A Method For Developing Churchmanian Knowledge Management Systems

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A METHOD FOR DEVELOPING CHURCHMANIAN KNOWLEDGE MANAGEMENT SYSTEMS

by

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ABSTRACT

Some problems confronted by managers include ill-formulated wicked planning problems, a type of problem that is difficult to solve because, in part, it is difficult to know what the problem is. The Churchmanian Knowledge Management Systems (CKMS) (Richardson & Courtney, 2004) is comprised of design principles for aiding system designers, managers, and clients who make decisions pertaining to these ill-formulated wicked planning problems. Problemography theory is proposed as a method for developing a CKMS. The method aims to measure CKMS development by using development tools that enables stakeholders and theoreticians to clarify CKMS development.

A study was conducted to test a proof-of-concept development tool. The tool tested is a proposed list of processes that occur during CKMS development, processes derived from Churchman's (1971) Singerian inquiring systems theory. A gap analysis was performed whereby the proposed processes were compared with the processes found during a case study of people confronting issues related to the "wicked" problem of Florida's invasive plant problem.

A second study was conducted to explore possible design principles for developing a CKMS. Two proposed design principles, Every Person Principle and Connectedness Caretaker Principle, were used to develop a Describe a Wicked Problem Inquiring System (DAWP), a Web site which aims to enable inquirers to confront wicked problems. Participants in the study formulated problems related to Florida's native plants and suggested potential solutions. Using Wengraf's (2001) theory-driven qualitative research, interviews with participants were analyzed and the results suggest that the Web site being developed enabled the consideration of the ethical ramifications of knowledge.

Dedicated to my father
and in memory of John and Aili Linden

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

A METHOD FOR DEVELOPING CHURCHMANIAN KNOWLEDGE MANAGEMENT SYSTEMS

Essay #1

Abstract

Some problems confronted by managers include ill-formulated wicked planning problems, a type of problem that is difficult to solve because, in part, it is difficult to know what the problem is. Mason and Mitroff (1973) discuss the design of management information systems that aid managers who make decisions pertaining to these ill-formulated wicked planning problems and propose that Churchmanian-Singerian inquiring systems theory (Churchman, 1971) be used as the basis for how these information systems generate evidence and guarantee truthfulness. Richardson and Courtney (2004) advance that proposal by defining a set of design principles for guiding the development of Churchmanian Knowledge Management Systems (CKMS), design principles that emphasize the ethical imperative of Singerian inquiry. However, applying these theories is a challenge because Singerian inquiring systems theory has many design imperatives, many of which are seemingly contradictory and deserving of design statements unto themselves. Problemography is proposed as a method that overcomes the challenges of interconnecting theoretical CKMS and applied CKMS through the use of CKMS development tools. A proof-of-concept CKMS development tool, called the target process list, is developed and validated using a gap analysis. Fifty target processes, theoretically used to inquire about ill-formulated wicked planning problems, were compared with the processes found during a case study of people confronting issues related to Florida's invasive plant problem.

1. INTRODUCTION

Managers within organizations sometimes confront a type of problem that is difficult to solve, in part, because the problems involve many stakeholders with diverse perspectives. The different assumptions from each perspective result in differing views of the problem and potential solutions. It is difficult to produce a satisfactory potential solution when the formulation of the problem definition is the major concern and when applying a potential solution risks unintended consequences. Churchman (1967) writes that the solutions proposed to solve these problems "often turned out to be worse than the symptoms" (p. B-141). This type of problem is often referred to as a "wicked" problem (Rittel & Webber, 1973), playfully suggesting that a nefarious pain is inflicted upon those attempting to resolve them.

Recognizable examples of the ill-formulated wicked planning problems include the problem of reducing crime in a neighborhood, the problem of improving the education of children at a school, and the problem of supplying food and energy to a city. Later in this research report, the problem of managing invasive plants in Florida will be considered a quintessential example of this type of problem.

Among the many qualities of ill-formulated wicked planning problems, a characteristic that appears central to understanding this type of problem is that stakeholders have differing and often diverse perspectives. Stakeholders, who are interconnected within the context of a problem, have difficulty finding and agreeing upon a potential solution because, due to their different perspectives, they disagree about what the problem is. In the extreme, a stakeholder may even suggest that the problem is not even a problem and that the best solution is no solution. Others, as Churchman writes, may devise potential solutions that have the potential to make matters

worse. In short, as Rittel and Webber (1973) state, “The formulation of a wicked problem is the problem” (p. 161). But, as Linstone (1984), Mitroff and Linstone (1993) and Courtney (2001) have shown, a way to approach the dilemma of problem formulation is to consider perspectives.

As managers within organizations confront ill-formulated wicked planning problems, a call arises for management information systems (MIS) to support this task. The irony of developing information systems to support ill-formulated wicked planning problems is that the development design process itself has been characterized as a wicked problem (Buchanan 1992; Coyne 2005; Yeh 1994). Managers, opting to use MIS to confront ill-formulated wicked planning problems, sometimes meet the nature of these problems firsthand while attempting to apply information technology to solve the problem. The boundaries of the original problem extend to envelop the manager who is trying to solve it. A manager, whose goal it is to solve the problem, risks exacerbating the problem by commissioning an information system. A manager employs an MIS to aid a client in confronting the problem, and in the process becomes a stakeholder, involving yet another person with assumptions about how to solve the problem.

In the development of MIS, there are system designers, who apply technical knowledge, domain knowledge, and creative labors to design and build the MIS aiming to mitigate the client’s problem. The system designers have their own mental models of (a) the problem and (b) how to apply information technology to solve that problem. It may be easy to see where this train of thought is going. The system designers have their own assumptions, and they have their own definition of the problem and their own potential solutions. Even if these solutions consider all other known stakeholders, the system designer possesses the tacit design knowledge.

To understand the predicament of a given systems designer, consider that the system designer may have his or her own view of the problem. In addition to their individual views, the

system designers also share a collective view with the other stakeholders (i.e., managers and clients) (Richardson & Courtney, 2004). This collective view is conceptualized by the system developers engaging other stakeholders during the design processes, allowing them to participate in the design. One objective of participating in a development theory, such as Richardson and Courtney (2004) and Mumford's (2000) ETHICS, is that the system designer forgoes any control he or she might have upon the design of the MIS and promotes participation and a united design solution. And, like the manager, the system designers are enveloped by the problem. A stakeholder secures benefits and possesses implied responsibilities.

In addition to the managers and system designers, who are considered to be enveloped by the problem, should the theoreticians be included? What if our point of view pans back even further to a vantage point from which the authors of design principles (for example, Richardson & Courtney, 2004) are no longer behind the scenes? Or, in Singerian inquiring systems terminology, what if we "sweep in" the theorists as stakeholders?

A client confronts an ill-formulated wicked planning problem. A manager aims to add value by innovating how to mitigate the problem, deciding to commission an MIS. One or more system designers are enlisted to build the MIS, and they may choose to adhere to design principles. Theorists codify these design principles by grounding them upon kernel theories.

If the given ill-formulated wicked planning problem is not difficult enough to solve from the client's perspective, is the theorist in any better position? The analysis started by considering a manager whose goal is to create value by solving a client's problem. "Every wicked problem can be considered to be a symptom of another problem" (Rittel & Webber, 1973, p. 165). But, by the manager electing to use an MIS to confront the problem, another problem is introduced.

In this research, consideration is given to the question of how to develop the MIS system proposed by the manager, a system that is charged with confronting an ill-formulated wicked planning problem. Much of the design theory work has been done.

This research takes the design principles of CKMS as given and addresses the question "How do we develop a CKMS?" The proposed question considers both the never-ending nature of the problem domain and the imperative of the CKMS design principles and then aims for clarification to demonstrate this concept. An IT artifact is proposed to be used to aid the development of a CKMS by clarifying the processes occurring in the problem domain and the development domain. The tool is a target process list, a checklist by which CKMS focal points are assessed during their development. A proof-of-concept (Gregg, Kulkarni & Vinzé, 2001) of the CKMS developmental tool is aimed to clarify the processes of the ill-formulated wicked planning problem and Singerian inquiry.

Richardson and Courtney (2004) have formulated 11 design principles of a class of MIS, dubbed the Churchmanian Knowledge Management System (CKMS). These principles aim to help stakeholders to confront ill-formulated wicked planning problems. This system is defined as a "purposeful and ethical information system that creates exoteric knowledge and provides a link between knowledge and action in an organization" (Richardson & Courtney, 2004, p. 1). Within this definition are signs of a solution: (a) the system goal and (b) a system that reflects open, inclusive knowledge that is ideally available to all. In addition, Richardson and Courtney (2004) specified ethically-focused development imperatives. The CKMS design principles, complete with the concepts of "exoteric," "purposeful," and "ethical" imply kernel theories upon which to ground these concepts. Hence, theorists are stakeholders.

To evaluate the target process list, a gap analysis was conducted, whereby the proposed target process list was compared to empirical data developed using a case study (Yin, 2003). The context of the case study is how people confront aspects of Florida's invasive plant problem with the aid of information systems.

2. THEORETICAL FOUNDATION OF CHURCHMANIAN KMS

Before proposing a method for developing Churchmanian Knowledge Management Systems, the theoretical foundations upon which they are grounded are explored. The research question “How does one develop a CKMS?” is formulated by drawing upon five sets of ideas from prior literature. The first set contains the key concepts of the kernel theory, the philosophy of E. A. Singer, Jr.

2.1 Kernel Theories of a Singerian Inquiring System

A CKMS is grounded upon the Churchmanian-Singerian inquiring system, as Mason and Mitroff (1973) call it. This name refers to the Churchman’s (1973) “Singerian inquiring system” and has included the archetype “Churchmanian” perhaps to note the importance of how Churchman, who was a student of Singer, infused this inquiring system design with his own ideas. By reading the writings of Singer and the writings about Singer, it is possible to establish some ideas that Churchman possibly built upon when inventing the Singerian inquiring systems theory. With so much resting upon the design ideas of the Singerian inquiring systems theory, four of Singer’s ideas are named and described: Teleological, Enabling, Sweeping-in Operation, and an Endless Pursuit.

2.1.1 Teleological

Singer’s (1914) arguments can be parsed into the following statements. Singer argued that what separates humans as living beings from the mechanical is that humans have goals. Life is teleological. Singer differentiated mechanism and life, using the deciding characteristic of

"self-preservation" (Singer, 1914, p. 650). While striving to fulfill this primary purpose, at times perhaps to just survive, a human adjusts and adapts within the constraints of the environment. The implications are that humans have an "existential mandate to create" (Stevens, 1977 p. 79).

2.1.2 Enabling

Singer argued that the individual, as a teleological being, is the central component of an inquiring, progressive society. Singer provides reasons to enable the independence of the inquirer. The individual inquiring upon a topic may embark upon a heroic journey. To a person embedded in the status quo, this heroic journey may appear to be extremely disruptive. So, how does a society happen in the context of the heroic journey of all individuals? The answer is enabling, a form of cooperation. Churchman considered Singer to have posed the question this way: "How [does one] construct a world, inhabited by many wills, in which each will pursuing its utmost desire shall in so doing serve to the utmost each other doing the same?" (Stevens, 1977, p. 78, quoting from Churchman's (1948) *Theory of Experimental Inference*, p. 191). This question expresses the ideal embraced by Singer that cooperation was possible within a society of teleological beings, even as these beings maintain their independent goals. The inquirer does not forfeit independence. Person A strives toward his or her own goal, an ideal, but a goal that may enable person B to reach his or her goal (Churchman, 1979). Singer (1923) said that cooperation is the measure of progress in a society. The question of how to achieve this "enabling" is an ongoing question, an actual project of the inquiring system. Singer considered an inquiring system to encompass an entire society (Stevens, 1977).

2.1.3 Sweeping-in Operation

The concept of enabling can be viewed from a different perspective. As each individual pursues goals, understanding grows, and often, as exemplified by scientific disciplines, specialized knowledge grows. This specialization may result in differences that hinder cooperation. However, Singer argues that in the specialties (i.e., scientific disciplines) can be found all other disciplines and that understanding may be pursued by continually adding concepts rather than continually dissecting concepts (see Churchman, 1968). The "sweeping in" operation is correct to the degree that it is only changing a viewpoint of an observer's perception. At issue is a holistic perspective; that is, the observer is aware of the system and that which is found already inherently in existence.

2.1.4 An Endless Pursuit

That Singer's philosophy entails an endless pursuit is described by expending the given goals; and more cooperation is always sought. New ways of viewing our specialties and our specialization is attempted. Understanding this, consider the collection of data about the real world. Singer's experimental method recognizes that each measurement reading has an error associated with it. Singer regards the real world as being essentially unattainable. One might expect this to generate a disposition marked by futility, but, on the contrary, for Singer this provides endless opportunity. The never-ending knowledge-gathering project means philosophical designers together may just create a more perfect design theory or possibly try a kernel theory that sweeps in a little more that is vitally pertinent to our understanding of the real world. Singer's experimentalism is a reminder that our designs may be lacking because we are unable to "comprehend a cohesive pattern that contains the problem we wish to solve" (Barratt,

1980, p. 302). Singer's "Idealistic Realism" (also labeled "Empirical Idealism" by Krikorian (1962)) is the belief that the pursuit of knowledge about reality is as never-ending effort because our measurements should be held as approximations and the refining of our measuring tools an endless task (Churchman, 1979). With these ideas in mind, it is possible to reflect upon the concepts of ill-formulated wicked planning problems (see the Introduction, page 1) and consider the ongoing nature of the problem: (a) the problem formulation and (b) the development of potential solutions. The recognition of never-ending effort implied by this situation is met with a theme of endless opportunity. "[T]he heroic individual who would dedicate himself to progress 'must design to live as though he were immortal'" (Stevens, p. 75, quoting Singer's *In Search of a Way of Life*, (NY: Columbia U. Press, 1848, p. 9)).

2.2 Inquiring Systems as Analysis Tools and Design Tools

Having considered the ideas of Singer, some ideas of Churchman are considered. Churchman's (1971) work on the design of inquiring systems was discussed before in the context of being a kernel theory used by Mason and Mitroff (1973), and Richardson and Courtney (2004). Churchman's theory is a design tool. Next, it is argued that the design of inquiring systems may be used as both an analysis tool and a design tool.

2.2.1 Inquiring Systems in 72 Words

What is an inquiring system? Churchman (1971) describes the epistemological theories attributed to five philosophers (Leibniz, Locke, Kant, Hegel, Singer) in terms of systems, producing five inquiring system designs. Each inquiring system is critically examined with an acute focus upon the system's guarantor, a built-in strategy by which the knowledge acquired by

the inquiring system is assessed. In each case, any knowledge that is acquired is accompanied by a degree of uncertainty.

2.2.2 Level of Analysis: All

Although primarily described in terms of small-scale systems at the individual level, Churchman's (1971) inquiring systems have been applied to other levels of analysis. Courtney, Croasdell, and Paradice (1998) describe "inquiring organizations," as viewing the inquiring system at the organizational level of analysis. These inquiring system designs are also attributed to very large domains as well, such as all of science, or, as in the case of the Singerian inquiring systems, a society.

2.2.3 Analysis Tools

The designs of inquiring systems provide researchers with a useful analysis tool. Investigators view human artifacts and human behaviors and find epistemologically minded patterns, ways in which humans grasp, accumulate, and discard facts and patterns that were originally described by philosophers (Leibniz, Locke, Kant, Hegel, Singer). An example of using inquiring systems as an analysis tool was conducted by Richardson, Courtney, and Paradice (2001), who analyzed a utility company and a department in a university in terms of the Singerian inquiring systems model, concluding that the model is useful because it encourages a view of all things, draws in knowledge from various sources, and emphasizes cooperation among decision makers.

2.2.4 Design Tools

In addition to the use of Churchman's theory of inquiring systems as a tool for critical analysis, it can be used as a design tool. In this case, the theory is applied for design purposes. This research asks, "How should one develop a CKMS?" and, consequently, the focus occurs during the creation of artifacts. From the design tool perspective, Churchman's (1971) inquiring systems designs are viewed as kernel theories to guide the design and development of information systems. Viewing the world through an "inquiring system" lens may accompany the development of designed artifacts with the intention of using Churchman's (1971) inquiring systems theory during the modeling of the system's epistemological "guarantor" functions. Mason and Mitroff (1973) focus attention on the manager's information as the "evidence upon which his decision will be based" (p. 480). It follows then that any management information system that is hosting that information might also factor into our guarantor, our "guarantee" that facts are truthful.

Within the last decade, researchers have designed systems using the inquiring system designs. Hall and Paradice (2005) argue that these systems are rich designs for learning systems. Hall, Paradice, and Courtney (2003) describe the theoretical foundations of a learning oriented knowledge management system. Courtney, Richardson, and Paradice (2002) discuss sustainable development and ecosystems management in the context of information systems. Peachey and Hall (2006) express how inquiring systems inform the design of KMS. Linden, Kuhn, Parrish, Richardson, Adams, Elgarah, and Courtney (2007) trace the ideas from Churchman's (1971) writings directly to the design possibilities of KMS artifacts. Elgarah (2002) applied Hegelian inquiring system design to a city zoning context. Parrish (2008) embraces Churchman's inquiring system meta design (viewing an epistemology as a system) and extends Churchman's

inquiring systems theories by considering information system designs based upon another philosophers (i.e., Weick's sensemaking theory). Kuhn (2009) explores how Churchman's designs can be applied to the forecasting simulation to address issues in a specialized field, Accounting Information Systems. It is probable that other projects exist. The research on inquiring systems design tools is summarized as being an interest in how the design of inquiring systems informs the design of management information systems.

2.3 Applied Inquiring Systems

Among the many design recommendations for applying inquiring systems, it is important to reiterate one such recommendation, the one by Mason and Mitroff (1973), who describe designs for management information systems grounded upon inquiring systems. One of these design imperatives established by Mason and Mitroff (1973) is that a management information system built to aid managers who are confronting ill-formulated wicked planning problems should be based upon the Churchmanian-Singerian inquiring system.

Mason and Mitroff's (1973) justification for this imperative provides a useful explanation of the Churchmanian-Singerian inquiring system as a two-way process. First, use the design to make wicked decisions more like structured problems. Second, use the design to make structured problems more like wicked problems. The design of solving the problem actually includes confounding the problem.

2.4 Sweeping in Multiple Perspectives

Courtney (2001) argues that Singerian inquiring systems are appropriate for confronting ill-formulated wicked planning problems because Singerian inquirers view the world holistically and appreciate the connectedness of social systems. The addition of multiple perspectives gives this systems view an added technique for exploring the problems within the problem.

Courtney (2001) combines and extends several theories: building upon Gorry and Scott Morton (1971); Singerian inquiring systems theory; Unbounded Systems Thinking (Mitroff and Linstone, 1993); and the theory of Multiple Perspectives (see Linstone, 1984). Central to Courtney's (2001) model of decision-making is the inquirer's mind progressing through the stages of decision-making. The objective is to aid decisions by critically considering a variety of perspectives (i.e. Technical, Organizational, Personal, Ethical, and Aesthetic) when confronting an ill-formulated wicked planning problem (Figure 1). The technical perspective views the problem as being predominately technical and mechanical in nature. The organizational perspective views the problem in terms of the features of social institutions. The personal perspective is a view generated from an individual person. The ethical perspective views the problem in terms of moral arguments. The aesthetic perspective views the problem in terms of beauty and an appreciation of the principles of good artistic principles.

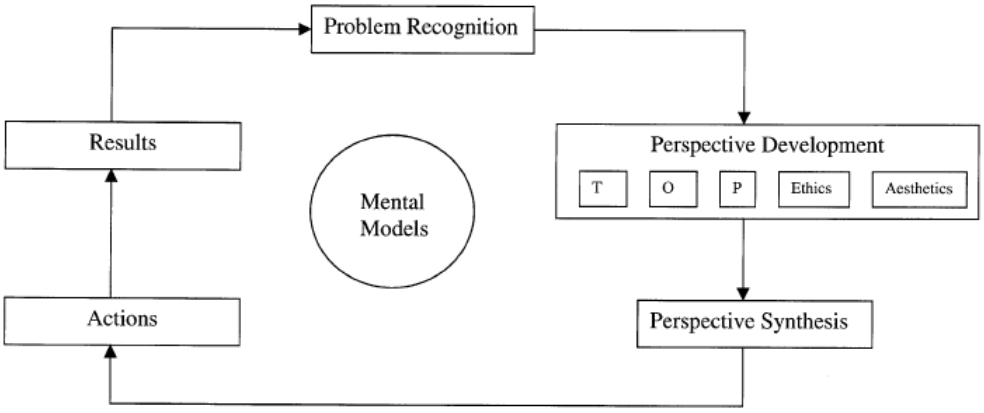


Figure 1. Courtney's (2001) new decision-making paradigm for DSS.

Perspectives are highlighted by Courtney (2001). The consideration of multiple perspectives includes a change of perspective of Decision Support Systems (DSS) research altogether by the adoption of a paradigm for making decisions with decision support systems and knowledge management systems. Courtney's (2001) model of DSS/KMS decision-making, places mental models at the center. The decision-maker's perspectives have a central, ongoing influence during inquiry.

Linstone (1984) and Mitroff and Linstone (1993) viewed multiple perspectives as a way to consider stakeholders. In the context of ill-formulated wicked planning problems, this is relevant. The process of devising a potential solution requires that an inquirer consider what data are needed when pursuing a potential solution (as Rittel and Webber (1973) point out). Furthermore, how one initially casts a definition of the problem is dependent upon assumptions. The consideration of different perspectives changes the solution and the question.

