PROJECT DEFINITION AND WICKED PROBLEMS

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ABSTRACT

It is now almost 30 years since Horst Rittel coined the term "wicked" for ill-defined problem sets which are too complex to be solved by rational systematic processes. To what extent today's industry practice has adequately come to terms with such problems still remains open to discussion. This paper is concerned with team decision making during project definition, understood as the phase in which the design task is defined and its constraints are established sufficiently to launch design development. The concept of wicked problems is applied in an effort to improve project definition processes. Based on collaborative argumentation and reflection processes, a project learning model is proposed to better manage the resolution of wicked problems in project definition. Particular emphasis is placed on considering project definition as an adaptive process that incorporates project change through the co-evolution of problem formulation and solution generation.

KEY WORDS

Design management, organizational learning, project definition, stakeholder complexity, wicked problems.

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INTRODUCTION

Project definition[3] is the first phase in project delivery and consists of three modules: determining purposes (stakeholder needs and values), translating those purposes into criteria for both product and process design, and generating design concepts against which requirements and criteria can be tested and developed. The process requires developing flexible project definition solutions that support customer value generation. More effective project definition processes are needed to support changing project objectives and means. Where decision problems are more complex and cannot be easily defined by the decision-makers, rational methods are more difficult to apply. Such problems involve solving a set of interlocking issues and constraints by multiple stakeholders. A set of auxiliary management tools are required by groups engaged in project definition to help manage such complexity.

Barrett (1999) criticizes client briefing practice in the U.K. and Barrett et al. (1998) argue that rational systematic processes are limited in project effectiveness. Barrett's investigation into the process of briefing reveals process inefficiencies, many of which are attributed to organizational and human factors. Barrett et al. (1999) propose key solution areas that include: client empowerment to make decisions within the team, management of project dynamics, user involvement, information and visualization techniques and team building. Green's (1996) analysis of metaphors by which client organizations operate, offers direction in understanding the sociotechnical complexity. As Simon (1984) suggests, the design process can take on complex organizational forms or structures as project complexity and size increases. While systematic step by step approaches to problem solving provide structure and direction to a decision problem, this cannot overcome a lack of collective understanding by the teams that influence, shape, make, take or approve decision problems and solutions. The naturalistic decision behavior of organizations as explained by March (1994) and the acknowledgement of "ill-structured" problems by Simon (1984) provide an understanding of industry practice. The work most appropriately identifying the wicked nature of design and planning problems is that of Horst Rittel.

Other notable investigations on decision influence and frames by which organizations structure a decision problem include: Woodhead's thesis (2000) on what paradigms and perspectives effect the client's decision to build; Billello's (1993) thesis on organizational decision structures and frames by which a building project gets built; and the theoretical perspectives of Buenano's thesis (1999), whose analysis of problem framing supports Rittel's "wicked problem" dilemma theory. Woodhead recognizes the need for greater understanding of the multiple paradigms and perspectives. Understanding who the decisions agents are and their decision power may help the project definition team uncover the wicked nature of design problems.

Exploratory research of the authors suggests that greater and timely understanding of stakeholder interests is necessary in order to better manage wicked problems. The exploratory phase[4] of this research has concentrated on the behavior of design and

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[3] The term "project definition" will be used in this paper to encompass all project activity prior to lean design development.

[4] The following descriptive case studies, documented in summary format in Table 1, were gathered, analyzed and compiled over an 18 month period of exploratory descriptive research. The principal research (Cases A, B, and C) was carried out with a project management organization that represents a public state entity in the planning, design, construction, and life cycle management of its capital projects.

planning organizations during early phase project definition. The research seeks to establish practical limitations of systematic development processes, primarily through highlighting the different approaches by which stakeholders approach project definition problem and solution formulation. The primary questions of this paper therefore are to what extent project definition organizations perceive the existence of wicked problems within complex environments and, secondly, whether these sociotechnical organizations are adequately equipped to manage multiple decision frames by which project definition stakeholders shape, influence, make, approve and take decisions.

