DESIGN
Principles & Practices:
An International Journal

Volume 2, Number 3

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DESIGN PRINCIPLES AND PRACTICES: AN INTERNATIONAL JOURNAL
http://www.Design-Journal.com

First published in 2008 in Melbourne, Australia by Common Ground Publishing Pty Ltd
www.CommonGroundPublishing.com.

ISSN: 1833-1874
Publisher Site: http://www.Design-Journal.com

DESIGN PRINCIPLES AND PRACTICES: AN INTERNATIONAL JOURNAL is a peer refereed journal. Full papers submitted for publication are refereed by Associate Editors through anonymous referee processes.

Typeset in Common Ground Markup Language using CGCreator multichannel typesetting system
http://www.CommonGroundSoftware.com.

Future Design: Impossible Problem Solving by Novices

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Abstract: How will humans take responsibility to design their own future while living in the present? Human beings already possess the motivation and innate thinking abilities to make these decisions. Technological processes and tools now exist to help informed citizens to respond to day-to-day problems as well as the more serious problems such as natural disasters. Future Design provides a conceptual thinking framework to organize problem types, technological processes and systems, and human abilities.

Keywords: Design, Future Design, Future Designer, Problem Solving, Novices, Decision Support Systems, Portals

Introduction

DESIGN CAN BE a proactive process which engages people with potential problems rather than reactions after the fact (Banathy, 1996). Future Design provides a conceptual framework to leverage the innate and developing features of humans, social processes (i.e., dialogue and collaboration), technological systems and tools to address pressing, messy, intractable, and seemingly impossible problems. The very large problems that fit this category of seemingly impossible problems include disease, pandemics, natural disasters, and terrorism, problems that would appear to experts as impossible problems. What are common citizens to do when faced with such problems? On a more local and personal level individuals and groups will need to assume responsibility for their safety, health, education, and well-being, as governments fail to meet the "general welfare" of its citizens. More and more institutions, corporate and governmental, offload many details and responsibilities to customers. While governments, institutions, and organizations will continue to serve important functions, individuals and groups have already begun to mobilize action to provide their own welfare. In cases of floods, for example, people cannot wait for assistance. They must act.

How will humans take responsibility to design their own future in the present? Literate human beings possess the motivation and innate thinking abilities that are up to the task. In addition, technological processes and tools now exist to help informed citizens to respond to serious threats as well as manage their day-to-day challenges. How can we leverage these capacities, human motivation and cognition, as well as technological tools? The notion of Future Design aims to organize these capacities into a way of design thinking aimed at this design problem – how do we design our future in the here and now?

This paper provides an overview of Future Design and consists of three sections. The first section describes three categories to organize problems. Section two summarizes the cognitive abilities that humans have to address these complex problems. Section three profiles Future Design systems, and the skills and sensibilities of the Future Designer.

Problem Categories

Problem complexity has been characterized in a number of ways. A common approach is the use of well-defined, ill-defined, and wicked as labels for the continuum of problems. Well-defined are school-type problems where a clear goal is known, a procedure can be applied, and the correct solution obtained. We grow up thinking that most problems are like this. Most problems are ill-defined problems, which are characterized by fuzzy goals and procedures, and the effort expended usually involves trying to clarify the problem. Wicked problems (Churchman, 1967) are those whose scope cannot be bounded or understood and for which there is no definitive answer. In other words, the problem can't be clearly formulated (Rowe, 1987). Impossible problems generally cover both the ill-defined and wicked categories. The following three categories more closely relate to the issues faced by humans. We can categorize the future in terms of routine problems, survival problems, and change problems (see Figure 1).