Courtney (2001) associated the change to perspective changes in the inquirer's mental models. Humans are attributed with a mental phenomenon—the ability to hold and to contemplate, in their mind, models of the external world (Craik 1943). Mental models can be considered as having a substantial impact upon how an inquirer views events. The holistic

mental models of a person's assumptions are called by differing names, including Weltanschauung (Kant), natural image (Singer), and worldview.

Several authors discuss Courtney's (2001) paradigm. The overall theme of these works is difficult to describe because of the variety and large scope of the ideas. Tentatively, the theme is described as being an action-cooperating-knowledge-producing-problem-solving-intelligent-agent-based decision support system. Cil, Alpturk, and Yazgan (2005) describe a web-based collaboration system framework grounded on a multiple perspective approach. Kolkman et al. (2005) describe a framework of cycles that includes problem solving, knowledge production, and computer model interface. Vahidov (2004) describes pluralistic, multi-agent decision support systems. Sheffield and Guo (2007) describe "ethical inquiry in knowledge management." Van Kouwen, Schot, Wassen (2008) describe a "framework for linking advanced simulation models with interactive computer maps." Adla, Soubie, and Zarate (2007) describe an integrated framework "based on a distributed architecture when each decision-maker uses a specific cooperative intelligence decision support system" (p. 241) in which expert knowledge is combined with collaboration. Siew (2009) describes an objective as being something "to develop a conceptual framework for integrating science and decision-making spheres through knowledge management" (p. 913). Chatterjee, Serka, Fuller (2009) describe ethical collaboration.

In summary, Courtney (2001), along with several other researchers, contribute a focus upon perspectives as being central to confronting ill-formulated wicked planning problems.

2.5 Design of Churchmanian Knowledge Management Systems

Lastly, we turn to the actual target of development, the Churchmanian Knowledge Management System. Richardson and Courtney (2004) define a CKMS as "a purposeful and ethical information system that creates exoteric knowledge and provides a link between knowledge and action in an organization" (p. 1). "Exoteric" knowledge is defined as the opposite of specialized knowledge. A design goal of exoteric information is that, for the most part, the information is readily understandable and usable by everyone, or at least a wide audience.

Richardson and Courtney (2004) specify 11 design principles for a KMS (Appendix A). The application of Churchman's (1971) definition of systems results in the roles of manager, client, and system designer being considered both individually and collaboratively (Appendix B). In addition, the teleological and ethical concepts found in the Singerian inquiring systems theory are considered.

Knowledge Management Systems (KMS) are defined as a class of information system developed "to support creation, transfer, and application of knowledge in organizations" (Alavi et al. 2001, p. 107). The KM Success Model (Jennex and Olfman, 2006) describes three categories of causal influences, System Quality, Knowledge Quality, and Service Quality, which create two effects, Intent to Use and User Satisfaction, and, in turn, Net Benefits.

How does the CKMS implement Churchmanian ideas? To answer you question, a CKMS is grounded upon (a) Churchman's 9 components of a System and (b) the definition of the Singerian inquiring system which includes the concepts of teleology, reflecting upon the ethical use of knowledge, and that the system creates exoteric knowledge.

The imperatives of ethical reflection are contained within the CKMS design principles proposed by Richardson and Courtney (2004). Richardson and Courtney (2004) propose the design principles of a Churchmanian Knowledge Management System, such that knowledge management system design entails moral obligations. Others discuss KMS from an ethical standpoint (for example, see Chae, Paradice, Courtney, and Cagle, 2005). Richardson and Courtney (2004) relate the ethical standards as being a design feature and design method to pursue.

2.6 Conclusions

One approach for designing management information systems that aid managers and their stakeholders when ill-formulated wicked planning problems are being confronted is by using Churchmanian-Singerian inquiring systems (Mason & Mitroff, 1973). This approach can be recast using Churchman's nine system components to create a set of design principles for a type of KMS, a design ideal, called the Churchmanian Knowledge Management System (Richardson & Courtney, 2004). The design of the CKMS binds together contradictions. Its stakeholders are goal-seekers aiming for self-preservation, who embark upon (possibly tragic) heroic journeys. The independent endeavors are seen as enabling others to maintain their own goals. Another consideration is that working toward a potential solution, the primary system by which an inquirer is to sort out these facts actually is allowed to transform solved problems into wicked problems. In addition, mental models describe our own tendencies to move forward in solving these problems based upon our (possibly inadequate) worldview. The processes of making

decisions include the recommendations for the consideration of ethical design and ethical behavior, although these perspectives may be wholly alien and upsetting.

However, by what method should a CKMS be developed?

3. TARGET PROCESS LIST FOR CKMS DEVELOPMENT

When considering methods for developing a CKMS, two characteristics stand out. First, the CKMS is a large theory, representing many ideas. There are 11 design principles offered by Richardson and Courtney (2004), with each principle deserving of its own treatise. Second, the CKMS is an ideal. Working definitions of ethical principles, success measures, dignity, exoteric knowledge, guarantors, and other concepts should be developed further, a task that implies that the development of a CKMS requires a CKMS.

The theory of a CKMS borders on being too big and too rich. These characteristics provide the challenge when answering the question of how one should develop a CKMS. The approach proposed here, therefore, is to adopt a long-term strategy and build in a self-correcting system directly into the development method. Consider the following scenario/argument.

3.1 Ill-Formulated Wicked Planning Problems

People confront a type of problem that is referred to here as ill-formulated wicked planning problems (Figure 2). This type of problem has many names. Ackoff (1974; 1999) describes “messes” as complex systems that “lose their essential properties when taken apart” (p. 117). Mitroff and Mason (1981) define these types of problems as “ill-structured and problematic because they rest upon a base of critical but tenuous assumptions” (p. 331). Churchman defines wicked problems as a “class of social system problems, which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing” (p. B-141). Rittel and Webber (1973) propose 10 characteristics of wicked problems (Appendix C),

describing many open-ended qualities, such as time to solve, assessment criteria, and the problem solver's liability.

Figure 2. Clients confront ill-formulated wicked planning problem.

3.2 Knowledge Generators for Effective Action

The need for effective action gives rise to an organizational context. Managers strive to add value for the people (i.e., clients) who are confronting an ill-formulated wicked planning problem. As Mason and Mitroff (1973) point out, the need for effective action requires knowledge, and the management information system is conceptualized as the whole enterprise that isolates information for knowledge and the justification of action (Figure 3).

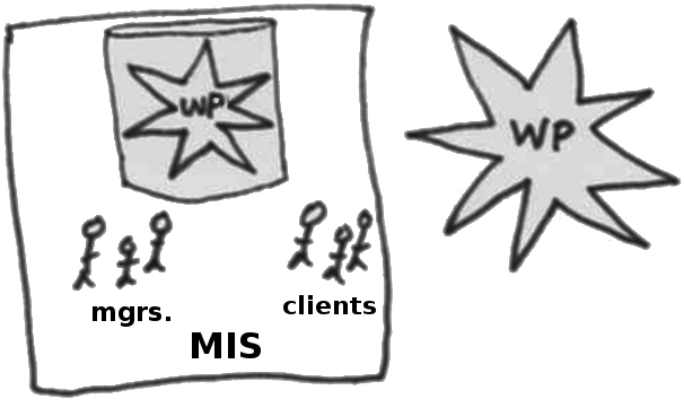


Figure 3. Managers commission MIS.

Here is a database, a repository of data that models what exists in the real world. Because there is a need to assess the degree to which the database differs from the real world, theory is applied to the design of the MIS. In this case, because the clients and managers are confronting the ill-formulated wicked planning problem, Mason and Mitroff (1973) recommend the application of the Churchmanian-Singerian inquiring system (Figure 4).

Figure 4. Grounded upon Churchman-Singerian Inquiring System (Mason & Mitroff, 1973).

This situation (despite its depiction in the static diagram) is highly unstable. The clients and managers are humans, with independent personalities and physical trajectories within dynamic environments. The MIS is constantly changing. The MIS itself is a wicked problem (Figure 5).

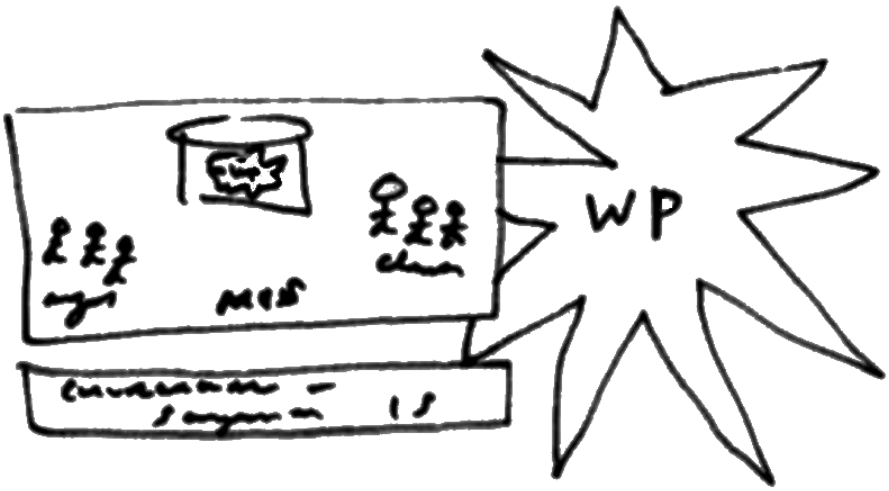


Figure 5. Developing a solution may itself be a wicked problem.

3.3 CKMS Designers

The MIS is so challenging that people adopt the role of system designer and focus on understanding the phenomenon of MIS. Of course, in his or her own way, everyone in this scenario is a designer. The clients design a solution by hiring (or engaging with) managers. The managers design organizational systems, strategies, policies, etc. The system designers, however, are of particular interest because they design the flow of information that supports (or hinders) these activities. In this research, the CKMS is being used as the design foundation, the central kernel theory and overall guidance for issues pertaining to the system's design (Figure 6). Richardson and Courtney's (2004) and Richardson, Courtney, and Haynes (2006) design

principles for a CKMS are one way of viewing how this scenario can play out, a theory argued to encourage success. The CKMS perspective is biased in that it views the MIS as a KMS and it views the decisions being made and the resulting actions as moral acts.

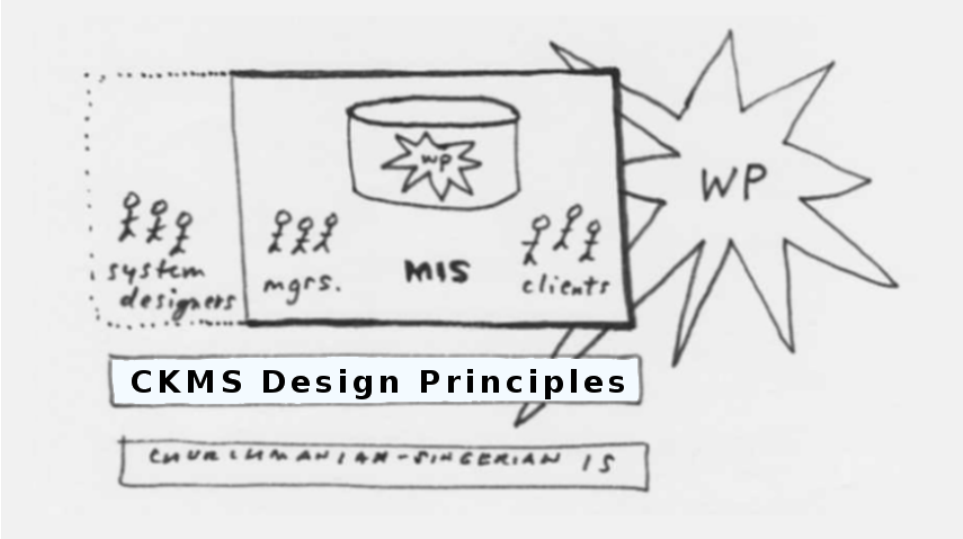


Figure 6. Add design principles of CKMS (Richardson & Courtney, 2004).

Rittel and Webber (1973) express a concern that professionals, as they design to achieve the goals of clients and as they formulate problems, must increasingly consider equity issues. They ask whether professionals, people who plan and perform actions in ways that can be characterized as applied science, are able to plan in the contemporary setting. Professionalism is questioned because the instruments of professionals, while being proven successful for solving efficiency problems in isolated situations, may not properly answer questions of how to effectively solve problems in which equity issues are of major importance. This dilemma is more apparent in the contemporary setting because system boundaries have broadened, and value-based criteria, such as equity issues, are increasingly considered part of decision-making.

By viewing the decision-making that pertains to wicked problems as being fundamentally contingent about one's ability to conjure and comprehend (i.e., appreciate) multiple perspectives

(Courtney, 2001), the MIS/CKMS is no longer populated with one-dimensional specialists. From this vantage point, the CKMS is understood as MIS/KMS development from the "E" perspective (Figure 7).

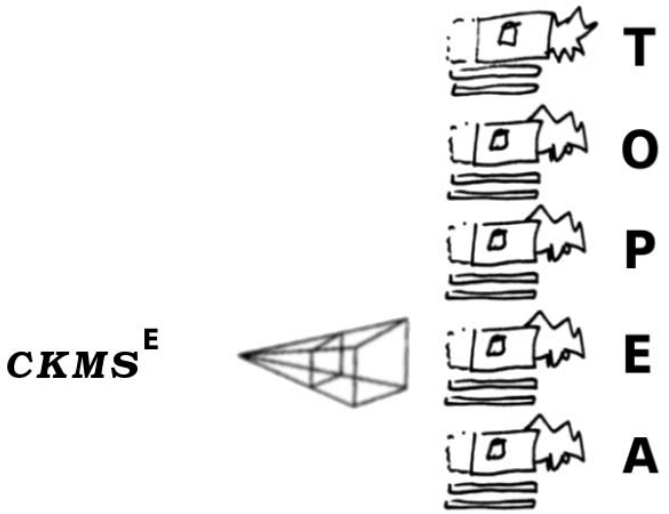


Figure 7. Design of a measurement system agent for CKMS development (based upon Courtney, 2001)

The clients, the managers, and the system designers are all on the hook, responsible for decisions as being moral acts. So to arrive at a CKMS development methodology, and focus upon the need to add value for the system developers, who are charged with considering the ethical ramifications of new, potentially truthful knowledge, it is asked, "What can be done (if anything) to aid the system developers' task?"

3.4 Theoreticians

To attempt a solution to the research question, theoreticians is swept in. Theoreticians are designers of models, and their craft is the finding and assessment of kernel theories. The CKMS

design theoreticians play a crucial role because they are specialists at inquiring about moral obligations and, so, they are added to the model (Figure 8).

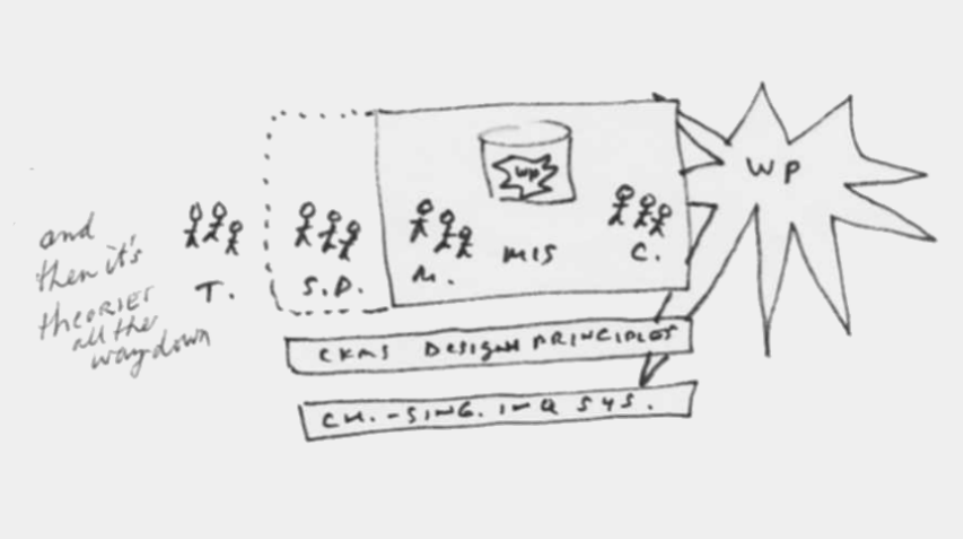


Figure 8. "Sweeping-in" theoreticians.

A theoretician aiming to develop a CKMS decides to develop an information system and needs to select appropriate kernel theories. This selection involves a creative act. A CKMS developer articulating the problem domain and development environment is performing a creative act. As Churchman (1971) describes at the end of his chapter on Singerian inquiring systems, this has not been designed yet. For example, a MIS can't contemplate a policy statement that guarantees ethical decisions. Ethical questions can be open questions, not that right or wrong doesn't exist, but that knowing right and wrong may be extremely difficult to determine. Accordingly, the development of a CKMS should be viewed as, for the most part, applied philosophy. The development of a CKMS commits the MIS and its stakeholders to some degree of ethical reflection. The approach advocated here, then, is to strive to discern the nature of this commitment.

So, start by just trying to define a CKMS further; create a tool that helps to measure an aspect of the CKMS being developed, and open up the processes so that others can engage in the effort.

3.5 Problemography

Problemography theory is a normative design theory for the domain of CKMS development. The theory conceptualized CKMS development as the building and using of tools that help clarify CKMS development. The tools are comprised of an Application Programmer Interface (API) that allows access to codified theory and IT artifacts, which measure ill-formulated wicked planning problem contexts. The tools are CKMS development tools, and, as such, aim to convey, escort, deliver, and transmit CKMS ideas among stakeholders. In the ideal, a tool subscribing to problemography theory is measured by the degree to which it "bootstraps" awareness and the understanding of CKMS design. These tools for CKMS development, while being IT artifacts, imply a method because they are "design kits" in that they incorporate (a) a design by which to model (i.e., measure the problem domain in terms of CKMS design principles) and (b) a set of instructions (i.e., an application programming interface). A measure of performance for a problemography-based CKMS development tool would be the degree to which a community is formed and actively discussing the measurement system and its readings. While the Problemography API is free and open, and is dedicated to the *exoteric* output principle; one design goal is to construct a "broom" by which to try to "sweep in" many theoreticians (Figure 9).

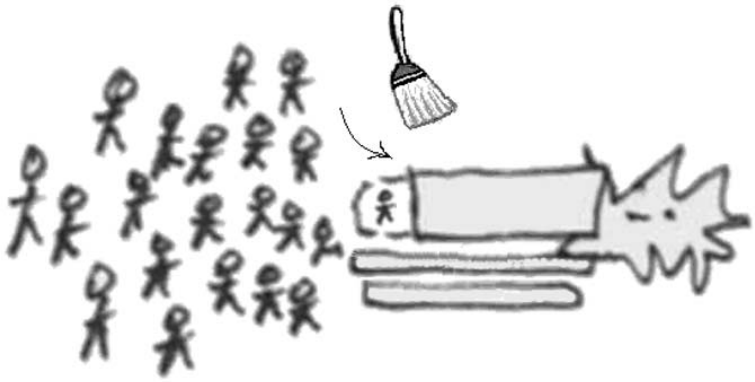


Figure *9. "Sweeping-in" many theoreticians.*

To be clear, the word "problemography" is defined as the study of ethically clarifying the development of management information systems that enable Singerian inquiry of ill-formulated wicked planning problems. Problemography is what CKMS developers do when dedicated to a theory tool approach. The term "study" is used to mean many types of inquiry, inquiry that is purposeful (i.e., teleological, goal-driven) inquiry, inquiry that is taken to be a fundamental human activity, including both formal or informal inquiries, the active pursuit of gathering and appraising evidence, a kind of tool-making in which theories and tools are managed into IT artifacts called theory tools. "Ethically" connotes that these actions should recognize that standards of moral judgment exist, that there are right and wrong actions, and that while answers to questions about these issues may not be easily forthcoming, they can be studied with reason and creativity. The word "clarifying" denotes a process to make an object of study clear, to purify ideas, or make transparent with illustration. Rather than the work of finding answers, this view promotes work upon the question.

3.6 Proof-of-Concept

To move toward demonstrating the validity of problemography theory as a method for CKMS development, a prototype as proof-of-concept (Gregg et al., 2001; March & Smith, 1995) was built. The inaugural IT Artifact for CKMS development, the "target process list" is published on a Web site (http://problemography.org) and made accessible via the Problemography API (Figure 10).

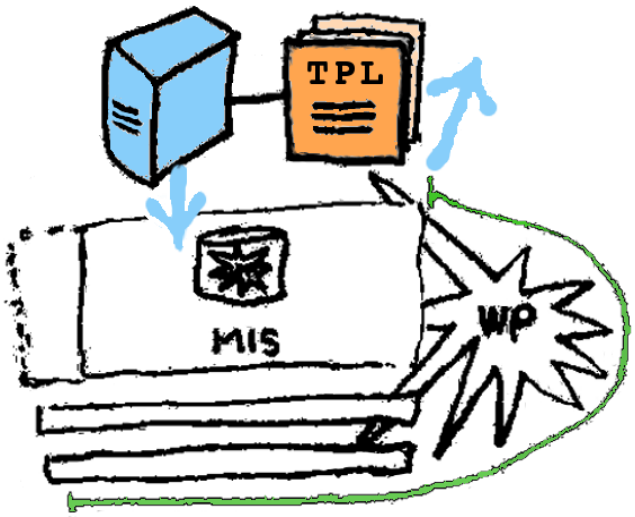


Figure 10. Hosted IT artifact for CKMS development as proof-of-concept.

