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Leadership by Design and Design by Collaboration: Processes for Illuminating 'The Box'*

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Effective problem solutions depend on the effective naming of problems. Effective problem naming is rarely accomplished within the limited perspective of a single individual. Unfortunately, it also is rarely accomplished by most technically deterministic problem-solving collaborations—whose internal dynamics tend toward converging rather than diverging perspectives. This paper is an exploration of the design of design environments—both social and cerebral—to maximize the elegance and effectiveness of both problem namings and the consequent problem solutions in a universal design process.

'MESSY, INDETERMINATE SITUATIONS'

IN HIS BOOK *Educating the Reflective Practitioner* [1], Donald Schön discusses a contemporary dilemma facing traditional discipline-focused professions and professional education:

- '. . . as we have come to see with increasing clarity . . . 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, organizational roles, past histories, interests and political/economic perspectives, we frame problematic situations in different ways. . . . It is not by technical problem solving that we convert problematic situations to well-formed problems; rather, it is through naming and framing that technical problem solving becomes possible.'
- '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 . . . It is just these indeterminate zones of practice, however, that practitioners and critical observers of the professions have come to see with increasing clarity over the past two decades as central to professional practice. And the growing awareness of them has figured prominently in recent controversies about the performance of the professions and their proper place in our society . . . critics voice a common complaint: that the most important areas of professional practice now lie beyond the conventional boundaries of professional competence.'

I believe we are here—exploring something we are naming 'Social Dimensions of Engineering Design'—because we are concerned that our conventional model of engineering design is inadequate; that in our drive to engage familiar processes, we are missing something critical. I believe the dilemma Schön identifies—the inability of our traditional 'technical rationality' to extract effective problem framings from the 'messy indeterminate situations' which so persistently surround us—is both the source of our discomfort and a fertile ground from which to begin our present exploration.

The dilemma Schön identifies is also, I realize in retrospect, the Great Attractor of my own history. My professional and educational pursuits, my private and public lives have all been drawn—by a fascination with 'messy indeterminate situations'—in a continuing search for better, more insightful perspectives from which to understand these situations and our individual and collective relationships with them. A necessary outgrowth of this effort is an on-going reflective attempt to understand the unwitting mechanisms whereby we obstruct our own search. I describe these combined efforts as 'processes for illuminating "The Box".'

THE PREMISE FOR UNIVERSAL DESIGN

The process of 'naming and framing'—of generating the breadth of perspectives needed to form uniquely insightful, robust problem statements from 'messy, indeterminate situations'—is

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fundamentally critical to initiating a broadly successful design process. Lacking the language, and both the internal and external tools for soliciting broad perspective, it is not surprising that traditional technical problem solving falters in the face of these situations. Most other traditional problem-solving processes falter also. When these processes falter, they tend toward panic. They rush to convergence—to 'name' a known problem—so that a familiar 'design process' might proceed. While this rush is familiar, it is seldom very successful.

In contrast, a robust collaborative design process is the foundation of proactive engagement with situations that are neither obvious nor familiar. It is a process that fosters a climate of expansive vision and inquiry—a process devoted to understanding the scope and uniqueness of problems. It is a process based on the synergies of collective curiosity, knowledge and wisdom. Guided with effective leadership, this design process can produce a clarity of purpose and direction that is impossible otherwise and allow its participants to move, with appreciable effect and security, beyond conventional roles and responsibilities. It can lead to broad and robust solutions.

To find this expansive vision—to find broadly diverse perspectives—requires broadly diverse input. Such input, however, is of little value to a design process that lacks the capability to effectively incorporate these perspectives. This capability rests on the willingness and the ability of the design team—as a group and as individuals within that group—to continuously challenge itself to identify and modify the dynamics of its own process. These dynamics both constrain the flexibility and expansiveness of the group's internal perspectives and constrain the effective solicitation of broadening external perspectives. The former capability—observing and, based on that observation, modifying one's own process—we call 'reflective practice'. The latter capability—the effective solicitation and incorporation of the broadest possible range of (society's) individual perspectives and needs—we call 'universal design'.

While neither of these realms—reflective practice and universal design—is new, I don't believe the synergy of linking their combined concerns to an observation-based design process is generally recognized. In the context of our workshop, I believe these two realms—one of critical concern to the internal functioning of the design process, the other of critical concern to the external relationships of that design process—precisely define the social dimensions of engineering design.

THE COURSE

This paper describes the context and content of a university course designed with the explicit intent of exploring the synergy of combining reflective practice, universal design and observation-based problem framing and problem solving. I believe these collaborative design skills are essential for effectively engaging the world Schön describes above. Through addressing indeterminate situations, the students explore the strengths and inherent blind spots in both their personal and professional perception and experience of the world.

The course is designed to promote the participant's fluency and effectiveness in:

- generalized and universal design/problem-solving processes applicable to indeterminate zones of practice;
- languages of problem-framing processes used in other disciplines;
- skills of self- and group awareness essential for effective collaborative problem solving.

The course is cross-listed in three colleges to bring an intentionally broad mix of student experience, perspective and discipline-specific language and process to the classroom. Through the interactions implicit in required collaborative design projects and their presentation to public review, the classroom dynamic—and the students' reflection on that dynamic—are the course laboratory.

