Grounding IS Design Education in the First Principles of a Designerly Way of Knowing

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Abstract

"The Golden Age of Design may finally be upon us!" or so reported the New York Times in September of 2014. On the one hand everyday personal information appliances emphasized beauty and function. Apple™ took a lead by marketing the "feeling" of the iPod's design. The business world took notice and the cachet of designers soared both in terms of demand and compensation. Regrettably, the "golden age of design" has not swept the Information Systems (IS) discipline along with it. News stories weekly report huge project cost overruns, long delayed delivery dates, and complete project failures with irretrievable sunk costs. What explains the difference? Perhaps IS has not yet embraced the design mindset founded in professions prefixed by: architectural, fashion, industrial, graphic, product, urban, and interior. We examine the mindset of design professionals all but absent in IS education. This mindset fuels the enthusiasm for agile development methodologies. Appropriating it may be a relatively inexpensive re-centering of current IS pedagogy that can pay huge dividends for society down the road as information systems grow more and more essential throughout the commercial and private sectors. We explore this design mindset following Nigel Cross's retrospective on research in *Designerly Ways of Knowing*. With that as a frame we name five core elements of that mindset to frame IS pedagogy for design – First Principles of a Designerly Way of Knowing and propose guidelines for situating them in IS education.

Keywords: IS design education, design pedagogy, tacit knowing, design theory, first principles of design

1. INTRODUCTION

The tenets upon which the information systems, IS, discipline rests are the pillars upon which our curriculum and pedagogy rest, and the lens we apply to stakeholders and constituents. IS as Davis and Olson (1985) characterize it is fairly canonical: the nexus of computer science, management and organizational theory, operations research, and accounting. Each of these disciplines has a "spanning" influence raising a broad range of concerns that overarch computing in its social context.

Computing and information systems continue to be a dominant force in the daily life – a diffusing and diffuse innovation (Rogers & Shoemaker, 1971). The pervasive and ubiquitous aspect of computing and information systems is both a backdrop (Carr, 2003; Lyytinen and Yoo, 2002) as well as an acute driver of societal change (Bernstein at al., 2010). Despite the near omnipresence of information systems, failures remain headline-grabbing affairs, incurring considerable financial loss (Syal, 2013). As IS educators, it is our responsibility to ask in what role we might address this situation?

This paper explores the challenges in information systems development and the nature of factors that recur among successful projects. We reference a history of IT project outcomes reported in the Standish Group's CHAOS reports. We examine the meaning of "success" framed through the lens of *appreciative system* (Vickers, 1983). We reach beyond the bounds of computing to appropriate the manner that expert designers address ill-defined, "wicked" problems (Cross, 2007). Based upon this understanding we propose *first principles of a designerly way of knowing* to guide the pedagogy of design for IS students as a complement to a mindset of reflective practice (Schön, 1983).

We argue that design is an essential, core professional competency necessary for any successful system development project. And thus, design is essential to IS education. We recommend guidelines for design pedagogy that characterizes systems development as the creation of useful and usable artifacts.

2. CHAOS: Systemic Recurring Failures

Since 1995, the Standish Group publishes a yearly report of software and systems failures – both private and public (The Standish Group, 1995, 2001). The CHAOS report surveys IT and project managers to study the characteristics of software and systems projects that succeed and fail. The report categorizes projects as: successful (completed on time and within budget); challenged (completed, but was one or more of the following: over-budget, over-time, or feature/function incomplete); or, impaired/failed (cancelled or not completed). Figure 1 shows a 5-year accounting of project assessment:

Figure 1 shows software and systems project outcomes as less than "sure things." Although there may be flaws in and detractors of the CHAOS report (Ambler, 2014; Eveleens and Verhoef, 2010; Glass, 2006), the impact of the report is clear: the state of the art in systems development is less than reliable and success/failure rates of this proportion are not acceptable in disciplines like engineering or medicine.