The target process list (Table 1) was developed as an example of one of many possible IT artifacts for problemography-based CKMS development. It is an instantiation of the design theory method. The target process list is focused upon CKMS development, and has the design goal of including both the processes of Churchman's (1973) Singerian inquiring systems theory and the processes of Rittel and Webber's (1973) wicked problem propositions. The justification for these two sets of processes being selected and merged into one is based upon the view that these sources cover an end-to-end view of the problem, in that the "wicked" problems theory covers important processes in the problem domain (i.e., the actual real world) and Churchman's

theory covers processes in the (potential) solution domain (i.e., the epistemological-governing theory).

The purpose of the target process list is to aid the development of a CKMS by functioning as a checklist. Developers (and the stakeholders) use the checklist to assess the extent to which an information system may be considered a CKMS. A target process list helps to declare what a CKMS does, or, at least, what it does in terms of the actions performed by the users and stakeholders of the Singerian-informed MIS and the given ill-formulated wicked planning problem.

Each of the (currently) 50 processes is modeled in terms of the parts of speech of an English sentence; these sentences are instantiated as Web Ontology Language (OWL) documents. These process specifications in OWL are documented in Appendix D. The selection of modeling parts of speech as sentences was influenced by Pentland's (2003) description of how processes are expressible by parts of speech. The selection of OWL as the language by which to depict the schema of the target process list semantics was influenced by it being a standard ontology language of the Semantic Web (Berners-Lee, 2001) and by the anticipation of using its features that allow a more expressive description of properties and classes. Additionally, having the target process definitions in machine-readable form, may increase the likelihood that the definitions are used as, in inquiring system terms, a Lockean fact net.

Number	**Title of Process**	**Definition of Process**
1	Define the operational design of a measurement system	The steps to obtain the measurement and to resolve differences. The system design is comprised of standard and units.
2	Justify that the measuring system is accurate	Answer the question: What theory grounds the measurement system?
3	Use measurement system	Follow the steps of the system.
4	Establish community	A group of people who use the same measurement system.

5	Compare readings	Try to resolve differences.
6	Measure the degree to which the community members agree.	This is a measure of the measurement system.
7	Consider the history of the measuring system design	A measurement that tries to compensate for the weaknesses of the Lockean community design.
8	Replicate measurements	Need to take more than one reading, so that they can be compared.
9	Critique readings	Ask if the measurement is true to reality, and ask if the measuring system is working properly (and be the Hegelian over observer).
10	Create disagreement by refining measurement system	Improve the measurement system so that two readings can be differentiated.
11	Revise the hypothesis	When all the readings appear the same, then one choice is to revise the hypothesis by either adding variables or changing the function.
12	Revise the reading adjustment procedure	If there are contrary hypothesis which have readings that are the same, perhaps it is time to adjust how the readings are adjusted.
13	Tolerate the inconsistency	If two contrary hypotheses have the same reading, one process is to tolerate it until more readings are available.
14	Ask: Why revise?	Answer the questions as to what is the goal of changing worldview (Singer's natural image).
15	Revise a measurement system	Change the measurement system itself in order to have it perform better.
16	Distribute controlling authority	The authority of the system is distributed and an attempt is made to encompass the whole breadth of inquiry.
17	Sweeping-in a variable or model	Sweep in a variable or a model.
18	Instigate debate	Upset the apple cart, and rock the boat, challenge the status quo theories.
19	Describe the goal of the inquiring system	Is the purpose to create knowledge?
20	Evaluate performance of inquiring system	The overall performance of the inquiring systems as a system is assessed.
21	Describe the client	Is the client all humankind?
22	Inspect the design of the inquiring system and determine if the knowledge created is exoteric or esoteric	The components of the system should be designed for exoteric knowledge. How are the components organized?
23	Enable others	Is the environment cooperative?
24	Describe the decision makers	Are the decision makers everyone? (This may go against property rights ideas? What exactly

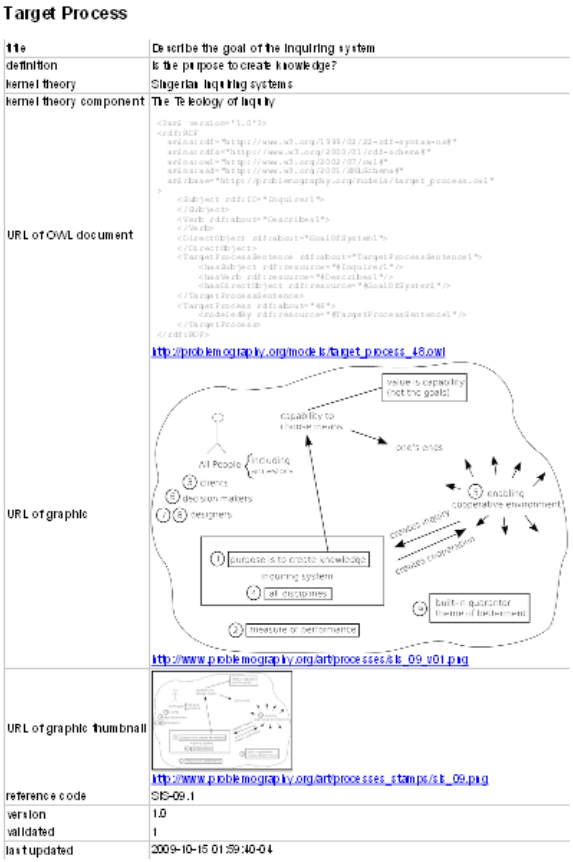
		is being decided here?)
25	Describe the designers	The designers should be everyone.
26	Consider express the knowledge by expressing uncertainties	Was the object really the object being observed and what is the certainty of the description of the observation
27	Declare imperatives	Recognize that acceptance of data readings implies an imperative. Even the database is an imperative.
28	Ask: Process or Progress?	Following Churchman, ask: Have we learned anything via the inquiring system or just another illusion?
29	Adopt heroic mood	Adopt the heoric mood.
30	Design a heroic mood	The relationship between a person and their god.
31	Define the elusive concepts	An approach for design grasping the creative in people.
32	Express initial wicked problem formulation	Express a problem formulation.
33	Express initial potential solution	Express a potential solution.
34	Ask information-gathering questions	Ask questions.
35	Input gathered information	Place information into the system.
36	Revise wicked problem formulation	Create a new version of a problem formulation.
37	Revise a potential solution	Create a new version of a potential solution.
38	Consider terminating the problem-solving	The process of considering whether to terminate the problem-solving usually occurs when a problem-solver asks if a solution has been found or if the problem-solving job is done and either stops or continues the problem-solving process. However, with wicked problems, there are no solution-based stopping rules. There are just problem-solving-based stopping rules. (The situation is that these stopping rules are based upon the problem-solving and not the solution.)
39	Define problem-solving-based stopping rules	The process by which a problem solver defines the problem-solving-based stopping rules that will be used as the criteria for deciding whether to terminate the problem-solving job (if only temporarily in order to implement a solution). (The situation is that these stopping rules are based upon the problem-solving and not the solution.)
40	Judge potential solution	The process of judging a solution is where an

		inquirer as judge adopts the assessment role and provides an assessment of a potential solution. The judge is considered to be influenced by a worldview. (The situation is that the assessment is impacted by worldview.)
41	Evaluate an implemented solution	Little by little, the repercussions of an implemented solution may become known (aka resolution analysis). This process involves (a) recording the observation, (b) tracing the observation to an implemented solution, and (c) evaluating whether the observation reflects well or poorly upon the implemented solution (The situation is that there might always be waves of consequence not being traced.)
42	Fix an unfortunate consequence of implemented solution	A post-implementation planner is faced with a bad outcome of an implemented decision (because there was no possibility of experimentation) and tries to fix it.
43	Decide whether to implement solution or formulate another solution	Because there may always be another potential solution, the planner must decide whether to find another potential solution. This decision is based upon judgment factors. And decide what policy-generating tool or technique will be used.
44	Identify distinguishing property	An inquirer cannot use off-the-shelf solutions because every wicked problem has a distinguishing property that makes it unique. So, identify distinguishing property of problem and then create a unique and specialized potential solution based upon it.
45	Describe discrepancy causal chain	Describe the causal chain model with attention to if there are problems behind the problem.
46	Assess the level at which the problem is solved	Decide this and factor it into the decision because one can try solve a problem at too broad a scope (where it is harder to find a solution) or too fine a scope (incrementalism).
47	Argue for and against problem formulations	This is the process of creating arguments, often (but not necessarily) based upon some sort of empirical evidence.
48	Rank the arguments	Rank the arguments in order to decide which problem formulation is best.
49	Consider liability	The goal of wicked solutions is to make human conditions better. The solutions to

		problems are not mere academic problems. Because of the ramifications of goal, the problem solver has no right to be wrong. A solution is an ethical issue. Liability in the sense of ethically on the hook.
50	Judge potential solution against array of scales	An inquirer assesses a potential solution against a variety of scales. R&W discussed the pluralism.

Table 1: Target Processes

A webpage (Figure 11) of a target process description contains a variety of descriptive information, including a text definition of the process, the OWL definition, an illustration, and information which traces the process to a kernel theory.



Target Process

title	Describe the goal of the inquiring system
definition	Is the purpose to create knowledge?
kernel theory	Singerian inquiring systems
kernel theory component	The Teleology of Inquiry
URL of OWL document	http://problemography.org/models/target_process_48.owl
URL of graphic	http://www.problemography.org/art/processes/ds_09_v01.png
URL of graphic thumbnail	http://www.problemography.org/art/processes_stamps/ds_09.png
reference code	SIS-09.1
version	1.0
validated	1
last updated	2009-10-15 01:59:40-04

Figure 11. Screenprint of a Target Process description webpage.

4. RESEARCH METHODOLOGY

Before problemography theory can be fully tested, it appears prudent to validate the first IT artifact for CKMS development, the target process list. A great deal of interpretation occurred during the selection and codification of the 50 target processes that comprise the target process list and so it is important to subject them to an empirical analysis. The objective is to consider the certainty of each target process being a *qualified* target process of CKMS development. In other words, for each target process, is there evidence that suggests that that target process actually occurs? To validate the *a priori* target process list, a gap analysis by case study was conducted.

4.1 Quick Overview of Gap Analysis by Case Study

To evaluate the target process list, data was collected from empirical sources. This empirical data was gathered using a case study that focused on the context of the invasive plant problem in Florida. Interviews were conducted, and the transcripts were then compared with the *a priori* target process list. The comparison itself was achieved using a measuring system agent inheriting the Problemography API. The comparison yielded a gap analysis report that illustrated the degree to which each process on the target process is used during CKMS development.

4.2 Overall Research Strategy

Having specified *a priori* the target process list, data was collected from the real world. A context (the invasive plant problem in Florida) was selected, and a case study was conducted,

during which data was gathered from three sources: informants via interview, webpages via spider (i.e., bot), and secondary sources via traditional research means. Upon completion of the case study, 16 transcripts from interviews with 18 informants were then automatically compared with the target processes. The output of the automatic comparison produced 50 animations, one for each *a priori* target process. These animations were used as the basis of data analysis, along with guidance from field notes. The gap analysis categorized each target process according to three possibilities:

1. A target process was assessed as *found* if there was evidence from the empirical context that the process existed.
2. A target process was assessed as *not found* if there was no evidence from the empirical context to suggest that the target process was being used.
3. A target process emerged from evidence from the empirical context, but was not yet listed on the target process list.

4.3 Environmental Management Information Systems

The generalizability of the conclusions is limited by the fact that only one case study was conducted and the assumptions that the context studied was a Singerian inquiring system scoped at the state level. Nevertheless, the context selected (the invasive plant problem in Florida) is deemed appropriate (and important) based on the burgeoning subfield that is exploring Environmental Management Information Systems. The context of environmental management and planning is considered to be appropriate for the application of Singerian inquiring systems (Courtney, Richardson & Paradice, 2000), and information researchers are increasingly turning

their attention to how information systems help to manage environment-related issues (El-Gayar & Fritz, 2006).

4.4 Data Collection via Case Study

The conclusions based upon the data analysis are limited by the inference that the data represent the problem domain. This methodological issue is exacerbated by the possibility of the context of the case study being an ill-formulated wicked planning problem and having unknown boundaries. To better assess the inferences made by the researcher during the collection of the case study, data here is a concise description.

The case study (Yin, 2003) examined how people use and develop information systems to aid the inquiry of the invasive plants problem in Florida. One justification for the case study is that the method is appropriate for situations in which "the boundaries between phenomena and context are not clearly evident" (Yin, 2003, p. 13).

As mentioned, evidence was gathered from three sources: information, webpages, and traditional secondary sources. During this data collection, the focus was on (a) how people inquired about the problem of invasive plants in Florida, (b) how information systems where used to inquire about the problem, and (c) how future information systems (real and imagined) might be used to inquire about the problem.

4.4.1 Sample Selection of Informants

A potential source of bias is how the informants were selected. Borrowing the stratified concept from survey research, the interviews were selected such that at least one informant represented a category in which the categories were the perspectives found in Courtney's (2001)

model (i.e., TOPEA). Table 2 shows the breakdown of informants by perspective. The reasoning for obtaining interviews from informants possessing all five perspectives was that this would help provide a balanced set of data respect to worldviews of the "wicked" problem. Although the A perspective and the E perspective are each represented by a single informant (and, more specifically, by a nature photographer and a professor of ethics, respectively), these perspectives were assessed to be duly represented.

T	**O**	**P**	**E**	**A**
7	9	4	1	1

Table 2. Perspective Counts of Data Set
(multiple perspectives allowed)

In total, 16 interviews were conducted. All but one was a telephone interview. Every informant was identified as being involved in Florida's invasive plant problem in one way or another. Three informants lived outside of Florida but had business interests in Florida (to some degree) either currently or in the past. The first few informants who were interviewed were identified as being knowledgeable on the invasive plant problem because their names were listed on a Web site devoted to the problem (http://floridainvasives.org/). Informants selected in this manner, in general, appeared to be actively working on the problem. This active interest can be seen by noting the organizations these informants represented, for example, the Florida Invasive Species Partnership, one of five Water Management Districts, and a local Invasive Species Working Group.

Another rough guide used during the selection of informants, employed to help ensure a balanced variety, was the authority level designation. Attention was given during informant selection to ensure that the transcript set would represent at least one informant from the following contexts: local community, country, regional, state, and federal.

Guesswork played a role in the sample selection process. Early in the interview process, it became clear that the application of herbicides was itself an ill-formulated wicked planning problem related to the invasive plant problem in Florida. Similarly, it became clear that education (also called "outreach") was a major problem "within" the problem. In addition, the concepts of citizen scientists tracking invasive plants with GPS receivers and then mapping these on a Web site sparked a keen interest in the researcher. So, midway through the selection process, informants were sought to represent these "discovered" (to the researcher, at least) subtopics in more detail.

Finally, the selected informants as a group do not represent several important constituencies that are assumed to have a stake in the problem. Despite attempts to systematically select a variety of informant viewpoints, some interviews could not be secured. The following roles were sought but not conducted: representatives of Florida government (i.e., state legislators), horticulture experts working for a public garden or public zoo, plant buyers for the large home improvement "box" stores (which have garden centers), representatives of the Florida Department of Transportation (think *side of the road*), lawyers who were knowledgeable in property boundary disputes, and representatives of any company that offers herbicide application and other professional services related to the eradication of invasive plants. The conclusions of this study should, therefore, be assessed accordingly.

4.4.2 Collection of Supporting Data

During the case study, supporting data was collected so that better questions could be posed when interviewing the informants. The transcripts of the interviews were supported by two other types of data, webpages and secondary sources. The webpage data was collected by

downloading (in a robot-friendly way) the entire site of the Florida Invasive Species Partnership (FISP) (see floridainvasives.org). The site is a communication hub used by many professionals across the state. The site has approximately 600 entities, including webpages, PDFs, slide presentations, and photographs. The webpages that happened to be linked on that site were also downloaded.

In addition to webpages, secondary sources provided a history of the problem. Books, journal articles, government reports, flyers, news articles, and other documents were collected and studied.

4.5 Gap Analysis Comparison

Once the interview transcripts were collected via the case study, it was then necessary to compare them to the *a priori* target process list. To increase the likelihood that the comparison and resulting gap analysis can be replicated, the *a priori* data and the empirical data were compared using a computer software program. This program drew concepts of business intelligence that focus on technology that examines organized knowledge from written descriptions (Froelich, Olson & Ananyan, 2005). The program matched patterns of words and output scientific visualizations (Wright, 2007). The output, which is in the form of interactive animations, was used, along with a small set of field notes, to draw conclusions. These conclusions are discussed in the next section.

5. GAP ANALYSIS AS CASE STUDY

Data was collected from a case study, during which informants were interviewed and asked questions. The words of the informants' answers were compared to the words of each target process, in particular, the words of each target process OWL specification. The result of this comparison is a list of matched words for each target process. These lists of words are used to determine the degree to which the process is found in the empirical case study setting.

The comparison results in 14,663 matches. The lists can be found on the Web site (http://problemography.org/matches.php?study_id=1). Many of the matches can be discarded as providing little value in helping determine if the theory was found. For example, the 14th target process on the list (Theory ID #46) contained 13 words that matched a total of 1,298 times (Table 3):

Words	**Count**
the	549
of	339
is	290
what	159
process	15
goal	10
direct	6
subject	6
4	6
changing	3
version	2
target	2
asks	1
Total Matches	**1,298**

Table 3. Matched Words in Target Process (Theory ID #46)

Three categories of words can be treated as noise and removed. First, the number (e.g., *4*) can be removed. Second, common words (e.g., *the*) can be treated as noise and removed from the list for

further analysis. Third, words contained in the metadata of the OWL instance (e.g., *direct*, *process*, *target*, *subject*, and *version*) matched with all 50 target processes. These five metadata words are treated as noise and removed from the list for further analysis. After filtering the wordlists for words contained in these three categories, filtered wordlists are produced. For example, the 14th target process on the list (Theory ID #46), after filtering, contained four words that matched a total of 173 times (Table 4):

Words	**Count**
what	159
goal	10
changing	3
asks	1
Total Matches	**173**

Table 4. Matched Words in Target Process (Theory ID #46) after filtering

Forty-five of the 50 filtered wordlists had matches, providing some evidence that these processes are found in the empirical context. However, five of the wordlists contained zero words. The five target processes associated with these five wordlists (Theory IDs #15, 17, 43, 49, and 53) have no empirical support, are considered to be not found, and are marked "tentative" to indicate a degree of uncertainty (Table 5).

Theory ID	**Process Title**
15	Declare imperatives
17	Adopt heroic mood
43	Revise the hypothesis
49	Describe the client
53	Design a heroic mood

Table 5. Target Processes Not Found and Marked as "tentative"

The words that are drawn from the answers of the informants of the case study's are found in the definitions of 45 target processes. Because these results rely upon the assumption that it is meaningful that the words are found both in the target process definition and in the

informants' answers, more study needs to be conducted so that a higher degree of certainty can be ascribed to the validity of these 45 target processes. To aid in exploring the connections between the theoretical target processes and the empirical context of the case study, some selected connections are discussed below. These connections are, in part, drawn from field notes.

5.1 Connections Between Theory and Empirical Context Based Upon Field Notes

Many reasons exist to doubt the gap analysis that compared the text of the fifty processes and the text of the informants' answers during interviews. The purpose of performing the gap analysis by means of automated text matching was to remove a degree of human bias that would have occurred if the data analysis was coded by hand. However, it may be helpful to describe some of the connections between the people in the empirical context (as viewed by the case study) and the proposed target processes. While these connections are based upon the primary investigator's field notes and, therefore, include a degree of bias, these ideas may help provide a better understanding of how the target processes are used to confront the invasive plant problem in Florida, what serves as an example of an ill-structured wicked planning problem.

5.1.1 Lockean Labels

While investigating the invasive plant problem, many other problems are discovered. Of these other problems, the most difficult to understand was the herbicide problem. Management plans for eradicating invasive plants routinely include the application of herbicides. These herbicides, as possible or actual chemicals in an ecological system, represent a knowledge problem. Associated with each herbicide is information, such as how it should be applied. So, from the mindset of the Singerian inquirer, the data representing these herbicides may be

considered to be the focus of a measurement system. Furthermore, the herbicide problem, as a problem-within-the-problem, suggested a need for the Singerian inquiring system maneuvers. Not only is there information that is known about each herbicide, there is also unknown information. Part of the information problem is knowing the risk associated with the unknowns; much depends upon the risks associated with the conceiving, manufacturing, applying, and monitoring herbicides. The ability to accurately assess the risk of a given herbicide may require years of labor to acquire.

Based upon the interviews, one important information artifact is the label that is on the outside of the herbicide container. The containers holding the herbicides are required to have labels describing the appropriate use of the herbicide. The applicators are required to abide by the label. Based upon interview data, the safety of herbicides rests upon the person who is applying the herbicide to read the label and abide by the label's instructions (i.e., imperatives). Because these herbicide labels constitute a primary social agreement of what is and what should be done, these are called "Lockean Labels."