AN EVOLVING DESIGN PROCESS

Most students have had experience with team projects. While this might be considered to be experience with both design and collaboration, subsequent reflection on their experience generally reveals familiarity with neither a rigorous, iterative process of designing, nor the concerns of universal design, nor any notion of the relationship among individual and group self-reflection and an effective collaborative process. A mechanism is needed for demonstrating an evolution of this limited experience of a team process into a broad and effective process of collaborative design.

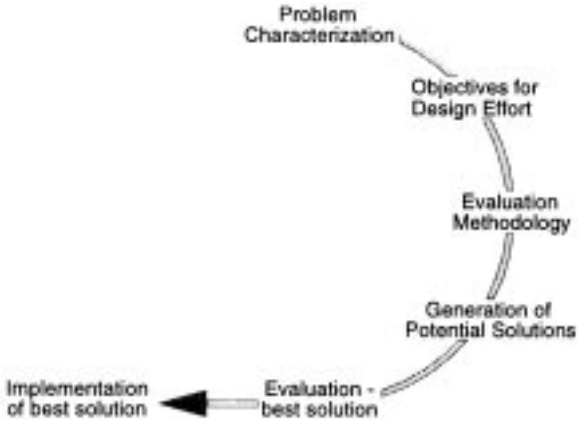

Fig. 1. A simple design process.

Fig. 2. A conventional design cycle.

A simple design process

'Design' can be examined as a series of processes—progressing from the very simple, truncated process characteristic of the majority experience to a robust process incorporating universal design and reflective practice.

The most common experience is diagrammed in Fig. 1. Here, the starting point of a team design project is the characterization—the examination and understanding—of an already formed problem. Typically, this and the following phases of the design process are subdivided along familiar lines and parceled out according to self-selected competencies. In multi-disciplinary teams, this becomes the identification of engineering tasks for the engineers, business tasks for the business majors, etc. Indeterminate concerns are often dropped—unintentionally, from not having been identified, or intentionally—from lack of interest or fear of the unknown. While the objectives and evaluation methodologies, presuming they are intentionally formulated, tend to be predictable, this process preserves the possibility of generating creative potential solutions to the problem—the only place this process can benefit from novel and insightful perspectives. This is an essentially lifeless and fundamentally limited process.

A design cycle

Most upper level students have experience with the more advanced process shown in Fig. 2—a process now with the option of iteratively feeding back to itself as a cycle. While the problem statement must be created, it is generally done so from a familiar context.

There is an implicit immediacy to forming the problem statement—it must be sufficiently standard to push the process in a direction consistent with the specific discipline-based objectives of the exercise. The problem statement is expected to produce the desired solution.

This is a design process inclined to know the answer before it knows the problem—it is not a design process substantial enough to deal with the 'messy indeterminate situation'.

It is, however, substantial enough to provide a context for studying how design processes can fail—an exploration critical to developing the sensibilities necessary for successfully incorporating subsequent lessons of reflective practice and universal design.

Failures of a conventional design cycle

Figure 3 shows a way in which each specific stage of this design process can fail. In considering how each of these failures might occur, we begin to sense the impact of inadequate perspective—and a potential benefit of collaboration. By illuminating each other's 'blind spots, ' we might start to collectively remedy the impact of our individually limited perspectives.

While it is quite obviously a possibility in theory, it still comes as something of a shock to consider that the problem statement itself can fail. From the first day of our formal education, we are conditioned to focus on the answer. We learn the process of creative problem solving, which, we're promised, will so gracefully—and so reliably—carry us to the answer. We grow accustomed to a design process that begins with 'Here is the problem . . . now solve it'. If we arrive at the wrong answer, we simply check our mathematics. The

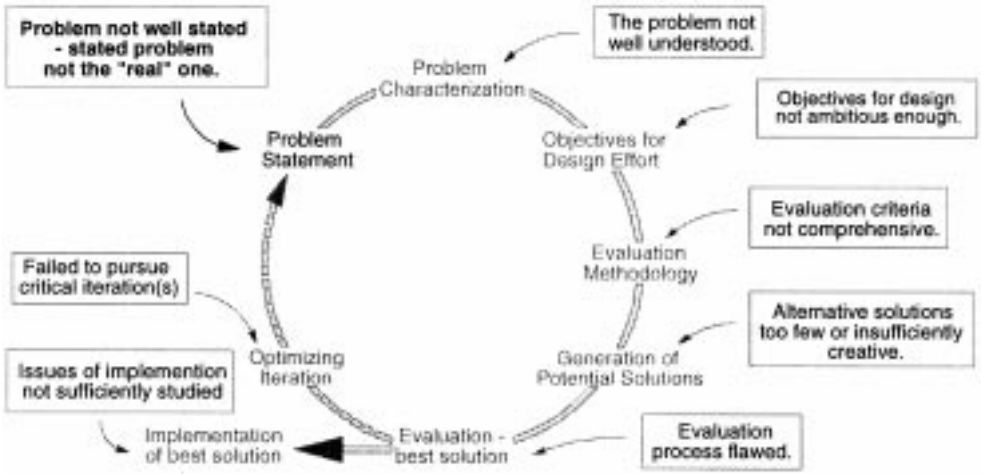

Fig. 3. Some failures of a conventional design process.

difficulty we find in the indeterminate zones of practice, however, is that we tend to arrive at the wrong answer even though our math is correct. Where do we go wrong?