This paper applies Rittel's work to understanding the characteristics of wicked problems and investigates whether existing organizational structures and design and planning processes are adequately equipped to deal with the wicked problems that exist in complex projects, or whether their existing structures and operations nurture symptoms of "wickedness". The paper establishes the need for teamwork protocols in order to recognize the existence of such problems and to develop learning processes and multiple frame analysis toward their iterative problem definition and solution. A project definition learning model is proposed to improve group activity. A set of research propositions are stated regarding approaches to resolving wicked problems in project definition activity.

PROBLEM DEFINITIONS: WELL DEFINED, ILL-STRUCTURED OR WICKED

The world of design problems makes a distinction between well-defined and ill-structured (or ill-defined) problems. Simon (1984) defines an ill-structured problem as a problem whose structure lacks definition in some respect. The problem has unknowns associated with the ends (set of project goals) and means (set of process actions and decision rules) of the solution, at the outset of the problem solving process. Problem definition and re-definition activity is considerable. Rowe (1987) reviews the research on procedural aspects of design problems. Well defined problems are those for which the end or goal is already prescribed or apparent, and their solution requires the provision of appropriate means. Many design problems are so ill-defined and complex that they can only be called wicked problems. Rittel et al.'s (1972) seminal work illuminates the complexity of design and planning processes. Rittel et al.'s (1972) analysis of planning problems describes their new approach:

> *We have been learning to ask whether what we are doing is the right thing to do. This to say, we have been learning to ask questions about the outputs of actions and to pose problem statements in evaluative frameworks. We have been learning to see social processes as the links tying open systems into large interconnected networks of systems, such that outputs from one become inputs to others. In the structural framework it has become less apparent where the problem center lies, and less apparent where and how we intervene even if we do happen to know what aims we seek. [...] By now we are beginning to realize that one of the most intractable problems is the problem of defining the problem and of locating the problem.*

Buenano (1999) acknowledges that in stating a problem: facts, beliefs, ideas, discrepancies, causes and consequences continuously interplay. The acknowledgement that design problems are framed differently by project stakeholders points the way to understanding the wicked nature of design problems. Zimring et al. (2001) suggests a unique role for social interaction in solving wicked problems. If a problem is wicked, dealing with the complexities within a dynamic social context may encourage activities such as exploration and integration of multiple perspectives. Accepting that project definition activity involves uncertainty, multiple objectives, and multiple stakeholders directs us to Rittel's theory of wicked problems.

NATURE OF WICKED PROBLEMS – ILLUSTRATION THROUGH CASE INSTANCES

Rittel's work focuses on the problems of governmental planning, and especially those of social and policy planning. Such problems are ill-defined and rely on political judgment for resolution. Wicked is the term given to planning problems that exhibit ten distinguishable properties:

There is no definitive formulation of a wicked problem.

Understanding the problem and conceiving the solution are directly related to each other. Each cycle of solution formulation can reveal a new understanding of the problem. The information needed to understand the problem depends on one's idea for solving it.

Case A is a seismic retrofit and renovation project. The project definition team did not question the client's initial statement of purpose, pursuit of which pushed the product concept towards technological and budget limits. That led to re-evaluation of the project goals and objectives (See Figure1). The constraints imposed by public and regulatory bodies on the proposed design concepts set the team into a 'forced' learning process where the problem required re-formulation and analysis after each phase gate. Questioning and testing the original client purpose at the planning study phase may have led to development of an alternative and less costly solution.

