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ABSTRACT

Confronting recent design challenges, instructional designers have latched onto adaptive procedural techniques from outside the Instructional Systems Design (ISD) field. This discussion of rapid prototyping (RP) examines the perspectives of: (1) the prototype as the designer"s cognitive tool; (2) the designer as co-inquirer; and (3) the practitioner as producer of knowledge. It brings to the foreground key issues often passed over in the discussion of instructional design models--the importance of knowledge derived in doing and the seldom-examined assumptions underlying a "scientific" approach to design. In RP, designers bring a product into being through the creation of successive prototypes. The intermediate prototypes become an important means of getting feedback as the design and development process become intertwined. Viewing RP as a "tool-for-thought" challenges the design/development hierarchy reflected in traditional instructional design models; the act of conceptualizing is integrated into the act of practice. When development is seen as "concrete knowing" or "bricolage," development can be elevated to the status that design now holds in the traditional view of ISD as "design, then development." The designer, in the act of doing, uses the prototype as a tool of inquiry and the hierarchical relationship between design and development is equalized. When rapid prototyping is viewed primarily as an inquiry tool that may be used collaboratively with nondesigners, the designer's responsibility is to support collaborative investigation. The highly iterative nature of RP involves frequent evaluation and revisiting of the problems addressed and created by the product under development. The mockup or prototype becomes the focal point for the group's critique, idea generation, and idea testing. (Contains 24 references.) (AEF)

Reconceiving ISD: Three Perspectives on Rapid Prototyping as a Paradigm Shift

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Confronting recent design challenges, instructional designers have latched onto adaptive procedural techniques from outside the Instructional Systems Design (ISD) field. One of the most frequently mentioned is "rapid prototyping" (e.g., Jones, Li, & Merrill, 1992; Tessmer, 1994; Tripp & Bichelmeyer, 1990), the iterative creation of partial products over the course of design and development. The importance of the notion of rapid prototyping to our field is not, however, as a technique to be adopted, but as a vehicle for understanding the instructional design/development process. Rapid prototyping (RP) brings to the foreground key issues often passed over in the discussion of instructional design models: the designer as inquirer and facilitator, the importance of knowledge derived "in" doing, and the seldom-examined assumptions underlying a "scientific" approach to design.

Prototype as the Designer's Cognitive Tool

In rapid prototyping, designers bring a product into being through the creation of successive prototypes. The intermediate prototypes become an important means of getting feedback; the design and development process become intertwined. Rapid prototyping "provides the designer with concrete feedback in terms of the final product, as compared to the more abstract feedback provided by the standard products of analysis and design." (Jones, Li, & Merrill; 1992). Below the surface, however, rapid prototyping seems to support two very diverse orientations to design. The purpose of this section is to discriminate between two views of rapid prototyping — one in which prototyping is a development technique and one in which rapid prototyping represents a distinct way of knowing — and then to suggest how viewing the prototype as a tool-for-thought challenges the design/development hierarchy reflected in instructional design models.

While rapid prototyping is said to offer more opportunities for feedback, earlier in the development process, exactly what constitutes feedback is not always specified. It's easy to think of feedback in instrumental terms: does the prototype work? Did it achieve the desired effect? However, we discriminate between two kinds of feedback, feedback gained from testers and feedback used by the designers themselves. In the case of the former, getting feedback is very much like a formative evaluation, defined by Dick and Carey (1996) as "the collection of data and information during the development of instruction which can be used to improve the effectiveness of the instruction." In the second case, however, when the prototype "talks back" to the designers themselves, the prototype being tested becomes a tool for thought and critical reflection.

The idea of the prototype as an intimate mediator of immediate feedback follows philosopher Larry Briskman's work (1981) on creativity in science and art. He suggests that intermediary products (i.e., prototypes) are important because they serve as aids to the reflection/creation process. He writes:

> The artist must build up his painting gradually, stroke by stroke; while the theoretician must build up his conjectural explanation bit by bit (even though he may have got his explanatory 'core idea' in a flash). But if this is the case, then it is highly likely that the very thought processes of the artist or scientist will themselves be affected by the work done so far. In other words, the creator, in his very process of creation, is constantly interacting with his own products; and this interaction is one of genuine feedback, for the creator is as much influenced by his own initial creations as these were influenced by him.... If all this is correct, then it follows that we shall not be able to describe, let alone understand,

the creative process unless we make reference to the "intermediary" products which function, so to speak, as "tools" in the creative process itself.