A missing phase

On considering that not only can the statement of the problem itself fail, but that such failures actually abound, it seems obvious that something very important is missing from this conventional concept of a design process.

There needs to be, in fact, another explicitly recognized phase included in this cycle—a precursor to the actual formation of the problem statement. This critically missing phase is the act of explicitly 'observing the (messy indeterminate) situation'—in which it is understood that the observer, and the unwitting limitations of the observer's perspective, are also part of the situation. This is where we start to intentionally learn the process of creative problem framing. This new phase—'observing the situation'—is shown in Fig. 4.

Observing the situation

Unlike the implicit intent of the problem statement phase of the conventional design process shown in Fig. 3, the intent of this new phase cannot be misconstrued as being intended to propel us as quickly as possible to the naming of the problem. The objective is, in fact, to give us pause—to ponder, to listen, to try to understand the extent and complexity of the situation we are observing. To do this requires generating as many different perspectives on the situation as possible—an objective that cannot be taken seriously without openly acknowledging that the perspective of the designer(s) is, in all probability, too limited to accomplish this objective. The task of this phase is to illuminate 'The Box'—the box that is the situation in its entirety and the box that, in limiting our perspective (both individually and collectively) on the situation, is limiting our potential to fully apprehend the situation.

So, assuming we accept the inadequacy of our own perspectives, what do we do? Do we simply throw up our hands and announce, 'We aren't too sure what we're seeing here?' Although we have come to this point by a series of rational steps, this doesn't seem like the conventional behavior of professionals. Where do we find the humility and the courage to acknowledge our limitations—and the resolve to actively expose them? How do we learn about this box and the art of illuminating it? The answer is hiding in our failures.

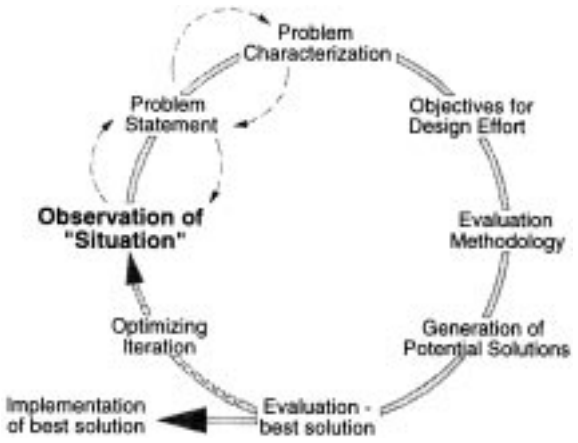

Fig. 4. An observation-based design process.

LEARNING FROM FAILURES OF THE DESIGN PROCESS

In many team projects, the initial meeting of the group coincides closely with the appearance of the problem statement. The design process is launched with very little attention to the context of the process or the individual personalities involved. There is a tacit assumption that the design process itself is inert and stable—little more than a road map to the solution. For students who have experienced unsatisfactory or failed team projects, the inadequacy of these starting conditions may be vaguely recognized after the fact. Unfortunately, however, an exploration for specific understanding of the failure is very rarely within the scope of the project. Little, if anything, is learned from the failure of the process.

An explicit concern of this course is to explore the dynamic of such failures. This generates the fundamental perspectives on which the appreciation and practice of a reflective process begin to emerge. This exploration looks at three general areas in which design processes fail:

- specific phases of the design process (Fig. 4).
- the internal process of the design team and the individuals comprising it.
- the world external to the design process and the design team.

THE PHASES OF THE DESIGN PROCESS

Framing the problem—observing, naming and characterizing

A principal focus in studying problem framing is to understand the systemic behavior of most situations—to explore the dynamic processes of feedback which determine the nature of the system and the potential mechanisms for affecting it. An appreciation of the complexity and resilience of such systems becomes a starting point for understanding the importance of looking beyond elementary expectations of cause and effect. A parallel appreciation—that the behavior of the whole is not to be found in the sum of the pieces, but rather in the relationships among the pieces—becomes the basis for looking beyond the limited possibilities of purely technical naming [2–4].

A corollary perspective to this limited capability

of technical naming is found in understanding the reluctance of social information systems to succumb to the predicted triumph of digital information systems [5]—to appreciate the complexity and resilience of the larger system of human society.

Another important systems concept is that of dynamic equilibrium and time-delayed feedback [6]. While in some circumstances this dynamic requires us to be very judicious in predicting the effect of modified feedbacks, in others it tells us that the dynamic does not reflect a problem to be 'solved' but rather a problem to be 'managed' [7].

An additional component in studying problem framing is to explore the importance of language in the process of naming. It is critical to understand the power of words to obscure and mislead—to misrepresent the reality of the system we are observing [8]. It is equally important to understand the potential for discipline-specific language and concepts to both illuminate—if well translated—and to obfuscate—if left untranslated.

Augmenting these concerns is the importance of understanding the power of visual presentation of quantitative information. This is also a form of communication with immense power—to either illuminate or obscure the dynamic behavior of complex situations. Insightfully designed graphic presentations can not only reveal otherwise frustratingly complex dynamics, they can reliably replace great amounts of potentially confusing verbal or written communication [9–11].