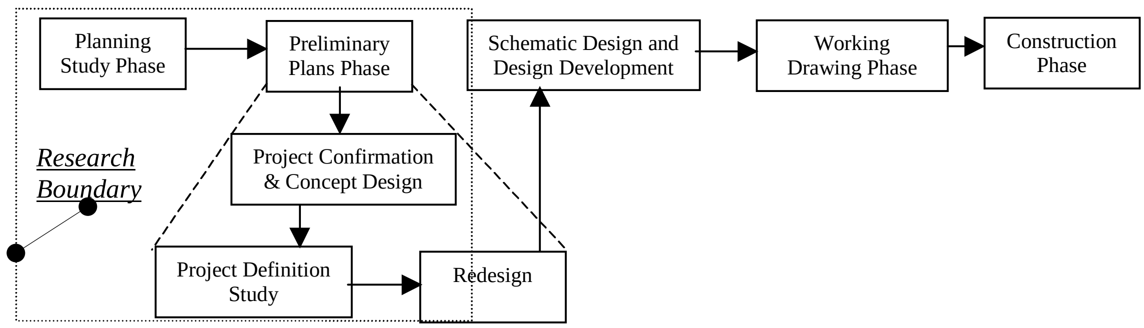

Figure 1: Case A - Project Delivery Model

In Case B, the client believes an existing facility requires renovation, and initiates a facility condition assessment. The case instance represents the issue of problem formulation[5]. The team has already made a decision on what the problem is and resources are allocated to development of a renewal plan. Opportunity for testing client purpose becomes limited due to the "channeling" of the problem in a certain solution direction. While the client requires information to make informed decisions, the process has been slightly narrowed in focus (in the form of a facility condition assessment) and a higher level meta-planning process is required in order to test other possible problem definitions and solutions. Designers and

5 In a "process reflection session" within a design and project management firm, project managers frequently remarked that their assumptions in problem definition require careful attention and continued evaluation and testing, so to better understand the direction of their solutions. Posing the question: "Are we doing the right project" as opposed to "doing the project right"?

planners may quickly converge on problem formulation which can lead to re-work once constraints are revealed. The goal should rather be to state and conceive problem statements in solution neutral form, and then deliberately explore alternatives.

Wicked problems have no stopping rule.

For this class of problems, there is always a better solution possible. Limitations of time and resources terminate this infinite search. Consequently, it is vital that problem solving processes be structured and facilitated so that the best solution is achieved within those limits. Participants may converge on a solution that sufficiently satisfies the design criteria and project needs, although suboptimal. Rowe states that human problem solvers are rarely in a position to identify all the possible solutions to a design problem and settle for choices that satisfy the problem definition at the point in time. Simon (1969, pp. 64-76) refers to this search for solutions as "satisficing".

Quite often phase gates of systematic structures may fail to consider sets of decisions as complete[6]. Phases pass without explicit recognition for action to be taken on design issues. Equally the designer may decide on the solution as "good enough", under pressure of habit or the press of time or budget.

Solutions to wicked problems are not true-or-false, but good-or-bad.

Different stakeholders view problem formulations and alternative solutions with different performance criteria and value sets. Case A represents a revelation of expanded values as new project criteria become apparent through concept generation. Developing decision matrices for screening evaluations may aid performance assessment and consensus amongst groups. Along with quantitative metrics, qualitative performance matrices form the basis for consensus making in this case. Whelton et al., 2001a details consensus matrices for the solution options for Case A. It is insightful that this process reveals project definition alignment through expansion of the solution set[7]. Establishing a set of definitive criteria upon which to create rational choice may be difficult, particularly amongst multiple stakeholders. Testing and consensus making occurs through collaborative dialog with large stakeholder groups.

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

A solution, after being implemented, can generate waves of consequences over a period of time. Tracing total effects is difficult. In Case A, the process also highlights the dynamic changes that can occur during the development cycle of a project. The project which entered the "fit out" stages of construction has returned to the initial requirements specification to check for alignment of product specifications. Interestingly, this current process has revealed inconsistencies in what the client had initially decided on, and what changes in purpose occurred over the time of the project development cycle. The importance of project memory is highlighted here, particularly with long development time spans and possible dynamic changes ongoing in project organization and client business models.