The notion of intermediary products as tools-for-thought is important because it points to a particular vision of rapid prototyping. Rapid prototyping is sometimes described as a process of continual refinement in which a product is brought closer and closer to its final realization. Certainly this is a valid and useful conception. However, thinking of rapid prototyping as a partner in thought enables us to conceive of the prototype in another role. As well as being a step on the way to a final product, each prototype becomes a means of investigation, a cognitive tool.

Seeing a prototype as a cognitive tool questions some of the central metaphors of the development process. Michael Reddy (1993) has described how the English language is filled with metaphors which imply that "language functions like a conduit, transferring thoughts bodily from one person to another." For instance, we are taught to "put ideas into words." Sentences may be "empty of both meaning and feeling." Language is seen as a container or conduit for thought. The development process in traditional instructional design is often thought of in much the same way. The instructional design is a blueprint which development brings into a tangible form. A hierarchical relationship is created in which concept is prized at the expense of the concrete; instantiation becomes a mere container for strategy. Seeing a rapid prototype as a tool for discovery challenges this hierarchy. The act of conceptualizing is integrated into the act of practice–the act of doing is the act of thinking. This view of rapid prototyping is based on a praxis orientation to design. Praxis thought affirms the importance of an "engagment with materials", and most importantly, promotes deliberation about purposes as well as about means (Craig & Tracy, 1995). From the praxis orientation, rapid prototyping is much more than a method for collecting information. It embodies a particular kind of thought process that occurs in interaction with materials.

This alternative to formal, propositional reasoning is frequently described as a "concrete approach" to knowing. It is tactile and contextual. Turkle and Papert (1990) have used Levi-Strauss's term "bricolage" to describe concrete knowing. Levi-Strauss associated what he also called the "science of the concrete" with primitive societies. Piaget saw bricolage as typical of a developmental stage in children. Writers such as Gilligan, Belenky, and Keller (cited in Turkle and Papert, 1990), have identified the concrete approach to knowing as characteristic of many women. Until recently, the "bricoleur" knower seemed inferior to the "formal" knower. The revelation that important scientific discoveries begin with down-to-earth, concrete, tactile experimentation has done much to elevate concrete knowing..[1] No longer a developmental stage, a primitive form of science, or an "essentially" feminine characteristic, bricolage is now considered a legitimate style of reasoning. Paradoxically the computer, a product of formal logic and propositional knowing, by facilitating rapid prototyping, has helped revaluate concrete approaches to knowing by giving people access to and experience of them (Turkle and Papert, 1990). When development is seen as "concrete knowing" or "bricolage", development can be elevated to the status that design now holds in the traditional view of ISD as "design, then development". The designer, in the act of doing, uses the prototype as a tool of inquiry; development is not mere execution. The distinction between design and development is blurred; the hierarchical relationship is equalized.

The Designer as Co-inquirer

ISD is not a process in which the designer is left alone with his or her materials. It is a social process as well. If rapid prototyping is to act as a vehicle for understanding the instructional design/development process then we must examine RP in the context of how it is positioned and used by a group. Other people join the designer's "conversation with materials", adding their own conversations and their communications with each other.

When rapid prototyping is viewed primarily as an inquiry tool that may be used collaboratively with non-designers, the designer's priority and responsibility is to support collaborative investigation. The prototype helps the designer and her collaborators create the proper environment in two ways: by helping the collaborative group "reflect-in-action" (Schon, 1983) and by serving as a focal point for development of a project culture. The shift in the designer's role from technical specialist to co-inquirer is not, however, simple to make, and this section suggests some of the paradoxes and additional obligations that the paradigm shift presents to the professional designer.

[1] For example, Nobel Laureate Barbara McLintock's acknowledgement that a "feeling for the organism" has been essential to her scientific discoveries (Keller, 1983, cited in Turkle & Papert, 1990).

Based on their work designing an electronic learning and information environment for AT&T, and on their work using prototyping and participatory design techniques in instructional design at Indiana University, Dorsey, Goodrum and Schwen (in press) put forward a view of rapid collaborative prototyping as a paradigm for instructional development. Contained within this view is a brief description of how the paradigm changes the relationship between the user and the designer, the designer's primary responsibilities, and the nature of the designer's expertise:

> In a collaborative prototyping model, the user 'uses' the designer as an information resource and facilitator of a design process to solve their instructional need. Emphasis in designer responsibility and expertise shifts more to project management, establishing realistic expectations, facilitation of structured meetings, creative brainstorming, and evaluation.