Generating potential solutions to the problem

In the same way that the resilience of the mental models we employ limits our capacity to process contradictory—and often potentially perspective-expanding—feedback [4], the same resilience limits our horizon in constructing potential solutions to the problems we have framed. Techniques for overcoming these inertial barriers help not only in this phase of the process, but in fact, become fundamental tools for every other aspect of the design process and its internal reflective practice [12, 13].

THE INTERNAL PROCESS OF COLLABORATION

Elements of a reflective practice

An effective reflective group process is based on the sensibilities and capabilities of the individuals within that group. To the extent that each individual understands, and is interested in further understanding, his/her own personal dynamic—motivations, expectations, abilities, personality, responses to 'feedback' and stress, perceptual inclinations, etc.—that individual's role in the dynamic of a group can be recognized and modulated. This self-knowledge requires an appreciation of emotional intelligence, personality type, the difference between 'intelligence' and 'thinking skill, ' the definition of 'asset', the influence of 'culture' and the importance of 'context'.

Emotional intelligence

To modify our dynamic with others, we must first understand the existing dynamic and our own role in it. To understand these, we must be willing and able to accurately observe ourselves. While every aspect of our life is based on 'mental models, ' the models we carry to understand and explain ourselves—who and how we are—are among the most deeply ingrained [4]. To challenge and change these models is a complex and difficult task—a task requiring curiosity and courage, self-awareness, self-discipline and empathy. Collectively, these qualities form an intelligence critical to an effective collaborative design process—emotional intelligence [14]. Some of the dynamics through which the failure of emotional intelligence hijacks group processes include:

- an aversion to dumb questions—a fear of failure;
- an obsession with leadership;
- the need to control;
- the need to not be controlled;
- a need to 'own' the process;
- a discomfort with ambiguity—the need for determinacy;
- a discomfort with silence;
- a defensive reaction to feedback;
- the lack of patience.

There is also an important role for emotional intelligence in the collective functioning of the group [15]. The presence of emotionally intelligent individuals does not, in and of itself, guarantee an emotionally intelligent group. For the group to build emotional capacity—the ability to respond constructively to emotional stress—takes an explicit set of expectations and practices. As a system, the multiple relationships within a group represent a greater challenge than do the internal relationships of an individual. An emotionally intelligent individual is aware of and able to regulate both his/her own emotions and the emotions of others. An emotionally intelligent group, however, must know and tend the emotions of its individual members, of itself as a collective entity, and of others outside itself. This ability can only come from intentional awareness, explicit policy and continuous practice.

Personality type

We differ from each other in fundamental ways. Understanding that there is nothing inherently good nor inherently bad about these differences is critical for the health and growth of a collaborative process. Knowing one's own personality type and how it tends to complement or conflict with another person's type is the basis for this understanding [16]. Normal personality tendencies that can predictably affect collaborative processes are:

- being energized or drained by group processes;
- relying on facts and observation or on intuition and introspection
- being tough-minded and impersonal or sympathetic and friendly
- valuing detail and resolution or ambiguity and opportunity

The difference between 'intelligence' and 'thinking skill'

We live in a culture that values intelligence over thinking skill. We assess intelligence without assessing the thinking skills necessary for productively utilizing its potential. In the absence of thinking skills, intelligence becomes self-justifying and self-limiting. In being consistently first to know the answer, it sees no need to seek alternatives or to understand other perspectives. It erects unassailable defenses around poorly conceived ideas. Thinking skills can be learned and practiced [12]. As the operating skills required for productively using intelligence, they are critical for realizing the collaborative potential. With these skills, we can redirect:

- the competitive rush to 'own' the answer before exploring the situation;
- the tendency to get stuck in an individual or group perception;
- the inclination to see judgment and argument as ends unto themselves.

The influence of culture

Culture determines much of what we believe to be true of our existence [17]. It determines much of what we perceive and how we interpret and respond to that perception. In a closed environment, culture tends to limit our perspective. In an intentionally open environment—in an effective collaboration—the interaction of cultures can foster a rapid expansion of perspectives. An ability to recognize, understand and effectively encourage and incorporate culturally different perspectives is an invaluable asset to a collaborative effort. This ability can address:

- communication failures resulting from languages specific to discipline, nationality, etc.;
- differences in the perception of risk, need, and priority [18];
- differences in the perception of appropriate style and progression of group processes;
- the importance of interest-based rather than position-based negotiation [19];
- the tendency to grant legitimacy only to perspectives from one's own culture;
- the tendency to form a single group perspective, the blind spot called groupthink.

The definition of 'asset'

In many collaborations, there is an operating assumption that roles and assignments should be based on occupation, discipline or otherwise identified dominant skill-sets. The potential of the group—to synergistically expand the perspectives available to the process of problem framing and solution—is greatly diminished if this happens. There is no reason to assume the most potent sources of diversity are to be found in discipline—as opposed to gender, age, culture; life experience, birth order, family history, or astrological sign, etc. The power of the collaboration, in fact, is greatly enhanced, if, from the inception of the process, a conscious effort is made (and maintained) to identify and incorporate a broadly defined range of individual assets [20]. In the absence of such an explicit effort, there is a undesirable tendency toward:

- an expectation that the problem must (can only) reside in one of the assigned fields;
- an ego investment in 'finding the answer' through one's own assigned role;
- a reduced sense of entitlement to contribute perspectives falling outside one's role.