The term *Lockean* refers to the Lockean inquiring system, one of Churchman's (1971) inquiring systems. The Lockean inquiring system achieves truthfulness by a strategy of having a community of inquirers who compare inputs and strive for consensus. This can be found in the case of the people confronting invasive plants in Florida, by the adherence to the herbicide labels as being centrally important to the reduction of risks associated with herbicides.

Based upon the interview data, the social systems that produces and uses herbicides to eradicate invasive plants operate under the premise that the risks associated with the herbicides is acceptable to society. These social systems appear to make clear that it is of the utmost importance that the label is followed. For example, people who want to be herbicide applicators

must be trained, and part of this training is to learn how to read the label of an herbicide and make judgments as to the given herbicide's proper use.

The significance of the herbicide labels being designated as Lockean Labels, again from the mindset of the Singerian inquirer, is that the herbicide labels can be viewed as fact net, a concept drawn from Churchman's (1971) Lockean inquiring systems theory, which suggests that the validity of the label's information is provided by consensus. The Lockean Label represents the institutionalization of these inquires. Decisions based upon the label are wholly professional. The label represents facts associated with these decisions and the process to create that label is assumed, alleviating the Lockean inquirer from having to inquire as to the validity of these other bodies of knowledge.

This is important because a Singerian inquirer can then challenge the information by asking if the consensus is wrong. For example, a Singerian inquirer might question the risk of the herbicide by providing evidence that a particular piece of information implied by the label is incorrect, such as saying that the approval by a regulatory agency (i.e., EPA) was flawed or studies that were performed to test the effects of the herbicides were flawed. A Singerian inquirer might challenge all or part of the truthfulness of the herbicide label.

Evidence suggested that there were indeed Singerian inquirers among those confronting the invasive plant problem in Florida, who questioned the effectiveness of the labels. One person that was interviewed criticized the "fact net" at several points: (a) criticized the availability and accuracy of the data reported from the regulatory agency (i.e., EPA), (b) reported that, in general, technical workers in the industry viewed the problem from a technical (chemical) standpoint and not from a long-term ethical standpoint, (c) conveyed that the risks were unknown (despite current risk assessments,) and (d) reported that there were problems within this problem (i.e., the

testing of these chemicals on mammals). One person who was interviewed suggested that the labels were not universally read and followed before application of the herbicide.

The evidence suggests that the overall community that confronts the invasive plant problem in Florida maintains herbicide labels (conceptually referred to as Lockean Labels) as an output of a large measurement system that encapsulates knowledge of an herbicide, including its risk assessment. This social agreement that is associated with the herbicide label is counter-balanced by some within the community who express uncertainties about information associated with the label. The acceptance of the labels and the questioning of the labels is evidence of Singerian inquiry. In particular, the questioning can be tied to the target process (Theory ID #14), which involves the consideration and expressing of uncertainties.

5.1.2 Active Establishing of New Communities

People confronting the invasive plant problem in Florida appear to routinely establish communities to address the problem from a different standpoint, for example, to address a local infestation of a particular invasive plant. In the context of Singerian inquiring systems, these communities are established to collaborate around measurement systems, which aim to detect invasive plants and the processes of eradicating them.

The Florida Invasive Species Partnership (FISP) is an example of an organization that actively strives to establish communities. FISP, with the aid of a Web site (http://floridainvasives.org), assists others in establishing communities by providing a database of documents that aid others in establishing effective local communities that confront local invasive plant issues. The documents contain information about how landowners may obtain assistance (e.g., grants and technical advice), which help to establish their own efforts to confront

their local invasive species problems. This database is officially called the “Florida Landowner Incentive Programs” but is usually referred to as the “Matrix.” New communities are provided with information that is, based upon experience, crucial to success.

Another effort to establish community is a Web-based information system called EDDMapS (Early Detection and Distribution Map System). This information system allows people to input the GPS-enabled coordinates of invasive plant sightings and then display maps of these sightings. This site also allows people to input images of the invasive plants sighted. Others in the communities validate the plant information.

These active efforts to establish communities provide evidence that validate the target process (Theory ID #3) of “Establishing community.”

5.1.3 Defining “Invasive”

Several informants mentioned the need to define “invasives,” and often, the intention was to separate the invasive issue from the “non-native” issue. The distinction is viewed as important because not all non-natives are considered to be invasive, and some natives may be considered to be invasive.

The definition of what is “invasive” appears, in general, to be well considered and important to those confronting the invasive plant problem. As with many words, there is a need to be specific and to qualify what is meant by “invasive.” The importance of the definition rests with the idea that if a plant is designated as invasive, it becomes the focus of efforts to eradicate it. This designation of which plants in Florida are invasives is important as viewed by Florida Exotic Pest Plant Council’s (FLEPPC) Invasive Plant Lists.

This effort to define “invasives” in the problem domain supports the target process (Theory ID #54), which reads “Define the elusive concepts.”

5.1.4 Stewardship Philosophy

The term “stewardship philosophy” is used here to describe ideas and actions witnessed during the case study. People acted to aid the community or the environment. This was evident from the moment that the primary investigator started telephoning to ask for interviews; one of the first persons called forwarded an e-mail containing an explanation of the research to many others in the community. That person took responsibility of enabling the researcher’s goal and aligning it with the goals of others in the community.

One indication of the stewardship philosophy is that many of the efforts to eradicated invasives are performed by volunteers. In addition, the overall importance of education as a central strategy to confront invasives can be reasonably characterized as a public endeavor, one in which people are guided by the demonstration of ideas. A pervasive belief in a stewardship philosophy supports the validity of the target process (Theory ID #13), which reads “Enable others.”

5.2 Concept of Time Found Lacking from the Target Processes

In addition to considering what processes are supported and not supported by the data of the case study, it is important to consider what concepts might be lacking altogether from the target processes. The central concept found lacking in the target processes was time.

To understand why time is important, consider that while reading this a few plants are growing in an invasive way. That is, the invasive plant problem is live, an ongoing problem.

The consideration of time may not be easy, however. We can consider sunrise and sunset easily perhaps. But, it is more difficult to consider time as reflected by the seeds, in that they may wait until certain conditions before germinating. The study of the plants in Florida also includes the history of invasives and the history of people, such as when Columbus arrived, a point on the timeline that helps to qualify what constitutes a "native" plant. Finally, the concept of "patience," a person's ability to wait for time to elapse, was found to be important. After an infestation of invasive plants is removed, it may take time (e.g., three years) for native plants to grow and fill in the spaces.

The data suggested a mix of time frames, some social, some individual, some biological, and some technological. However, the target processes were found to lack any meaningful capturing of these ideas. Therefore, the target processes may need to be adjusted or appended to consider the concept of time.

6. CONCLUSION

This research report discussed a method for developing a Churchmanian Knowledge Management System. The main purpose of the proof-of-concept IT artifact, a Web site that hosts the target process list, is to point to one of many possible methods for describing the measurement of Churchmanian Knowledge Management System development. The key question asked in this research report is: “What method should be used for CKMS development?” The key concept we need to understand the theory of problemography is how to measure the problem domain in terms of engaging theoreticians who can provide the theory needed to understand CKMS development.

It seems clear, despite limitations, that the people confronting the invasive plant problem in Florida comprise a Singerian inquiring system. These people were found to perform many processes that can be characterized as Singerian inquiry. The challenge going forward with future research on CKMS development is to understand how these Singerian qualities originated and how they can be more accurately described and measured in a real-time manner.

The main assumptions underlying this information system development strategy is that a Knowledge Management System can be considered a Management Information Systems, that the methodology is satisfactory in that the method is straightforward, and that humans are largely teleological beings. If we take the line of reasoning described in this report to be true, the 45 target processes that filled the gap may be used as basis upon which to measure the development of CKMS.

DESCRIBE A WICKED PROBLEM INQUIRING SYSTEM (DAWP)

Essay 2

Abstract

Environmental managers work on projects and advocate policies to protect and restore the natural world. While working toward their goals, they confront wicked problems, complex social planning problems that have no definitive formulation. While a number of information systems that support environmental managers' activities exist, information systems dedicated to the managers to articulate wicked problem formulations are needed. This research proposes an Information Systems Design Theory (Walls, Widmeyer & El Sawy, 1992) showing how to develop information systems that support inquiring environmental managers. The requirements of this class of information systems are grounded in Churchman's (1971) Singerian inquiring system, a theory for creating knowledge in an ethical manner. Two design principles are developed, the Every Person Principle (enable the "sweeping-in" of experts) and the Connectedness Caretaker Principle (create "exoteric" knowledge that goes to all of humankind). An implementation of the development method was used by a small set of participants who aimed to discuss the problems related to native plants in Florida. This research report describes the initial instance of the information system under development and the results of the Singerian inquiring system development method being tested.

1. INTRODUCTION

In the previous study, a group of people, confronting the invasive plant problem in Florida, was attributed the status of a Singerian inquiring system. An attempt was made to understand how the group's existing information systems supported the group's inquiry processes. In this second study, rather than describing a *found* Singerian inquiring systems, an attempt is made to develop, *from scratch*, an information system based upon the Singerian inquiring systems theory. To guide this development attempt, two design principles, the Every Person Principle and Connectedness Caretaker Principle, are devised. These two design principles encompass a prescriptive theory, an answer to the question, "How should we develop a knowledge management system that enables a group of people to perform Singerian inquiry upon a wicked problem?" These design principles imply that that there are two critically important problems when developing a Knowledge Management System (KMS) based upon the design of a Singerian inquiring system.

One problem with developing a Singerian inquiring system is that Singerian inquiring systems theory is large and complicated, making it difficult to learn. The subject matter of the Singerian inquiring system includes the topics of systems, measurement, creativity, and epistemology. Although Churchman's writing has a straightforward style and exquisite clarity, the subject matter demands extensive study. For example, the Singerian inquiring system rests upon the other four inquirers devised by Churchman's (1971) inquirers, so knowledge of the philosophy of Leibniz, Locke, Kant, and Hegel can be considered prerequisites. Learning the intricacies of the Singerian inquiring system is a scholarly endeavor. The primary outlets for the discussions of the theory are academic journals, which might be the opposite of what is expected

when considering that one of the Singerian inquiring system's major design objectives is to produce exoteric knowledge, knowledge for common people. So, to address this problem, the Every Person Principle is codified as an imperative that reflexively applies the Singerian inquiring system's imperative for exoteric knowledge. The design goal is to describe Singerian inquiring systems so that the uninitiated public increasingly understands this inquiry system. The developer of such an inquiry system should consider the information system being developed as being used by everyone and anyone.

The difficulty of abiding by this imperative in the extreme may be obvious. Simply consider the digital divide. Much of the population does not have easy access to computers or the Internet's World Wide Web; the guideline that *every* person should be considered in the development of the knowledge management system appears stringent. The principle is a challenge: Aim to make the Singerian inquiring system's ideas readily available to an increasingly wider audience. The Singerian inquiring system is a learning system, but, to be developed, the learning system must be learned. The juggling of design considerations, when following the principle, focuses chiefly on how users learn about the nature of the system itself. The design of a menu and the descriptions of the system's components have natural limits to the number of people finding them useful and helpful. The Every Person Principle considers the problems of development in terms of how to reach everyone, both with access to the ideas contained in the system's knowledge base and with access to the ideas of what the system is. A Singerian inquiring system seeks to produce exoteric knowledge, but with the Every Person Principle, this is not enough; the information system delivering that knowledge, as a Singerian inquiring system, should be comprehensible to every person.

A second problem with developing a Singerian inquiring system is the apparent tendency for policy discussions to degrade to a contentious polarity of opposing sides with little hope of finding a resolution. This may not be a problem with the presence of the activity of debating itself. The Singerian does not shun the dialectic. The Singerian inquiring system contains the design imperative that suggests thatwhen a stasis of opinion has been reached an inquirer increase the level of debate. An inquirer is allowed, in all fairness, to “rock the boat” by asking new questions. But, does this debate resolve itself in bitter disputes that isolate, or in innovative solution-gathering that joins the opposing inquirers in understanding? The Singerian inquiring system recognizes that debate and independent knowledge conquest (i.e., “heroic mood”) is an important part of learning; however, accompanying the “rock the boat” and “upset the applecart” maneuvers is the “sweeping in” of new ideas.

The sweeping-in operation is a cooperative gesture. Sweeping in is justified by the concept of holism and goals rather than opposing camps and tactics. The Connectedness Caretaker Principle is an imperative to encourage each developer of the inquiring system to be a custodian of holism by actively pointing out how the system’s data might be connected to everything else. The design challenge is to find ways to enable inquirers to more readily see the connections among the parts. This design principle is suggesting something different from the Hegelian synthesis, which solves the problem by creating a position that results in the dissolving of the two sides; rather, this Singerian maneuver considers the parts already connected; the influx of knowledge helps by describing these connections.

In framing the problem as a need to have a perspective that views the whole, the design challenge can be stated also as a need to overcome the tendency for specialization and “dug-in” positions. The Connectedness Caretaker Principle is an imperative to reflect upon the ethical

qualities of imperatives. For the developer of Singerian inquiring systems, the design principle cues up a question: By what logic does one designer implore another designer to adhere to design principles? The moral implications of stating that one *should* design a certain way equates imperatives to ethical statements. The Singerian inquiring system is a robust ethical platform because the Singerian inquirer accepts a stewardship role and takes responsibility for descriptions of the real world. The developer of Singerian inquiring systems, in addition to debating, seeks a cooperative role, reversing the reductionism of science and system analysis. and encouraging a view that is interconnected and dynamic.

This report discusses these two design imperatives, the Every Person Principle and the Connectedness Caretaker Principle, and the attempt to use them to develop an IT artifact, a Web site that supports the activities of Singerian inquirers. This research report describes a study in which a small set of participants used the method to develop a Singerian inquiring system for discussing the problems pertaining to native plants in Florida. The attempt was to create a virtual Singerian inquiring system.

1.1 What is a Singerian Inquiring System?

Singerian inquiring systems theory (Churchman, 1971) models how to inquire and is based upon the philosophy of E. A. Singer Jr. (1873-1954), who studied measurement, the teleology of life forms, and what constitutes progress for society. An inquirer using the methods of the Singerian inquiring system is asked to consider knowledge holistically and to consider the ethics of any potential knowledge. The Singerian inquiring system is an open system; the process of measurement in the Singerian inquiring system has no boundaries because there is no ultimate

authority. Holistic knowledge is obtained by this precept. An inquirer, over the long run, engages in a process of attempting to gain knowledge by continually "sweeping in" new concepts. Knowledge is associated and used in combinations, not just refined. Ideas become tools by which to understand other ideas. A Singerian inquiring system is dynamic, seeking to argue when all are in agreement and shifting to a tactic of cooperation when there is a need to form a community upon which to devise a subsystem that might lead to the settling of a debate. Also, a goal attributed to Singerian inquirers is that of producing exoteric knowledge, knowledge that can be used by society, as opposed to narrowly focused knowledge that results from the specialization found in many scientific endeavors.

The Singerian inquiring system is one of Churchman's "five archetypal ways of modeling and generating evidence for any problem," and it can be used by managers (Mason & Mitroff, 1973, p. 480). In particular, the Singerian inquiring system is described as involving "continual learning and adaptation through feedback" (Mason & Mitroff, 1973, p. 480). This feedback occurs through a back-and-forth re-casting of two types of questions. First, when the answers to questions are too well accepted, the next move is to refine the questions and ask more difficult questions. Second, when the answers to questions find little agreement among people, the next move is to refine the question and ask more general questions.

Based upon these attributes and functions of the Singerian inquiring system, it is considered to be well suited to aid the knowledge management of wicked problems (Mason & Mitroff, 1973; Mitroff & Linstone, 1993; Courtney, 2001). The dynamic and social nature of the Singerian inquiring system matches wicked problems, which are related to open social systems. Wicked problems are social planning problems so complex that defining the problem is the problem. The concept of a wicked problem, discussed by Churchman (1967) and explored by

Rittel and Webber (1973), can be explained by first contrasting them with tame problems. Tame problems have exhaustive formulations and clear indications that a solution is correct. Wicked problems, in contrast, have to do with open social systems in which solutions are not technically solvable.

Rittel and Webber (1973) enumerate several propositions of wicked problems. Wicked problems have no stopping rules when generating solutions. There is no ultimate way to test whether or not a given solution is correct. Moreover, the attempts at a solution are usually one-offs; that is, they are unique attempts to solve a problem that will most likely not be useful in another situation. Wicked problems are particularly problematic for the solution designer because they are not true or false but are better or worse. The person attempting to solve the problem may even be caught in the causal web of the problem. Similar conceptualizations of non-tame problems include “messy” problems, or social messes, described by Ackoff (1974), and “ill-structured” organizational problems discussed by Mitroff and Emshoff (1979). Wicked problems are the class of problems the information system being developed is aiming to solve.

1.2 Why Develop a Singerian Inquiring System?

Singerian inquiring systems theory is important because several people, including Mason and Mitroff (1973), have argued that it is appropriate for solving wicked problems. Courtney (2001) argues that the use of Singerian inquiring systems in combination with Unbounded Systems Thinking (Mitroff & Linstone, 1993) is applicable to several problem domains in the world, for example, sustainable development.

The purpose of this research is to increase our understanding of how to develop Singerian inquiring systems. The two proposed design principles are an attempt to codify natural forms and functions, which govern the building of an information system that enables inquirers to formulate wicked problems by using processes grounded upon Singerian inquiring systems theory. This is important because the Singerian inquiring system is a model for learning about wicked problems.

However, there is little guidance about how to develop a Singerian inquiring system. Mason and Mitroff (2005) write that the application of Singerian inquiring systems theory is unrepresented and virtually nonexistent.

This research is also important because there is a need to aid inquirers in confronting wicked problems. The current decision environment, characterized by uncertainty, complexity, and a large number of stakeholders, suggests the need for knowledge management systems and decision support systems that aid in solving problems related to strategic planning, social responsibility, and sustainable development (Courtney, 2001).

The context selected for this research is that of environmental managers. The management of natural resources and the establishment of public policy on environmental issues are contemporary problems. In particular, this study includes people who are interested in discussing the problems related to the native plants of Florida. The immediate purpose of the Web site is to help people, who are concerned about this problem, arrive at a better understanding of the problem, both the formulation of the problem and potential solutions for the problem.

The next two chapters explore the prior literature and establish the definitions of the Every Person Principle and the Connectedness Caretaker Principle, respectively.

2. EVERY PERSON PRINCIPLE

The starting point for this research is a combination of two subfields of MIS research, one long-standing, one newly discussed. The first subfield is the body of research that has followed in the wake of Churchman's designs of inquiring systems. In particular, researchers following the trajectory established by Mason and Mitroff (1973) have recommended the Singerian inquiring system design as a basis of the design of information systems that aim to aid managers and their clients who all confront wicked problems. Courtney's (2001) model is a way of viewing decision-making and knowledge management; the use of mental models and multiple perspectives throughout the decision-making process. This is dubbed here as the Applied Singerian Inquiring System trajectory.

The second subfield is focused upon a context: all things Management Information Systems with respect to environmental issues as they pertain to organizations. The overview of this subfield is El-Gayar's and Fritz (2006) review of Environmental Management Information Systems (EMIS). This body of ideas starts from the perspective of management and organization and asks how to manage a large number of issues related to the environment. The information systems are tangible. This subfield includes pragmatic systems that are out in the field reducing the waste of resources and reducing the use of damaging byproducts. This subfield creates information systems that help preserve and conserve natural resources while organizations produce products and services. This EMIS trajectory is relatively new.

If the Singerian inquiring system's design is applied to the environmental issues context, then the result should be an EMIS, and be at the intersection of these two subfields. The bias is

clear; this research project approaches environmental problems with an information systems design perspective.

The combination of these two subfields is useful in explaining the Every Person Principle because it helps to see that the merging of two constituencies is far from clear-cut. There can be groups within a group. On one side, consider a group loosely defined as environmental managers. These are, for the most part, professionals working in natural areas, such as fields, forests, swamps, prairies, beaches, springs, rivers, lakes, and estuaries. Environments are open systems and are changing. These professionals confront wicked problems. That is to say, they confront a type of problem that is contingent upon a point of view, a type of problem that does not have a provable solution, and a type of problem in which the unintended consequences of a potential solution may result in wholly new problems.

The theory found in the literature (Mason & Mitroff, 1973; Mitroff & Linstone, 1993; Courtney, 2001) suggests that Singerian inquiring systems design might help these managers confront these problems. Here is where every person becomes the focus. The imperative of the Singerian inquiring system is for exoteric output, but why not then also exoteric input?

2.1 Widening the Definition of Environmental Managers

So, the definition of Environmental Managers is widened. Consider a homeowner as having a supply chain, even when not scaled to the size of a large US corporation. What if we say that everyone in his or her own way manages the environment? We all use natural resources to different degrees. So, begin by creating information systems that support widely scoped definitions of environmental managers. Following are some systems to consider. Focus on the

people, ask: Are they designers or clients, or both? A wide variety of information systems are used when they decide upon environmental issues and engage in activities that impact the environment. The information systems are grouped into four categories based upon their use. And, these are just some expressions of this widened EMIS concept.

The first category of information systems enables cyberactivism, a process of activism on the Internet, such as pressuring corporations through protest movement organizations or mass media coverage visibility (Illia, 2003). Computer-mediated communications fundamentally alter an environmental manager's capacity to globally network with people, mobilize participatory resources, share solutions, and disseminate digital alternative media (Pickerill, 2003).

