INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

NORTHWESTERN UNIVERSITY

Patterns of Work:
Exploring Ways of Working In Logistics Management

A DISSERTATION

SUBMITTED TO THE GRADUATE SCHOOL
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

for the degree

DOCTOR OF PHILOSOPHY

Field of Civil Engineering

By

Benedicto Benjamin Villacorte Medina

EVANSTON, ILLINOIS

December 1999

UMI Number: 9953342

Copyright 1999 by
Medina, Benedicto Benjamin Villacorte

All rights reserved.

UMI

ii

ABSTRACT

Patterns of Work:
Exploring Ways of Working in Logistics Management

Benedicto Benjamin Villacorte Medina

The complex shift of the economy from the industrial age to a knowledge-driven future has placed new demands on the logistics professional to manage work and relationships, improve on existing capabilities, and develop new skills. Conventional approaches of using technology to increase efficiency and decrease cost may not be sufficient to address the new challenges. One promising management approach is to focus on enhancing people's ways of working. Central to this approach is the development of patterns - the explicit representations or expressions of the essential elements of ways of working. The concept of patterns originated from architecture and urban planning and recently emerged as a subject of study in management research.

In this dissertation, we explored the applicability and usefulness of using the pattern concept to guide logistics activities. We implemented the pattern concept in three case studies. First, we used patterns to document

and refine previously implicit or semi-explicit ways of work that had evolved within a line organization as part of a strategic initiative. Second, we applied the pattern concept in a deliberate process of supporting business strategy implementation. Third, we integrated pattern development to a training process and showed how patterns could be used to elicit, document, and communicate key concepts and ideas.

In addition to the case studies, we also examined the fundamental issues in knowledge management and developed a pattern-based conceptual framework. To contribute to the body of knowledge on patterns, we also summarized the insights gained and lessons learned from the case study experience.

Although we could not unequivocally conclude that patterns enhanced people's ways of working, the results of the research suggest the usefulness of patterns in supporting various aspects of logistics activities.

iv

ACKNOWLEDGEMENTS

I wish to gratefully acknowledge the people who have made this accomplishment possible.

I am greatly indebted to my advisor, Prof. Marvin L. Manheim, for his guidance and support. He maintained faith in my abilities even at times when I had doubts on what I could achieve.

I also thank the members of my committee, Prof. Louis M. Gomez, Prof. Ahmad Hadavi, and Prof. Joseph L. Schofer, for their support and understanding of the unusual conditions under which I completed the dissertation.

Finally, I will always be grateful to my wife, Isabel, and my children, Benedicto and Margarita for all that they gave up so that I could finish what I started. This is as much their accomplishment as it is mine.

v

To Benito and Marga

TABLE OF CONTENTS

TABLE OF CONTENTS

viii

LIST OF TABLES

LIST OF FIGURES

x

CHAPTER I

INTRODUCTION

Background

The general business environment is characterized by intense competitive pressures in cost, quality, service and time. The scope is going global, involving different cultures and expanding markets. The dynamic changes in the economy, characterized as a complex shift from the industrial age to a 'knowledge-driven' future, are impelling firms to reevaluate its business processes, work practices, and culture (Moore 1998).

The implications of the emerging knowledge-driven economy are especially profound for logistics management. It is no longer sufficient to build supply chain strategies that are based primarily on infrastructure and equipment. Information, technology, and relationships have become significant and essential components of logistics practice (Anderson et al. 1996; Manheim 1996b; Copacino 1997).

Previously dealing mostly with the movement and storage of physical goods, the nature of logistics management is evolving. Supply-chain

1

responsibilities have migrated from the traditional activity and process based roles to responsibilities that involve the structural integration of multiple roles, components, and relationships (Sherman 1994). There is a new demand on the logistics professional to manage work and relationships, improve on existing capabilities, and develop new skills. However, conventional approaches (e.g., using technology to increase efficiency and decrease cost) that have brought about electronic data interchange, bar code scanning, and shipment tracking may not be sufficient to address these new challenges (Manheim 1996b).

Management Approach

One promising approach for management is to focus on bringing about changes in the ways in which people work in the organization and associated enterprises or what Manheim (1996a; 1996b) calls as 'ways of working'. Ways of working include the practices, processes, procedures, and principles that people employ in their daily activities.

The goal of changing people's ways of working demands a management approach that emphasizes the development and implementation throughout the orghanization of practices, processes, and

skills as characteristics that distinguishes an organization relative to its competitors (Leonard-Barton 1995; Manheim and Medina 1997). Two companies may be able to design identical logistics strategies around the same technical initiatives. However, the results are not necessarily the same because the organizations and people involved in executing the strategy are different.

