THE PRInCiPleS DESIGN FRAMEWORK

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Abstract: *Some disciplines focus on analytic research and some disciplines focus on synthesis. Design disciplines are interesting because designers need to do both analysis and synthesis tasks. The HCI & design program I presently direct is organized around a framework I have named with the acronym PRInCiPleS, both at the curricular scale and as an organizing device for individual design projects within classes that serves as a kind of design rationale framework. The PRInCiPleS framework is not a scientific framework, but it does have an analogy to an idealized notion of a scientific framework. One of the biggest issues in design pedagogy and practice is how to get students and practicing designers to ensure that analysis leads to synthesis in a sound way and that synthesis follows from analysis in a sound way--that is, the issue of how to bridge the creative, semantic gap between design research and insights and concepts. In much of the curriculum, design research projects are paired with design concept projects in a way that is targeted at addressing this issue by means of iterative practice. Taking a curatorial attitude towards designs constructed according to the PRInCiPleS or indeed other frameworks is an appropriate way to connect notions of creativity to notions of design rationale.*

Keywords: *design, creativity, PRInCiPleS design framework, design challenge based learning (DCBL), transdisciplinarity, transdisciplinary design, sustainability & food.*

INTRODUCTORY DEFINITIONS

PRInCiPleS is an acronym for a design framework. By design framework—especially as distinguished from process, I mean an organizing structure and container for a notion of recording and presenting particular design plans or explanations in terms of (i) analysis frame elements named predispositions, research, insights, and (ii) synthesis frame elements named concept systems, prototypes, and strategies (Figure 1). One of the primary goals—both as design pedagogy and as practice—of

The PRInCiPleS Framework for Design Plans & Explanations

Analysis			Synthesis		
Predisposi-tions	Research ⇩	Insights	Concepts & Concept Systems	Prototypes ⇩	Strategies ⇩
	Observations Literature Collections			Exploratory Appearance Usability	Social Value Technology Enterprise
Predispositions are the things we believe to be true at the outset of a design process or explanation.	Research comes in three forms, namely (i) observa-tions—or pri-mary research, (ii) literature review—or secondary re-search, and (iii) collections—or knowledge about cultural forms.	Insights are the design issues that arise out of research.	Concepts and systems of concepts are the things, services, com-munications, or strategies that we envision in response to insights.	Prototypes come in three forms, namely (i) exploratory—or behavioral or low fidelity prototypes, (ii) appearance—or look and feel prototypes, and (iii) usability—or proof of concept or high fidelity prototypes.	Strategies come in three forms, namely (i) social value—or social desirabil-ity planning, (ii) technology—or technological feasibility plan-ning, and (iii) enterprise—or economic viabil-ity planning.
⇩⇧	⇩⇧	⇩⇧	⇩⇧	⇩⇧	⇩⇧

An Analgous Scientific Framework

Initial hypothesis	Literature search	Reserch hypothesis	Experiment Design	Experiment	Results

Figure 1. Summary of the PRInCiPleS design framework.

recording and presenting design plans or explanations in the PRInCiPleS framework is to ensure that analysis leads to synthesis and that synthesis follows from analysis in a clearly articulated way.

The letters that play a substantive role in the acronym are easily remembered as the word "principles" from which the word "nile" is removed.

The framework elements are straightforward (Top of Figure 1):

1. Predispositions are the things we believe to be true at the outset of a design process or explanation.
2. Research comes in three forms, namely (i) observations—or primary research, (ii) literature review—or secondary research, and (iii) collections—or knowledge about cultural forms.
3. Insights are the design issues that arise out of research.
4. Concepts and systems of concepts are the things, services, communications, or strategies that we envision in response to insights.
5. Prototypes come in three forms, namely (i) exploratory—or behavioral or low fidelity prototypes, (ii) appearance—or look and feel prototypes, and (iii) usability—or proof of concept or high fidelity prototypes.
6. Strategies come in three forms, namely (i) social value—or social planning, (ii) technology—or technology planning, and (iii) enterprise—or economic planning.

THE PRInCiPleS FRAMEWORK

As defined and stated above, the PRInCiPleS framework is an organizing structure and container for a notion of recording and presenting particular design plans or explanations in terms of (i) analysis elements named predispositions, research, insights, and (ii) synthesis elements known as concept systems, prototypes, and strategies. The PRInCiPleS framework was not specifically inspired by the literature on design rationale (notably Moran & Carroll, 1996), but rather by an oral tradition and practice I learned while teaching off-and-on at The Institute of Design, at IIT in Chicago in the later half of the 1990's, as well as directly by Christopher Alexander's notions of pattern language (Alexander et al., 1977). The PRInCiPleS framework owes to a sense of design as it is understood in broad "traditional design" notions of product design or strategic design planning—neither specific to nor exclusive of human-computer interaction, nor human-centered computing, nor interaction design. This historical account and attributive rigor is repeated and greatly elaborated later in this chapter for those who may be interested, in a section titled "Historical Background and Attributions."

Description by Example: Designing for Sustainable Food Practices

In this section, I give a deliberately simple and somewhat sketchy example to illustrate the content and possible form of a design plan or explanation in the PRInCiPleS framework. The example is deliberately simple in order to serve to articulate the form of explanation in the most general way and one should expect that a design explanation of this form in a practical context would have rather a lot more detail. As a matter of situating what follows in terms of scientific or computing or mathematical notions of formality, kindly understand the the level of discourse in what follows is more along the lines, intents, informality, and scale of a pattern in Alexander's (1977) pattern language. For a more complete example of a design explanation organized according to the PRInCiPleS framework, please see Reed, Wang, & Blevis, (2005).

As a practical matter, I focus in what follows on the features of the PRInCiPleS framework that are less common in HCI design methods, under the assumption that the reader is already familiar with more common notions of design methods in HCI.

Title

As design explanations have titles, the title of this example is "Designing for Sustainable Food Practices."

Predispositions

Predispositions are the things we believe to be true at the outset of a design process or explanation. These are statements we imagine to be tautological and which frame our initial contentions or understandings of the design context at hand. With respect to designing for sustainable food practices, one predisposition we might have could be:

Predisposition One
In western society, most people don't have time to ensure their food is local and healthy.

and another could be:

Predisposition Two
Fast food tastes good, but increases obesity rates in the population.

Predispositions motivate a design in the first place, and often point to a tension

we think we need to resolve—such as the tension between time and eating well with the least environmental impact, or the tension between how certain generally high calorie foods taste and obesity effects. Predispositions are a starting point for an explanation. Importantly, they do not represent a particular position, but rather an attempt to inventory all of the prevailing positions that may motivate a design. When presenting a design explanation, people in attendance of the explanation will need to see that their individual points of view are represented, even if they are uncomfortable with the points of view of others, and that is the rhetorical point of predispositions as a technique of presentation.

In Figure 1, an analogy between the PRInCiPleS framework and an idealized notion of scientific framework is diagrammed. Predispositions are analogous to the notion of an initial hypothesis in a scientific process. They are a mechanism for stating initial thoughts and tensions which merit further study in the case of science and further design in the case of design. It is important to note that this comparison is only an analogy. The tensions between notions of science and design are discussed in great deal in the design literature. See Cross (2001) for a particular cogent example. The issue is really not much of an issue for the present chapter. The matter is simply understood by noting that design is not strictly science, although it may make use of scientific results and should do so whenever it can.