The second category groups together information systems that environmental managers use with the Internet to facilitate communication between scientific communities and the general public. For example, Scorecard.org is a public environmental disclosure Web site that enables a person to input a zip code of a geographic area and receive information about pollution problems and toxic chemicals in that area (Green Media Toolshed et al., 2005). A similar tool revealed by the case study in the previous essay was the Pesticide Action Network, which had a chemical database that was based upon data from a US Environmental Protection Agency (EPA) data source.

The third category includes natural resource managers' use of decision support systems. These information systems aid decision-making and, in particular, problem domains. Different systems allow people to model different problems.

The fourth category is a class of information systems, the dialectical methodology developed by Elgarah et al. (2002). These systems help to estimate the degree of divergence in the opinions among people.

There are many possible categories to be added. However, none of these information systems directly fulfills the purpose of support for environmental managers confronting wicked problems.

2.2 Re-Defining Environmental Managers

The Singerian inquiring system maintains a “sweep-in” operation. So, take a definition of environmental manager, and sweep in everyone, and treat everyone as a natural resource manager. Environmental managers are defined here as being both professional and non-professional. The research sweeps in the homeowner who works on the lawn or sweeps in the product manager who is considering deep aspects of the supply chain, such as the landfills where the by-products (i.e., waste) of the manufacturing process goes. Even a tourist who is visiting a state park in Florida can be viewed as managing the land by, for example, his behaviors (i.e., littering or picking up trash, adhering to safety rules or taking risks, staying on trails or thrashing about).

An environmental manager is an individual who believes in managing the environment and that environmental issues should be decided in an ethical manner. Environmental managers include people who act upon their beliefs by behaving in ways aimed at preserving, protecting, or restoring the environment, including animals, plants, and natural resources.

The following people are considered to be environmental managers: scientists of environment-related disciplines, engineers of environment-related technology, participants in the planning and review of environmental projects, workers of government agencies and legislative bodies whose mission is related to environmental policy, people who design environmental

solutions and provide environmentally-related services, people who work with environmental regulatory compliance, people who research environmental policy and proposals, legislators of environmental policy, people who help to establish communication between environmental managers and other stakeholders, auditors and reporters of environmental management financial information, managers in business enterprises who work on corporate sustainability and environmental policy and related projects, people who write environmental best practices, programmers and developers of environmental management systems, people who manage the technical aspects of environmental projects, people who protect or investigate illegal environmental activities, and people who help to educate others upon environmental issues or participate in these education initiatives.

2.3 Define Every Person Principle

The Every Person Principle states that an artifact that tends to be usable by every person will successfully fulfill the requirements. This design rule aims to achieve the Singerian inquiring system's goal of creating exoteric knowledge. The Every Person Principle is an imperative to be followed by anyone participating in the development of the system's design and is available to all humans, including future generations.

The Every Person Principle is a concept against which a developer considers the existing system and changes and considers a way of approaching the design of information technology. Consider, for example, a system that uses only the English language. Against the Every Person Principle, such a system is challenged by a developer and considered in light of people who do not speak English. The resulting multi-lingual system is then challenged and considered in light

of people whose eyesight requires large print, people who use sign language to communicate, or people who are in circumstances in which there is no light by which to read. As an imperative, the Every Person Principle encourages the transformations of ideas expressed in one medium to another medium that expands the range of those ideas.

The Every Person Principle is grounded upon the concept of exoteric knowledge, which is found in the design of Singerian inquiring system. The Every Person Principle is a recognition that a problem exists when taking knowledge from esoteric to exoteric. Courtney, Richardson, and Paradice (2002) write that the Internet is a grand initiative in the exoteric direction. The Internet represents a channel by which esoteric information is routed and re-purposed for many audiences. The Internet is a technology that is inclusive.

Even with acceptance of the World Wide Web as a positive technology relative to other exclusive technologies, the Every Person Principle encourages consideration of designs that address the system requirements in terms of people who do not have access to the World Wide Web.

Here is another example. Plant names are communicated in a binomial nomenclature based upon Latin words. The common names of plants can vary from region to region. The question then is how to take the esoteric out of Latin names and how information technology can make enable a wider range of people to more easily understand the scientific names. Here, training may be an important tool of the developer embarking upon solving a design problem initiated by the Every Person Principle. That training is a vital feature of a Singerian inquiring system should be of no surprise for those familiar with the Singerian; it is a learning system.

2.4 Attempt

How does this design principle aid the completion of the development task? This was attempted with the “Inquiry Cue Card”. For example, Hall (2004) envisions the next generation of online discussion as an “immersive layered rich media” (p. 3,144). The Inquiry Cue Card is an attempt to organize the components of the Singerian inquiring system with graphic design elements and color (Figure 12).

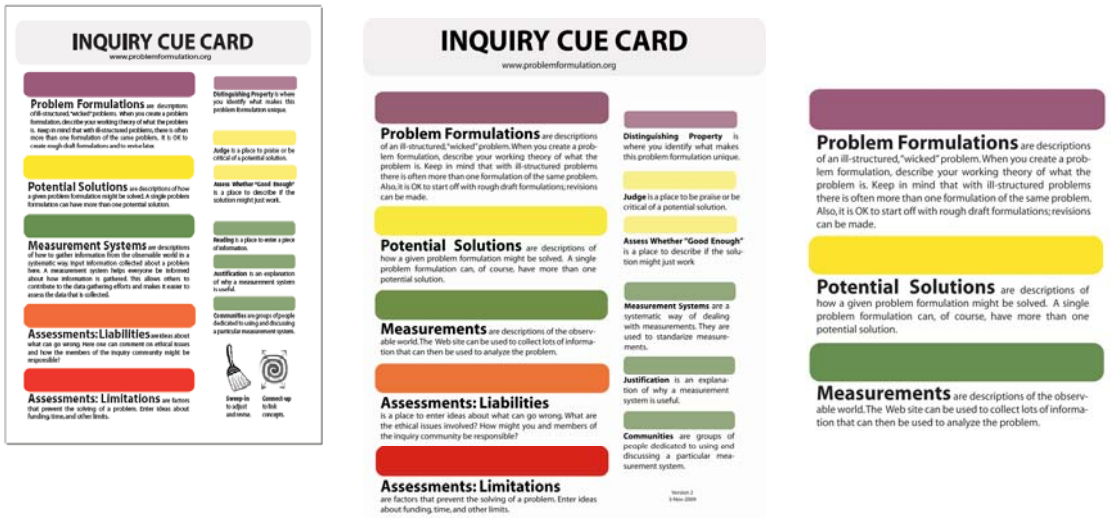


Figure 12. Inquiry Cue Card (version 01, 02, and close-up)

The “Inquiry Cue Card” uses colors which to into the Web site icons in order to indicate categories of Singerian inquiry functions. The “Inquiry Cue Card” is purposely only on 1 side of 1 page of paper so that it does not contain a large amount of information. The “Inquiry Cue Card indicates items in a sub-category by decreasing the size of the accompanying color fields and explanation paragraphs of text. The “Inquiry Cue Card” shows two important icons so that the names of these icons are highlighted over other icons. The “Inquiry Cue Card” is designed to be distributed both on a webpage and printed out on a sheet of paper.

3. CONNECTEDNESS CARETAKER PRINCIPLE

The Connectedness Caretaker Principle is a design imperative declaring that each unit of information (i.e., webpage about a problem) should encourage one or more people to accept the responsibility of connecting that unit to another unit of information. This principle is guided by Churchman's (1982) lecture on connectedness, which included the idea that "All social systems are strongly nonseperable with respect to their components" (p. 2). The connection serves to increase the observation of relationships and is considered related to and facilitated by hypertext. The objective of connecting/linking is not merely to fuse disjointed information but to fulfill a role of caretaker, whereby the person seeks to preserve value and perform a duty in a morally aware manner that considers others, including those in future generations.

This design principle embraces the theme of linking people's efforts with the goals of others. The links are assessed in terms of the gaps they traverse. A gap of high value would be one that helps to facilitate another person's goals. The Connectedness Caretaker Principle places importance upon the role of the linker, perhaps weighing design considerations from the linker's perspective higher than even those representing the nodes or the edge joining the nodes. The creation of links is regarded as a form of cooperation because it implies that two pieces of information are related and meaningfully joined. This is observed as the creation of knowledge, represented by the whole that is more than the sum of the parts. Churchman (1971) credits Singer for the theory that value is brought about by "enabling" (p. 200). The Connectedness Caretaker Principle could be renamed a Scheme for the Study of Teleological Cooperation.

3.1 A Brief History of the Hyperlink

One conception of linking is, of course, hypertext, the practice of marking-up prose so that the reader can navigate to related prose. Linking is a major part of the World Wide Web, implemented by the "A" element, its "HREF" attribute, and an infrastructure of webservers and clients. Reviewing the technical history of the hyperlink enriches an understanding of the Connectedness Caretaker Principle.

Vannevar Bush's (1945) essay on the Memex mechanized record linking system is widely considered as the first writing that anticipated the importance of hypertext. The essay remarks upon the difficulties of using the expanding esoteric knowledge. Ted Nelson, another pioneer of linking, is credited with coining the word "hypertext" (McAleese, 1999). Nelson details Project Xanadu, an electronic literary machine, as a form of storage containing interconnected documents of non-sequential writing and allowing universal publishing and eternal revision (Nelson, 1992). Examples of early implementations of hypertext are NoteCards, developed by Franz Halaz, and HyperCard, developed by Bill Atkinson (McAleese, 1999).

Berners-Lee (1999) developed the first Web programs and helped to codify the World Wide Web's three important technologies: HyperText Markup Language (HTML), Hyper Text Transfer Protocol (HTTP), and Uniform Resource Locator (URL). The significance of the World Wide Web with respect to the *exoteric* knowledge goals of the Singerian inquiring system can be emphasized by the historical fact reported by Berners-Lee (1999) that the first name given to his invention was "Enquire," short for "Enquire Within upon Everything" (p. 1).

3.2 Management as Custodian

The connecting/linking concept of the Connectedness Caretaker Principle also relies upon management theory, a large area of study that includes efforts to understanding the "theoretical roots" of agency. One person may perform actions for another. From this situation, arises many concepts, but by temporarily filtering out a myriad of issues (i.e., communications, pricing, strategy, leadership, assurance, institutionalization), the focus is placed upon responsibility, obligation, and, the question of the degree to which a manager is answerable to a client, or to all clients.

An information system is said to incorporate the caretaker theme if each user of the information system is charged with the responsibility of being a facilitator, an enabler, and a server of connections. In this respect, the proposed design principle is grounded upon Drucker's (1973) conceptualization of a manager. Drucker (1973) seeks an answer that will justify the role of management as beneficial for society. Drucker (1973) asks (*paraphrasing)*, "Where does a manager's power come from such that it is a social benefit?" Drucker (1973) concludes that a manager's power is acceptable in society if the purpose is to make human strength productive. In an identical way, a person using the information system as Singerian inquiring system is provided with connectedness caretaker functions, methods enabled by software code that make the Singerian inquirers' inquiring productive. Furthermore, these functions focus upon the linker's responsibilities, seen primarily as a need to try to comprehend the overall scheme being implemented, the inquiry of all clients using the system. These functions, which are in a natural state of being in development (and, at times, obviously so) are evaluated as beneficial if any created links (to existing pages or new information) serve another person.

While still within the consideration of management, the context of the Internet as a platform for information services (such as the World Wide Web) is deemed important. A manager is framed as an inquirer who uses these information system networks but is also responsible for their disuse and misuse. Courtney, Richardson, and Paradice (2002) describe how the Internet can be used to support the Singerian approach. The Internet can facilitate the "creation, organization, storage, and sharing of ecosystems information and knowledge" (p. 1). The Internet provides a platform for a global dialogue that can allow people interested in ecosystem issues to develop common goals and make policy decisions. Conceptualizing the manager as a custodian, however, only momentarily satisfies the need to define our terms concretely, as questions quickly surface about how the vision of the manager, the clients, and society is to be defined, amplified, and unified, or, whether this is possible or beneficial on net.

3.3 Confrontational and Not Confrontational

A third way of viewing this design principle is to consider it an information system development method in its own right and then to contrast it with Elgarah, Courtney, and Haynes's (2002) MPDP Methodology, a dialectic approach that it is based upon another of Churchman's (1971) inquiring system designs, the Hegelian inquiring systems. Based upon the dialectic, Elgarah et al.'s (2002) method has the developer view the participants as "opposing parties" (p. 4). Once identified, an over-observer seeks to find a synthesis that is a newly-created theoretical middle ground upon which the arguments of the opposing sides dissolve. The synthesis is a new solution upon which universal agreement is found.

The dialectic process of MPDP is a conflict-driven approach. Its bias is that it assumes opposition, conflict, and the polarity of thesis/anti-thesis. The dialectic process begins with decisive dissension. The opposing parties only unite based upon the performance of the Hegelian over-observer. The Connectedness Caretaker Principle, on the other hand, is naturally both conflict (i.e., “rock the boat,” “upset the apple cart,” etc.) and cooperation (i.e., Singer’s enabler). The inquirer not only questions the positions of others, but also questions his/her own positions, questions whether that position enables others to consider positions, and questions what attributes of others’ positions are similar to his/her own position.

The Connectedness Caretaker Principle is more finely grained in its view of clashes among people. Disagreements exist, but are not context-wide and as all-encompassing as those of the dialectic-based inquiry methods. Disagreements exist, simultaneously with agreements, and at times may be indistinguishable (i.e., in programming, when a “bug” is a feature).

The role of the Connectedness Caretaker is to match ideas that probably can be measured to have a variety of identifiable conflicts and synergies. The role forms networks. The network is dynamic. People may often refine their opinions, or refine the descriptions of their opinions. The structure of observation also creates a basis for confrontation and enabling, as the connections themselves become objects upon which agreement and disagreement result. The Connectedness Caretaker Principle is both confrontational and not confrontational.

3.4 Environmental Ethics

A link between the ideas of Churchman and Environmental Ethics occurs when Churchman (1971) mentions Spinoza. The writings of Spinoza are used to ground environmental

ethical issues. For example, de Jonge (2004) argues that Spinoza's writings support an ethical position toward the environment that begins through self-realization. Spinoza places importance upon self-knowledge. Self-realization is a starting point from which a great understanding of the self and the self's place in the natural world, forming the basis of concern for what is [the] outward form [of] the self (de Jonge, 2004). Spinoza is credited with anticipating ecological consciousness (Nash, 1989).

Churchman (1971) mentions Spinoza and how Spinoza and his contemporaries considered whether knowledge was good or bad. The writings of Spinoza have also been used to support a non-violent branch of the concept of deep ecology, which aims "to show how a harmonious relationship with nature can be made available, through extended care from the human to the non-human world and does not rely upon moral theory but rather on Spinoza's self-realization, the knowledge of the self that includes nature and non-human beings and so provides an internally-generated sense of what is good" (de Jonge, 2004).

Environmental philosophy is a large topic that includes several fundamental questions asking what humankind's obligation to the natural world is and how the benefits and responsibilities with respect to the natural world are to be managed (Bourdeau, 2004, after Naess, 1973). Environmental ethics is rooted in moral philosophy, referencing ancient philosophers, such as Plato, and is about choices and decision-making. Much could be written on how environmental philosophy might be "swept in" to inquiring systems research.

"Environmental ethics is that branch of applied ethics that has been most concerned with the moral grounds for the preservation and restoration of the environment (Light, 2003, p. 633).

One question of environmental ethics is "what is humankind's relationship with nature?" This question is frequently related to religion. For example, White (1967) traces the historical

roots of the ecologic crisis to an anthropocentric view embraced by Medieval Christianity (Bourdeau, 2004). The anthropocentric question pertains to whether or not “humans are the measure of all value” (Nash, 1989). Should environmental decisions be based upon human values, or is this an arrogant viewpoint that should be replaced by views that place humans and nonhuman life on an equal status? (Seip & Winstop, 2006)

And from here questions can be raised as to the design of inquiring systems based on various assumptions such as *Peter Singer (cite) believes that a weed has rights*.

In summary, environmental ethics is a long-standing inquiry system. The DAWP is not novel.

3.5 Design Challenge in Terms of Connectedness

Another design challenge is the interconnected nature of wicked problems and their ethical assessment. The concept of connectedness, as discussed by Churchman (1982), can be found in his statement: “All social systems are strongly nonseparable with respect to their components” (p. 2). The concept of connectedness embraces the idea that within each human problem can be found all other human problems (Churchman, 1982). In contrast to the concept of connectedness is the reductionist view, or the dissection of concepts into constituent parts (Flood, 2001). A theme arises from systemic thinking and the contemplation of connectedness that the contemplation of entities in the world cannot be separated from ethical considerations (Churchman, 1982).

As Churchman (1981) describes it, the “fact-finding [is] nonseparable from the aftermath” (p. 3). The person observing influences the observed. Therefore, fact determination

and ethical determination are linked, meaning that an inquirer should ask what the consequences of determining a fact are and what the consequences of any gained knowledge is (Churchman, 1982).

3.6 Attempt (Ethical Method/Manner of the Singerian Inquiring System)

Courtney, Richardson, and Paradice (2004) concluded that the decision support system used to support the infrastructure decisions should incorporate ethical issues. Incorporating ethical perspectives into the DSS is difficult; "ethical issues are wicked problems in their own right" (Courtney, Richardson & Paradice, 2004, p. 14).

The Singerian inquiring system is an ethical system in that after an inquirer comes to a particular set of conclusions, the Singerian inquiring system obliges that inquirer to consider the ethical ramifications of such knowledge. "In a Singerian inquiry, there is no solid foundation. Instead, everything is 'permanently tentative'; instead of asking what 'is,' it is asked what are the implications and consequences of different assumptions about what 'is taken to be'" (Lester & Wiliam, 2002, p. 13). Any plan of change in the environment, from "planting a tree" to "a million-dollar invasive plant management plan," might require the same attention. "An important consequence of adopting a Singerian perspective is that with such an inquiry system, one can never absolve oneself from the consequences of one's research" (Lester and Wiliam, 2002, p. 13). The Singerian inquiring systems' ethical method is found in the acceptance of the responsibility to consider other stakeholders during and after the pursuit of knowledge.

The "scoreboard visualization" is a graphic plotted on-the-fly on the DAWP site (Figure 13). The scoreboard visualization is an attempt to adhere to the design of the Connectedness

Caretaker principle. The visualization aims to display a representation of all of the major points being made so that they can be reflected upon at once.

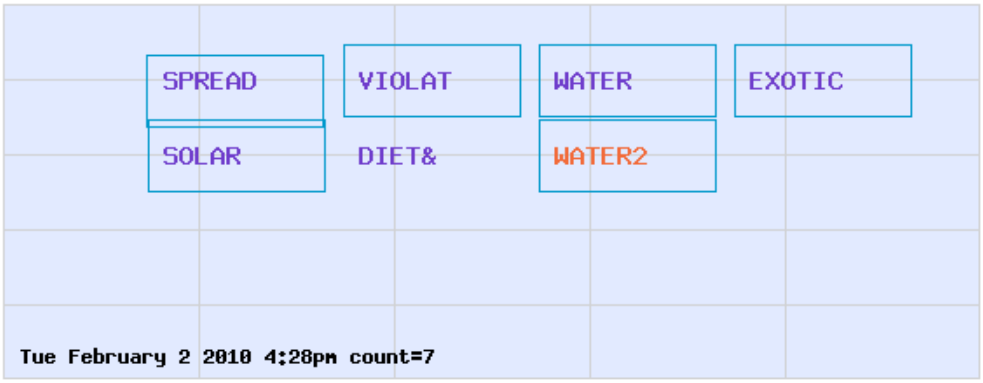


Figure 133. Glyph on Graph Scoreboard Visualization

The “scoreboard visualization” is drawn each time a user clicks, so that the most current pieces of data may be represented. The “scoreboard visualization” has glyphs which are meant to represent the major pieces of information, such as problem formulations, potential solutions, and other entities. The glyphs are plotted on a background that has grids so that the user can more easily compare the relative positions of the glyphs.

The “scoreboard visualization” is interactive, (i.e., if the user hovers his or her mouse over the glyph some details are listed) and this aims to allow the user to obtain more information about the data that the glyph represents.

The “scoreboard visualization” includes hyperlinks from the glyphs to the webpages of the data represented by the glyph so that the user can navigate to the data represented by the glyph by just clicking on the glyph.

The “scoreboard visualization” contains scoreboard features, such as the timestamp that the image was plotted and the total number of pieces of information, providing the user with metadata about the aggregate of the data in the database.

4. RESEARCH METHODOLOGY

The aim of the study is to evaluate the design theory of how to develop a knowledge management system grounded upon Singerian inquiring systems theory. An instantiation of the Web site (http://problemformulation.org/) was bootstrapped, and nine participants were enlisted to assist in the development of a new, prototype system and to inquire about the problems related to Florida's native plants. Drawing conclusions about the success or failure of the design principles is difficult because there are several biases that may emerge to invalidate conclusions about the meaning of the actual development of the information system by the participants in light of the design principles. Attempting to recognize and minimize these threats to conclusions, the following research methodology was employed while measuring the impact of the design theories applied in an empirical setting.