Coyne and Snodgrass (1993) suggest how collaboration transforms traditional definitions of expertise. They conclude that one must work against the overwhelming legacy of the Cartesian rationalist and Romantic philosophical traditions, which both glorify the individual, in order understand oneself in relation to society; both traditions "militate against cooperation". Coyne and Snodgrass arrive at a redefinition of professionalism and expertise in the general context of design. Expertise is seen aa a matter of skill in facilitating and managing the collaborative process, "not as an objective outsider but as a participant." Expertise resides within a community and makes sense only in relation to the other expertise brought into the design process. "Positing design ideas is an act of self-disclosure, projecting expectations into a conversational domain, illuminating prejudices, challenging norms, and bringing about meaningful action" (Coyne and Snodgrass, 1993).

The forgoing re-formulation of designer's position within the design process asks instructional designers to reflect on the actions they take in collaboration with others. However, just as the distinction between the use of a prototype to refine (rationalistic orientation) and the use of a prototype as a way to gain knowledge in doing (praxis orientation) has been made, we can more clearly make the distinction between reflection *on* action involving others and reflection *in* action with others.

The highly iterative nature of rapid prototyping (RP) involves frequent evaluation and re-visiting of the problems addressed and created by the product under development. RP can facilitate what Schon (1983) calls "reflection-in-action" which he says is vital to coping with particularly troublesome situations. In a collaborative view of rapid prototyping, the group builds and responds to the mockup or prototype. The mockup or prototype is the focal point for the group's critique, idea generation, and idea testing. The group's conversations or interactions with the prototype can be extremely varied in quality and intensity. The designer faces a moment to moment challenge of balancing the free rein of ideas and critical judgments with bringing about progress.

Schrage has aptly called the design product "congealed culture" (1993). Through the collaborative building of concrete objects--plans, prototypes--shared language and artifacts develop, central to the development of a unique project culture. "The instructional designer must be sensitive to the meanings that are constructed collaboratively within the larger culture of the project and the smaller culture of the design team" (Campbell-Bonar and Olson, 1992). The product serves as a means of both defining and promoting the negotiation that takes place during the process. When products are brought into being early in the design process they serve as a shared focal point for reliable communication and knowledge generation as well as provide a structure and a vocabulary for that communication. It then becomes the designer's responsibility to consciously and explicitly use the prototype as a means to insure that two levels of need are met: problem-solving and setting at one level and the political and interpersonal needs of the developing collaborative design group at another. Schon and Rein (1994) call this "double-designing".

Collaborative rapid prototyping suggests that collaboration is more than an alternative design technique, another way to organize the work of others. It is also a way of being and knowing, an alternate vision of professional identity and practice. When the prototype is viewed as a tool of inquiry used in collaboration with others, the designer publicly throws off the mantle of the expert admitting her lack of cultural and problem knowledge and valuing the cultural and problem knowledge of others. But while the image of the collaborative inquirer is often encouraged and glorified, living up to the image can be difficult, as pointed out above, especially when the cultural context of instructional design and development is so heavily rooted in a positivistic, rationalist approach to science. Further, questions arise as to whether the instructional products of collaborative inquiry are superior to those created in a more traditional way, and as to whether just as successful instructional products might be created by designers with a more traditional image of their profession. Again, however, we return to the point that collaborative rapid prototyping is not an alternative set of techniques; our purpose here is to make a legitimate place in the field of instructional design for an alternative view of the designer, practice, and the essential nature of the relationship between design and science.

Practitioner as Producer of Knowledge

The theme running throughout this paper with a starting point of rapid prototyping, is the conceptualization of Instructional Systems Design as inquiry. One way to examine design as inquiry is to ask if the practice of Instructional Design is a science.

Whether referred to as Instructional Design (ID), or its traditional, procedural Instructional Systems Design (ISD) model, it is not particularly difficult, or rare, to imagine practice within the field or its components as *not* being a science. Davies (1991) for a commonly cited example, eloquently argues that ID is *definitely* an 'art' in which craft and science might play a role. If one were to ask practitioners if they were 'scientists', they would probably answer 'no'. They label themselves 'designers' or 'consultants' or perhaps 'technologists' (an exception might be those in academia some of whom might call themselves 'researchers'). In recent discussions about alternatives to traditional ID practice, there is a linking to other fields of design, such as architecture, software design, and so on (e.g., Tripp & Bichelmeyer, 1990; Rowland, 1994; Tessmer & Wedman, 1995; Winer & Vázquez-Abed, 1995) and a contrasting of design with science.

There are a number of 'scientific' labels that are often applied to ID — the scientific approach, the systems approach, the learning theory base, and so on — but the actual practice of ID is frequently considered something else, either an art or a craft. This may be because, as a field, ID considers itself a fairly young discipline and recognizes it still has a lot to figure out. Much, if not most, of ID has not been expressed as 'natural law' or 'empirically tested theory' or even 'established fact', though there is a generally accepted mode of practice referred to as the 'systematic approach'. Furthermore, it's hard not to recognize the contributions that aesthetic judgments and even personal fiat, for example, contribute to a final product. But perhaps more importantly, the practice of ID is not generally considered a science because it does not seem to conform to a traditionally held view of what scientific practice is: It is difficult to consider the average ID project as a rigorously controlled experiment or even an in-depth naturalistic case-study.