Finally, the choice of the term Predispositions is inspired in this context by Minsky's (1988) "The Society of Mind." He states *"These must be the genes responsible for what we call "human nature"—that is, the predispositions every normal person shares."* (Minsky, 1988, p. 310).

Design Research

People often make a distinction between design research—research conducted in order to inform design, and research about design—research conducted to advance understanding of design, methods, and reasoning. In fact, this distinction is not very important and it is hard to strictly separate the two. Moreover, design research and research about design both play a role as both scholarship and practice. These sorts of distinctions are discussed in Blevis, Lim, & Stolterman (2006), Blevis & Stolterman (2008, 2009), in which a broader literature related to the distinctions between scholarship and practice are described more fully than in this present chapter.

The idea of Research as a framework element in the PRInCiPleS framework is more modest in nature. Although primarily practice oriented, the choice of framework sub-elements is in fact not very different than the necessities one expects in a scholarly research paper. These sub-elements are (i) observations—or primary

research, (ii) literature review—or secondary research, and (iii) collections—or curatorial knowledge about cultural forms.

Research : Observations

Design research within the PRInCiPleS framework usually requires a certain amount of primary—first hand—observation work. Methods of conducting observations may vary and may include ethnography, surveys, interviews, and so forth—standard fare in HCI. A particular mode of observation research I emphasize is photo-ethnography. For the "Designing for Sustainable Food Practices" example, we have:

Research Observation One
Figure 2A shows a photo-ethnographic recording of a market scene. The image uses selective focus to highlight the figures engaged in the transaction. The scene is one of cheerful engagement and speaks to a healthy relationship between people and locally produced food.

Research Observation Two
Figure 2B shows a photo-ethnographic recording of a street scene. As a matter of content, this type of photograph speaks to a condition of obesity. The ethics of taking this photograph are a matter of some concern. The photograph is taken in a public place in which people do not have a reasonable expectation of privacy, but it is still prudent to use a mosaic filter to obscure the person's face given the use of this photograph here. The rules that apply to the use of such photographs seem to vary depending on if the photograph is used as un-captioned street photographic Art, or captioned photo-ethnographic research.

Research Observation Three
Figure 2C shows a "hot pot" meal cooked at home. It is clearly posed, and even photographic lighting equipment is part of the image. The food appears to be healthy and in fact is locally produced.

Research Observation Four
Figure 2D shows modern and older rice cookers sharing counter space in a home. The image was taken as part of an in-home study concerning sustainability and technologies. The owner of the rice cookers kept the old one around, even though the newer one had some improved features, because the old one had been given to her by her mother and held sentimental value as a result. The study in which this image first appeared (Blevis & Stolterman, 2006) introduced the notion of personal inventories as a means of understanding why some things have enduring value and
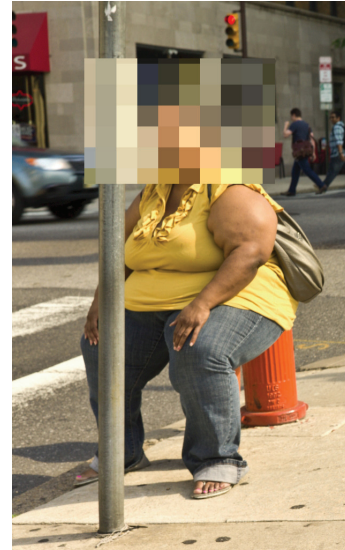
Figure 2A. (Top Left): Photo-ethnography design research.

Figure 2B. (Top Right): The ethical boundaries of photo-ethnography as design research.

Figure 2C. (Left): Photo-ethnography design research (also appears in Choi & Blevis, 2012).

Figure 2D. (Bottom Left): Photo-ethnography design research.(also appears in Blevis & Stolterman, 2006).

others do not, and this image appears as part of that original work.

Photo-ethnography is only one way to do observation design research. The four images characterize a range of approaches. Observations one and two are street scenes. Observation three is staged with friends. Observation four differs from observation two because it is part of an ethics review board approved study which engages people by means of interview, as well as by means of documentary photography. The issue of if observation two is research data, design research, or Art is a complex one, which raises genuine ethical issues about the use and handling of such images.

I am privileging photo-ethnography as an observation design research method, since it is less common than many others that are already well known in HCI and since it is one that is key to my own practice.
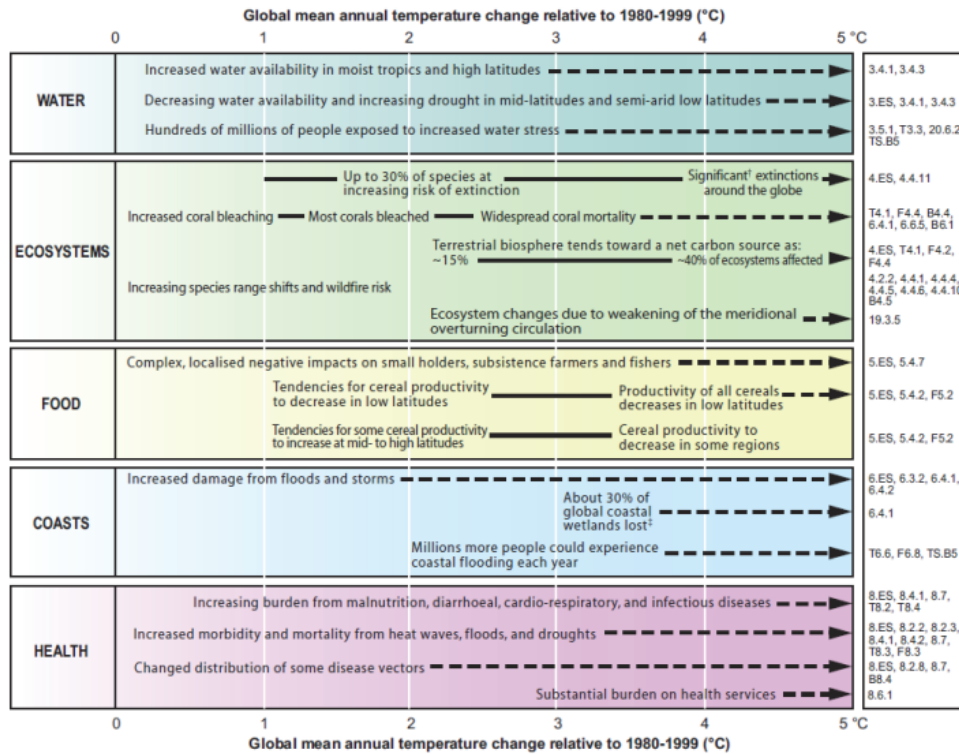
Research : Literature

Design research within the PRInCiPleS framework always requires a certain amount of secondary research—that is, literature review. Doing adequate and conscientious literature review is a matter of some training. The largest problem one faces in working with designers and design students is that they may not have much experience in doing solid literature review. Moreover, they may have learned in grade school to "put things in their own words." This grade school advice is extremely harmful and puts designers and design students at risk of unwittingly engaging in egregious plagiarism. There are a number of things one can tell design students, namely (i) make certain your sources are of high quality, (ii) if you think your idea is new, it probably isn't—do a thorough literature search, (iii) attribute others generously, and (iv) using or re-using work without attribution is plagiarism, whereas attributing others and attributing re-use is scholarship. The most important thing I tell my students is so important that it is worth emphasizing here:

> *Avoid paraphrase, rather quote and attribute.*

And importantly, this advice also appears in Blevis (2010):64, in the form *"Instead of asking students to put things in their own words, ask them to quote and not paraphrase others."*

For the "Designing for Sustainable Food Practices" example, there are several articles that may be referenced, including Choi & Blevis (2010; 2011), Blevis & Coleman Morse (2009), and Hirsch et al. (2010). As a matter of sustainability and more important than any of these is the diagram of Figure 3 taken from the Intergov-

Key impacts as a function of increasing global average temperature change

(Impacts will vary by extent of adaptation, rate of temperature change, and socio-economic pathway)

Global mean annual temperature change relative to 1980-1999 (°C)

| | 0 | 1 | 2 | 3 | 4 | 5 °C | |

WATER

Increased water availability in moist tropics and high latitudes — 3.4.1, 3.4.3

Decreasing water availability and increasing drought in mid-latitudes and semi-arid low latitudes — 3.ES, 3.4.1, 3.4.3

Hundreds of millions of people exposed to increased water stress — 3.5.1, T3.3, 20.6.2, TS.B5

ECOSYSTEMS

Up to 30% of species at increasing risk of extinction — Significant† extinctions around the globe — 4.ES, 4.4.11

Increased coral bleaching — Most corals bleached — Widespread coral mortality — T4.1, F4.4, B4.4, 6.4.1, 6.6.5, B6.1

Terrestrial biosphere tends toward a net carbon source as: ~15% — ~40% of ecosystems affected — 4.ES, T4.1, F4.2, F4.4

Increasing species range shifts and wildfire risk — 4.2.2, 4.4.1, 4.4.4, 4.4.5, 4.4.6, 4.4.10, B4.5

Ecosystem changes due to weakening of the meridional overturning circulation — 19.3.5

FOOD

Complex, localised negative impacts on small holders, subsistence farmers and fishers — 5.ES, 5.4.7

Tendencies for cereal productivity to decrease in low latitudes — Productivity of all cereals decreases in low latitudes — 5.ES, 5.4.2, F5.2

Tendencies for some cereal productivity to increase at mid- to high latitudes — Cereal productivity to decrease in some regions — 5.ES, 5.4.2, F5.2

COASTS

Increased damage from floods and storms — 6.ES, 6.3.2, 6.4.1, 6.4.2

About 30% of global coastal wetlands lost‡ — 6.4.1

Millions more people could experience coastal flooding each year — T6.6, F6.8, TS.B5

HEALTH

Increasing burden from malnutrition, diarrhoeal, cardio-respiratory, and infectious diseases — 8.ES, 8.4.1, 8.7, T8.2, T8.4

Increased morbidity and mortality from heat waves, floods, and droughts — 8.ES, 8.2.2, 8.2.3, 8.4.1, 8.4.2, 8.7, T8.3, F8.3

Changed distribution of some disease vectors — 8.ES, 8.2.8, 8.7, B8.4

Substantial burden on health services — 8.6.1

| | 0 | 1 | 2 | 3 | 4 | 5 °C | |

Global mean annual temperature change relative to 1980-1999 (°C)

† Significant is defined here as more than 40%.
‡ Based on average rate of sea level rise of 4.2 mm/year from 2000 to 2080.

Figure SPM.2. *Illustrative examples of global impacts projected for climate changes (and sea level and atmospheric carbon dioxide where relevant) associated with different amounts of increase in global average surface temperature in the 21st century [T20.8]. The black lines link impacts, dotted arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left-hand side of the text indicates the approximate onset of a given impact. Quantitative entries for water stress and flooding represent the additional impacts of climate change relative to the conditions projected across the range of Special Report on Emissions Scenarios (SRES) scenarios A1FI, A2, B1 and B2 (see Endbox 3). Adaptation to climate change is not included in these estimations. All entries are from published studies recorded in the chapters of the Assessment. Sources are given in the right-hand column of the Table. Confidence levels for all statements are high.*

Figure 3. Using Scientific Reporting as Design Research. Source: IPCC (2007).

ernmental Panel on Climate Change (IPPC) Summary for Policy Makers (IPPC, 2007). This diagram shows the predicted effects of climate change on food supply as well as four other broad sustainability concerns—water, ecosystems, coasts, and health—at various degrees of global average temperature change. The diagram presents the imperative for undertaking design planning for sustainable food practices in a very compelling way. The use of the diagram here illustrates what is meant by the notion that design, while not strictly a science, can and should make use of scientific reporting.

Research : Collections

One mode of design research within the PRInCiPleS framework that is not often—if at all—represented in HCI is what I call "collections." By collections, I mean bringing a non-reductive curatorial gaze to the world apropos of the design topic at hand. The idea of collections is to gain an understanding of what is out in the world with a particularly designerly orientation. Photographic essay books like Peter Menzel and Faith D'Aluisio's "Hungry Planet" (Menzel & D'Aluisio, 2007) are a form of curatorialism that constitutes designerly observation in a manner that crosses the line between research observations and photographic arts. Each and every image in Menzel's work chronicles some aspect of world culture relevant to our theme of "Designing for Sustainable Food Practices" in a way that is not intended as reducible data, but which is rather more like curated exhibit which may inform design process as much as any technical observation work. Other examples of curatorial gaze include Burtnsky (2005), Ranjan (2010) and Art galleries and museums and any kinds of private collections in general. The idea of collections as design research is an important one and as a matter of creativity and design rationale in keeping with this present volume, may be worthy of more attention from the HCI community. Moreover, regarding photographs in particular as the material of design research collections yields a different perspective than the notion of using photographic recording as observation research, one which is germane to designerly visual thinking, a matter taken up in Blevis (2011).

Insights

The idea of the insights framework element is to describe design issues which arise out of the interpretations of the design research and which prompt design concepts. Insights may be confirmations of predispositions, or they may be different owing to the research conducted. As per Figure 1, insights are somewhat analogous to research hypotheses in the sciences—that is, initial hypotheses that have been validated by or modified as a result of secondary research. In the PRInCiPleS framework, insights owe to interpretations of primary observations, secondary lit-

erature research, and curatorial collections. There are many ways to represent insights. Prose will do. Figure 4 shows a diagrammatic semantic differential—or 2 factor model—for the "Designing for Sustainable Food Practices" example. This diagrammatic form is a good way to articulate a design space, in this case mapping various meal contexts and food sources in a space defined by a typically convenient to typically inconvenient factor, compared to a typically healthy to typically unhealthy factor. Sometimes, the space that is empty in such a diagram denotes a design opportunity. In the specific case of Figure 4, the space of not convenient and not healthy is rather a circumstance to be rightfully avoided. The insight denoted by Figure 4 is that typical fast food is not typically healthy, but is typically convenient, and that growing food yourself is typically healthy, but not typically convenient, in keeping in this case with the original predispositions. In this particular example, there is a certain amount of subjectivity—sometimes it is possible to be more rigorous than other times depending on the design domain and the quality of the design research conducted and available.

Concepts & Concept Systems

A concept is an idea for a product, communication, or strategy. A concept system is an idea for a system of concepts—products, communications, and strategies—that work together in a coherent way.