Manheim (1996a) argued that strategies based on people's ways of working could be a source of sustainable competitive advantage. He presented a strategic management model (illustrated in figure 1) in which management vision and strategy is reflected on people's ways of work throughout the organization. Focused on ways of work is one of the key characteristics of a "Truly Productive Organization" - an organization that utilizes its resources effectively over the long term and that deals with new and novel situations efficiently (Manheim 1996a; 1996b).

Objectives of the Research

In this dissertation, we investigate how we could articulate people's ways of working into explicit forms that could guide people's actions. We refer to these explicit representations of ways of working as *patterns*

(Alexander 1975; 1977). In a Truly Productive Organization, these patterns of work represent critical resources to be managed (Manheim 1996a).

The objectives of this dissertation were three-fold:

1. *Test the applicability and usefulness of using the pattern concept to guide activities in logistics.* We explored the usefulness of the pattern concept through three case studies in logistics.

2. *Examine the role of patterns in knowledge management.* It is more accepted in many business sectors that knowledge is a source of sustainable competitive advantage (Earl and Scott 1999). We examine the role of patterns as one operational framework for implementing knowledge management initiatives.

3. *Contribute to the body of knowledge on the pattern concept within management research.* The concept of patterns originated in field of architecture and urban planning (Alexander 1975; 1977) and was adopted within the object-oriented programming community (Gamma et al. 1994). The concept had also recently emerged as a subject of study in management research (Manheim

1996a, 1998, 1999) and logistics (Manheim, 1996b; Manheim and
Medina 1997, 1999). In this research, we study the concept of
patterns in three ways:

> *3.a. Examining the theoretical basis for the concept of*
>
> *patterns.*
>
> *3.b. Describing the properties of patterns.*
>
> *3.c. Exploring alternative ways to develop and deploy*
>
> *patterns in practice.*

Key Findings of the Research

We accomplished the objectives of the research in several ways:

- Through three case studies, we demonstrated the
usefulness of the pattern concept in supporting logistics activities. We
used the concept to examine the implementation of the Core Carrier
Strategy, to execute the product strategy for a Warehouse
Management Software Company, and to summarize and
communicate key concepts in performing Logistics Network Analysis
and Design.

- We provided the background concepts and the fundamental propositions that formed our perspective on pattern-based knowledge management. The case studies also provided empirical support to these propositions. We concluded that patterns could be the principal entities in a knowledge management system.

- We formulated a conceptual framework for patterns that is grounded on case experience as well as relevant literature in management and cognitive sciences. Through observations and formal linkages to well established theories, we also provided a theoretical foundation for firms to make decisions on the pattern concept's implementation and for academics to pursue future research. In addition to building a theoretical foundation, we also examined the practical aspects of pattern use. We reviewed the relevant features of the pattern entities and suggested a general methodology for pattern development.

- We also examined the potential for future work in patterns and management research. We suggested avenues for

further exploration of the theory as well as other areas where patterns could be implemented in practice.

We could not unequivocally conclude that the use of pattern concept enhanced people's ways of working. Given the nature of the research and organizational settings where we tested the concept, it was difficult and impractical to design an experiment that would provide a definitive answer. Nevertheless, the pattern concept was successful in addressing actual business issues in two of the case studies. In management research, we could judge the ideas as valid and generally acceptable based on its successful execution (Gummesson 1991).

Overview of the Dissertation

Eight Chapters follow this introduction. In Chapter II, we review the formulation of the methodology used in conducting the research. In Chapter III, we discuss the theoretical foundation of the pattern concept. We also examine insights derived from the literature that contributed to the formation of our conceptual model. In Chapter IV, we explore the relationship between the pattern concept and knowledge management. In the succeeding chapters, we review in detail the three case studies, with Chapter V on the