4.1 Purpose of Research

The purpose of this research is to increase our understanding of how to develop knowledge management systems (KMS) that are grounded upon Singerian inquiring systems theory. The methodology aims to develop an information system that enables users to formulate wicked problems. The purpose of the research methodology is to help understand whether the design principles of the Every Person Principle and the Connected Caretaker Principles as embodied by the two design artifacts, the "inquiry cue card" and the "visualization scoreboard" impacted the development of the information system and in what way.

4.2 Summary of Research Design

Using a design science methodology, the design principles were stated as a hypothesis that can be subjected to empirical examination. The empirical study involved the creation of a bootstrapped Web site that contained features that encapsulate the developmental processes described by design principles. Participants were then trained on how to use these features, and, after a period during which they could use the site, an interview was conducted.

The design of the interview is based upon Wengraf's (2001) theory-driven interview. This design links the theoretical concepts of the proposed design principles to the interview questions (Appendix E & F). This is done by beginning with the theory and devising questions that are clearly based upon the theory. Because the interview protocol is linked to the theory, after the participants have been interviewed, their reported answers can be used to assess the proposed theory.

4.3 Design Science Methodology

The use of the design science methodology stems from the idea that a theory about a development methodology is being developed. The theory is a normative theory, containing statements about what *should* be done and providing an argument as to why. The roots of design science can be traced to Herbert Simon's (1996) *The Sciences of the Artificial*, in which Simon outlines a curriculum of design. The curriculum deals with the evaluation of designs, the search for alternatives, the theory of structure and design organization, and representations of design problems. Simon's theme is that "the proper study of mankind is the science of design" (p. 138) because the complexity of human behavior can be found in the human search for good designs of

humans within environments. In this research, an *information system development method* is being designed. In particular, a process by which to boostrap, develop, and use a knowledge management system based upon Singerian inquiring systems design is being developed. The assumption is that a Singerian inquiring system-as-KMS can be purposefully brought into existence by developers.

The methodology of design science is different from the methodology of traditional science, as found in a discipline, like biology. Much of the literature on design science describes this difference. Simon (1996) delineates the study of artifacts from the study of natural things. Artifacts are different from natural things because they may have a designer's purpose. The purpose for the Web site (i.e., IT artifact) in this research is to help people in confronting wicked problems.

Simon argues that natural sciences deal with what is necessary, while applied-endeavors, such as Business, Architecture, Medicine, and Art, deal with contingencies. Despite this difference, the production of designed, artificial artifacts can be considered the creation of knowledge. A Singerian might say that we are sweeping in design rationale. Arguments help to justify a normative theory. If the design principles represent ideas that are shown to achieve the goal to which they subscribe, then they are attributed the status of design knowledge.

Many researchers writing about design science have paid particular attention to specifying what constitutes a design theory and design science methodology. One of the early formulations of a design science research design was offered by Walls et al. (1992); it specified the elements of an Information System Design Theory (ISDT). The aim is to describe a method by which to rigorously develop a theory of an information system.

An ISDT can be viewed as a way to organize an instance of design science research. Specifically, the research instance is comprised of meta-requirements, meta-design, kernel theories, and testable design hypotheses.

So as not to be distracted by the jargon, what is pointed out as being important about this progression of research components is that the description proceeds from (a) a definition of what is being designed to (b) the selected theoretical underpinnings of the design (i.e., kernel theories) and then (c) to the description of what must be found for the design to be supported as truthful. From this, the elements of traditional science can be seen within the purposefully-oriented framework of design science. Walls et al. (1992) ground their theory upon Dubin (1978) and Simon (1996) when developing the specifications for an ISDT.

4.4 ISDT

There are several parts of an ISDT. A design theory incorporates kernel theories. A design theory has meta-requirements that define the class of goals that an artifact seeks to accomplish. A design theory also has a meta-design and design process. Finally, an ISDT has testable propositions with which to test whether the meta-design and design process have succeeded. In general, an ISDT is prescriptive in nature.

The argument regarding the prescriptive nature of design theories also was argued by March and Smith (1995), who wrote that design theories are separate from natural science. March and Smith also described what constitutes the output of design research, that being constructs, models, methods, and implementations.

Gregg, Kulkarne, and Vinzé (2001) develop the idea of a Software Engineering Research Methodology (SERM). They argue that in addition to functionalist and interpretivist research, there is Socio-technologist/Developmental research. Gregg et al. (2001) describe a model of this type of research, a model showing that foundational research (proofs) and developmental research (proof-of-concept artifacts) are based upon conceptual knowledge. Hevner et al. (2004) aim at clarifying for reviewers and researchers what constitutes design science: Continually add descriptions of design research in the information systems context.

Design science definitions with Churchman's (1971) views on design are compatible with the design science definition described here. For example, Churchman writes that a designer is interested in determining patterns of behavior. In terms of Gregor and Jones's components, Churchman's patterns of behavior are represented by principles of form and function and mutable artifacts. A particular design is held to produce a particular change of state. For example, Churchman also views the designer as needing to choose the appropriate pattern of behavior such that a goal is achieved. Churchman's interest in the teleological nature of system design can be found in aspects of design science research. For example, Gregor's component is called "purpose and goal." Churchman also discusses the need for a designer to be able to communicate, an important feature of design science research discussed by Hevner et al.

However, Churchman's design view states that temporary separability of components is not readily found in the research stream of design science. Although, this is more of a design strategy to be employed by a designer and, therefore, this design view of Churchman's might perhaps be reflected in an actual instance of design science research, not the methodology itself.

Walls et al.'s ISDT (1992) will guide the constructing of design theory, helping to ensure that it is properly specified. A design theory is a conceptual model that specifies the properties

that the information system artifact should have and how the information system artifact should be constructed (Walls et al. 1992, p. 4). The ISDT for a Describe a Wicked Problem Inquiring System (DAWP) includes two design principles for guiding development and they have been used to produce two designs ("inquiry cue card" and "scoreboard visualization") which are to be tested in order to determine if they result in indications that there exists Singerian inquiring system development.

4.5 Theory-driven Interview

Here is a specific description of how the theoretical concepts of the design principles and the empirical data are linked. Based upon Wengraf's (2001) theory-driven qualitative research interviewing design, the research design begins with a specification of the research purpose (RP) (see Figure 14). This RP is linked to central research questions (CRQ), which is then linked to theory questions (TQ) that are then linked to interview questions (IQ).

RP --> CRQ --> TQ --> IQ

Figure 14. Design of Theory-Driven Interview Questions

The benefit of this research design is that the theory questions are in the language of the principle investigator's research community and the interview questions are in the language of the participants. The assumption is that this design will allow each group to communicate its ideas more clearly.

After the interview questions are established, the participants are trained, allowed time to use the site, and are then interviewed. Data analysis involved taking the data collected (transcripts of the interview), applying it to the theory-driven design (Wengraf, 2001) and drawing conclusions. The process of data analysis can be seen in the reverse direction, as shown in Figure 15; that is, moving from the empirically exposed interview questions (IQ) step-by-step, in reverse direction, back toward the central research question (CRQ).

Here is a more specific description of the analysis and interpretation of the interview data. The answers to the interview questions (AIQ) will be organized by theory question and analyzed to determine if there is evidence to support an answer to the theory questions (ATQ). The conclusions drawn about the answers to the theory questions will then be considered simultaneously in order to draw conclusions about an answer to the central research questions (ACRQ).

ACRQ <-- ATQ <-- AIQ

Figure 14. Design of Interview Analysis and Interpretation

By linking the interview questions to theory, the *a priori* design principles can be exposed to an empirical test and then evaluated.

4.6 Participant Selection

The principal investigator sought a Florida environmentalist group to host the study so that the members of the group would participate in the study. An environmentalist group easily qualified given the research's a widened working definition of environmental managers. The

principal investigator became an active member of the environmental managers' group. The system was implemented on an information technology infrastructure that was totally separate from the environmental managers' group's infrastructure. The site development was hosted by the principal investigator, which is made to appear similar to the existing information systems. Because it is impractical to interview the entire population of members of the group, the sample of people to be interviewees was based upon several factors, including the practicality of the interview (time and location considerations).

The number of participants in the study was nine; however, there were many different degrees of participation. Participants were paid volunteers and were each issued a username and password. Participants were trained. Participants were asked to use the Web site to inquire about a problem related to environmental management in Florida. The expressed goal was to create a set of problem formulations by a deadline that is approximately 12 weeks from the beginning of the inquiry. This study was to assess the feasibility of the development method.

4.7 Bootstrap

With a method for developing a Knowledge Management System grounded upon Singerian inquiring system design as described by the design principles (EPP and CCP), the method was evaluated with an empirical study. The aim was to bootstrap an instance of the Singerian inquiring system in the form of a Web site. The Web site (http://problemformulation.org) allows participants to perform developmental tasks and inquiry about wicked problems. The Web site is an initial "seed" that is to incorporate the functionality

that reflects the design of the design principles and that encourages the development of a fully functional Singerian inquiring system.

The Web site embodied the design principles in the following ways. The Every Person Principle is shown by the fact that (a) the output of the site is open to everyone, (b) the site had a "sweep-in" icon that allowed the mention of additional information, and (c) there was an Inquiry Cue Card. The Connectedness Caretaker Principle is shown by (a) the site's functionality, which allows the connecting of ideas, (b) the site had a "connected-up" icon, and (c) the navigation of the system included the use of a visualization of the inquiry processes.

4.8 Two Levels

The Web site can be viewed as working on two levels. One, the participants are developing the actual site they are using. Two, the participants are developing an actual instance of a problem formulation.

4.9 Bias During Coding

The interview data will be coded by the Principal Investigator and two paid coders. All coders will be guided by the coding rules for each question (as described above). Support for the theory will be based upon the degree to which the coders find evidence in the transcripts to support the hypothesis.

4.10 Summary of Research Methodology

This research employs a design science methodology that uses theory-driven qualitative interviews to draw conclusions about the hypotheses based upon the proposed design principles. The following chapter describes the results of the study.

5. DATA ANALYSIS

In summary, after just having analyzed the data, the conclusion is that the design principles were not convincing theories. While there are signs that the theory may help to explain the development of the inquiry system, there are doubts that particular voiced ideas can be attributed any design decisions based upon the Every Person Principle or the Connectedness Caretaker Principle. Nevertheless, the data contain interesting observations of the system, which may be important if this research trajectory is pursued.

In the next few sub-sections, each theory question will be addressed in turn. Many decisions were clear cut, but not all were. A summary of results (Table 6) shows a range from "Yes" to "No." The "Skip" is a part of the study where the methodology broke down, and the results are not valid and best removed from analysis. The table also lists the result of the central research questions, as "Mixed," which perhaps encapsulates the theme of the whole study, which mixed together design ideas and people.

Questions	Main Results
ATQ-0 Role of Environmental Manager	Yes
ATQ-2 Connectedness Caretaker Principle	No
ATQ-3 Every Person Principle	No (3:2)
ATQ-4 Customization of Visualization	Skip
ATQ-5 Is Singerian Inquiring System	Yes
ATQ-6 Understand Problems Holistically	Yes
ACRQ Answer Central Research Question	Mixed

Table 6: Main Results from Data Analysis

5.1 Answer to Theory Question 0, Role of Environmental Manager: "Yes"

Overall, the informants conveyed qualities attributable to a definition of environmental manager. More confidence could be ascribed to the results if the population was a larger and more rigorous environmental manager assessment. While there are differences among the people who participated in the study, to one degree all participants were interested in participating in the study and discussing the Web site.

Additionally, the generalizability of the results may increase if the hours spent using the Web site increased. Although, one seemingly important consideration found in more than one instance during the interviews is that people spent time considering the data to be entered into the inquiring system while not actually using the Web site.

5.2 Answer to Theory Question 2, Connectedness Caretaker Principle: "No"

The data did not support that the visualization aided the development of the Singerian inquiring systems. The Connectedness Caretaker Principle is not supported by the evidence of the DAWP project. To begin, there was a span where some people completely rejected the visualization to where the visualization was useful and used. Stepping back from these data, the visualization is seen as being disliked by inquirers because interacting with it will produce unknown results.

The aim of the visualization was to aid in understanding all the parts of the system. And, while one informant relayed that the visualization represented the whole system, the overall conclusion is that the visualization cannot be assessed in that it was not readily used.

So, there are two paths. Scrap the visualization concept as a way to achieve the design principles of the Connectedness Principle. Or, find a way to achieve acceptance of the visualization so that more people use it.

One design feature might be to add controls to the visualization so that a user could adjust the qualities of the visualization. For example, users could change the colors of the grid background to better suit their taste in display design sensibilities. Another control on the visualization might be to make it completely text based, reducing the whole scoreboard to a purely textual data stream.

Another consideration is the placement of the visualization. The layout of the DAWP versions, which users surfed, placed the visualization top and center. The size of the image occupied at least a quarter of the screen space when tested. Moving the visualization scoreboard to a side column might change the results.

5.3 Answer to Theory Question 3, Every Person Principle: "No 3:2"

Based upon the informant responses, the answer to this theory question is, overall, weighted three "No" and two "Yes." So, there is no conclusive support for the "inquiry cue card," and the Every Person Principle should be re-assessed. Reflecting upon the experience of the study, the "inquiry cue card" was more of an object of conversation than a study aid. When considering the entire How-To training section, in which the "inquiry cue card" was placed, the main insight is that the search function was found to be useful.

Given these results, it may be necessary to question whether a user needs to be trained on the concepts of Singerian inquiring systems. The How-To section may be an institutionalized

part of the Web site architecture; however, a user has many ways to learn how to be a Singerian inquirer, something which he or she may already know how to do.

Based upon the experience of training people to use the DAWP Web site and then interviewing them to record their ideas about the site, it appears that the users were able to learn the concepts of “Problem Formulation” and “Potential Solution” with little difficulty. It is possible that the main menu, which was on the left-hand column and contained these words, was a key factor in the development of a working vocabulary.

This brings up a point that might be pursued. What are the keywords that definitively describe the functions of the Singerian inquiring system? Furthermore, how should these definitive keywords be arranged into a menu?

Reflecting upon the development of the DAWP, there were several versions of the menu. Overall, the menu was steadily simplified, mostly by removing functions from the list. Consider that 50 processes are listed and defined in other studies. Here, the version of the DAWP menu, which the study informants used, had five selections, and, for all practical purposes, only “Problem Formulation,” “Potential Solutions,” and “Measurements” held meaning during the interviews. While this may seem to be a limited vocabulary, ideas about describing wicked problems and inquiring about them were discussed.

5.4 Answer to Theory Question 4, Customization of Visualization: “Skip”

This theory question inquires about the effectiveness of a user manipulating the visualization. However, this functionality was never built into the Web site. The visualization

tested had not user controls. Therefore, the interview questions were rendered meaningless and not even asked.

5.5 Answer to Theory Question 5, Is Singerian Inquiring System: "Yes"

Theory Question 5 was a summary question, which asked, "Does the methodology result in a Singerian Inquiring System?" This question aimed to capture a few important concepts (e.g., the consideration of alternate perspectives, the consideration of ethical ramifications of knowledge, and the degree to which the site was cooperative or contentious) such that a generalized view of whether or not the development principles led to development artifacts that enabled development of the inquiry system. Naturally, it is tenuous to state that it is possible to detect these concepts.

As reported, the Web site enabled one person to look at different levels of the problem. This leaves open the possibility that an inquiring system can enable a user to consider alternate perspectives.

Four people reported that during the Web site period they had considered the ethical ramifications of knowledge. One person said no. To follow up on these results, it might be useful to determine what might be attributed to these reports. Was there a particular part of the development method that leads to an inquiring system that resulted in four "Yes" and one "No" of the consideration of the ethical ramifications of knowledge?

A final idea that can be found from analyzing the data is that it is difficult to ask questions about the degree to which the site was cooperative or contentious. These questions would benefit from being asked verbatim. Much attention should be on the phrasing of these

questions because the concepts of cooperative and contentious are not necessarily mutually exclusive.

5.6 Answer to Theory Question 6, Understand Problems Holistically: "Yes"

Theory Question 6 reads: "Does the methodology result in an information system artifact that is successful in terms of Courtney's (2001) justification for using Singerian Inquiry?" The interview questions aimed at discerning one particular concept—the idea that an inquirer may understand a problem (or the problems) more holistically than before he or she used the system.

Three people said "Yes," one person said "No," and one person said that he or she viewed the problems holistically before using the system. From this, it is concluded that the Web site may indeed have increased the user's understanding of holism with respect to the wicked problems being discussed. However, there is a need to understand exactly what functions or attributes of the Web site, if any, contribute directly to this understanding of holism, keeping in mind that it might be the entirety of the Web site that contributes to it.

The concept of holism demands careful analysis. The informants, in answering the questions on holism, appear also to be concentrating on describing the inquiring system. This means that peoples' views of the holism of the problems are different. One might, therefore, also consider the holistic view of all the informant's views of his or her understanding of the holistic view of the problem formulations. Overall, opinions of an inquiring system appear to vary greatly.

5.7 Data Analysis Conclusion

The answer to the central research question is “Mixed.” These results suggest that the functionality that embraced the design principles was not useful to all participants. However, the development method instance raised the issue that produced ideas, ideas by which to replace the initial poor development functions.

So that a second version of the prototype development application can be built and tested in a follow-up study, development ideas include the following directives:

1. Save drafts of Problem Formulation and Potential Solution text.
2. Use Twitter to increase traffic to the site and increase support.
3. Make the visualization into a hierarchy, and make it more appealing.

6. CONCLUSION

Beyond these recommendations, little can be convincingly known about the the development of an inquiring system for environmental managers who have goals that result in their confronting wicked problems. This research proposes an information system design theory and a research study to implement a system based upon the proposed design theory.

The contribution of this research will be the design principles and the conclusions as to how well they fulfilled the requirements of a Singerian inquiring system. There is a rich stream of research upon both the Singerian inquiring systems and information systems that support wicked problems. This research added to these streams by proposing two design principles and testing them with an implemented system and participants who reported on their ideas.

The study contributes to the knowledge on this subject, first, by providing a rationale for a method aimed at producing feasible instances of a Singerian inquiring system and, second, by creating and testing an artifact that enables (provokes) the development method. While attempting an actual implementation of a Singerian inquirer-based information system in the context of environmental managers confronting wicked problems proved exceptionally challenging, the results, in part, suggest the possibility of beneficial incremental development and the potential for future research to reveal insights into Singerian inquiry.

APPENDIX A: DESIGN PRINCIPLES OF CHURCHMANIAN KNOWLEDGE MANAGEMENT SYSTEM (RICHARDSON & COURTNEY, 2004)

1. The CKMS designers, the design process and the CKMS itself should adhere stringently to ethical and moral principles, for example, those espoused by the Association for Computing Machinery[1] in its code of ethics and professional conduct.

2. A CKMS should be a learning system itself and exhibit sustainability by being easily adaptable to changing environmental conditions.

3. CKMS success measures should be developed for specific applications, based on information system and organizational memory success measures existing in the literature.

4. The client of the CKMS should include all salient stakeholders.

5. The CKMS should be designed to encourage the decision maker to manage the system in such a way as to increase the measure of performance to the client, and to do so in an ethical manner.

6. The CKMS should do minimal harm.

7. The designer must ensure that the CKMS and the knowledge it handles, are used to enhance the dignity of humankind[2] and choose only those clients and decision makers who also abide by this imperative.

8. Design is highly participatory in a CKMS environment, and the client, the decision maker and relevant stakeholders are all swept into the design process along with the CKMS design staff members themselves.

9. Another dimension of success of a CKMS is the extent to which designers, clients, and decision makers are one and the same.

10. Each system component should shaped in relation to the other components and to the system as a whole, so as to co-produce the measure of performance (that is, contribute to the creation of exoteric knowledge) and should not be constrained by organizational boundaries in doing so.

11. The CKMS should include mechanisms for guaranteeing the validity of the knowledge it contains.

[1] Association for Computing Machinery, "ACM Code of Ethics and Professional Conduct," October 16, 1992, available at http://www.acm.org/constitution/code.html, accessed May 22, 2003.

[2] Mason, R.O., "Four Ethical Issues of the Information Age," Management Information Systems Quarterly, 10 (1), March 1986.

APPENDIX B: NECESSARY CONDITIONS FOR SYSTEM (CHURCHMAN, 1971, p. 43)

1. *S* is teleological.

2. *S* has a measure of performance.

3. There exists a client whose interests (values) are served by *S* in such a manner that the higher the measure of performance, the better the interests are served, and more generally, the client is the standard of the measure of performance.

4. *S* has teleological components that coproduce the measure of performance of *S*.

5. *S* has an environment (defined either teleologically or ateleologically), which also coproduces the measure of performance of S.

6. There exists a decision maker who—via the resources—can produce changes in the measure of performance of *S*'s components and hence changes in the measure of performance of *S*.

7. There exists a designer, who conceptualizes the nature of *S* in such a manner that the designer's concepts potentially produce actions in the decision maker, and hence changes in the measures of performance of *S*'s components, and hence changes to the measure of performance of *S*.

8. The designer's intention is to change *S* so as maximize *S*'s value to the client.

9. S is 'stable' with respect to the designer, in the sense that there is a built-in guarantee that the designer's intention is ultimately realizable.

APPENDIX C: “WICKED” PROBLEM CHARACTERISTICS (RITTEL & WEBBER, 1973)

1. There is no definitive formulation of a wicked problem.

2. Wicked problems have no stopping rule.

3. Solutions to wicked problems are not true-or-false, but better or worse.

4. There is no immediate and no ultimate test of a solution to a wicked problem.

5. Every solution to a wicked problem is a “one-shot operation”; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.

6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.