Technology, including digital technologies, are not more nor less than materials of concepts, just like any other materials. I ascribe this notion of technologies as materials of design to Erik Stolterman and Harold Nelson (i.e. Nelson & Stolterman, 2005). A concept or concept system may also call for eliminating or substituting products, communications, or strategies. Fry (2008) proposes notions of redirective practice—for example, substituting a push lawn mower in place of a gas powered lawn mover, as a matter of sustainable design, and acts of elimination—for example, replacing a lawn with wild flowers or an organic vegetable garden, as a matter of sustainable design. I believe that concepts are always political and need to be constructed in a values-rich way—not just taking values into account, not just adding value, but primarily starting with values and taking on important issues like sustainability, health, equality, and so forth. This belief is in accordance with transdisciplinary notions that values, ethics, and philosophy precede all other design choices—see Max-Neef (2005) and Nicolescu (2002) for compelling accounts of transdisciplinarity, and also Blevis & Stolterman (2009) for an account within HCI. In HCI, Batya Friedman (1997) is noted for advancing issues of the relationship between values and technology. Bonnie Nardi is also known in HCI for values-rich approaches (Nardi & O'Day, 1999). In design, Margolin (2002) and Papanek (1984) are good representatives of values-rich orientation. In our program, there is
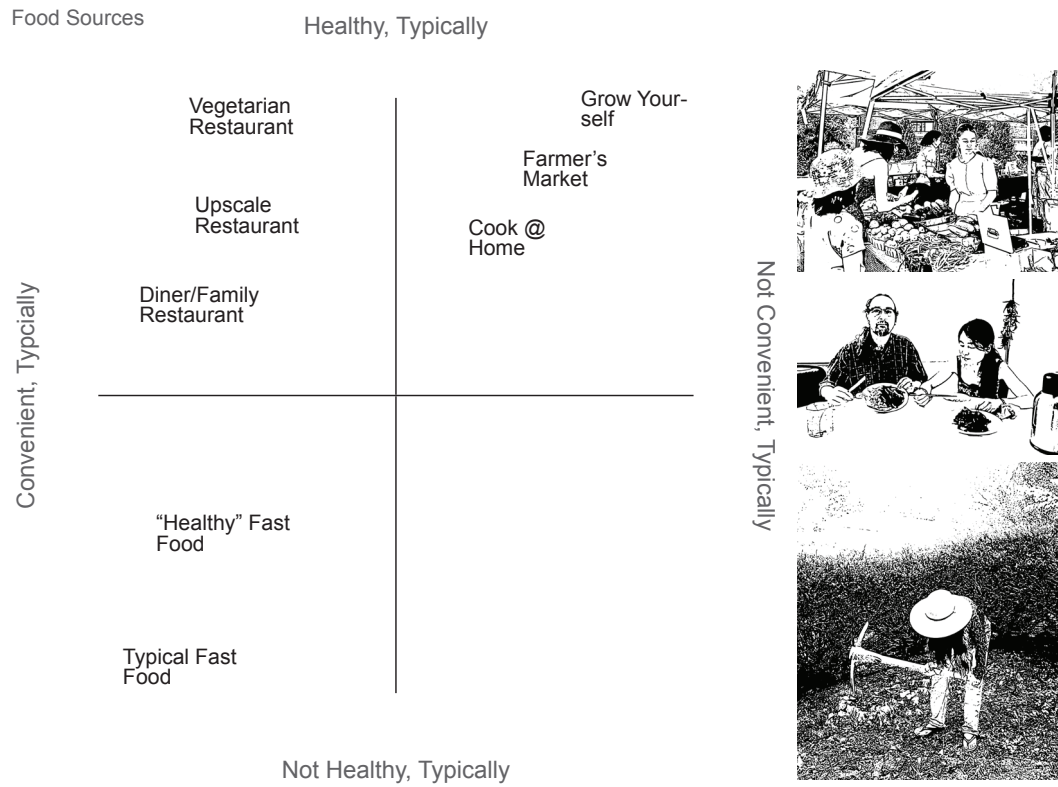
Food Sources

Healthy, Typically

Vegetarian
Restaurant

Grow Your-
self

Farmer's
Market

Upscale
Restaurant

Cook @
Home

Convenient, Typcially

Diner/Family
Restaurant

Not Convenient, Typically

"Healthy" Fast
Food

Typical Fast
Food

Not Healthy, Typically

Figure 4. Creating and representing insights by means of semantic differentials.
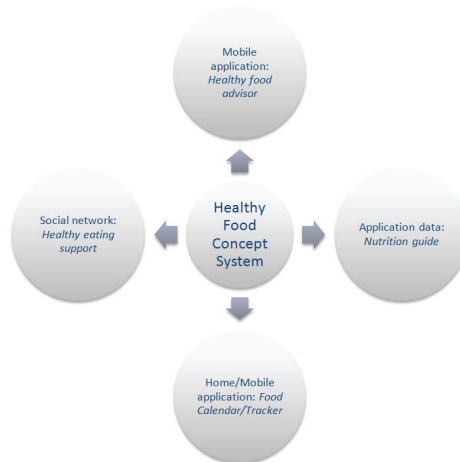
Figure 5. Concept system for healthy food design**.**

a requirement that concepts and concept systems are constructed in a values-rich way.

Figure 5 provides an example for our theme of "Designing for Sustainable Food Practices." Pictured is the very minimal sketch of a concept system for Healthy Food Choices. The diagram shows that the concept system consists of four concepts, namely a healthy food advisor mobile application, a healthy eating support social network, a food calendar/tracker for mobile and home settings, and nutritional guide and other data to support the applications. Clearly there is a lot more detail that needs to be provided to define this concept system, and this figure should be taken as only the barest sketch of an example. Notwithstanding, the important notion is that concept systems should precede concepts, as a matter of designerly approach—that is beginning with a notion of a system to promote healthy food choices precedes the notion of any particular concept in the service of that system.

The types of concepts that one focuses on as a designer determine in some sense the type of designer you are. In our HCI/d program, there are three tracks, namely (i) interaction design—a form of product and communications design, (ii) strategic design planning—a form of strategy design, and (iii) research, scholarship, and creative activity. All of the frame elements of the PRInCiPleS framework may vary depending on focus according to these three tracks, but the framework does apply to all three. Moreover, the most salient differences between the three tracks are at this level of choice of conceptual arenas. I provide the following advice to students in our HCI/d program handbook:

There are three main career goal themes in the program. These are: (i) Interaction Design, (ii) Strategic Design Planning, and (iii) Research, Scholarship, & Creative Activity.

Interaction Design
The theme of interaction design will appeal most to those students who want to design products using the materials of digital technologies. If you want to professionally design interfaces, interactive applications, social networking sites, digital products, and so on and so forth, interaction design is the theme for you. In our program, interaction design is always a values-rich theme—we require that everything we design adds genuine and sustainable value to peoples' lives and respects humankind's relationship to the natural environment.

Strategic Design Planning
The theme of strategic design planning will appeal most to students who want to start their own design consultancies, or who want to achieve executive level posi-

tions and influence in design firms or other firms that make use of digital technologies, or who want to pioneer systemic design innovations for social good. If you want to design strategy from the perspectives of social values, technological insights, and enterprise considerations, strategic design planning is the theme for you.

Research, Scholarship, & Creative Activity
The theme of research, scholarship, & creative activity will appeal most to students who are considering a career in scholarship, as a professor or researcher.