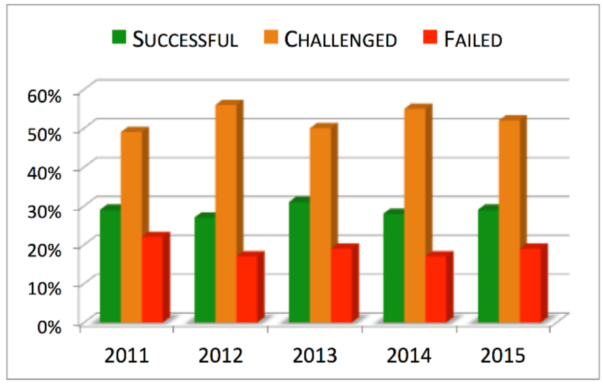

Figure 1. CHAOS Report outcomes 2011-15

The 2015 CHAOS report (The Standish Group, 2016) surveys factors commonly accepted by the Project Management Institute: on Time, On Budget, on Target, on Goal, Value and Satisfaction. We note ten of those factors in table 1 categorized primarily as being most pertinent to either technological or people concerns.

CHAOS Success Factor	Technology	People
Executive Sponsorship		X
Emotional Maturity		X
User Involvement		X
Optimization	X	X
Skilled Resources	X	X
Standard Architectures	X	
Agile		X
Parsimony		X
Project Management Expertise		X
Clear Business Objectives		X

Table 1. CHAOS Report outcomes 2011-15 (The Standish Group, 2016)

Table 1 does not prove that successful information systems development is solely a function of good project management. However, across a growing sample of respondents, the surveys that contribute to the CHAOS report generalize that organizational concerns play a primary role that require study.

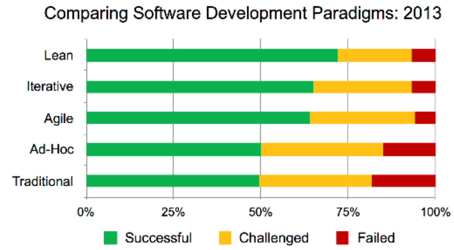

Figure 2 – Project Success according to development paradigm

Dr. Dobb's Journal published its own IT Project Success Rates survey from 2007 to 2013 and the 2013 results are interesting not as much in the overall success rates, but in the apparent impact of development paradigm, Figure 2 (Ambler, 2014). Projects that focus on frequent iterations, frequent delivery of product, and discursive balancing between stakeholders and developers, had greater success rates.

Factors reflecting communication, collaboration, and project coherence resonate in both the Chaos and Dr. Dobb's reports. The degree to which the overall project vision is shared and there is a community wide conception of the project goal the greater the probability that the artifact that finally emerges meets the community's expectations. The organizational goals, constraints, culture, and needs combine and frame the project aspirations and foreshadow the prospective product artifact.

3. RECONCILIATION, RESONANCE AND RESOLUTION IN DESIGNING AN ARTIFACT

As a discipline, Information Systems endeavors to create human activity systems, which harness data and computing technology, to facilitate organizational goals and functions. This is a sociotechnical perspective, as in Emery and Trist (1969), recognizing the emergent and iterative nature of an information system as it evolves, and hopefully, thrives (Lee, 2010; Waguespack, 2010). The sociotechnical perspective views an information system characterized by the mutual shaping influences that technology and organizational, as subsystems, exert within the information system.

Figure 3 conceptualizes an information system as a confluence of a number of concerns – organizational, informational, and technological (Lee, 2010). These considerations can be conceptualized as subsystems within an information system, each exerting influence within the wider system. Generally, the realm of organizations and management represents a set of requirements for the system. However, both the data and the technology exert their own influence within the system as well.

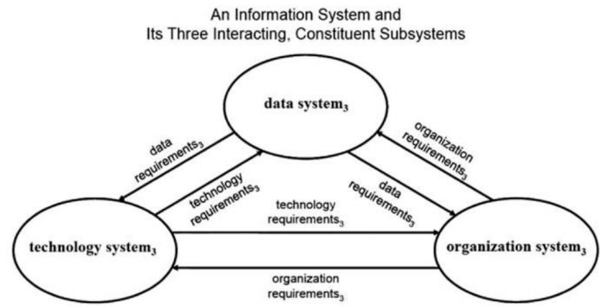

Figure 3 – Interaction between the sub systems of an Information System from (Lee, 2010)

Each of these subsystems has agency to some extent. In each subsystem the human actors reside amidst social and cultural components as well. These actors may align with disparate disciplines – each with their own assumptions: ontological, epistemological, praxeological, and phenomenological. For instance, it is possible to characterize the IS as existing betwixt management and computer science (Backhouse et al. 1991). The utility of this characterization is recognition that each discipline brings its own world-view to the relationships described in Figure 3. What codification of culture and communication does each community bring to the subsystem interactions?