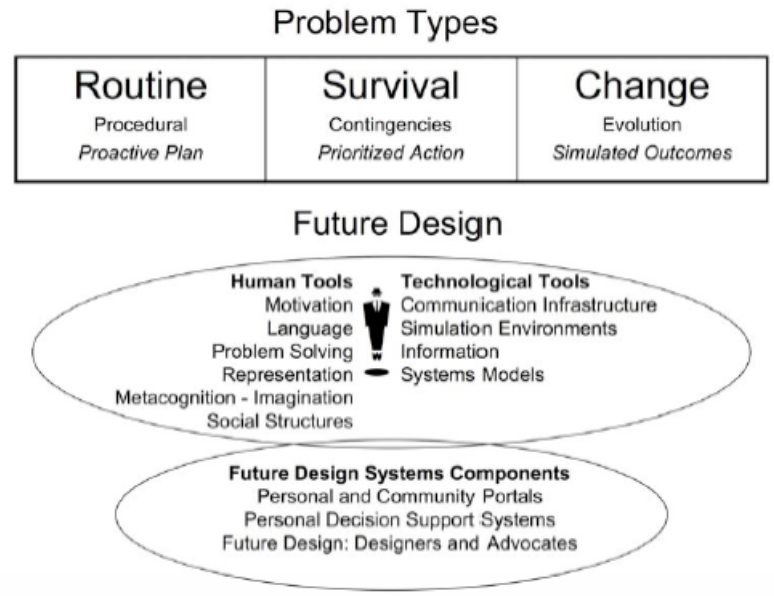

Figure 1: Future Design Problems and Solutions

Routine Problems

Responsibility for daily life has always been the domain of the individual and the family. Paying bills, searching for a health care provider and participating physician, and financing college are typical routine problems that can be seen in advance and addressed or solved. Individuals tend to discount the need to make decisions and/or the belief that institutions and governmental agencies will impose decisions on them. Daily life continues to be constrained by institutions and governments, and by the unseen consequences of technological innovation. Much of daily life requires navigating these constraints and impacts. More and more time is needed to manage one's personal affairs even with technological progress. Routine problems consist of complex options with short-term benefits and unknown long-term implications. However, routine problems are known in advance, and a proactive, procedural plan can be developed to address them.

Survival Problems

Three examples of survival problems include natural disasters, terrorism, pandemics, and incurable disease. Natural disasters, such as hurricanes, tornadoes, floods, drought, volcanic eruptions, earthquakes, and meteorite impacts, can also include gradual changes brought about by global warming. Radical changes could involve results of nuclear winter, the shift of the moon's orbit, or pole shifting of the earth's magnetic field. Terrorism provides a more recent survival problem brought about by racial cleansing, violence between religious groups, undermining of governments through corruption and assassination, chemical warfare, and destruction of neighbourhoods and infrastructure. Pandemics have always occurred throughout human history but have taken on serious implications given technological developments in genetics. Incurable diseases represent a survival issue for individuals, but are no less serious than natural disasters, terrorism, or pandemics. Disease presents the most personal of survival problems. Documentation of these efforts can be found in movies and books. A commonality amongst these stories is the motivation of individuals, family members and extended family advocates who struggle against what they don't know and connections they do not have. Survival problems cannot be predicted, fully characterized, and their impact overwhelms the capacity of any existing system. Addressing survival problems relies partly on contingency plans based on prior experience but also on the immediate needs of people in a specific situation. Prioritized action steps are required, some of which are based on lessons learned while some action steps are unique.

Change Problems

Citizens face the dilemma of change. While we understood that change is inevitable and necessary, we tend to resist it. Change tends to be long-term and not an item on one's "To Do" list. Change problems, however, do exist and that ultimately there will be a realization that existing paths of action will lead to significant consequences. The "solution" to change problems is evolution, or the capacity of people or systems to learn, modify, change, or grow. Awareness of change problems signal a need for people to make long-term proactive change decisions in light of multiple paths or scenarios (Schellnhuber,

Crutzen, Clark, Clausssen, & Held, 2004). Proactive decision-making enables humans to become aware of and address serious consequences of prior decisions by individuals, groups, institutions, and governments, as well as the impact of technological innovations. However, change problems tend to be low priority, require significant resources, and they resist consensus due to their apparent intractability. The value of simulations and virtual environments are that they will be needed to help citizens experience an existing path as well as alternative routes (Stanney, 2002).

Human Problem Solving Tools

An important idea behind Future Design is that humans possess unique problem solving tools as well as technological tools. Humans possess the innate ability to recognize and solve complex problems. Another unique trait is that humans tackle problems that technically cannot be solved because of information that is incomplete, redundant, ambiguous, and even incorrect (Lauriere, 1990). Ironically, these technical deficiencies enable humans to be motivated to address impossible problems, and specifically for designers to do their work. Humans possess very unique and powerful mechanisms to understand the world, the most important of which is language, the ability to communicate thoughts, feelings, and actions to others.