Mapping Research to Insights to Concepts

The example of Figure 5 does not really do justice to what is possible in terms of detail for a concept. A ready-at-hand small example of how concepts follow from insights which follow from research, and the corollary—how research leads to insights which lead to concepts, appears in Figures 6A and 6B. This example does not follow our theme of "Designing for Sustainable Food Practices." It is an example I use as a model solution for a course in HCI and design, which uses an approach to teaching I call Design Challenge Based Learning (DCBL). I have reported on this example in article about DCBL Blevis (2010):

A very common project in introductory HCI classes is to ask students to design a thermostat that illustrates their understanding of the commonly held incorrect mental model many people have of a thermostat as a continuous control rather than the switch that its operational semantics actually denote. The DCBL approach in my treatment recasts this problem, not as a problem of incorrect mental models and thermostat design *per se*, but rather as a design research project about what makes a space comfortable paired with a design concept project about how to use digital technologies as a material of creating comfortable spaces. My model solution for the design research project describes a passive climate control green home as an example of comfort achieved with minimal energy, a Pullman train dining car as an example of old-world notions of opulence and comfort, and thermostatic climate control devices in a car and a home that are clearly hopelessly complex and unusable (Figure 6B). My model solution for the design concept project describes a wearable encoding of temperature preference and ambient room sensors that enable temperature preferences to follow people rather than be assigned to individual locations (Figure 6A). The description is:

Concept: E-Ink Fabric Wearable Personal Thermostat & Ambient Sensors
The idea of this concept is that a digital thermostat control is woven into the fabric of clothing or worn like a bracelet or as part of a watch. The control travels with the wearer and electronically signals (many tiny transmitter/receiver technologies are
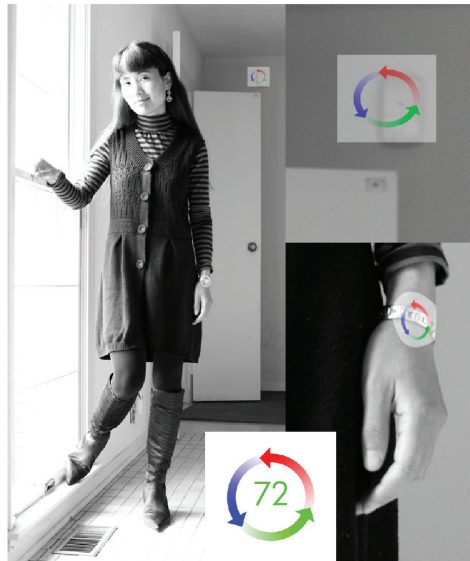
Concept: E-Ink Fabric Wearable Personal Thermostat & Ambient Sensors

The idea of this concept is that a digital thermostat control is woven into the fabric of clothing or worn like a bracelet or as part of a watch. The control travels with the wearer and electronically signals (many tiny transmitter/receiver technologies are available) desired temperature settings to the ambient sensors in whichever environment the wearer occupies at the moment. The environment—home, office, car, train, plane, etc.—adjusts to the needs of its occupants based on reading the desired setting, averaging desired settings when there is more than one person present, or tailoring to specific individual settings where possible, as in—for example—a car equipped with individual climate control settings capabilities. When no one is present in a particular environment, that environment does not need to use as much energy to maintain a temperature and its climate control system can respond accordingly. There are of course details to work out about how fast an environment needs to react to the entrance of a person and to what extent an environment needs to keep a certain temperature when empty in order to respond quickly. These details need to be worked out as a matter of energy use versus convenience and perceived viability of the system.

Research

source [2]
Passive Climate Control Green Home
passive | acts of elimination

source [3]
Dining Car
comfortable and absent of digital controls

source [1]
Digital Thermostats
variance of control design and interactivity by location | less than thoughtful usability design

Insights

Elimination
Can we eliminate the need for interactivity in climate control systems and still afford comfort while also acting more sustainably?

Locations
Why do controls need to vary by location? Why are they different in automobiles than in homes?

Usability
Why are programmable home thermostats so hard to use?

Concept

Allow individual temperature setting preferences to travel with the person in wearable, reconfigurable forms. Let each location sense the preferences of the people in it and respond systemically by use of environmental sensors rather than interactive devices.

Figures 6A/B. Research to insights to concepts (also appears in Blevis, 2010).

1. Image source for picture of woman in hallway, automobile and home climate control devices : E. Blevis
2. source: http://www.flickr.com/photos/jeremylevinedesign/3590460562/ @ 9.14.09 under creative commons license
3. source: http://www.flickr.com/photos/14589121@N00/2070419285/ @ 8.31.09 under creative commons license
4. Image source for circular arrows: http://www.mattstow.com/circular_arrows.html @ 9.21.09

available) desired temperature settings to the ambient sensors in whichever environment the wearer occupies at the moment. The environment—home, office, car, train, plane, etc.—adjusts to the needs of its occupants based on reading the desired setting, averaging desired settings when there is more than one person present, or tailoring to specific individual settings where possible, as in—for example—a car equipped with individual climate control settings capabilities. When no one is present in a particular environment, that environment does not need to use as much energy to maintain a temperature and its climate control system can respond accordingly. There are of course details to work out about how fast an environment needs to react to the entrance of a person and to what extent an environment needs to keep a certain temperature when empty in order to respond quickly. These details need to be worked out as a matter of energy use versus convenience and perceived viability of the system.

The intermediary step between the research and concept is shown in Figure 10B to include insights about elimination, locations, and usability. This relationship between research and concepts mediated by insights is at least one way to understand a notion of methodological approach to creativity as part of design rationale.

Prototypes

According to Figure 1, a concept is analogous to an experiment design, and prototypes are analogous to experiments. The HCI literature frequently distinguishes high fidelity and low fidelity prototypes. To these, I add a third kind of prototype, appearance prototypes. Notions of prototypes are well understood in HCI and there is little to add here. Low fidelity or behavioral or exploratory prototypes are designed to push the boundaries of concepts. Appearance prototypes are designed to show the look and feel of a concept. High fidelity prototypes are designed to demonstrate that a concept is technically viable and usable.

For the example of "Designing for Sustainable Food Practices," specifically the concept system shown in Figure 5, we can imagine examples of prototypes as follows.

A low fidelity (or behavioral or exploratory) prototype for the healthy food advisor mobile application might involve an over-the-shoulder study. This would entail following a willing person around pretending to be the application, commenting on food choices the person makes as she or he makes them. One expects that such a prototype would reveal how annoying a healthy food advisor might become to many people and respond to such revelations with design changes. Observations conducted in the service of research to develop insights are distinct from observa-

tions conducted to experiment with behavioral prototypes—this point seems obvious, but is often a point of confusion for students.

For an appearance prototype, we might produce relatively high production value visual representations of what the healthy food advisor application will actually look like. At the level of concept system, we might produce communications that enable people to understand the system and its components.

For a usability prototype, we may actually want to program enough of for example, the food tracker/calendar status program or other system elements to be able to conduct a task-directed usability study.

Prototyping—at least low and high fidelity prototyping—is well understood by the HCI community, and there is no need for further treatment here.

Strategies

To complete a design plan or explanation requires producing a strategic diagram of how a concept system may be implemented according to social value, technology, and enterprise concerns. These are not very different than business plans, except that they emphasize social values and technology as well as the economic sustainability of a concept.