An information system may be considered from a transactional perspective: an occasion and opportunity to satisfy organizational problems (needs and aspirations) through technology – and data-driven solutions. The opportunity for information systems project failure arises in the attempt to join these perspectives.

The discordance that arises in many IS implementation failures often appears as disconnect between the perspective inherent in organizational aspirations for a system and the perspective of the technologists who create the tools and artifacts which are consolidated and synthesized into solutions (Figure 4).

Figure 4 – Joining Perspectives on IS

That we may further explore the phenomenon of discord between organizational and technical perspectives we turn to *appreciative systems* (Vickers, 1984). An appreciative system is a personally held conception of culture and values, essentially a world-view that mediates each individual's experience of the world. This world-view is the product of education and experience and as such is continually evolving. It determines the cues deemed worth attending to and forms a personal basis for judging the merits of everything.

When actors and agents within the organizational subsystem communicate with actors and agents in the technology system, each does so in their vernacular, "codes," of their culture, discipline, and values. As an oversimplification, conversations may be an exchange of the same words, but the understanding may not always coincide with the intent.

When two groups meet (those whose roles and functions in an organization resonate more with the technology system, and those whose roles and functions resonate with the organizational system), these groups may not have sufficiently compatible or aligned appreciative systems. This may be more than misalignments of language, but rather a form of discord that involves and extends from culture and values.

The challenge of resolving discordant appreciative systems is prevalent in ill-defined and "wicked" problems. It is also a recurrent aspect of information systems development projects and contributes to the frequency of failed projects. The convergence of social aspirations and the technology of building systems can only be resolved through the creation of bridging concepts that allow the organizational aspirations to be realized in artifact properties. Design as a skill, an art, a profession has always been the basis of such a bridging.

4. DESIGNERLY WAYS OF KNOWING

The practice of design in the computing arena has traditionally followed the lead of its ancestral disciplines in the sciences founded on the premise of technical rationality.

> Technical Rationality depends on agreement about ends. When ends are fixed and clear, then the decision to act can present itself as an instrumental problem. (Schön, 1983, p.41)

This premise of technical rationality basically posits that design is problem solving where the "solution" is determined through an exhaustive search of every possible alternative to achieve the optimal result.

> According to Herbert Simon … the process of rational decision-making is an act of choosing among alternatives which have been assigned different valuations. It involves the following process:
>
> 1. Listing all of the alternative strategies.
> 2. Determining all the consequences that follow upon each of these strategies.
> 3. Comparatively evaluating these sets of consequences.
>
> Simon, however, admits that total rationality is an unattainable idealization in real decision-making – who can be aware of all existing alternatives?
> (Simon quoted by Skyttner, 2005)

Perhaps the translation of a mathematical equation into the code of a programming language may be classified as problem solving, but when the stakeholder community is realistically accounted for in information systems design, there is no calculable, optimal "solution." This "social" dimension casts the design of information systems as ill-defined or "wicked" problems. (Skyttner, 2005, p. 460)

As a "wicked" problem, designing information systems requires a conception of design that shapes the design task with a goal of satisfaction rather than optimality. (Samuelson, 1977) Thus we turn to the *Designerly Ways of Knowing,* DWOK*,* Nigel Cross's compendium of major research contributions to design understanding in order to explore design as the construction of artifacts in the design space confounded by the intersection of technology and society. (Cross, 2007)

	Phenomenon	Methods	Values
Science	The natural world	Controlled experiment, classification, analysis	Objectivity, rationality, neutrality, "truth"
Humanities	Human experience	Analogy, metaphor, evaluation	Subjectivity, imagination, commitment," justice"
Design	The artificial world	Modeling, pattern-formation, synthesis	Practicality, ingenuity, empathy, "appropriateness"

Table 2. Conceptions on Design

As Cross (2007, p.18) summarizes it, design traditionally assumes one of three stripes as depicted in Table 2. Design in the sciences versus humanities is objectivity versus subjectivity or experiment versus analogy. The realm of professional designers (e.g. architecture and engineering) engages in constructing or creating new things rather than explaining what already exists.