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6 Case C illustrates instances of phase gate inefficiencies as described later in this paper.

7 The case represents the lean design principle of set-based design as a means of developing a collaborative solution.

Management tools that can facilitate change across many dimensions of a project over time are lacking in this case instance. As a default position, project definition teams should consider client purpose to be dynamic over time as opposed to fixed. Adaptive design solutions may aid in resolving purpose uncertainty.

Every solution to a wicked problem is a "one-shot operation"; because there is little opportunity to learn by trial and error, every attempt counts significantly.

Rittel refers to public works examples, such as roadways, in arguing that consequences may be irreversible if performance is unsatisfactory. Case A illustrates this point where the client decides on the facility purpose which demands high functional performance relative to cost expenditure. Failure to test this need against alternatives set the project up for complex design and production processes. Capital investment decisions may be irreversible once production and assembly of the product begins. In Case B, the planning process evolved by identifying code compliance issues unforeseen at the outset of the study. Project definition processes should be structured and managed in expectation of multiple cycles of problem definition and exploration of alternatives. Allowing the project definition team more time to expand the solution set with adequate verification and testing of concepts typically lowers the technological, financial, social and political risks.

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.

"There are no criteria which enable one to prove that all solutions to a wicked problem have been identified and considered". Judgment is usually taken by the project definition team in expanding and appraising the solution set. Case A in its project confirmation phase generated a range of solutions. Eventually the team converged on a commonly acceptable solution, once options were assessed by client and stakeholder groups. In Case B the solution set was point based towards one solution direction; i.e., systems renewal. Opportunity for testing other possibilities (e.g. program changes and improvements) was lacking in the process. Structuring conversations about solution options with client representatives may challenge and test premature solution directions.

Every wicked problem is essentially unique.

Despite similarities between a current problem and a previous one, there always might be an additional distinguishing property that is of overriding importance. Project definition organizations may oversimplify the problem formulation in order to make sense for decision purposes. Over-reliance on experience and negative aspects of "groupthink" (Janis, 1982) may direct project definition activity towards a premature solution. Client organizations and project contexts all differ, some more significantly than others. Creating group awareness of the dynamic environment within which projects are set can help identify the unique issues involved in decision making.

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

Design by its nature has interdependent variables that constrain the solution set. Depending on the design context, a solution to satisfy some purpose may trigger incompatibilities on other aspects of the design problem. Case B typifies wicked problems as a symptom of another problem. A facility renewal study predicted that investments in existing systems renewal would trigger a regulatory clause in accessibility code compliance. This clause required accessibility code issues to be addressed in the process of renewal given that a percentage budget amount was passed in the renewal estimate. Timely development of this issue was found wanting in the process of problem definition. Structuring the process as data gathering and information processing caused the issue in question not to surface until later when the information was being scrutinized for correctness. The organizational issue reflected in this instance relates to the lack of emphasis on problem definition and was directed more towards the processing of information. Timely recognition may have avoided the new reactive design process triggered at a late stage in the planning process. Awareness by the project definition team of the client and project dynamics over time is important to have in the process and the acceptance that change will occur within the problem formulation.

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.

Attitudinal criteria may guide the choice of solutions. Decision agents may choose the explanations which are most plausible to them, when defining the problem, defining purpose, explaining causality and proposing solutions. Time may change the explanations are offered. Maintaining a worldview of the problem definition can aid in resolving the complex situation.

The planner has no right to be wrong.

Finally, Rittel asserts that the planner has little room for error in formulating the problem and is liable for the consequences generated. Professional designers are subjected to projects that are increasingly complex with respect to the coordination of domain knowledge specialists and dealing with the needs of multiple stakeholder organizations that are multi-faceted in nature.

Satisfying the needs of all stakeholders is a challenging demand on the project definition group or team. Project definition groups deal with open systems that are ambiguous and complex. Case A exemplifies this issue, as the process was redesigned to incorporate the expanded stakeholder values that the initial design concept revealed in testing at the phase gates.