Figure 7 shows a sketch of a design plan for our theme of "Designing for Sustainable Food Practices." The figure shows that such a plan is developed in terms of level of details, and may in fact be illustrated at the leaf levels. The social value plan includes scheduling of activities to promote the health possibilities, study system effects, tweak the system, and advertise results, as examples. The technology plan includes scheduling of activities to create the information architecture, system elements development, beta testing, and roll out, as example activities. The enterprise plan includes scheduling of activities to create alliances with food providers, promote the system, and calculate chasm crossing—the point at which the enterprise becomes economically sustainable, as examples (see Moore, 1999). The figure also shows a second level development of a specific activity in the technology plan, expanded to show the detail of activities to create research studies, prototype studies, use case analyses, data sourcing, and object-oriented models, as examples. Finally, a plan for experience studies and paper prototype studies appears in Figure 7 as yet a further, illustrated expansion of the second level technology plan.

Strategic Design Plan: Sustainable Food System

Level 1

Social Values	Y1.Q1	Y1.Q2	Y1.Q3	Y1.Q4	Y2.Q1	Y2.Q2	Y2.Q3	Y2.Q4
promote possibilities	□	■	○	○	○	○	○	○
study system effects		□	■		□	■		
tweak system			□	■		□	■	
advertsie results				□	■		□	■
...								

Technology	Y1.Q1	Y1.Q2	Y1.Q3	Y1.Q4	Y2.Q1	Y2.Q2	Y2.Q3	Y2.Q4
information architecture	□	■	○	○	○	○	○	○
system elements	□	■	○	○	○	○	○	○
research & evaluation			□	■		□	■	
roll outs				□	■		□	■
...								

Enterprise	Y1.Q1	Y1.Q2	Y1.Q3	Y1.Q4	Y2.Q1	Y2.Q2	Y2.Q3	Y2.Q4
chasm crossing				□	■	○	○	○
capitalization	□	■	○	○	○			
promote system		□	■	○	○	○	○	○
create alliances			□	■	○	○	○	○
...								

Level 2

Technology: IA	Y1.Q1	Y1.Q2	Y1.Q3	Y1.Q4	Y2.Q1	Y2.Q2	Y2.Q3	Y2.Q4
research studies	○	■	■	○	○	○	○	○
protoype studies			□	■	■	□	■	■
use case analysis		□	■	○			○	○
data sourcing			□	■	□	■	○	○
object oriented models					□	■	○	
...								

Legend: ○ ongoing activity | ■ primary activity | □ preparation for activity

Technology Strategic Design Plan: Sustainable Food System Collaborative Menu Planning Research & Prototyping Plan

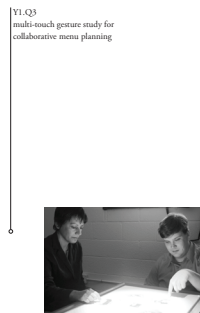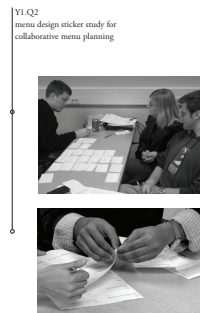| Y1.Q1	Y1.Q2	Y1.Q3	Y1.Q4
experience studies	menu design sticker study for collaborative menu planning	multi-touch gesture study for collaborative menu planning	
paper prototype usability studies			detailed paper prototype study for collaborative menu planning
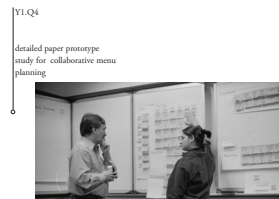
Figure 7. Representing strategies.

HISTORICAL BACKGROUND & ATTRIBUTIONS

Prior & Anticipated Work, Commons Advice

This chapter is closely related to prior and anticipated publications, and as such it requires necessary disclosures and attributions. I—alone and with various others—have described the notion of design plans or explanations and the PRInCiPleS framework here and there over some time, but never before in an archival format. The prior non-archival work which describes design plans or explanations and the PRInCiPleS framework in substantive ways is Blevis (2004), Notess & Blevis (2004), Blevis & Siegel (2005), Reed, Wang, & Blevis (2005), Blevis, Lim, Stolterman, & Makice (2008), and Blevis (2010). Kindly note that much of this present chapter will also appear in "Design in the Age of Climate Change" (Blevis & Blevis, 2013, anticipated) and that an account of the use of design plans or explanations and the PRInCiPleS framework in design pedagogy will appear in "The Design Habit" (Siegel, 2013, anticipated).

Origins and Historical Attributions

The PRInCiPleS framework in particular is my augmented account and renaming of what is or is at least closely inspired by a design framework for product and strategic design planning that is part of an oral, pedagogical tradition I learned while teaching in the late 1990's with Dale Fahnstrom, Greg Prygrocki, and Patrick Whitney at The Institute of Design at IIT in Chicago. ID-IIT is a school of design thinking as much as it is a design school, most famous because for a short time during 1937-1938, it was officially known as the New Bauhaus, and remains so associated unofficially. The observation that one of the design tasks which presents the most difficulty is making sure that analysis leads to synthesis in a sound way and that synthesis follows from analysis in a sound way also owes to this mid 90's teaching experience at ID, especially to Fahnstrom's, Prygrocki's, and Whitney's insights into design pedagogy.

There are other influences as well, aside from these origins at ID. Nonetheless, as a matter of historical fact and sound scholarship, the origins of the PRInCiPleS framework that occur in large part in the traditions of design planning at ID may not be discounted, and must be so acknowledged by those who use this framework. The importing, adaptation, augmentation, renaming, and refinement of this method into the pedagogical framework that serves as a substantial part of the infrastructure of the HCI/d program I now direct should equally be attributed to the non-archival works I describe above, as well as to a practice which is now in place in the program. Moreover, one of the goals of this chapter is to provide a definitive summary

of and reference for this prior mainly non-archival reporting, without the need to refer to these earlier sources.

It may seem that these origins and attributions are described here in a manner more than necessary. I do this because design methods in design schools have somewhat of a guild knowledge status. Consider that (i) in writing about a scholarly abstraction derived from design practice, it is important to appropriately honour the framers of the design of design as it is practiced in design schools, where practice and hard-won experiential knowledge and reflection precede scholarship in some sense and perhaps in another sense are an alternative notion of scholarship worthy of recognition, and (ii) after a decade of graduating students who use the PRInCiPleS framework as an organizing device for design, it is important to provide an alternative to their sometimes less than careful attribution of the framework and its origins by here providing a definitive, archival source to be referenced—one which in turn chronicles and honors the hard won insights of others whose work precedes it.

In the sometimes guild-like context of a design school, notions of design methods and frameworks may sometimes be considered to be intellectual assets and proprietary knowledge. In the context of scholarship—at least in design-oriented HCI—notions of design methods and frameworks are more oftentimes considered to be foundational knowledge that is meant to be widely disseminated, discussed, studied, deployed, and advanced. I write what precedes in this paragraph from personal experience and as a matter of conjecture only—attitudes about proprietary guild knowledge and foundational scholarly knowledge must surely vary widely within both design and HCI. The real point here about design frameworks and methods is that nothing really exists in a vacuum, if one is willing to look around—for example, one of the most widely known design methods in design-oriented HCI is Contextual Design (Beyer & Holtzblatt, 1998). In Notess & Blevis (2004), the PRInCiPleS framework is compared to Contextual Design, and here the comparison is tabulated in Figure 8 as presented in that source. There are differences. There are similarities. For a complete explanation, please see Notess & Blevis (2004).