The basic challenge of information systems design is two-fold: 1) the characterization of the desired relationship between the stakeholder community and the artifact, and 2) the construction of the artifact that delivers the appropriate behavior to sustain that relationship. The design task is to comprehend the aspiration instigating the stakeholders' desire for the artifact and to reflect that aspiration in the stakeholder(s)' experience of the artifact. Design must grasp the intension rather than requirements for the artifact. Furthermore, the human nature of the stakeholders ensures that the entire system is not static, but dynamic, because aspirations evolve with their experience of the artifact and the environment that enfolds both stakeholders and artifact evolves because of, and in spite of, both of them. Rather than prescribing a design methodology, Cross describes a mindset, an attitude, observed repeatedly among highly successful designers that facilitates the formation of consistently satisfying designs. We draw liberally from Cross's survey and explore his findings as follows. (Cross, 2007)

> It is widely accepted that design 'problems' can only be regarded as a version of ill-defined problems. In a design project it is often not at all clear what 'the problem' is; it may have been only loosely defined by the client, many constraints and criteria may be undefined, and everyone involved in the project may know that goals may be re-defined during the project. In design, 'problems' are often defined only in relation to ideas for their 'solution', and designers do not typically proceed by first attempting to define their problems rigorously. (Cross, 2007, p. 99)

Typically, in a succession of trial solutions each attempt provides a concrete object with which to constructively challenge the stakeholders' confidence in their expressed intensions and to refine an apposite vocabulary to hone the dialogue between stakeholders and designers that exposes "what's working" and "what's not!" Each prototype reveals a degree of accord (or discord) between intensions and artifact. "Proposed solutions often directly remind designers of issues to consider. The problem and solution co-evolve." (Kolodner & Wills, 1966)

> [O]nly some constraints are 'given' in a design problem; other constraints are 'introduced' by the designer from domain knowledge, and others are 'derived' by the designer during the exploration of particular solution concepts. (Ullman, 1988)

DWOK cultivates an unfolding of the artifact's properties, but also a continuous re-certification of the stakeholders' intensions.

> Designers are not limited to 'given' problems, but find and formulate problems within the broad context of the design brief. This is the characteristic of the reflective practice identified by Schön (1983) as problem setting: 'Problem setting is the process in which, interactively, we name the things to which we will attend and frame the context in which we will attend to them'. (Schön quoted by Cross. Cross, 2007, p. 101)

The prototype (on paper, in mockup, in simulation, etc.) centers the design process on personal experience and draws out the stakeholders' feelings and thereby their *world-view*, their sense of appreciation, and what they value about the artifact. This last element, what they value, is core to the DWOK, the role of *appreciative system*. (Vickers, 1983)

> The appreciative settings condition new experience but are modified by the new experience. Such circular relations Vickers takes to be the common facts of social life, but we fail to see this clearly, he argues,

> because of the concentration in our science-based culture on linear causal chains and on the notion of goal-seeking.
> (Checkland, 1999, p. 262)

Interestingly enough, Vickers refers to the stakeholders' expression of their intensions as their *code*! (Vickers, 1983) "Code" is a familiar term for IS developers, but Vickers has a more expansive conception of it that envelops both their expression of intensions and their appreciative system. And therefore what they express, rather than specific implementation elements, is metaphoric or representative of their intensions.

> 'Metaphoric appreciation' is an apt name for what it is that designers are particularly skilled in, in 'reading' the world of goods, in translating back from concrete objects to abstract requirements, through their design code. (Cross, 2007, p. 27)

The design process continues as a dialog, a conversation, between stakeholder aspirations and the unfolding artifact. The cycle forms an exercise of mutual learning as each generation of the artifact illuminates and refines both the stakeholders' intensions and the suitability of the designer's choices.