CASE STUDIES - PROCESS MANAGEMENT ISSUES

Much of the empirical evidence gathered in this work is consistent with that reported in the literature. Instances of poor task planning and control, lack of shared understanding of decision making processes, socio-political factors dominating decision making, poor information management and processing are some of the primary features that impact the performance of project definition in these observed studies. Without process quality inefficiencies, the design problem is complex as it stands. Process inefficiencies compound the wicked nature of design and can hide or delay the exposure of an existing wicked problem.

Table 1: Summary of Case Study Analysis

Project Case	**A**	**B**	**C**
Name & Description	Building Seismic Retrofit & Program Improvements	Facility Renewal Planning Project	Housing Development – Green Design Process
Owner/Client	Public State Entity	Public Client Division	Public Client Division
Facility Use	University Building mixed uses: Lecture, research laboratory, administrative and public space	Residential housing, dining and conference services	Mid-rise housing development
Approx. Size / Cost	140,000 sq. ft / $80 million	371,072 sq. ft / $42 million	215,000 sq. ft / $74-84 million
Research Methods	Process re-construction, interviews, and archival documentation study.	Meeting observations, archival study, interviews, process and decision influence mapping.	Meeting observations, archival study, interviews, process and decision influence mapping.
Wicked Problem Properties ***1) No definitive formulation***	Lack of full evaluation of alternatives initially Decision influences created high competing performance goals Final process generated numerous concepts to test and expose project constraints	Overall decision framework not planned. Lack of an explicit proactive client requirements process and a work assignments planning process. Organization protocol does not exist for documentation of decision-making processes and procedures.	Design Goals not explicitly prioritized; Lack of process planning as a design management skill by team. Clarification of job design and intra/inter-organizational collaboration needed. Minimal Learning on process impacts.
2) No stopping rule	Final consensus by large stakeholders groups based on multiple criteria Constrained by unrealistic funding source - budget.	Unrealistic time schedule – allocated schedule limits project definition activity Information flows and batch sizes are unbalanced for processing.	Design resources focus on what is “creating the most heat” rather than holistic performance assessment. Implicit stopping rules apparent
3) Solutions not true or false, but good or bad	Goal driven approach used in decision process throughout project – constant use of performance alignment check with stakeholder needs/values	Renewal program allocation used qualitative judgments (based on ranking matrix).	Us e of judgment skills in green design process
4) No immediate or ultimate test	Project needs developed as a learning process through concept development and testing.	Understanding of future facility purpose untested	Predictive design studies limited
5) Solutions have consequences	High functional demands create project constraints re: regulatory and social values Changing client purpose apparent	Facility opportunity untested explicitly Program changes may occur in long term life span of facility	Decision-making impacted by impressions of socio-political factors within environment.
6) No enumerable set of solutions	Product concepts well tested in concept generation through collaborative & creative project team	Client requirements are design solution focused and modeling of requirements is not explicit. Project definition opportunity untested explicitly.	Design product is point-based i.e. without multiple alternates developed as possible solution sets.
7) Problem is essentially unique	Facility unique historic structure with high functional performance specifications & Innovative technological solution	Client misbelieved that project is similar to former renovation projects – lead to premature formulation of problem Other client program effects project scope.	Green design process mapping is incomplete and process-planning experiment is difficult given client commitment or prioritization of “green”.
8) Problem maybe a symptom of another problem	User needs set without ‘alternatives’ evaluation process. Functional needs triggered high safety criteria, which in turn set high production costs	Instances of reactive design tasks - Unrealized project requirements – Code compliance needs triggered by systems renewal -Legislative constraints untested through environmental planning.	Program definition incomplete prior to schematic design. Lack of process planning and control.
9) Numerous explanation of problems	Public opinion necessary in decision process. High public awareness and interest by public groups. Building Historical Importance Nationally.	Multiple performance goals – aggregated for decision-making	Stakeholder frames fragmented - lacking holistic decision framework.
10) Designer has no right to be wrong	Project is high profile facility with public interest. Design performance scrutinized by multiple stakeholder value sets	Unclear visibility of design decision product-process issues Large batches of detailed information	(Green Design) Performance of product is developed in post evaluation process.