In 2002, Marty Siegel and I founded the Human-Computer Interaction/design (HCI/d) Program at the then new School of Informatics—now, the School of Informatics & Computing—at Indiana University, Bloomington. This program has come to be known as possibly the design-oriented HCI program with a strong presence in HCI venues like the ACM SIGCHI, DIS, and CSCW conferences, as well as at design conferences such as DPPI, IASDR, and DRS. From the very first, the PRInCiPleS framework was used as an organizing pedagogical framework, and Marty Siegel and I discussed it at length as a matter of curricular organization. Figure 9 shows a sketch of the logical structure of a design plan for a digital music

Contextual Design	PRInCiPleS
	predispositions
contextual inquiry	research
work modeling	
consolidation	insights
work redesign	concepts & concept systems
user environment design	
paper prototyping	prototypes
	strategies

Contextual Design Steps		PRInCiPleS Design Framework Elements	
Step	Activities and Deliverables	Element	Description
		predispositions	enumeration of all significant points of view about the population being designed for
contextual inquiry	pairs of design team members observe work practice in the field, co-interpreting data with users	research	data from observations of the target population and/or collected instances of the culture being studied and/or literature review
work modeling	back with the design team, replay the story of what was observed while other team members create diagrammatic models to organize and represent what was observed: sequence model – intents, steps flow model – movement of work between people in the form of communication or artifacts cultural model – pressures, influences and emotions within the work environment physical model – workspace layout, computer screen layout, network topology, etc. artifact model – objects created or used to accomplish work		
consolidation	design team looks across multiple sets of models to combine data in a way that shows the larger patterns without hiding details and differences	insights	interpretations of the research data that express essential opportunities for improvement of the environment of the target population relevant to the designer's focus and values
work redesign	design team uses consolidated models to share findings with the larger community of stakeholders and conducts a visioning session to generate ideas for improving users' work; one or more ideas are selected for storyboarding	concepts & concept systems	an enumeration of design ideas germane to insights gained from research, organized into systems of concepts that work together coherently to create an improvement in the human condition of the target group
user environment design	a system design is created by walking through a storyboard to identify the main components ("focus areas") of the system and the necessary pathways or connections between them		
paper prototyping	low-fidelity paper prototypes are generated from the system design; prototypes are taken back into users' contexts and users "operate" the prototypes to see if they work better than their current methods; findings from prototype interviews are used to validate and refine the design	prototypes	high (working) and low fidelity (behavioral or exploratory) and physical (appearance) expressions of selected design concepts, useful for concept exploration and refinement
		strategies	a proposal for moving forward, not neglecting business, technical, or social and ethical issues

Figure 8. Comparison of Contextual Design steps with PRInCiPleS framework elements (reproduced from Notess & Blevis, 2004).
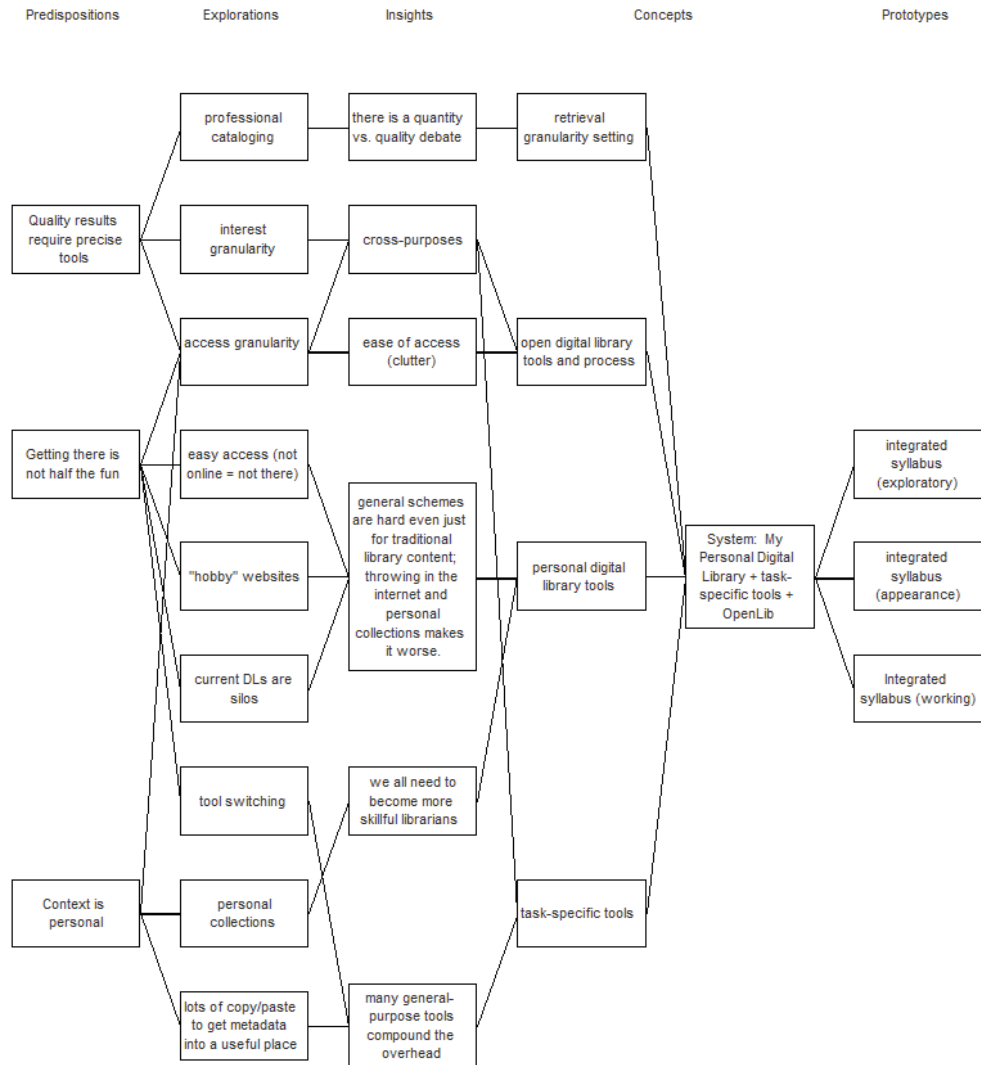
21

**Figure 9.** Mark Notess' Digital Music Library project (reproduced from Notess & Blevis, 2004).

library system of concepts organized in this framework from the very first course offered in 2002. The sketch is by Mark Notess, and it is reported also in Notess & Blevis (2004). At the time, the acronym PRInCiPleS was not used *per se,* rather the much more inscrutable acronym PEICPS was used to denote Predispositions, Explorations (a relaxed notion of research—since design research, that is research conducted in the service of design has different emphasis than scholarly research in many people's minds), Insights, Concepts, and Strategies. By 2004, I proposed the acronym PRInCiPleS in response to critical feedback about the inscrutability of PEICPS and the first detailed design plan—concerning sustainability and travel— appears in Reed, Wang, & Blevis (2005), to which the reader is referred for a much more elaborate and much better illustrated example than what appears here. The design plan in this example is Reed's Masters of Science in HCI/d "Capstone" thesis. The illustrations in the article are by Wang and they are so delightful as to prompt a specific invitation here to the reader to consult that source. Two of Wang's concept illustrations appear in Figure 10.