> A designer begins a conceptual design session by analyzing the functional aspects of the problem. As the session progresses, the designer focuses on the three aspects of function, behavior and structure, and engages in a cycle of analysis, synthesis and evaluation. Towards the end of the design session, the designer's activity is focused on synthesizing structure and evaluating the structure's behavior. (McNeil et al., 1998)

The designers choose design actions to shape each prototype informed by their own appreciative system tailored by their knowledge of the design domain and the medium of construction – an appreciative system formed through education, training, and practical experience.

> The designer knows (consciously or unconsciously) that some ingredient must be added to the information that he already has in order that he may arrive at an unique solution. This knowledge is in itself not enough in design problems, of course he has to look for the extra ingredient, and he uses his powers of conjecture and original thought to do so. What then is this extra ingredient? In many if not most cases it is an "ordering principle." (Levin, 1966)

This appreciative system influences design decisions that strengthen: a) the fidelity of the artifact with the stakeholders' intensions and b) the artifact's plasticity in an environment of inevitable change.

The portrayal of a *Designerly Way of Knowing* in the research that Cross summarizes characterizes a design project as a confluence of human perceptions and aspirations extruded through the technology of construction and rendition. This activity unfolds in an environment where all of the above inevitably evolve as they are impacted by one another. The whole of an IS design project is an "ill-defined" and "wicked" problem. And although optimality is impractical, design success is feasible if the design process is committed to first principles consonant with the DWOK.

5. FIRST PRINCIPLES OF A DESIGNERLY WAY OF KNOWING

A *first principle* is a basic, foundational, self-evident proposition or assumption that cannot be deduced from any other proposition or assumption. The principles that follow distill aspects of the mindset observed in the protocols of expert designers and their engagement with stakeholders. Although we continually address designers separately, they are definitely stakeholders in their own right.

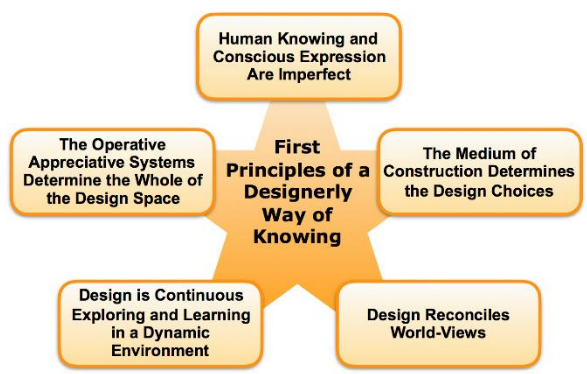

Figure 5 – First Principles of DWOK

Human Knowing and Conscious Expression Are Imperfect

If human knowing and their utterances were perfect all human behavior could be demonstrated algorithmically as with pure logic. In fact human behavior and decision-making processes always exhibits the involvement of *tacit* knowledge.

> We marvel at the story of the firefighter who has a sudden urge to escape a burning house just before it collapses, because the firefighter knows the danger intuitively, 'without knowing how he knows:' However, we also do not know how we immediately know that a person we see as we enter a room is our friend Peter. The moral … is that the mystery of knowing without knowing is … the norm of mental life.
> (Kahneman, 2011)

Kahneman's interest in tacit knowing weaves throughout his study of human decision making in economics from choosing laundry products to assessing the reliability of financial institutions. The act of design continually engages tacit knowing.

> Stakeholders [and designers] access their knowledge through explicit or tacit "knowing." A stakeholder can specify/explain their explicit knowledge (i.e. knowledge acquired through formal education) and be aware of but, not be able to specify/explain their tacit knowledge (i.e. knowledge acquired through their personal experience of "living"). This is the distinction between knowing "what" and knowing "how" (i.e. "We know more than we can tell").
> (Polanyi, 1966, Waguespack, 2016)

The fact of tacit knowing is the reason that design is as much art as science. The fact that *all possible alternatives* cannot be known in advance is why technical rationality is a false model of human behavior. Description in metaphor is a constant channel for connecting with tacit knowledge. And thus, a prime function of design is teasing out that knowledge. Although it may be tacit, it materially impacts the primary goal of design, satisfaction.