Problem Solving

There has been much literature describing novice and expert differences in problem solving (e.g., Newell & Simon, 1972). The logic behind such studies is that knowing how experts solve problems provides a benchmark to develop such expertise over time. While it is true that deep expertise and understanding requires time to develop, frequently cited as a deliberate practice of ten years (Ericsson, 1996), there are problems which require immediate attention depending on their severity. Novices solving any kind of problem need motivation and a set of beliefs about their ability to tackle such problems, as well as systems and tools that contribute to their development as intelligent novices (Bruer, 1993), those who can control and monitor their thought processes and make use of general strategies when necessary. Without these conditions, the human problem solver suffers from the internal limitations that Simon (1996) described as those who believe that they cannot accomplish a task will not attempt the task. One of the values of novices is that they are unaware of what they don't know, but are metacognitively aware of what they do know. Because experts may not be working on problems, intelligent novices are left to tackle them. Two values to novices are that they are intensely motivated to find a cure for a relative's disease and that they dedicate the time and resources (e.g., Weiner, 2004). Again, the quotation from a student is worth repeating here, "There is always a glimmer of hope in an impossible situation."

Humans tap whatever experiences and skills and beliefs they have in the moment. For example, the idea of satisficing (Simon, 1996) characterizes the human ability to make decisions with existing resources or past experience. Humans rarely have all of the knowledge and resources at hand, are unaware of what might occur from all options, and have faulty memories. Satisficing occurs when playing games, solving problems, and making financial decisions. Designers also "satisfice" when they make decisions based on what information they can gather in the time available.

Humans possess an array of innate tools to solve everyday problems. Some are rational approaches, including formal processes, systems, and thinking. Some approaches are non-rational, such as folk theory and tradition, common sense, and heuristics. Humans sometimes blend the rational and non-rational when they consciously talk through options, such as in town hall meetings and focus groups. Voting, for example, can be for some the result of carefully considered options while for others a choice is based on one or more sets of beliefs or perceptions, and no deliberation is needed.

Representation

An important mechanism of interest to designers is the human ability to represent everyday problems using mental models, gestalt pictures, iconic images, diagrams, and metaphors and analogies. Understanding any kind of phenomena or problem benefits from any means to know what parts make up an entity. Mental models are internal constructions that form the basis for our understanding of how things work, such as electricity. One may not be aware of the mental model for electricity, and our representation may be wrong conceptually or procedurally, but we get by if the light comes on when a switch is thrown. Gestalt pictures depict visually an idea or issue in a way that words cannot capture. Many memorable images from current events fit into this category (e.g., the World Trade Towers on September 11; stereotype of Appalachian families). Variations to Gestalt pictures include iconic images that provide a simple representation of a company through a logo and sign system, or internationally understood traffic signs. Our conceptual understanding may be retrieved through the use of mental models, Gestalt pictures, or icons. Diagrams, meanwhile, provide a tool to represent complex representations in the form of hierarchies to denote the relationships between the

parts. Diagrams are important educational devices to supplement text with visual representations. Examples include analytic (e.g., picture glossaries, scale diagrams) and synthetic diagrams (e.g., cutaways and cross sections), graphs, time lines, maps, tables, and graphic design (Moline, 1995). Analogies are figures of speech which suggest that something is like something (e.g., life is like an adventure), while a metaphor for life could be a ship. An analogy is an explicit verbal (written or spoken) connection between one thing and another, while a metaphor is a visual representation of that connection. The human repertoire of representation provides numerous options to understand problems, and depict and communicate "solutions".

Metacognition and Imagination

Humans have the ability to think about how they think, to make judgments on this process, and to make changes. Humans become more self-aware of individual skills or lack of skills. We can monitor, we can plan, and we can adjust. This awareness is key to solving routine, survival, and change problems. Without self-awareness and adjustment, we cannot hope to develop our problem solving abilities.

Meta-thinking and imagination are not usually discussed on the same page. While metacognition is the idea that we can think about how we have thought in the past, imagination may be meta-thinking set in the future. Going beyond what we physically see, to envision possibilities, some of which may be fanciful and based not on information but on desire, is an exemplary human ability. Perhaps daydreaming in school should be encouraged or nurtured in some ways as directions for learning (Egan, 2003). Imagination could be the one strength and the one direction that informs the motivation of citizens to tackle impossible problems as well as suggest new paths to solving them. The cognitive nature of metaphors, in particular, may be productively used to represent the mechanism of a disease and even suggest an approach to its cure. Imaginative pictures or stories also provide a stopping point for intractable problems. Technically, impossible problems have no stopping point in terms of a classical "solution."