The limited ability to facilitate and manage multiple stakeholder frames of analysis early in the definition stages is an area for further investigation. Facilitating transparency of stakeholder interests is a notable feature of the case materials. Such transparency can be structured through critical reflection points established by the project definition team. Highlighting the lack of process transparency identifies the difficulty of recognizing wicked problems.

OPERATIONAL PROCESS FACTORS - ADDED COMPLEXITY

While the exploratory case work reveals properties of wicked problems, equally notable is the complexity of understanding how an organization thinks as it administers project definition activity. Understanding the nature of design planning issues is only part of the problem. Figure 2 displays a "slice" of the design process from Case C, which is impacted by a wide range of issues. Through reason analysis and postmortem exercises the process of decision making is illustrated as a complex web of influence factors.

This design process lacks a reflective process for critical evaluation of the process by which the problem is being formulation and the quality of the information processing tasks. Creating a forum for process planning allows the team to learn of the organizational issues associated with the process. Adopting a systems process view allows organizations to identify factors that impact project definition quality. Improving on the process and organizational structures can become part of the product innovation cycles in project definition activity.

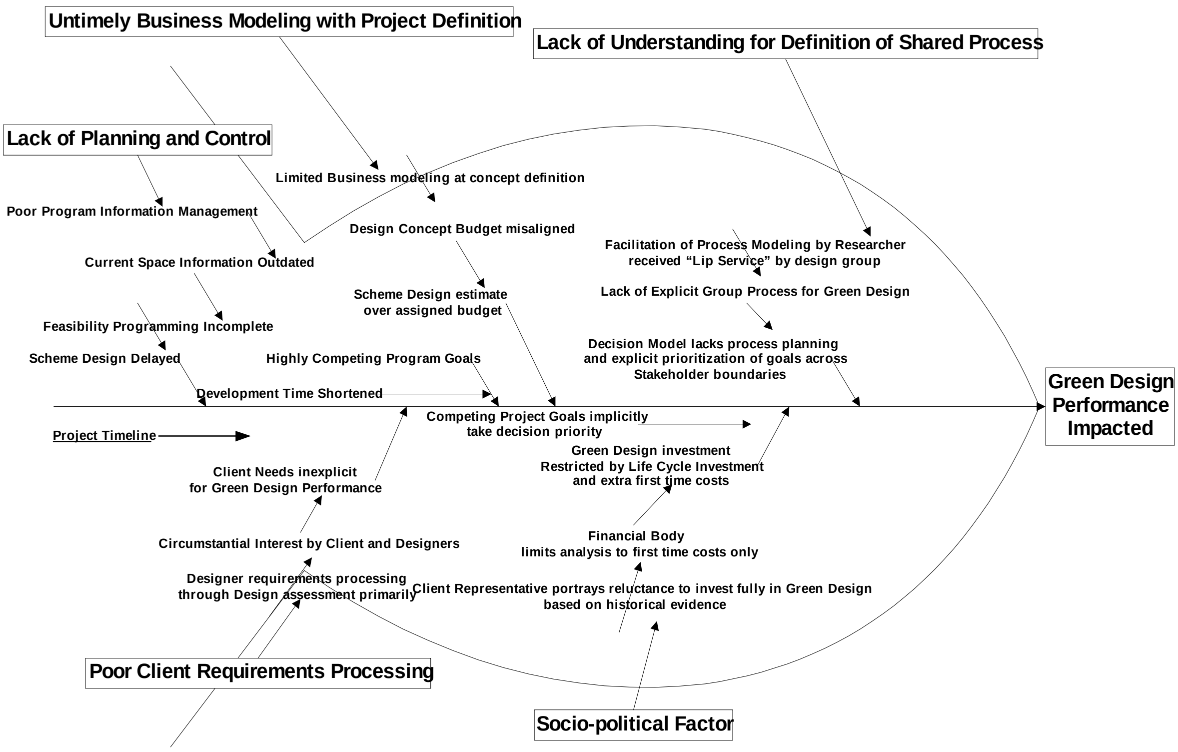

Figure 2: Process Influence Diagram

MANAGING WICKED PROBLEMS THROUGH PROJECT-BASED LEARNING