The Operative Appreciative Systems Determine the Whole of the Design Space

Whether held explicitly or tacitly, stakeholders and designers apply a personally held appreciative system to their perception of the world. That appreciative system is in fact their world-view. That view determines what cues they notice in their everyday activities and what properties of those experiences determine their sense of approval or displeasure. To the extent that stakeholders share a background of culture, education, or life experience there may be significant accord across their appreciative systems. And where this shared background does not exist, design must build bridges to attain "peaceful coexistence" or value resolution.

Design is Continuous Exploring and Learning in a Dynamic Environment

A central characteristic of both tacit knowing and appreciative systems is their continuous evolution. Together they are a product of "living:" the life experience of the stakeholders, the designer(s), and "living" with the artifact. Change is continuous and ubiquitous. It occurs in the stakeholders' environment through markets, government, politics, the changing community of stakeholders, etc. It occurs with the evolution of technology: theory, communication, computation, etc. First and foremost, the stakeholders' experience with the artifact of the design process itself changes everything. The design space is an ecosystem of mindsets, aspirations, and feedback.

> One of the unique aspects of design behavior is the constant generation of new task goals and redefinition of task constraints. (Akin, 1979)

Accounts of the design activity repeatedly demonstrate that stakeholders' aspirations evolve, as does the nature of the artifact. "The problem and solution co-evolve." (Kolodner & Wills, 1966) Indeed, this characteristic of organically evolving the artifact is a signature of agile development methodologies – "building lean:" only as much as is needed; when we know we need it.

The Medium of Construction Determines the Design Choices

Among the resources the designers bring to the design task is their skill with the medium of construction – the implements of fabrication, prefabricated frameworks, vocabularies, and (most important of all) the seasoned practice of applying these tools in design projects. Here the designer is a "performer" in the vein of an accomplished musician, sports athlete, surgeon, painter, or sculptor. These performers achieve an internalization of their instrument, the bat or ball, the scalpel, the brush, or the chisel. For the skilled performer it is as though the instrument becomes an extension of their own person – they know "what," "why," and "how" in the doing. They are one with their craft.

> When exercising a skill, we literally dwell in the innumerable muscular acts which contribute to its purpose, a purpose which constitutes their joint meaning. Therefore, since all understanding is tacit knowing, all understanding is achieved by indwelling.
> (Polanyi, 1969)

The designer's indwelling with these tools determines the form and dimensions of the artifact – what can be represented or expressed in this medium. In a real sense they determine what the designer is able to "see" and thus, what is imaginable in the artifact. This is the designer's world-view – what artifact is possible.

Design Reconciles World-Views

As we began this exploration of a *designerly way of knowing*, the basic challenge of information systems design is two-fold: 1) the characterization of the desired relationship between the stakeholder community and the artifact, and 2) the construction of the artifact that delivers the appropriate behavior to sustain that relationship.

What the stakeholders' desire is conceived and expressed through a lens of their world-view. What the designer is capable of constructing is shaped through the designer's world-view. Design success is achieving the desired relationship as "seen" through both of the respective world-views. The product of design is a practical artifact in which the stakeholders can perceive their intensions. In effect the design task is an artifact that reconciles the various operative world-views, appreciative systems. There is a tradition that the reconciliation requires a "creative leap."

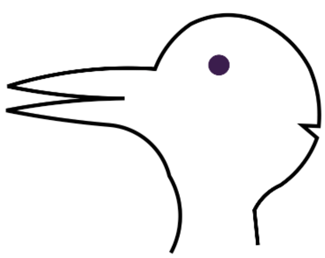

Figure 6 – Duck-Rabbit Image Puzzle

> The 'creative leap' is not so much a leap across the chasm between analysis and synthesis, as a throwing of a bridge across the chasm between problem and solution. The 'bridge' recognizably embodies satisfactory relationships between problem and solution. It is the recognition of the satisfactory concept that provides the 'illumination' of the creative 'flash of insight'.
>
> The recognition of a proposed design concept as embodying both problem and solution together may be regarded as something like the well-known duck-rabbit puzzle; it is neither one nor the other, but a combination which resolves both together and allows either to be focused upon.
>
> (Cross, 2007, p. 78)