Core Carrier Strategy Case, Chapter VI on the Warehouse Management

Software Company Case, and Chapter VII on the Logistics Network Analysis

and Design Training Case. We summarize the findings of the research in

Chapter VIII. In Chapter IX, we examine the potential areas for future work.
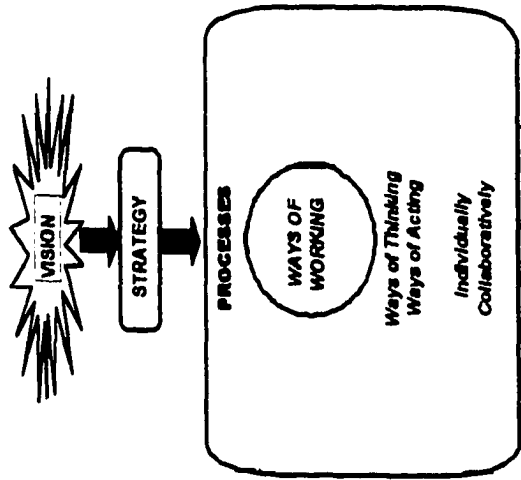
Figure 1. Strategic Management Model - Focused On Ways of Working
(Source: Manheim 1996a)

CHAPTER II

THE RESEARCH METHODOLOGY

Introduction

In this chapter, we discuss the methodology used in the research. We will first examine the various possible research approaches. Then, we discuss the unique nature of the research and present the arguments for a customized approach. Then, we present the formal methodology that we used in the research.

We also address specific issues facing our method of choice. We summarize the key points of discussion in the last section.

Alternative Methodologies

The first objective of the thesis was to test the usefulness of patterns to guide activities in logistics. We believed that testing the concepts within an organizational context would provide the best environment for learning about the utility of patterns. The need to test the concepts in a business setting was a primary consideration in the selection of a research methodology.

10

We examined several alternative approaches, including controlled experimental design, case-based approach, grounded theory, and action research.

Controlled Experimental Design. In an experimentally designed approach, one tests the proposed concepts by implementing interventions to an experimental group and comparing the outcomes with a control group that was not subject to the same intervention. Methods based on experimental design would be ideal if one could control extraneous events before, during, and after change (Barnes 1964). Generally, an experimental model requires a controlled setting where independent and dependent variables can be specifically defined and observed empirically as concrete structures.

A controlled experimental approach could be applied in an organizational setting if there were multiple organizational units available with the similar characteristics, and some units could randomly be selected as the test group and others as the control groups. In order for the approach to be robust, one would also need control over the research environment. In an organizational setting, this would require broad, multi-unit participation within

a sponsor organization. Generally, randomization and scientific control have

been difficult to implement within organizations (Cunningham 1993)

In this research, we did not have access to controlled business

settings. Although we recognized its value, a methodology based on

controlled experimental design was neither feasible nor practical.

Case-Based Approach. One alternative to controlled experiments is

the use of case studies. Case studies employ various methods, such as

interviews, participant observation, and field studies, to observe, reconstruct,

and analyze cases under study (Hamel, Dufour, and Fortin 1993).

Critics of the case study method cite its weak basis for scientific

generalization relative to a more structured experimental research design.

On the other hand, proponents of case-based research argue that case

studies are similar to experiments in that both are generalizable to theoretical

propositions and not to populations or universes. Alike to some experiments,

the goal of case-based research is to expand and generalize theories

(analytic generalization) and not to enumerate frequencies (statistical

generalization) (Yin 1993).

Grounded Theory. Grounded theory is an inductive, theory-discovery methodology that allows the researcher to develop a theoretical account of the general features of a topic while simultaneously grounding the account in empirical observations or data (Martin and Turner 1986). The major difference between grounded theory and other methods is the suggestion in grounded theory that there should be a continuous interplay between data collection, analysis, and theory formulation / revision (Myers 1997).

Action Research. Action research is a mode of the case study method that involves the active participation and intervention of the researcher (Argyris 1982; Gummesson 1991). It always involves two goals - to solve a problem for the client and to contribute to science (Gummesson 1991). Action research is rigorously empirical and reflective, engages subjects as active participants in the research process, and is intended to result in a practical outcome (Stringer 1996). In this approach, good research is determined by the degree to which the results are useful in solving practical problems and in contributing to the general knowledge of organizations (Cunningham 1993).

Action research was an attractive perspective from which to conduct our research. Its two goals were consistent with our stated research goals.

The Methodology Adopted

Because of the exploratory nature of the research topic and the need to test the concept in a business setting, we adopted a variation of the case study methodology for the research. The approach we adopted was composed of three stages:

1. *Build The Conceptual Model:* We developed the conceptual model through a review of definitions, background concepts, propositions and hypotheses. Also, in addition to reflection and discussions, we sought insights from the relevant literature.

2. *Undergo the Case Study Experience:* The case studies were the primary sources of research material. We took a case-iterative approach in the research (Kock, McQueen, and Scott 1997), where we conducted and analyzed the case studies in sequence. Consistent with Cunningham's (1993) suggestion, we used the results of each case experience to provide a renewed understanding of the research issues. We used the results of each case to reassess the conceptual model. For each case, we used the following procedures:

- Review the conceptual framework.