7. Every wicked problem is essentially unique.

8. Every wicked problem can be considered to be a symptom of another problem.

9. The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem’s resolution.

10. The planner has no right to be wrong (planners are liable for the consequences of the actions they generate).

APPENDIX D: TARGET PROCESS SPECIFIED IN WEB ONTOLOGY LANGUAGE (OWL)

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  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
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    <DirectObject rdf:about="MeasurementSystem1">
    </DirectObject>
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  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
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>
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    <Verb rdf:about="Defines1">
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    <DirectObject rdf:about="Reading1">
    </DirectObject>
    <Preposition rdf:about="Takes1">
    </Preposition>
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>
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    <Verb rdf:about="Establish1">
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    <Noun rdf:about="MeasurementSystem1">
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        >
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            <Verb rdf:about="Takes1">
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```
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>
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```
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  xml:base="http://problemography.org/models/target_process.owl"
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    </Subject>
    <Verb rdf:about="Revises1">
    </Verb>
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  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Subject rdf:ID="Inquirer1">
    </Subject>
    <Verb rdf:about="SweepsIn1">
    </Verb>
    <DirectObject rdf:about="SweptInVariableOrConcept1">
    </DirectObject>
    <Preposition rdf:about="Into1">
    </Preposition>
    <Noun rdf:about="MeasurementSystem1">
    </Noun>
    <PrepositionPhrase rdf:about="PrepositionPhrase1">
        <hasPreposition rdf:resource="Into1"/>
        <hasNoun rdf:resource="MeasurementSystem1"/>
    </PrepositionPhrase>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#SweepsIn1"/>
        <hasDirectObject rdf:resource="#SweptInVariableOrConcept1"/>
```

```
        <hasPrepositionPhrase rdf:resource="#PrepositionPhrase1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="10">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

<?xml version='1.0'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Subject rdf:ID="Inquirer1">
    </Subject>
    <Verb rdf:about="Injects1">
    </Verb>
    <DirectObject rdf:about="Argument1">
    </DirectObject>
    <Preposition rdf:about="About1">
    </Preposition>
    <Noun rdf:about="ProblemFormulation1">
    </Noun>
    <PrepositionPhrase rdf:about="PrepositionPhrase1">
        <hasPreposition rdf:resource="#About1"/>
        <hasNoun rdf:resource="#ProblemFormulation1"/>
    </PrepositionPhrase>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#Injects1"/>
        <hasDirectObject rdf:resource="#Argument1"/>
        <hasPrepositionPhrase rdf:resource="#PrepositionPhrase1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="11">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

<?xml version='1.0'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Subject rdf:ID="Inquirer1">
    </Subject>
    <Verb rdf:about="Describes1">
    </Verb>
    <DirectObject rdf:about="GoalOfSystem1">
    </DirectObject>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
```

```
            <hasSubject rdf:resource="#Inquirer1"/>
            <hasVerb rdf:resource="#Describes1"/>
            <hasDirectObject rdf:resource="#GoalOfSystem1"/>
        </TargetProcessSentence>
        <TargetProcess rdf:about="48">
            <modeledBy rdf:resource="#TargetProcessSentence1"/>
        </TargetProcess>
    </rdf:RDF>

    <?xml version='1.0'?>
    <rdf:RDF
      xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
      xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
      xmlns:owl="http://www.w3.org/2002/07/owl#"
      xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
      xml:base="http://problemography.org/models/target_process.owl"
    >
        <Subject rdf:ID="Inquirer1">
        </Subject>
        <Verb rdf:about="Makes1">
        </Verb>
        <DirectObject
rdf:about="EvaluationOfPerformanceOfInquiringSystem1">
        </DirectObject>
        <TargetProcessSentence rdf:about="TargetProcessSentence1">
            <hasSubject rdf:resource="#Inquirer1"/>
            <hasVerb rdf:resource="#Makes1"/>
            <hasDirectObject
rdf:resource="EvaluationOfPerformanceOfInquiringSystem1"/>
        </TargetProcessSentence>
        <TargetProcess rdf:about="12">
            <modeledBy rdf:resource="#TargetProcessSentence1"/>
        </TargetProcess>
    </rdf:RDF>

    <?xml version='1.0'?>
    <rdf:RDF
      xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
      xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
      xmlns:owl="http://www.w3.org/2002/07/owl#"
      xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
      xml:base="http://problemography.org/models/target_process.owl"
    >
        <Subject rdf:ID="Inquirer1">
        </Subject>
        <Verb rdf:about="Describes1">
        </Verb>
        <DirectObject rdf:about="Client1">
        </DirectObject>
        <TargetProcessSentence rdf:about="TargetProcessSentence1">
            <hasSubject rdf:resource="#Inquirer1"/>
            <hasVerb rdf:resource="#Describes1"/>
            <hasDirectObject rdf:resource="#Client1"/>
        </TargetProcessSentence>
        <TargetProcess rdf:about="49">
```

```
            <modeledBy rdf:resource="#TargetProcessSentence1"/>
        </TargetProcess>
    </rdf:RDF>

    <?xml version='1.0'?>
    <rdf:RDF
      xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
      xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
      xmlns:owl="http://www.w3.org/2002/07/owl#"
      xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
      xml:base="http://problemography.org/models/target_process.owl"
    >
        <Subject rdf:ID="Inquirer1">
        </Subject>
        <Verb rdf:about="Makes1">
        </Verb>
        <DirectObject
rdf:about="EvaluationOfTheDegreeOfExotericVersusEsoteric1">
        </DirectObject>
        <TargetProcessSentence rdf:about="TargetProcessSentence1">
            <hasSubject rdf:resource="#Inquirer1"/>
            <hasVerb rdf:resource="#Makes1"/>
            <hasDirectObject
rdf:resource="#EvaluationOfTheDegreeOfExotericVersusEsoteric1"/>
        </TargetProcessSentence>
        <TargetProcess rdf:about="50">
            <modeledBy rdf:resource="#TargetProcessSentence1"/>
        </TargetProcess>
    </rdf:RDF>

    <?xml version='1.0'?>
    <rdf:RDF
      xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
      xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
      xmlns:owl="http://www.w3.org/2002/07/owl#"
      xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
      xml:base="http://problemography.org/models/target_process.owl"
    >
        <Subject rdf:ID="Inquirer1">
        </Subject>
        <Verb rdf:about="Enables1">
        </Verb>
        <DirectObject rdf:about="Anyone1">
        </DirectObject>
        <TargetProcessSentence rdf:about="TargetProcessSentence1">
            <hasSubject rdf:resource="#Enables1"/>
            <hasVerb rdf:resource="#Anyone1"/>
            <hasDirectObject rdf:resource="#MeasurementSystem1"/>
        </TargetProcessSentence>
        <TargetProcess rdf:about="13">
            <modeledBy rdf:resource="#TargetProcessSentence1"/>
        </TargetProcess>
    </rdf:RDF>

    <?xml version='1.0'?>
```

```
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Subject rdf:ID="Inquirer1">
    </Subject>
    <Verb rdf:about="Describes1">
    </Verb>
    <DirectObject rdf:about="DecisionMakers1">
    </DirectObject>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#Describes1"/>
        <hasDirectObject rdf:resource="#DecisionMakers1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="51">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

<?xml version='1.0'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Subject rdf:ID="Inquirer1">
    </Subject>
    <Verb rdf:about="Describes1">
    </Verb>
    <DirectObject rdf:about="Designers1">
    </DirectObject>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#Describes1"/>
        <hasDirectObject rdf:resource="#Designers1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="52">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

<?xml version='1.0'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
```

```
    <Subject rdf:ID="Inquirer1">
    </Subject>
    <Verb rdf:about="Describes1">
    </Verb>
    <DirectObject rdf:about="LatitudeOfUncertainty1">
    </DirectObject>
    <Preposition rdf:about="Of1">
    </Preposition>
    <Noun rdf:about="ProblemFormulation1">
    </Noun>
    <PrepositionPhrase rdf:about="PrepositionPhrase1">
        <hasPreposition rdf:resource="#Of1"/>
        <hasNoun rdf:resource="#ProblemFormulation1"/>
    </PrepositionPhrase>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#Describes1"/>
        <hasDirectObject rdf:resource="#LatitudeOfUncertainty1"/>
        <hasPrepositionPhrase rdf:resource="#PrepositionPhrase1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="14">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

<?xml version='1.0'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Subject rdf:ID="Inquirer1">
    </Subject>
    <Verb rdf:about="Declares1">
    </Verb>
    <DirectObject rdf:about="Imperatives1">
    </DirectObject>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#Declares1"/>
        <hasDirectObject rdf:resource="#Imperatives1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="15">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

<?xml version='1.0'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
```

```
        xml:base="http://problemography.org/models/target_process.owl"
      >
          <Subject rdf:ID="Inquirer1">
          </Subject>
          <Verb rdf:about="Asks1">
          </Verb>
          <DirectObject rdf:about="EvaluationOfProgressOrProcess1">
          </DirectObject>
          <TargetProcessSentence rdf:about="TargetProcessSentence1">
              <hasSubject rdf:resource="#Inquirer1"/>
              <hasVerb rdf:resource="#Asks1"/>
              <hasDirectObject
rdf:resource="#EvaluationOfProgressOrProcess1"/>
          </TargetProcessSentence>
          <TargetProcess rdf:about="16">
              <modeledBy rdf:resource="#TargetProcessSentence1"/>
          </TargetProcess>
      </rdf:RDF>

      <?xml version='1.0'?>
      <rdf:RDF
        xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
        xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
        xmlns:owl="http://www.w3.org/2002/07/owl#"
        xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
        xml:base="http://problemography.org/models/target_process.owl"
      >
          <Subject rdf:ID="Inquirer1">
          </Subject>
          <Verb rdf:about="Adopts1">
          </Verb>
          <DirectObject rdf:about="HeroicMood1">
          </DirectObject>
          <TargetProcessSentence rdf:about="TargetProcessSentence1">
              <hasSubject rdf:resource="#Inquirer1"/>
              <hasVerb rdf:resource="#Adopts1"/>
              <hasDirectObject rdf:resource="#HeroicMood1"/>
          </TargetProcessSentence>
          <TargetProcess rdf:about="17">
              <modeledBy rdf:resource="#TargetProcessSentence1"/>
          </TargetProcess>
      </rdf:RDF>

      <?xml version='1.0'?>
      <rdf:RDF
        xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
        xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
        xmlns:owl="http://www.w3.org/2002/07/owl#"
        xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
        xml:base="http://problemography.org/models/target_process.owl"
      >
          <Subject rdf:ID="Inquirer1">
          </Subject>
          <Verb rdf:about="Designs1">
          </Verb>
```

```
    <DirectObject rdf:about="HeroicMood1">
    </DirectObject>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#Designs1"/>
        <hasDirectObject rdf:resource="#HeroicMood1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="53">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

<?xml version='1.0'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Subject rdf:ID="Inquirer1">
    </Subject>
    <Verb rdf:about="Defines1">
    </Verb>
    <DirectObject rdf:about="Definition1">
    </DirectObject>
    <Preposition rdf:about="Of1">
    </Preposition>
    <Noun rdf:about="ElusiveConcept1">
    </Noun>
    <PrepositionPhrase rdf:about="PrepositionPhrase1">
        <hasPreposition rdf:resource="#Of1"/>
        <hasNoun rdf:resource="#ElusiveConcept1"/>
    </PrepositionPhrase>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#Defines1"/>
        <hasDirectObject rdf:resource="Definition1"/>
        <hasPrepositionPhrase rdf:resource="#PrepositionPhrase1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="54">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

<?xml version='1.0'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Subject rdf:ID="Inquirer1">
    </Subject>
```

```
    <Verb rdf:about="Expresses1">
    </Verb>
    <DirectObject rdf:about="ProblemFormulation1">
    </DirectObject>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#Expresses1"/>
        <hasDirectObject rdf:resource="#ProblemFormulation1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="18">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

<?xml version='1.0'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Subject rdf:ID="Inquirer1">
    </Subject>
    <Verb rdf:about="Expresses1">
    </Verb>
    <DirectObject rdf:about="PotentialSolution1">
    </DirectObject>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#Expresses1"/>
        <hasDirectObject rdf:resource="#PotentialSolution1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="19">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

<?xml version='1.0'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Preposition rdf:about="Given1">
    </Preposition>
    <Noun rdf:about="ProblemFormulation1">
    </Noun>
    <PrepositionPhrase rdf:about="PrepositionPhrase1">
        <hasPreposition rdf:resource="#Given1"/>
        <hasNoun rdf:resource="#ProblemFormulation1"/>
    </PrepositionPhrase>
    <Subject rdf:ID="Inquirer1">
```

```
            </Subject>
            <Verb rdf:about="Asks1">
            </Verb>
            <DirectObject rdf:about="QuestionsToGatherInformation1">
            </DirectObject>
            <TargetProcessSentence rdf:about="TargetProcessSentence1">
                <hasPrepositionPhrase rdf:resource="#PrepositionPhrase1"/>
                <hasSubject rdf:resource="#Inquirer1"/>
                <hasVerb rdf:resource="#Asks1"/>
                <hasDirectObject
rdf:resource="#QuestionsToGatherInformation1"/>
            </TargetProcessSentence>
            <TargetProcess rdf:about="20">
                <modeledBy rdf:resource="#TargetProcessSentence1"/>
            </TargetProcess>
        </rdf:RDF>

        <?xml version='1.0'?>
        <rdf:RDF
          xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
          xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
          xmlns:owl="http://www.w3.org/2002/07/owl#"
          xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
          xml:base="http://problemography.org/models/target_process.owl"
        >
            <Subject rdf:ID="Inquirer1">
            </Subject>
            <Verb rdf:about="Inputs1">
            </Verb>
            <DirectObject rdf:about="Reading1">
            </DirectObject>
            <Preposition rdf:about="About1">
            </Preposition>
            <Noun rdf:about="ProblemFormulation1">
            </Noun>
            <PrepositionPhrase rdf:about="PrepositionPhrase1">
                <hasPreposition rdf:resource="#About1"/>
                <hasNoun rdf:resource="#ProblemFormulation1"/>
            </PrepositionPhrase>
            <TargetProcessSentence rdf:about="TargetProcessSentence1">
                <hasSubject rdf:resource="#Inquirer1"/>
                <hasVerb rdf:resource="#Takes1"/>
                <hasDirectObject rdf:resource="#Reading1"/>
                <hasPrepositionPhrase rdf:resource="#PrepositionPhrase1"/>
            </TargetProcessSentence>
            <TargetProcess rdf:about="21">
                <modeledBy rdf:resource="#TargetProcessSentence1"/>
            </TargetProcess>
        </rdf:RDF>

        <?xml version='1.0'?>
        <rdf:RDF
          xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
          xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
          xmlns:owl="http://www.w3.org/2002/07/owl#"
```

```
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Preposition rdf:about="With1">
    </Preposition>
    <Noun rdf:about="PArgument1">
    </Noun>
    <PrepositionPhrase rdf:about="PrepositionPhrase1">
        <hasPreposition rdf:resource="#With1"/>
        <hasNoun rdf:resource="#Argument1"/>
    </PrepositionPhrase>
    <Subject rdf:ID="Inquirer1">
    </Subject>
    <Verb rdf:about="Revises1">
    </Verb>
    <DirectObject rdf:about="ProblemFormulation1">
    </DirectObject>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasPrepositionPhrase rdf:resource="#PrepositionPhrase1"/>
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#Revises1"/>
        <hasDirectObject rdf:resource="ProblemFormulation1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="22">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

<?xml version='1.0'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xml:base="http://problemography.org/models/target_process.owl"
>
    <Subject rdf:ID="Inquirer1">
    </Subject>
    <Verb rdf:about="Revises1">
    </Verb>
    <DirectObject rdf:about="PotentialSolution1">
    </DirectObject>
    <TargetProcessSentence rdf:about="TargetProcessSentence1">
        <hasSubject rdf:resource="#Inquirer1"/>
        <hasVerb rdf:resource="#Revises1"/>
        <hasDirectObject rdf:resource="#PotentialSolution1"/>
    </TargetProcessSentence>
    <TargetProcess rdf:about="23">
        <modeledBy rdf:resource="#TargetProcessSentence1"/>
    </TargetProcess>
</rdf:RDF>

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APPENDIX E: DESIGN OF THEORY-DRIVEN INTERVIEW QUESTIONS

<?xml version='1.0'?>

<study>

<research-purpose>The purpose of this research is to increase our understanding of how to develop Singerian knowledge management systems (SKMS), an information system aimed at allowing users to formulate wicked problems by using processes grounded upon Singerian inquiring systems theory.</research-purpose>

<central-research-question>What design principles should govern the development of a knowledge management system that enables users to formulate a wicked problem using Singerian inquiry processes?</central-research-question>

<theory-question num="TQ-0">[Given the initial question, is it reasonable to consider the informant's answers to be meaning in answering the central research question?]</theory-question>

<interview-question num="IQ-0.1">Do you work in an occupation or have you ever worked in an occupation that you would describe as the role of an environmental manager?</interview-question>

<interview-question num="IQ-0.2">Have you had access to the Internet and World Wide Web during the study period?</interview-question>

<interview-question num="IQ-0.3">How often did you use the Web site? Can you identify the particular days and times?</interview-question>

<interview-question num="IQ-0.4">What was the wicked problem that you worked on with the Web site?</interview-question>

<interview-question num="IQ-0.5">Were you able to use the Web site? Find the homepage? Use the navigation? Reach the contact?</interview-question>

<theory-question num="TQ-2">Does the [Connectedness Caretaker] inquiry extravaganza design principle that the development process should include a process of interactive visualization of inquiry processes aid the development of a Singerian Knowledge Management System?"</theory-question>

<interview-question num="IQ-2.1">Did you use the visualization? Why, or why not? Did the visualization enable you to effectively interact with the data? If so, how was the interaction useful? Could you provide an example of how you used the visualization?</interview-question>

<interview-question num="IQ-2.2">Did you hover the cursor over the visualization to observe a pop-up window? Would you consider the pop-up windows to be a learning tool or just extra mainly useless information? What are the reasons explaining why you used the hover feature of the visualization this way?</interview-question>

<interview-question num="IQ-2.3">Did you click on any glyphs? Would you consider the visualization a helpful navigation tool? Did you navigate more using the visualization or the left-hand side text menu? What are the reasons explaining why you used the visualization this way (clicking on the glyph)?</interview-question>

<interview-question num="IQ-2.4">Did you manage or change the way in which the visualization was produced, by changing the visualization controls? What was your motivation when changing the controls? Did you experiment with different visualization controls in order to see the inquiry processes better? What are the reasons explaining why you used the visualization this way?</interview-question>

<interview-question num="IQ-2.5">Where you able to understand how the inquiry processes and the data were represented on the visualization? Was the Key/Legend to these depictions useful?</interview-question>

<interview-question num="IQ-2.6">Does the visualization lead to more sweeping-in where you added new concepts or invited new participants because of the visualization? Was this performed after having clicked on their representation on the visualization?</interview-question>

<interview-question num="IQ-2.7">Did the visualization lead to more consideration of the potential new knowledge in terms of the ethical ramifications of the knowledge? Was this performed after having clicked on their representation on the visualization?</interview-question>

<interview-question num="IQ-2.8">When it comes to the overall ability to inquiry about the wicked problem, do you consider the decisions made during this process to be important or not important?</interview-question>

<interview-question num="IQ-2.9">Did this process increase your appreciation of the whole set of inquiry processes? Do you think that the visualization is useful in that the data is displayed based upon the inquiry processes?</interview-question>

<interview-question num="IQ-2.10">Do you think it is worthwhile to have this visualization process, or could you do without it?</interview-question>

<theory-question num="TQ-3">Does the Every Person design principle, that the development process should include a development process that is accessible to many, aid the development of a Singerian Knowledge Management System?</theory-question>

<interview-question num="IQ-3.1">Did you use any of the development training materials? Why, or why not?</interview-question>

<interview-question num="IQ-3.2">Did you understand the development training material? Would you assess the development training materials as being understandable to a wide audience of people, or being understandable to only a very narrow range of people (for example, experts)?</interview-question>

<theory-question num="TQ-4">Does the Connectedness Caretaker design principle that the development process should include a process for a user to observe the relationships between their inquiry and the inquiry of others via the visualization aid the development of a Singerian Knowledge Management System?</theory-question>

<interview-question num="IQ-4.1">Did you adjust the visualization? For example, did you set the range of the Assessments highlighter? Why, or why not?</interview-question>

<interview-question num="IQ-4.2">Did the visualization impact the responsibility and the connection that you felt with other inquirers? Seeing the connections on the visualization, did you feel that you were in part responsible to help participate in the formulation of the problem?</interview-question>

<theory-question num="TQ-5">Does the methodology result in a Singerian Inquiring System?</theory-question>

<interview-question num="IQ-5.1">Did you add data? Did you gather any data? What data did you gather the first time? The first time, how did you choose what data that you gathered? Did you gather data more than once? If so, did you gather any data that you initially might not have thought that you were going to gather? If so, what impacted why you gather that data that didn't initially expect to need?</interview-question>

<interview-question num="IQ-5.2">Did you consideration of alternative perspectives? For example, did you sweep in, or include new concepts and new models to the problem formulation? Did you swept-in, or invite any people to the project? If yes, why did you ask them to join? If yes, did they have a specific skill set that was unaccounted for or for other reasons?</interview-question>

<interview-question num="IQ-5.3">Did you perform the function in which you assessed the ethical ramifications of any potential new knowledge?</interview-question>

<interview-question num="IQ-5.4">Would you describe the Web site atmosphere as being cooperative or contentious?</interview-question>

<interview-question num="IQ-5.5">Where you able to inquiry about a wicked problem? Did the system aid you in confronting, learning, or inquiring about the wicked problem? If so, how would you describe how it aided you?</interview-question>

<interview-question num="IQ-5.6">When working with the site did you perceive that there was more than one perspective of the wicked problem (that is, more than one way of looking at the problem)? Which perspective did you maintain? Did you consider other perspectives (worldviews) while using the Web site? For example, did you add data to other perspectives that support the arguments of that perspective? Did you have an initial conception of the wicked problem? Did your conception of the wicked problem change? If so, in what way and how many times, and what triggered the change?</interview-question>

<interview-question num="IQ-5.7">Is there progress being made with the system, or it is merely process? Is there a net benefit? Does the churning of theories and meta-theories bring any tangible benefits, or is there just a process of thought experimentation that leaves no measurable, consequential residue either physical or conceptual? Is the community or organization better off? Have any goals been reached, or do you anticipate that they might be reached or is it just a process with no progress?</interview-question>

<theory-question num="TQ-6">Does the methodology result in an information system artifact that is successful in terms of Courtney's (2001) justification for using Singerian Inquiry?</theory-question>

<interview-question num="IQ-6.1">Do you understand (or view) the problem more holistically than before? If so, any specific realizations about the problem that you learned about and made you view the problem more holistically? Do you appreciate the connectedness of the social systems that related to the problem more than before using the system during the study period?</interview-question>

</study>

APPENDIX F: AMENDED DESIGN OF THEORY-DRIVEN INTERVIEW QUESTIONS

RP: The purpose of this research is to increase our understanding of how to develop Singerian knowledge management systems (SKMS), an information system aimed at allowing users to formulate "wicked" problems by using processes grounded upon Singerian inquiring systems theory.