Social Structures

Language, problem solving, representation, metacognition, and imagination are means for humans to survive in the world, solving immediate or long-term problems. Our propensity to live in groups and communities implies a human-readiness to collaborate in the face of routine, survival, and change problems. Cultural norms sometimes dictate the readiness or expectations to participate in rituals and events. Communities are tested in survival problems or sub-groups of communities may clash vying for control or autonomy. For species other than man, change issues are out of their hands. Humans, however, have the capacity to plan for the future rather than just reacting. Despite our cognitive capacity to do so, humans are predisposed to problems of the moment and near-future. A future-orientation is difficult to comprehend, requires time and resources that cannot promise a cure, and there are always problems that are more immediate. Humans sometimes act in routine problems (e.g., financial planning), always react in survival situations, but do not always act with a long-term view as the pay-off cannot solve our immediate needs and desires.

Within social structures humans communicate using conversation, debate, and dialogue, all of which can be used in any design activity. Each of these three differ in terms of one-way or two-way perspectives, or in the case of dialogue, the suspension of one's point of view. The individual capacities of language, problem solving, representation, and imagination become leveraged within social structures to social advantage. Means of facilitation and collaboration, as well as role responsibilities and task identification, can be used to guide these solo/group phenomena.

Technical Problem Solving Tools

Communication, Simulation, Information, Systems Models

Future problem solving tools will tap the existing technological infrastructure of the moment to provide communication, simulation, and information, all critical to impossible problem solving. Wireless communication, whatever the physical devices, connects potentially everyone. While not true across the globe, wireless communication means that theoretically and technically all humans are networked and have access to all information. Simulation enables networked people to try out options. Simulation may function locally within one's imagination and expressed through images, voice, and text. Simulation may exist technically in systems that take existing information and "map" the details onto some technically constructed representation of reality. Although seemingly everywhere, information is only now being organized through the power of databases and schemes that "mine" these resources for meaning. More explicit systems will be available for citizens to integrate information and simulation and communication. Technically, these systems have existed in corporate and governmental settings as decision support systems. An overarching tool that runs through any technical problem solving tool are systematic features that may involve an algorithm, a search process, or a systems view in which a phe-

nomena can be bound in some way and decomposed to understand the interconnections of the parts. A systems approach is also a significant tool for coping with complex problems but also understanding them (Banathy, 1996).

Personal Decision Support Systems

Decision support systems (DSS) are integrated computer-based systems that feature databases, a problem-solving engine, and an interface to a human user (Gery, 1991). Decisions are then based on existing data. The focus of individuals is rarely on the past but on the present and the near future. Although the future cannot be predicted, trends based on past and current data provide a picture of where we are in our business, career, or personal life. Making decisions on what we want our life to be for ourselves, our families, and our communities, and even "what business are we in?" necessitates a different view that of Future Design, which is not about predicting the future but rather working towards a future based on our intent to continually cycle through rethinking, designing, and improving. A future design-oriented application would be a personal decision support system.

Personal DSS applications for routine problems can be seen in health care ranging from point-of-care use of personal data assistants (PDA) to helping patients make decisions on health care (Crawford, 1997; Pierce, 1998). The user interface is likely based on personal metaphors or specific needs, rather than on a "one-size fits all" standardized metaphor. The study of mental models and how humans project meaning from their experience to a new experience might provide a new means to think and act beyond old rules (Fauconnier & Turner, 2002). Not all problems and situations require the same interface, particularly as the severity of the problem may require a design focused on immediacy and limited choice. Continued collaboration between AI researchers who study representation and reasoning, and those in Human-Computer Interaction (HCI), in which interaction is addressed, may lead to intelligent interfaces with flexible planning, incorporation of human constraint issues (e.g., time, patience, attention, motivation, cognitive demands), and relevance of context (Lieberman & Selker, 2000). Such intelligent interfaces may find themselves first in wireless devices, such as PDAs.

Decision-making in survival situations will require customized model bases developed specifically for categories of extreme survival. In these type of situations problems are unique and tools will need to be developed see how users' beliefs about uncertainty and preferences on different outcomes can be visualized (Howard & Matheson, 1984). Applications for survival problems has emerged for counter-terrorism applications (Alward, 2004). Evolutionary decision-making, decisions that impact long-term change, will require that model bases evolve from new data. Continually re-defining expertise provides opportunities to analyze what people do on a daily basis (Gigerenzer, Todd, & ABC Research Group, 1999) and how daily, routine expertise becomes critical for individuals and groups of individuals.