As the case studies suggest, recognition of distributed expertise and ignorance over a set of project participants is necessary for developing alignment of project definition. Not only do participants (aka stakeholders) typically represent different interests, but also possess different capabilities, all of which should be brought to bear on project definition. Rittel (1984) suggests investigating "*designing as an argumentative process; where to begin to develop settings, rules and procedures for the open-ending of such an argumentative process; how to understand design as a counter-play of raising issues and dealing with them, which in turn raises new issues*". Schon's (1983) notion of reflection allows a group "to surface and criticize the tacit understandings that have grown up around a repetitive experience of the group, and make new sense of situations of uncertainty or uniqueness". Structuring appropriate settings and procedures for learning at individual, group and organizational levels is necessary to understand process impacts like those shown in Figure 2. Learning as discussed by Argyris (1999) occurs when an organization achieves what is intended, i.e. when there is a match between intentions and outcomes, and secondly when a mismatch is identified and corrected and turned into a match. The extended process results in double loop learning (understanding the governing problem variables and altering actions) to determine how the original project goals and design criteria were set and established. Single loop learning may focus on changing actions without a focus on the governing variables (See Figure 3).

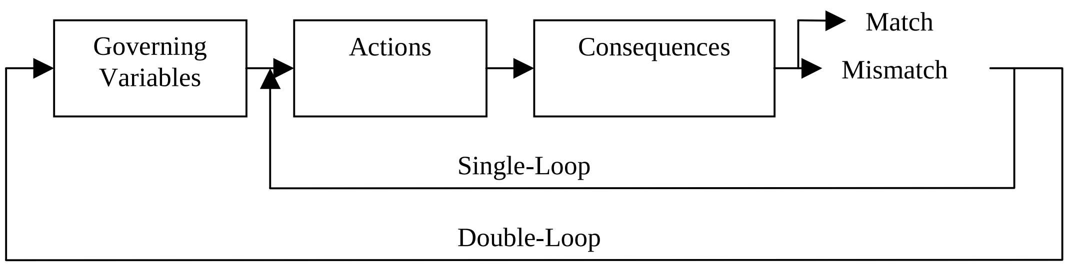

Figure 3: Single and Double Loop Learning (Argyris 1999)

To relate this learning model to project definition activity Figure 4 illustrates a set of learning cycles to test project purposes, criteria and concepts. Governing variables may include the initial problem formulations represented in client purpose, team assumptions, stakeholder needs and project constraints.