The prevailing notion is that through one avenue or another, some scientific basis of ID is generally assumed, but the practice of ID is not a kind of science itself.[2] Within such a view, the practice of ID is considered separate from both the theory generation and the controlled experimentation of science. Practitioners are the consumers, not the producers of 'science'; even the academics in our field have been characterized as consumers of research (Hannafin & Hannafin, 1991). As consumers, practitioners are led to depend on and follow the results of science. In other words, the practitioner should confidently proceed in the practice of ID because it is based on the results of *other*, scientific, work.

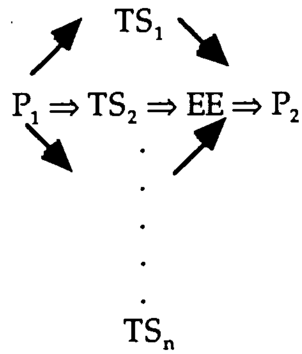
Applying the critical rational approach, espoused by the philosopher Sir Karl Popper, supplies a promising alternative to prevailing views of design practice that could include design within a liberal conception of scientific inquiry. A Popperian approach both resonates well with the vision of designing and designers presented in this paper and offers a path to the additional rigor desired by those conducting inquiry. The design inquirer searches for disconfirming evidence about the design or the design. It is through intending to root out error rather than to seek confirmation of a solution that design can move towards meeting the standards of rigor of the critical rational approach.

For Popper (1985; 1972), inquiry (i.e., effective thinking) is evolutionary and iterative. It starts with P_1, the identification of a problem; TS_1, a tentative solution (hypothesis or plan for action), EE, error elimination by severe critical examination through practical or theoretical testing, and P_2, the new problem situation as it emerges.

$$\mathbf{P_1 \Rightarrow TS_1 \Rightarrow EE \Rightarrow P_2}$$

[2] There is often a general distinction made between practice and science, where technology is the application of scientific discoveries, though it is argued that this idea is no longer in vogue among historians (Schwartz, 1992, cited in Seels & Richey, 1994).

But in this form, a serious aspect is still missing: a multiplicity of tentative solutions, a multiplicity of severe testings, a multiplicity of formulations about the problem situation. A final schema would look something like this:



(Popper, 1972, p. 243)

Popper's focus is on the building of knowledge through the elimination of error — both in our conceptualization of problems as well as our tentative solutions to them — through critical examination. In practice, this means, for example, placing a prototype, a tentative solution to a problem in a particular setting, under the most severe scrutiny of others, under the worst possible conditions, in the most hostile environment. One wants to know, in effect, what will break it, undermine it, destroy it, make it unworkable. If one tests a prototype only under the best of conditions, under the scrutiny of like-minded people, and so on, one is only looking for confirming evidence.

For Popper, the way to practical results, to find out whether some action "is likely to produce an expected, or desired result", is through "piecemeal tinkering" and critical analysis (Popper, 1985, p. 304). Popper favors a piecemeal approach for fundamentally ethical reasons: With the piecemeal approach a person conducting inquiry can approach the scope of the human change with an open mind, keeping a close eye on the range of unintended consequences and thus imposing a "discipline on our speculative inclinations" (Popper, 1985, p. 305). In short, a critical rational approach could be quite helpful in connecting (or, if you will, reconnecting) the practice of instructional design directly to rigorous inquiry, with the designer becoming a producer and contributor of knowledge in the field.

Conclusion

> A design paradigm specifies [...] the essential character of the design domain and proposes a set of design principles for working in that domain, utilizing a set of technologies, tools, and methods. A design paradigm prescribes values by highlighting the most important aspects of the design domain. Further, a design paradigm is motivated by a philosophical orientation and relies upon a set of relevant scientific principles. (Moran and Anderson, 1990, p. 383)

Our own day-to-day use of a particular technique, rapid prototyping, combined with thoughtful consideration of its impact — on our practice and on the experiences of the people we work with and for — has engendered our vision of a new paradigm for ISD. This picture of the paradigm is not complete, but we have sketched, we believe, key elements of it. The philosophical orientation of the paradigm is toward "practitioner as inquirer." Designers are valued not only for their own innovative response to unique situations, but for their ability to facilitate collaborative inquiry. The paradigm's relevant scientific principles arise from conscious problematizing in the course of practice. That these ideas have sprung from our practice lends further support for the notion of design as inquiry.

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