The value of a personal DSS for change problems is its proactive potential by identifying national, state, and local resources, recommending action, and triggering the development of institutional support and awareness that did not exist before. Another feature to add to existing systems would be to apply more structure to unstructured data, including information from remote sources, locally-developed databases, and context information. How might these different sources of information be integrated and generalized for use by others? How might context be characterized in terms of re-usable objects? A second path is that of modeling. Modeling or "capturing" expertise has been a long-standing challenge in artificial intelligence. Modeling decisions for routine problems, those that can be characterized by rules or procedures, and use static domain models, have been the most successful. But a bigger question beyond *What do we know?* becomes *How does the model update itself*?

Personal Portals

Humans might never use the term personal DSS; instead, modeling, databases, and communicating exist online as most software appears to be migrating toward. The user uses a terminal as a personal portal to access information, simulations, and communication with others. Personal portals directly support the user for purposes of education, collaboration and advocacy. In contrast with organizational portals which are systems based, personal portals are human-based (Shambaugh, 2007). A personal portal enables people to directly tackle a problem. Armed with a knowledge of the problem and its context, existing tools can be bundled to address impossible problems.

Another path for thought in future design is talking about how informed citizens create new societies, epistemic cultures that are themselves creating new bodies of knowledge (Cetina, 1999). These new societies could be a block of families, an online community of individuals, or physical neighbourhoods, cities, or countries, or geographic regions. The idea of a personal DSS does not limit itself to an individual but could be extended as community portals for the purpose of helping people in communities, neighborhoods, and cities grow (Longworth, 2006). The conundrum for researchers and designers is

realizing that in designing systems that are less logical and more approximations of the messiness of real life they may be helping humans come to understand what it means to be human (Johnson, 2005).

Future Designers

Many professions codify their professional standing through competencies. Skills and sensibilities are particularly appropriate for a Future Design professional.

Future Designer Sensibilities

Sensibilities, which involves the ability to feel or perceive, address the human side of designing. After all, design is about humans within a living world. Sensibilities for a design practice involve one's attitudes towards and values of human clients and human needs and world systems. A list of these sensibilities that might apply to all designers include the following:

- Regards the interconnectedness of entities in the world.
- Possesses a sensitivity towards people, needs, and resources.
- Possesses a responsiveness (feelings convert to action) towards people, needs, and resources.
- Practices with the client in mind but acknowledges the tension between client wants and needs.
- Believes in options while remaining pragmatic given limited time, expertise, and resources.
- Does not close down options prematurely.

Future Designer Skills

Skills are viewed in most professional fields as competencies. These provide the basis for most disciplinary certifications. A reasonable list of skills for future designers also might apply to other design fields. They include the following:

- Capable of seeing the big picture to a design issue as well as paying attention to the details of the issue and the developed response.
- Ongoing development of one's definition of design and one's design processes.
- Use of drawing and modeling tools to create a response to a design problem but also in the use of these tools come to understand the design problem and its contexts.
- Communicates with clients and constituents.
- Stays current with social and technological developments.
- Is a life-long learner and commits to developing expertise over time.
- Develops methods in which design thinking and action advocates for a person or groups of people.

Final Comments

Specific skills and responsibilities for living in the 21st century have been pushed down to consumers by organizations and governmental agencies. Individuals now require more time to make important decisions related to their personal and professional lives. These personal decisions add to the growing complexity of human living and require time and resources.

Technological developments in computing, networking, and communication provide humans with the capacity for making informed decisions. With the prospect of survival threats and long-term change, informed groups of citizens can initiate proactive priorities in their national, state, and local governments to address these potential problems.

Citizens must acknowledge their personal insight, experience, and motivation. Citizens must also take more responsibility for their lives and communities rather than relying solely on government. Today consumers drive technological innovation as they choose technological tools that serve their needs. Consumers also have the power to demand that innovation extends past the immediate needs of entertainment, self-expression, and Internet browsing to address community needs for health care, nutrition, counselling, housing, and education.

Future Design provides a conceptual framework to think about our future in the present by leveraging human abilities and motivation, personal and community, and technological innovations. The aim of this paper has been to encourage thinking by citizens, experts, and policy-makers to collectively design in the present what a future world will look like.

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