*, we must function as *whole people*.

As long as the over-arching objective of professional education is the development of a discipline-centric *'expert identity'* and *'way of thinking,'* sustaining *sustainable design* will be a problematic objective. How can we strive to *'see'* and explore everything when we are being judged on our willingness to *'see'* only certain things and to *'know'* them only in prescribed ways?

The creative sensibilities necessary in the exploratory phase of sustainable, whole-system design are *'pre-expert'* in that they are engaged in order to reveal what '*expertise'* is needed for the ensuing convergent phase. Being *'pre-expert,'* they are most effectively developed in truly open-ended contexts that are free of *'expert'* expectations. This means that engineering students need not be forced into constrained *engineering environments* in order to develop these *creative, pre-expert design sensibilities.* In fact, there is reason to believe that these critical *design sensibilities* will be more profoundly developed and transferred when the students are allowed to explore them without having to do any *'engineering'* at all. [6] Through this *'pre-expert'* process, they are able to be *whole people* and to *'think'* and *'know'* in any and all ways humanly possible.

To *sustain sustainable design* requires us to support students in manifesting the full range of their *creative sensibilities*. In an *'engineering'* context, this means supporting them in becoming a *whole person*—who has a mastery of and a passion for *'engineering'* and who knows when, why and how to apply *engineering techniques*—and, equally important, who knows when, why and how not to apply *engineering techniques*. This is very different than teaching them *'to become an engineer.'*

As whole people, we will know how to act as creatively-integrated *designers*. We will act as *creative explorers* before we will allow ourselves to act as *experts*. We will know how to breathe continuously, consciously and deeply. We will know how to renew the cycle of life.

9. EVIDENCE OF CONSCOIUS DEEP-BREATHING IN DESIGN

(All quotes are from Seniors and Graduate Students in Engineering) [7]

> It is crucial to understand every individual's complex and rather puzzling intelligence, and we cannot determine this by a simple test score.
>
> . . . (I know now that) a feeling of group efficacy (is) a sign of group emotional intelligence. With my view of my team members and my own frustrations, this was an emotionally dysfunctional group . . .
>
> . . . the first time in my life . . . where everything wasn't laid out and we weren't spoon-fed.
>
> The hard part . . . was balancing the divergences and convergences. . . . keeping to deadlines while still trying to gather perspectives . . . .
>
> How you see a problem can be very different from how another person sees it and together you can come up with a better solution. Often leaving a problem or looking at it from a new perspective (right side of the brain) can help you solve it.
>
> There are always multiple perspectives that something can be viewed from. What we need to understand as being important is the fact that we can all accept different ideas and attack a problem from a variety of different ways. When we do so the solution will be much more elegant and complete. If we allow our engineering tunnel vision to take over, the solution

may still work, however, it may not be the best approach.

. . . it is easy to think only of your specific component without taking serious considerations to it's effect on the overall system. (I understand the importance of) taking responsibility for the entire success and constantly redefining and updating the actual problem statement. By doing this it will be easier to make sure the systems we design are better and will actually accomplish what they are supposed to do.

I found myself looking at things from a different perspective and paying much more attention to the things.

(he) introduced new and broader ways of looking at problems, and I know they are useful since I successfully used this view point in coming up with an algorithm to a hard computer programming project.

. . . these are great guidelines of how to be productive on a team: share a purpose; know the right job; search for opportunity space; there's something beyond oneself; know the dynamic interrelationships between the subsystems; take responsibility for the entire system.

Engineering seemingly promotes mechanical and completely structured thought processes. Many people, when they think of engineering, see art and engineering on completely different sides of the spectrum. . . . art and engineering are in fact very closely related.

The studio taught me the key to good drawings: keen observation. Now I know that my drawing abilities were impeded because of my pre-conceived images of my subjects. . . . by not setting a goal, it is possible to create something beautiful, ... by just letting my fingers go wild, I was able to create something aesthetically pleasing, which greatly surprised me.

The painting was so relaxing with how free it made me feel about thinking of things.

. . . most participants were pleasantly surprised with their own work. Creating a similarly open environment can transfer this sort of success to a design problem. Often, design problems exist under stressful circumstances such as deadlines and high personal standards—relieving myself of anxiety in these situations will open up the right side of my brain and enable me to devise better solutions.

It was a chance for us to just be creative in a way that there are no right or wrong answers.

Not only did I walk away with some nice picture, I also got to relieve some stress through painting. The exercise got me to explore the creative side of my brain which I rarely do. It again taught me new ways to view ordinary objects.

It was really a fun activity and helped us to learn how to use both sides of our brain at the same time. . . . will be helpful for improving our creativity in design projects.

For many people in the session it was likely the first time in years that the right brain had been given explicit control of the hand. Where in the . . . Engineering curriculum is this allowed otherwise? This unlocking of the right brain was for many a revelation . . . allowing the brain to function in an environment with no penalties.

I recalled many a treasured memory of childhood.

Exploring creativity is not something you can lecture on, you have to actually do it.

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