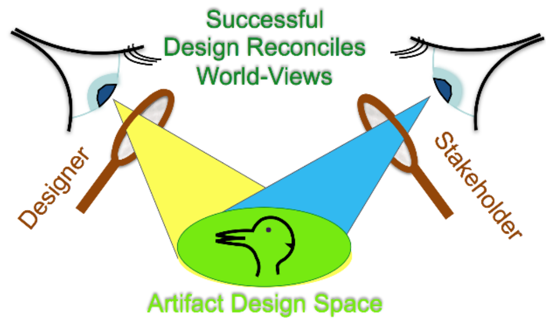

Figure 7 – World-Views Reconciled

This description of a *designerly way of knowing* does not prescribe a specific design theory or even a methodology. The focus is a mindset of systems thinking and practice of continuous dialog between stakeholders and designers to transact and build a shared understanding of what a "successful" artifact means in the design space they share. The challenge for IS education is to find ways to integrate this mindset of design in IS pedagogy.

6. FORMING THE DWOK IN THE STUDENT OF IS DESIGN

Educating the IS design student can take many forms. Rather than prescribe a pedagogy or curriculum, the following learning objectives outline the knowledge elements that resonate with a designerly way of knowing:

Practice Knowledge of a Domain

Understanding client intensions and crafting a shared design space requires realistic experience of "walking a mile in the client's shoes." The student needs enough practical domain knowledge to support the dialog between client and designer. In business school programs the domain is commerce: accountancy, finance, marketing, etc. Other domains may be engineering, medicine, or the physical sciences.

Technology Theory and Practice

The theory and practice of the relevant technology of construction are integral to the designer's world-view – again to inform the intercourse with the client's world-view. Design skill rests on "knowing how" as well as "knowing what" to the level at least of apprentice professional capability.

System Life Cycle Project Experience
An appreciation of the interplay between intensions and design actions must be learned by experience: making, applying, and assessing design action decisions with particular attention to immediate and longer-term consequences. Reflective cycles for forming and reforming artifacts reinforces a life cycle consciousness.

Discriminating Between Requirements and Design Choices
A prime goal of the designer / stakeholder authorship of the shared appreciative system they cast over the design space is to focus design decisions on essential elements of satisfaction. Every design choice incurs tradeoffs in quality and/or effectiveness. A design faithful to the intensions of the stakeholders must discriminate between tradeoffs arising from essential artifact properties and accidents of implementation due to implementation technology idiosyncrasies. (Waguespack, 2010, p. 93)

Collaboration and Development Methodology
Team skills (collaboration, negotiation, and "technical" writing) aligned with a practical systems development methodology establish basic project competency – a learning environment for designer as student or professional. Above all, effective design depends upon open, free, and honest communication throughout the artifact's community.

Incubating Creativity
Creativity is intrinsic to design. Most dictionaries add "especially in the production of an artistic work." That is the point, IS design as a "wicked" problem has much to do with art. Students need encouragement to seek out novel perspectives, interpretations, reactions, or descriptions in the design space. The *naming* and *framing* is a creative act that requires an open-minded perspective, imaginative tools, and generative metaphors. (Schön, 1983) Design pedagogy in IS needs room for dreaming and exploring these world-views with as little instructional prejudice or constraint as possible. The concept of design studio common in architecture and industrial design needs a home in IS pedagogy as well! (West et al., 2005)

7. DISCUSSION

A *designerly way of knowing* prefigures a design methodology capable of attending to ontological, epistemological, praxeological, axiological and phenomenological dimensions of information systems. We have intimated the link between the discordant appreciative systems and the frequency of development project failures. Substantiation of the link requires additional study. Although Cross's retrospective on the behavior of expert designers has focused predominantly outside the information systems artifact realm, the parallels in IS are self-evident. Our next step of inquiry is to prototype curricular vehicles to demonstrate and test the pedagogical guidelines presented herein.

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