The importance of context

The reflective process must look outward as well as inward. The context in which a collaborative design process occurs is often as dynamic as the internal process of the group itself. Changes in that context can have considerable impact on the group's internal process. Aspects of context which must be considered include:

- expectations and assumptions implicit in the process actually selecting the group;
- varying time pressure in mission-critical environments;
- political pressure to constrain the allowable perspectives to be explored;
- political expectation in knowing the answer before the problem;
- changes in the situation, including the appearance of new, related situations.

REFLECTIVE PRACTICE AND THE DESIGN PROCESS

We add another source of strength to the design process as we combine it with these elements of reflective practice (Fig. 5). It is no longer a predetermined series of discreet steps. The design effort now has the ability to observe and modify itself—it can collaborate with itself. There is now a method through which it can maximize its access to its own assets and manage its own effectiveness. It can cycle back on itself as the need is perceived.

Each phase of the design process can benefit from this reflective feedback. The design group can observe itself observing—detecting and correcting shortcomings in its own perspective. As the problem is framed—as it is named and characterized—emergent anomalies can be acknowledged and compel the process to reconsider the situation—rather than being discarded as 'externalities'

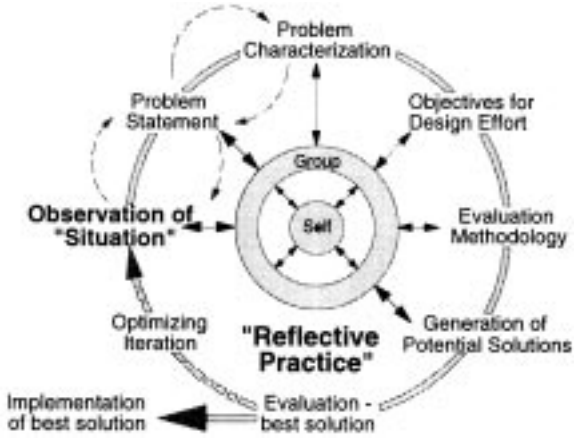

Fig. 5. A reflective design process.

as they might be in more conventional processes. Design objectives and methodologies can evolve as the problem is reconsidered. The ability to observe the generation of potential solutions allows the detection of conceptual impediments that would otherwise constrain the range of options to be evaluated. Beginning with its ability to derive robust problem statements, this is a process capable of designing robust solutions.

LEADERSHIP AND THE REFLECTIVE DESIGN PROCESS

A recent study of major US corporations concerned itself with characterizing a particular phenomenon—an uncommon organizational transformation from a state of mediocrity to one of sustained excellence [21]. Having applied an exhaustive series of qualifying filters to every company in the Fortune 500 between 1965 and 1995–1435 companies—the researchers were left with eleven companies meeting their definition of excellence. After considering and eliminating numerous business and organizational strategies as being the possible driving force behind this resurgent performance, they concluded that the only qualitatively different dimension of these eleven businesses was, in fact, their leadership. This leadership—called 'Level 5 leadership' in the study—they characterized as a combination of 'humility' and 'fierce resolve'—an unwavering professional will. These leaders were uniformly unassuming in their demeanor and were as quick to assume personal responsibility for collective failure as they were to reflect the responsibility for success onto others. Something of a mystery to the researchers was why this combination of traits brought such benefits to the organizations and whether these traits could, in fact, be taught.

If one assumes the sustained excellence of these business organizations' performance rests on the success of the business strategies they design; and the design of these strategies owes its success to the design objectives and evaluation methodologies that preceded them; and these objectives and methodologies followed directly from the preceding framing of the problem; then it is reasonable to conclude that the impact of this particular form of leadership would have its most fundamental impact at the level of observing the 'messy, indeterminate situation'. The organizational ability to extract the broadest, most insightful, most robust understanding possible of the complex global situation is the foundation of this excellence. Nurturing this collective ability is the leader's most important assignment.

A leader who:

- has the humility to not feel compelled to 'own' the process of naming the problem;
- is predisposed to providing others in the organization every opportunity to shine;
- can quietly marshal every possible asset of the organization to the task of illuminating the situation, from every possible perspective;
- understands the incredible value of such a process, and protects it with fierce resolve;

is the leader of an incredibly robust collaborative design process. There is no mystery to these leaders' success, and in fact, there is every reason to believe that such abilities can be taught.

THE EXTERNAL PROCESS OF UNIVERSAL DESIGN

With whom and for whom?

While expanding the internal perspective of the design group brings increased clarity to the problem framing effort, the breadth of any group's perspective is limited. A genuinely expansive perspective necessarily requires input from outside the group. As the degree of societal impact of a situation expands, so must the range of illuminating input being solicited. Access to the problem-framing effort is the essence of political participation, and the designer's assumed knowledge of 'what they need'—notwithstanding the probability that the designer often has no idea 'who they are'—is the essence of political exclusion. For a design process to be truly robust, broad participation in the framing of the problem statement must be actively pursued. The framing process will be well served if the designer continually asks, 'With whom are we designing?'