CRQ: What design principles should govern the development of a knowledge management system that enables users to formulate a wicked problem using Singerian inquiry processes?

Initial Question 0.1: Do you work in an occupation or have you ever worked in an occupation that you would describe as the role of an environmental manager? [See definition of environment manager.]

Initial Question 0.2: Have you had access to the Internet and World Wide Web during the study period?

Initial Question 0.3: How often did you use the Web site? Can you identify the particular days and times?

Initial Question 0.4: What was the wicked problem that you worked on with the Web site?

Initial Question 0.5: Were you able to use the Web site? Find the homepage? Use the navigation? Reach the contact?

TQ-2: Does the inquiry extravaganza design principle that the development process should include a process of interactive visualization of inquiry processes aid the development of a Singerian Knowledge Management System?

IQ-2.1: Did you use the visualization? Why, or why not? Did the visualization enable you to effectively interact with the data? If so, how was the interaction useful? Could you provide an example of how you used the visualization?

IQ-2.2: Did you hover the cursor over the visualization to observe a pop-up window? Would you consider the pop-up windows to be a learning tool or just extra mainly useless information? What are the reasons explaining why you used the hover feature of the visualization this way?

IQ-2.3: Did you click on any glyphs? Would you consider the visualization a helpful navigation tool? Did you navigate more using the visualization or the left-hand side text menu? What are the reasons explaining why you used the visualization this way (clicking on the glyph)?

IQ-2.4: Did you manage or change the way in which the visualization was produced, by changing the visualization controls? What was your motivation when changing the controls? Did you experiment with different visualization controls in order to see the inquiry processes better? What are the reasons explaining why you used the visualization this way?

IQ-2.5: Were you able to understand how the inquiry processes and the data were represented on the visualization? Was the Key/Legend to these depictions useful?

IQ-2.6: Does the visualization lead to more sweeping-in where you added new concepts or invited new participants because of the visualization? Was this performed after having clicked on their representation on the visualization?

IQ-2.7: Did the visualization lead to more consideration of the potential new knowledge in terms of the ethical ramifications of the knowledge? Was this performed after having clicked on their representation on the visualization?

IQ-2.8: When it comes to the overall ability to inquiry about the wicked problem, do you consider the decisions made during this process to be important or not important?

IQ-2.9: Did this process increase your appreciation of the whole set of inquiry processes? Do you think that the visualization is useful in that the data is displayed based upon the inquiry processes?

IQ-2.10: Do you think it is worthwhile to have this visualization process, or could you do without it?

TQ-3: Does the Every Person design principle, that the development process should include a development process that is accessible to many, aid the development of a Singerian Knowledge Management System?

IQ-3.1: Did you use any of the development training materials? Why, or why not?

IQ-3.2: Did you understand the development training material? Would you assess the development training materials as being understandable to a wide audience of people, or being understandable to only a very narrow range of people (for example, experts)?

TQ-4: Does the Connectedness Caretaker design principle that the development process should include a process for a user to observe the relationships between their inquiry and the inquiry of others via the visualization aid the development of a Singerian Knowledge Management System?

IQ-4.1: Did you adjust the visualization? For example, did you set the range of the Assessments highlighter? Why, or why not?

IQ-4.2: Did the visualization impact the responsibility and the connection that you felt with other inquirers? Seeing the connections on the visualization, did you feel that you were in part responsible to help participate in the formulation of the problem?

TQ-5: Does the methodology result in a Singerian Inquiring System?

IQ-5.1: Did you add data? Did you gather any data? What data did you gather the first time? The first time, how did you choose what data that you gathered? Did you gather data more than once? If so, did you gather any data that you initially might not have thought that you were going to gather? If so, what impacted why you gather that data that didn't initially expect to need?

IQ-5.2: Did you consideration of alternative perspectives? For example, did you sweep in, or include new concepts and new models to the problem formulation? Did you swept-in, or invite any people to the project? If yes, why did you ask them to join? If yes, did they have a specific skill set that was unaccounted for or for other reasons?

IQ-5.3: Did you perform the function in which you assessed the ethical ramifications of any potential new knowledge?

IQ-5.4: Would you describe the Web site atmosphere as being cooperative or contentious?

IQ-5.5: Where you able to inquiry about a wicked problem? Did the system aid you in confronting, learning, or inquiring about the wicked problem? If so, how would you describe how it aided you?

IQ-5.6: When working with the site did you perceive that there was more than one perspective of the wicked problem (that is, more than one way of looking at the problem)? Which perspective did you maintain? Did you consider other perspectives (worldviews) while using the Web site? For example, did you add data to other perspectives that support the arguments of that perspective? Did you have an initial conception of the wicked problem? Did your conception of the wicked problem change? If so, in what way and how many times, and what triggered the change?

IQ-5.7: Is there progress being made with the system, or it is merely process? Is there a net benefit? Does the churning of theories and meta-theories bring any tangible benefits, or is there just a process of thought experimentation that leaves no measurable, consequential residue either physical or conceptual? Is the community or organization better off? Have any goals been reached, or do you anticipate that they might be reached or is it just a process with no progress?

TQ-6: Does the methodology result in an information system artifact that is successful in terms of Courtney's (2001) justification for using Singerian Inquiry?

IQ-6.1: Do you understand (or view) the problem more holistically than before? If so, any specific realizations about the problem that you learned about and made you view the problem more holistically? Do you appreciate the connectedness of the social systems that related to the problem more than before using the system during the study period?

TQ-7: Does the methodology result in an information system artifact that is successful in terms of Jennex and Olfman's (2006) Knowledge Management Success Model?

IQ-7.1: Did you have the technical resources and the capability of using the Web site?

IQ-7.2: Do you consider the visualization to be an interface to all of the inquiry processes?

IQ-7.3: Did the Web site increase your ability to bring knowledge to bear upon the task of formulating the wicked problem?

IQ-7.4: Did using the Web site increase your ability of identifying knowledge users, knowledge that could be captured, or knowledge that could be reused again?

IQ-7.5: Did the visualization increase the accuracy, timeliness, or context of the stored knowledge?

IQ-7.6: Did the visualization increase your ability to identify sources of knowledge to other users of the Web site?

IQ-7.7: Did you have adequate resources to use the Web site?

IQ-7.8: Did you have adequate training and support to utilize the Web site?

IQ-7.9: Are you satisfied with the use of the Web site?

IQ-7.10: Do you consider the Web site to be beneficial?

IQ-7.11: Did the Web site produce an impact on you performance in formulating problems?

TQ-8: Does the methodology result in capability?

IQ-8.1: Do you have the capability to identify how inquiry processes vary?

IQ-8.2: Do you have the capability to identify how the inquiry processes interact as a whole system?

IQ-8.3: Do you have the capability to identify how the data of the problem relates to the inquiry processes?

APPENDIX G: IRB HUMAN SUBJECTS PERMISSION LETTERS

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Lars Linden**

Date: **October 21, 2009**

Dear Researcher:

On 10/21/2009, the IRB approved the following activity as human participant research that is exempt from regulation:

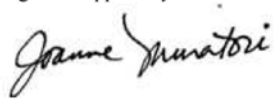
Type of Review:	Exempt Determination
Project Title:	A METHOD FOR DEVELOPING SINGERIAN KNOWLEDGE MANAGEMENT SYSTEMS, CASE STUDY
Investigator:	Lars Linden
IRB Number:	SBE-09-06509
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 10/21/2009 04:47:38 PM EDT



IRB Coordinator

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2012 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Expedited Initial Review and Approval

From : **UCF Institutional Review Board**
FWA00000351, Exp. 10/8/11, IRB00001138

To : **Lars Linden**

Date : **July 30, 2009**

IRB Number: **SBE-09-06259**

Study Title: **A METHOD FOR DEVELOPING SINGERIAN KNOWLEDGE MANAGEMENT SYSTEMS**

Dear Researcher:

Your research protocol noted above was approved by **expedited** review by the UCF IRB Vice-chair on 7/30/2009. **The expiration date is 7/29/2010.** Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The category for which this study qualifies as expeditable research is as follows:

6. Collection of data from voice, video, digital, or image recordings made for research purposes.

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The IRB has approved a **consent procedure which requires participants to sign consent forms.** Use of the approved, stamped consent document(s) is required. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

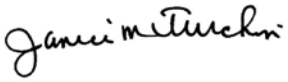
All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any unanticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at http://iris.research.ucf.edu .

Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies. The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 07/30/2009 04:30:50 PM EDT



IRB Coordinator

REFERENCES

Ackoff, R.L. *Re-Creating the Corporation: A Design of Organizations for the 21st Century,* Oxford University Press, New York, 1999.

Ackoff, R.L. *Redesigning the future: a systems approach to societal problems,* Wiley, New York, 1974.

Adla, A., Soubie, J.L., and Zarate, P. "A cooperative intelligent decision support system for boilers combustion management based upon a distributed architecture," *Journey of Decision Systems*) 2007.

Alavi, M., and Leidner, D.E. "REVIEW: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues," *MIS Quarterly* (25:1) 2001, pp 107-136.

Berners-Lee, T., and with Fischetti, M. *Weaving the Web: the original design and ultimate destiny of the World Wide Web by its inventor,* Harper, San Francisco, 1999.

Berners-Lee, T., Hendler, J., and Lassila, O. "The semantic web," *Scientific American* (284:5) 2001, pp 34-43.

Bourdeau, P. "The man-nature relationship and environmental ethics," *Journal of Environmental Radioactivity* (72:1-2) 2004, pp 9-15.

Buchanan, R. "Wicked Problems in Design Thinking," *Design Issues* (8:2) 1992, pp 5-21.

Bush, V. "As we may think," in: *The Atlantic Monthly*, 1945.

Carugati, A. "Information system development activities and inquiring systems: an integrating framework," *European Journal of Information Systems* (17:2) 2008, pp 143-155.

Chae, B., Paradice, D., Courtney, J.F., and Cagle, C.J. "Incorporating an ethical perspective into problem formulation: implications for decision support systems design," *Decision Support Systems* (40) 2005, pp 197-212.

Churchman, C.W. "Wicked Problems," *Management Science* (14:4) 1967.

Churchman, C.W. *Challenge to Reason*, New York, McGraw-Hill, 1968.

Churchman, C.W. *The Design of Inquiring Systems: Basic Concepts of Systems and Organization* Basic Books, New York, 1971, p. 288.

Churchman, C.W. *Thought and Wisdom; The Gaither Lectures* Intersystems Publications, Seaside, California, 1982.

Cil, I., Alpturk, O., and Yazgan, H.R. "A new collaborative system framework based on a multiple perspective approach: InteliTeam, Decision Support Systems," *Decision Support Systems* (39:4) 2005, pp 619-641.

Courtney, J.F. "Decision making and knowledge management in inquiring organizations: toward a new decision-making paradigm for DSS," *Decision Support Systems* (31) 2001, pp 17-38.

Courtney, J.F., Richardson, S.M., and Paradice, D.B. "Information Technology for Sustainable Development," Proceedings of the Americas Conference on Information Systems, Long Beach, California, August 10-13, 2000, pp. 1489-1492.

Courtney, J.F., Richardson, S.M., and Paradice, D.B. "The Internet, Sustainable Development and Ecosystems Management," in: *Internet Management Issues: A Global Perspective,* J.D. Haynes (ed.), Idea Group Publishing, 2002, pp. 165-177.

Coyne, R. "Wicked problems revisited," *Design Studies* (26:1) 2005, pp 5-17.

Craik, K.J.W. *The Nature of Explanation* Cambridge University Press, Cambridge, UK, 1943.
de Jonge, E. *Spinoza and deep ecology: challenging traditional approaches to environmentalism* Ashgate, Burlington, VT, 2004.
Drucker, P.F. *Management: Tasks, Responsibilities and Practices* Harper and Row, New York, 1973.
Dubin, R. *Theory building* The Free Press, New York, 1978.
Elgarah, W., Haynes, J.D., and Courtney, J.F. "A dialectical methodology for decision support systems design," 35th Annual Hawaii International Conference on System Sciences, 2002.
El-Gayar, O.F., and Fritz, B. "Environmental Management Information Systems (EMIS) for Sustainable Development: A Conceptual Overview," *Communication of the Association for Information Systems* (17:34) 2006.
Flood, R.L. "The Relationship of 'Systems Thinking' to Action Research," in: *Handbook of action research : participative inquiry and practice*, P. Reason and H. Bradbury (eds.), SAGE Publications, London ; Thousand Oaks, Calif., 2001, pp. 133-144.
Froelich, J., Olson, D.L., and Ananyan, S. "Business Intelligence through Text Mining," *Business Intelligence Journal* (10:1) 2005, pp 43-50.
Gorry, G.A., and Scott Morton, M.S. "A Framework for Management Information Systems," *Sloan Management Review* (13:1) 1971, pp 55-70.
Green Media Toolshed, and GetActive Software "About Scorecard," 2005.
Gregg, D., Kulkarni, U., and Vinzé, A. "Understanding the philosophical underpinnings of software engineering research in information systems," *Special Issue of Information Systems Frontiers* (3:2) 2001, pp 169-183.
Hall, D.J., and Paradice, D.B. "Philosophical foundations for a learning-oriented knowledge management system for decision support," *Decision Support Systems* (39:3) 2005, pp 445-461.
Hall, D.J., Paradice, D.B., and Courtney, J.F. "Building a Theoretical Foundation for a Learning-Oriented Knowledge Management System," *Journal of Information Technology Theory and Applications* (5:2) 2003, pp 63-89.
Hevner, A.R., March, S.T., Park, J., and Ram, S. "Design science in information systems research," *MIS Quarterly* (28:1), Mar 2004, pp 75-105.
Illia, L. "Passage to cyberactivism: How dynamics of activism change," *Journal of Public Affairs* (3:4) 2003, pp 326-337.
Jennex, M.E., and Olfman, L. "A Model of Knowledge Management Success," *Internatinal Journal of Knowledge Management* (2:3) 2006, pp 51-68.
Kolkman, M.J., Kok, M., and van der Veen, A. "Mental model mapping as a new tool to analyse the use of information in decision-making in integrated water management," *Physics and Chemistry of the Earth* (30:4-5) 2005, pp 317-332.
Lester, J., Frank K., and Wiliam, D. "On The Purpose of Mathematics Education Research: Making Productive Contributions to Policy and Practice," in: *Handbook of International Research in Mathematics Education*, L. English (ed.), Lawrence Erlbaum Associates, Mahweh, NJ, 2002.
Light, A. "Environmental Ethics," in: *A Companion to Applied Ethics (Blackwell Companion to Philosophy)*, R.G. Frey and C.H. Wellman (eds.), Blackwell Publishing, Malden, MA, 2003.

Linden, L.P., Kuhn, J., John R., Parrish, J., James L., Richardson, S.M., Adams, L.A., Elgarah, W., and Courtney, J.F. “Churchman's Inquiring Systems: Kernel Theories for Knowledge Management,” *Communications of the Association for Information Systems* (20:Article 52) 2007.

Linstone, H.A. *Multiple perspectives for decision making : bridging the gap between analysis and action* North-Holland, New York, 1984.

March, S.T., and Smith, G.F. “Design and natural science research on information technology,” *Decision Support Systems* (15:4) 1995, pp 251-266.

Mason, R.O., and Mitroff, I.I. “A Program for Research on Management Information Systems,” *Management Science* (19:5) 1973, pp 475-487.

Mason, R.O., and Mitroff, I.I. “Foreword: A Dedication to C. West Churchman,” in: *Inquiring organizations : moving from knowledge management to wisdom*, J.F. Courtney, J.D. Haynes and D.B. Paradice (eds.), Idea Group Publishing, Hershey, PA, 2005.

Mason, R.O., and Mitroff, I.I. *Challenging strategic planning assumptions: theory, cases, and techniques* Wiley, New York, 1981.

McAleese, R.e. *Hypertext: theory into practice* Intellecy, Oxford, 1999.

Mitroff, I.I., and Emshoff, J.R. “On Strategic Assumption-Making: A Dialectical Approach to Policy and Planning,” *Academy of Management Review* (4:1) 1979, pp 1-12.

Mitroff, I.I., and Linstone, H.A. *The Unbounded Mind: Breaking the Chains of Traditional Business Thinking* Oxford University Press, New York, 1993.

Mumford, E. “A Socio-Technical Approach to Systems Design,” *Requirements Engineering* (5:2) 2000, pp 125-133.

Nash, R. *The rights of nature: a history of environmental ethics* University of Wisconsin Press, Madison, Wis., 1989.

Nelson, T.H. *Literary machines* Mindful Press, Sausalito, CA, 1993.

Parrish Jr., J.L. ”Sensemaking in information systems: toward a sensemaking inquiring system,” University of Central Florida, Orlando, FL, 2008.

Pentland, B.T. “Grammatical Models of Organizational Processes,” in: *Organizing business knowledge : the MIT process handbook*, T.W. Malone, K. Crowston and G.A. Herman (eds.), MIT Press, Cambridge, Mass., 2003, pp. 191-214.

Pickerill, J. *Cyberprotest: environmental activism online* Manchester University Press, Manchester and New York, 2003.

Richardson, S.M., and Courtney, J.F. “A Churchmanian Theory of Knowledge Management System Design,” Proceedings of the 37th Hawaii International Conference on System Science, 2004.

Richardson, S.M., Courtney, J.F., and Haynes, J. “Theoretical principles for knowledge management system design: Application to pediatric bipolar disorder,” Decision Support Systems (42:3) 2006, pp. 1321-1337.

Rittel, H.W.J., and Webber, M.M. “Dilemmas in a General Theory of Planning,” *Policy Sciences* (4:2) 1973, pp 155-169.

Sheffield, J., and Guo, Z. “Ethical inquiry in knowledge management,” *International Journal of Applied Systemic Studies* (1:1) 2007, pp 68 - 81.

Siew, T. ”Scientific decision support for decision makers in practice through collaborative knowledge management,” 2009.

Simon, H.A. *The sciences of the artificial*, (3rd ed.) MIT Press, Cambridge, Mass., 1996, pp. xiv, 231.
Stevens, Jr., E.W. "Inquiry and the Good Society: The Experimentation of E. A. Singer, Jr.," *Journal of the History of Philosophy* (15:1) 1977.
Vahidov, R., and Fazlollahi, B. "Pluralistic multi-agent decision support system: a framework and an empirical test," *Information & Management* (41:7) 2004, pp 883-898.
van Kouwen, F., Schot, P.P., and Wassen, M.J. "A framework for linking advanced simulation models with interactive cognitive maps," *Environmental Modelling & Software* (23:9) 2008, pp 1133-1144.
Walls, J.G., Widmeyer, G.R., and El Sawy, O.E. "Building an Information System Design Theory for Vigilant EIS," *Information Systems Research* (3:1) 1992, pp 36-59.
Wengraf, T. *Qualitative research interviewing: biographic narrative and semi-structured methods* Sage, London; Thousand Oaks, Calif., 2001.
White, J., Lynn "The Historical Roots of Our Ecologic Crisis," *Science* (155:3767) 1967, pp 1203-1207.
Yeh, R.T. "System Development as a Wicked Problem," in: *The Impact of CASE technology on software processes*, D.E. Cooke (ed.), World Scientific, 1994, pp. 15-29.
Yin, R.K. *Case Study Research: Design and Methods*, (3rd ed.) Sage Publications, Inc, Thousand Oaks, Calif., 2003.