The notion that the PRInCiPleS framework may be understood as an informal (in the mathematical sense) notion of design as proof is represented by Figure 11A, which shows a logical style sketch of a design plan based on Alexander et al.'s (1977) Shopfront Schools pattern that may possibly annoy logicians for being too informal, and designers for being too formal. In Blevis, Lim, Stolterman, & Makice (2008), the problems of trying to integrate formality (in the mathematical sense) into design curricula are noted. Figure 11B shows a more abstract diagram of the kind of relationships expressed in Figure 11A, this time distinguishing presentation order from process order—that is, distinguishing the idea that design plans or explanations may be described in terms of logical connections between the framework elements is primarily a technique of presentation and that in practice, design processes are not so neatly ordered. In practice, one may have a concept before having done adequate research, insights may arrive after prototyping, and so forth. This observation about ordering in practice is the reason I claim that PRInCiPleS is a framework and not a process.

The relationship between these attempts at formality in design and the design rationale (i.e. Moran & Carroll, 1996), and pattern languages (i.e. Alexander et al., 1977), and even ideas like ontological designing (i.e. Winograd & Flores, 1986) must be noted. Nowadays, the PRInCiPleS framework is used in the context of our HCI/d program as an informal organizing structure for interaction design and strategic design plans. Based on my experiences at a design school, and now at a school of informatics and computing, I have concluded that rigor should not be taken to be a goal in-and-of-itself. It is at its best a tool of evidence. One hopes for students who are neither afraid of rigor, nor embrace rigor as an end goal. One hopes for
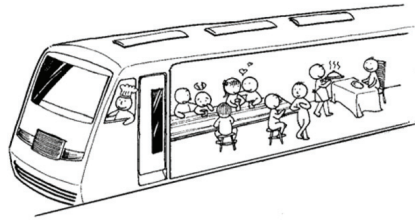
Dining and Drinking Subway/Train
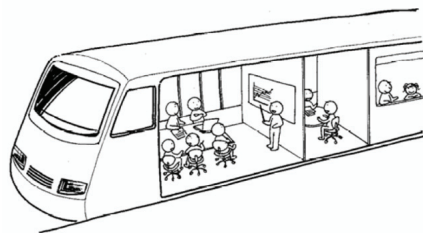
Company Skybox Subway/Train

Figure 10. Two concept illustrations by Hui-wen Wang (reproduced from Reed, Wang, & Blevis, 2005).
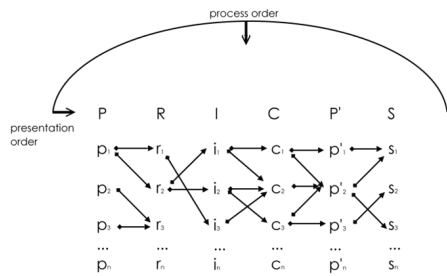

Figure 11B. Distinguishing process order and presentation order.

Title:
Distributed Learning
…
Predispositions (Viewpoint):
P1: Everyone is entitled to an education
P2: There aren't always enough resources to go around
…
Research-Observations:
P1,P2 ⇨ O1: Some of the townspeople in college towns have never been on the campus; Universities are sequestered from the general public
P1,P2 ⇨ O2: Not everyone can afford to attend the best colleges or universities
P1,P2 ⇨ O3: Internet technologies enable wider distribution of quality materials in the same manner that the introduction of recording technology enabled people to listen to the best performers
…
Insights:
O1 ⇨ I1: To make education accessible to everyone, it's a good idea to move the physical campus into the community with less intimidating artifice
O2,O3 ⇨ I2: To make education accessible to everyone, it's a good idea to distribute it more widely
…
Concepts:
I1 ⇨ C1: Shopfront schools (after Christopher Alexander)
I2 ⇨ C2: Distance education
…
Prototypes:
C1 ⇨ Pr1: Study Sylvan Learning Systems
C2 ⇨ Pr2: Study Existing Distance Education efforts
…
Strategies:
Pr1 ⇨ S1: Evaluate effectiveness of existing Shopfront education enterprises and develop plan for improvement, perhaps integration with other forms of democratization of learning
Pr2 ⇨ S1: evaluate effectiveness of existing distance education enterprises and develop plan for improvement, perhaps integration with other forms of democratization of learning
…

Figure 11A. Design explanation example fragment expressed as a frame, based on Christopher Alexander's Shopfront Schools Pattern (reproduced from Blevis & Siegel, 2005).

students who take rigor as a means of creating evidence for their design plans and explanations, and values-rich design as the end goal. In practice, this is one of the hallmark traits of our best and brightest students.

Purpose

This chapter serves several purposes, namely (i) the purpose of finally chronicling the origins of PRInCiPleS and documenting in an archival way my own present thinking about PRInCiPleS, (ii) as a kind of entre into the world of this notion of a design rationale framework for the many students whom I will ask to read it, and (iii) as an account of how creativity and design rationale are supported structurally within a curriculum and notion of design practice in a way which may appeal to others.

The students to whom I refer above will be asked to read this chapter as a chronicle of and manual for a heretofore primarily oral tradition and practice—that is the use of the PRInCiPleS framework as a notion of design rationale, which serves as one form of curricular organization within the program I direct. It is also my purpose that these students will as a consequence of reading this account of the structure of their curriculum take up an interest in the broader literature about creativity and design rationale elsewhere in this volume. The more general reader can understand what follows as a descriptive, quasi-ethnographic account of an oral tradition that scaffolds and structures a curriculum and the practice of its graduates, with a special emphasis on what it is about this curriculum, practice, and framework that fosters creativity as well as why and how this curriculum might be adopted by others, insofar as it is not already common.

ANALYSIS & THE FUTURE OF PRINCIPLES

As described above, a more or less complete example of a design explanation constructed according to the PRInCiPleS framework appears in Reed, Wang, & Blevis (2005). An interesting example of a design explanation based on observations and literature research, insights, and concepts only to support designerly collaborations appears in Wang & Blevis (2004). The students in our HCI/d program maintain a site (www.hcidpeople.com) with links to all of their individual professional, personal sites, and many of these sites contain projects that are structured according to the PRInCiPleS framework with varying degrees of fidelity to the framework. A particular future goal is to curate many examples of the best of this work on our program site, and to see some of it published. Another particular future goal is to see others use and adapt this framework to their own needs and sensibilities and advance the designerly culture within HCI.

Like any treatment that attempts to explain too much with too broad a brush, this account of the PRInCiPleS framework, its origins, and context of use, is likely to cause any particular reader to think of certain under-referencing about certain aspects of what precedes and the need for further comparison between the framework and other notions of design process. The PRInCiPleS framework is not in-and-of-itself a "very big deal," but notions of design processes and frameworks are important. The treatment of PRInCiPleS and its role in a particular curriculum here is more existentially quantified account than universally quantified advice. The relation of PRInCiPleS to other notions of design rationale is material for another chapter or article, possibly written by another author.

More importantly, the publishing and chronicling in a more public way of the many design projects that have been organized according to this framework holds much more utility for the future of the PRInCiPleS framework than do the implications of the framework as a design theoretic construct. This is a curatorial point of view— that collections of design plans or explanations constructed according to the PRInCiPleS framework are themselves a form or genre of design research and that more and more interesting individual such plans or explanations are at least as salient to advancing understanding of design as more and more refinement of the abstract framework. Moreover, I argue that it is the curatorial point of view which is most appropriate to connecting notions of creativity to notions of design rationale. To put it more simply, to understand the relationship between creativity and design rationale, collect more and more examples of design explanations and plans as artifacts of study in-and-of their own right.

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