On the evaluation side of the design cycle, we have the related question, 'For whom are we designing?' It is typical of many design processes to consider the needs of an average or typical user—the end user—in establishing design objectives and evaluation criteria. With this completely generalized, impersonal objective, that 'someone' uses the design is often taken as evidence of a successful design effort. Of course we will see that the end user, by definition, is the person who, in the end, is able to use the design.

Good design—poor design

A more significant assessment of the success of a design comes from knowing who isn't using it—the people who aren't able to adapt to it [22]. A poorly designed product or environment forces us to adapt—it works only if we are able and willing to struggle with its short-comings. From this perspective, a user population that lacks diversity indicates a failed design. A well designed product or environment accommodates us—it works easily for us regardless of our abilities (Fig. 6). A broadly diverse population participating in the design process indicates a successful design effort. This participation spans from the observation phase—with whom we are designing—to the solution evaluation phase—for whom we are designing. In an inclusive process, an average user is the antithesis of a diverse user. This distinction is at the heart of universal design.

UNIVERSAL DESIGN PROCESS

Universal design is a concept first named by a group of architects, product designers, engineers, and environmental design researchers coordinated by the University of North Carolina [23]. It is a process for creating environments and products to be easily and effectively usable by as many individual members of our society as possible. Although universal design was initially conceived as a design objective and an evaluation criterion, it is easily understood to be an overarching concept capable of critically informing all phases of the design process. In the context of this class, universal design has been discussed as it relates to the built environment [23, 24], consumer products [25], communication and media services [26], and education [27]. Universal design is understood to be a (potentially unattainable) goal toward which we strive—it serves as a continuous reference point for assessing the breadth of our particular perspective. The conscious recognition of, and responsibility for, those who we are excluding is a fundamental requisite for an inclusive, universal design process.

Universal design and the design process

In Fig. 7 we see the realm of universal design informing all phases of the observation-based design process. In the same way that the internal reflective process (Fig. 3) adds both strength and flexibility to the observation-based process,

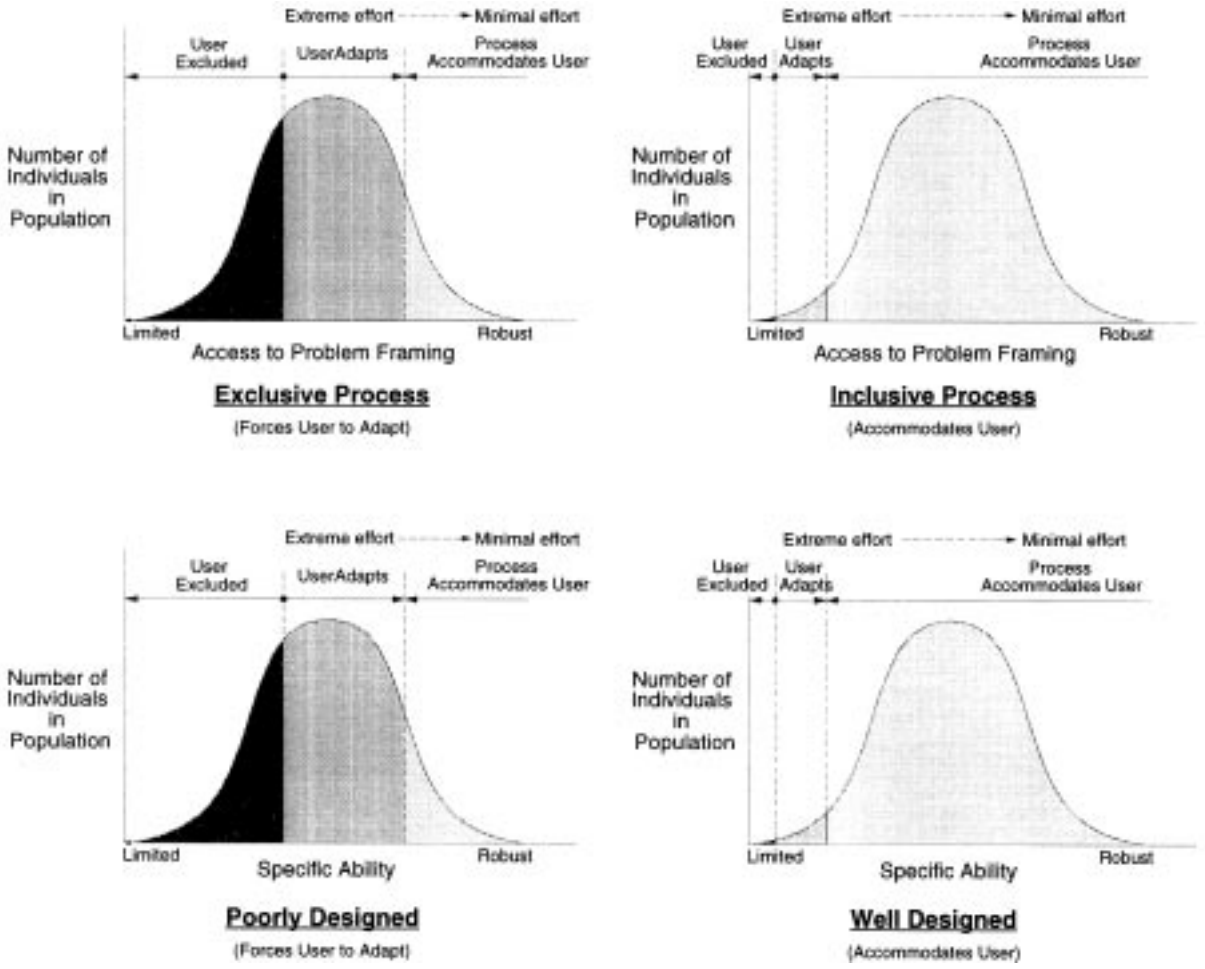

Fig. 6. Accommodation and forced adaptation.