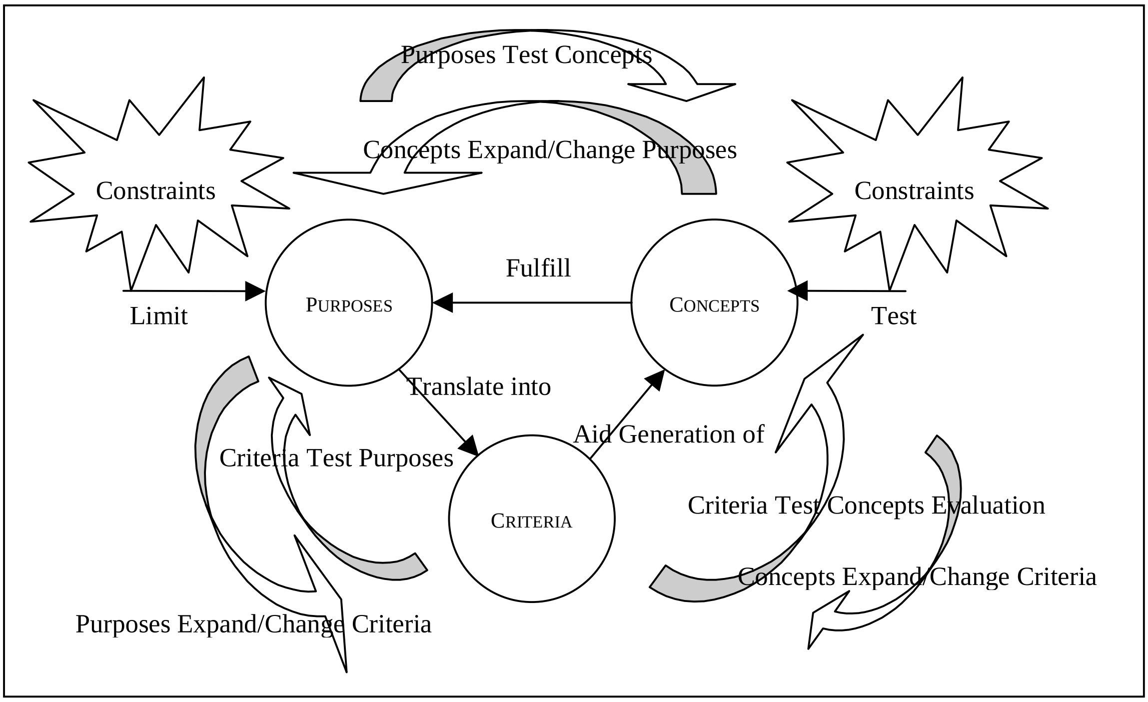

Figure 4: Project Definition Learning Model (adapted from Ballard et al. 2000)

While we agree that problems should be stated in solution neutral terms to the extent possible (as proposed by Kamara et al. 2000), full testing of purpose and criteria may be only be validated through concept generation and reflection. By structuring "reflection cycles" into the process, project teams continuously test their reasoning and rationale within their frame structures. Consistent with the wicked nature of the design task, designers are primarily solution focused (Cross 2001). While this may result in premature acceptance of a problem definition, this tendency can also be channeled into sharpening problem definition through exploration of possible solutions. Testing of client purpose and design criteria can only be fully verified and validated through the development of design concepts. Communication of such learning processes to responsible parties across organizational boundaries demands greater collaboration amongst project definition teams. Whelton et al (2002) address project definition group work and propose research hypotheses centered about task effectiveness within shared group processes. Developing and explicating stakeholder frames is central to facilitating effective project definition.

CONCLUSIONS AND DIRECTIONS FOR FURTHER RESEARCH

This paper has used wicked problem theory to describe complexity in project definition activity. The paper concludes with the following propositions:

- Wicked problems in problem definition are a function of the complexity of project context variables, and associated stakeholder needs and values.
- Recognition, formulation and resolution of wicked problems require auxiliary group management skills to compliment systematic processes.
- Organizational and process inefficiencies compound the process of uncovering and dealing with wicked problems. Organizational structures and processes add

to the complexity when solving wicked problems, should multiple stakeholder values be considered in the decision process. In order to generate greater value for customers and stakeholders, groups need to learn critically and collectively on project issues, and gain a greater understanding of how stakeholder organizations operate, and how their value sets are developed.

- Shared understanding is important for project definition teams, and can only be achieved through reflection and ongoing learning processes.
- While systematic processes provide structure, the communication practices by which action occurs requires further attention. To understand how communication and action can be improved, it is vital to achieve an understanding of stakeholder decision framing. Structuring a process for reflection and learning at strategic points in the process can lead to improved understanding of the problem definition, thereby challenging the quality of governing variables regarding problem-solutions.

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