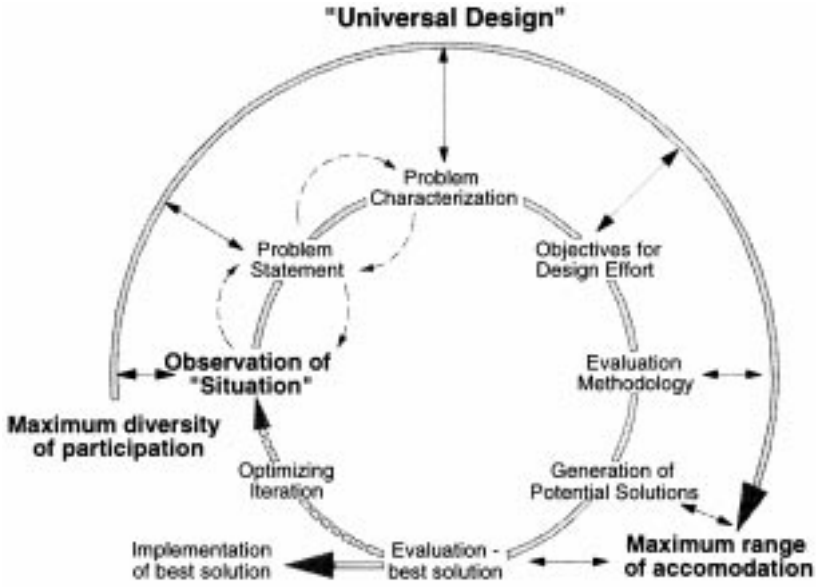

Fig. 7. A universal design process.

universal design adds an external process of reflective strength. This gives the internal group process access to a vastly expanded set of perspectives—allowing a vastly expanded capacity to observe the complexity of the external situation. At the other side of the cycle, this expanded perspective adds a much more inclusive set of perspectives for defining and measuring the success of the design process.

THE CONVERGENCE OF THE INTERNAL AND EXTERNAL SOCIAL DIMENSIONS

When we bring together these two social dimensions (Fig. 8)—the external realm of universal design and the internal realm of reflective practice—we arrive at a complete and robust design process. Now the fundamental activities of observing the 'messy, indeterminate situation' and framing those observations into robust problem statements are critically enriched. The diversity of perspectives generated through the concepts of universal design become feedback for the operating constructs of the design team—challenging the breadth of perspectives of that internal process. The consequent growth of the internal process, in return, solicits a broader set of external perspectives. This is a reinforcing feedback that continuously expands the breadth of perspectives brought to bear on the task of framing the situation. With the resultant broad and insightful mechanism for framing problems, the external oversight of the concepts of universal design, and the internal guidance of reflective practice, we finally have a design process broad enough and robust enough to

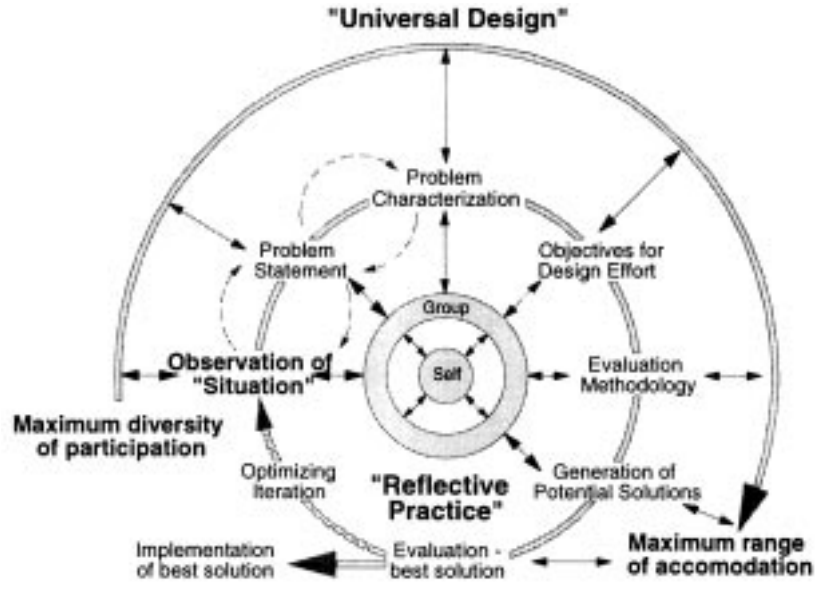

Fig. 8. A robust collaborative design process.

confidently engage the 'messy, indeterminate situation'.

TEAM PROJECTS IN EXPLORING REFLECTIVE, COLLABORATIVE, UNIVERSAL DESIGN

Team design projects were used as the laboratory for this course. The instructions given to the teams for this effort were:

- to find a 'messy, indeterminate situation' in their life—something 'vaguely annoying' on the periphery of their awareness;
- to explore the situation until a fundamental problem can be framed from it;
- to design a response to this problem;
- to find territories in which to explore that are unfamiliar to everyone;
- to attempt to consciously avoid assuming standard roles;
- to be aware of the concept of leadership in relation to the dynamic of their effort;
- to observe, on an ongoing basis, the internal process of their team;
- to assess and modify the impact on the teams progress of that internal process.

What we have learned from the collaborative (team) design process:

- the problems residing (deep) in a situation are elusive;
- with further investigation, what is taken to be a problem is often revealed to be only a symptom of something yet more fundamental;
- there is reason we have the saying 'ignorance is bliss';
- being in unfamiliar territory is more uncomfortable for some people that for others;
- not knowing the problem is uncomfortable for most people;
- others' insights can be stunning;
- leaving familiar roles is challenging and exhilarating;
- not being seen as the smartest, the leader, etc. is very difficult for some people;
- different activities, at different times, need different leaders;
- rigorous design is a substantially novel experience;

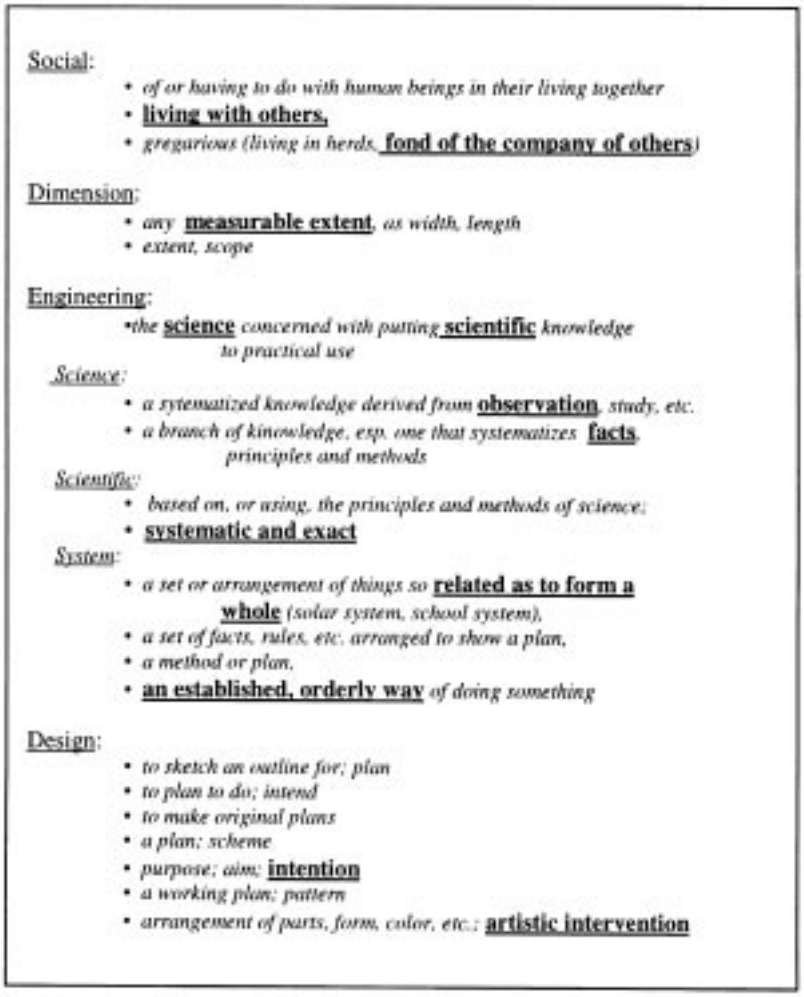

Fig. 9. Definitions: Social + Dimensions + Engineering + Design.

- some people don't like their process being observed—for others it is easy;
- this course has been, at some times and in some ways, an uncomfortably novel experience;
- *to see data become information become knowledge become wisdom is sublime.*

PARTING OBSERVATIONS

Social dimensions of engineering design

If we look at standard definitions of the specific words we are using to frame the situation we are discussing (Fig. 9) we can extract some interesting—and somewhat discomforting—observations and questions:

- '*Living with others*' is very different from 'designing for others'. The former is an active and specific engagement, the latter is often a passive and generalized engagement.
- '*Fond of the company of others*' is not a commonly held image of engineers.
- To what extent are the (systemic) dynamics of a society *measurable* and how do we (un)consciously restrict our perception of a society to permit us those measures we do use?
- In adding *social* considerations to our pursuit of the *facts* and *exactness* we call *science*, we are immediately conflicted by our acquaintance with Mr. Heisenberg—do we really believe it possible to have an (unengaged?) impact-free *observation* of society?
- A *society* is a group of many individuals *related as to form a whole.* It is one and many systems that most certainly dont behave in an *established, orderly way.* To know it—to understand its dynamics—with the exactitude of *science* is not likely.
- The *intention* of calculating the steel area of a concrete beam is simple. The *intention* of placing that beam in an environmentally controversial highway structure is very much more complex.
- Do we dare conceive of engineering design as an *artistic intervention*?

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