- Assess the conditions of the case environment and develop the research agenda.

- Immerse in the domain, implement the pattern concept, collect observations, and develop insights.

- Document the case experience.

- Summarize the key findings and reassess the conceptual model.

- Proceed to the next case study domain.

3. *Synthesize the Insights and Observations:* We summarized our findings across all cases and developed conclusions.

As would be shown below, this variation of the case study methodology was well suited to our research needs and objectives. This approach also shared similar features with the various approaches discussed in the previous section.

When we conducted the case studies, we implemented the pattern concept as part of a broader business process. In two of the three case studies, we performed dual roles of researchers as well as change agents. This circumstance is characteristic of action research projects (Gummesson 1991; Cunningham 1993; Elden and Chisholm 1993).

The concept of patterns was on the early stages of development in management studies when we started our research. The case-iterative approach permitted the evolution of the theory and concepts as the research unfolded, as would occur in grounded theory methods (Glaser and Strauss 1967; Martin and Turner 1986; Layder 1993). Given the scarcity of cases and resources, the inductive strategy could be useful in strengthening our ability to make meaningful insights and observations (Layder 1993). In accumulating findings over the iterations, we also built the 'chain of evidence' (Yin 1994) that supported the objectives of the thesis.

Even under experimental investigations, rarely are scientific facts based on single experiments. They are usually based on a multiple set of experiments conducted under different conditions. We were aware of the limitations in the number of cases that we could study and the threats it posed to the validity of our conclusions. The iterative approach increased the

robustness of the case methodology by permitting the collection of observations from different sources about the same variables and data (Kock, McQueen, and Scott 1997).

There were two major issues with our choice of research methodology: (1) the lack of quantitative measures and (2) the reliance on researcher observations. We address these issues below.

The Lack of Quantitative Measures. We were not able provide quantitative measures of success or effectiveness in our case studies. This was not unusual in research projects of this nature. When it come to human and social sciences, our measurement capabilities are limited at best (Norman 1994). However, such limitation should not hinder the research process.

From a practical perspective, the acceptance of recommendations could be used as indicators of success. In one study of organizational decision making, it was thought that managers defined the success of decisions based on the adoption, merit and duration of the resulting recommendations (Nutt 1996). In memoirs of executives, it was uncertain whether the descriptions, conclusions, and recommendations were correct

and generally valid. However, management ideas were given validity and general acceptance because they were successfully implemented (Gummesson 1991).

The action-research orientation of our approach also shifted the emphasis from measurements to outcomes. In action-research, the conception of an idea may not be termed successful unless it is successfully implemented (Cunningham 1993). A change in the organization's behavior after the intervention is a significant indicator of organizational acceptance (Huber 1991; Leonard-Barton 1995).

The Reliance on Researcher Observations. In all of the cases, the researcher was an active participant and not an outside observer. We had to be conscious of the potential for over-involvement that could result in biased outcomes or biased interpretations.

In organizational research, conclusions derived from direct observations by primary investigators were considered acceptable modes of analysis. Examples could be found in Isenberg (1987) in his study of managerial thinking, Nutt (1996) in the examination of organizational decision making, and Melone (1996) in her investigation of executive decision-making.

Similarly, Alexander (1977), Gamma, et.al. (1994), Coplien (1997) and other investigators used personal observations and insights as the basis for their contributions to the pattern literature. A similar mode of inquiry is the hermeneutic approach where the investigator's interpretation is the primary component of analysis (Bleicher 1980; Eisenhardt 1989; Myers 1997). In a hermeneutic approach, qualitative assessments partially replace quantitative data (Gummesson 1991).

During the research, we took precautions to reduce the potential for bias. In addition to general awareness, we incorporated iterative applications of the methodology to the research design. Repeated applications would show disconfirmatory evidence caused by researcher bias and could offer an opportunity to correct distortions observed in earlier iterations (Kock, McQueen, and Scott 1997). Another method used was discussions with co-investigators who made independent observations. In the Warehouse Management System Company case, for example, discussions with the team members confirmed key observations and findings.

Chapter Summary

In this chapter, we discussed our search for an appropriate methodology to conduct research on the pattern concept. We examined alternative approaches that could be used. The emergent nature of the subject, our research objectives, the need for an organizational setting, the limited case study opportunities, and other considerations led us to develop a case-iterative approach.

We had three opportunities to implement the pattern concept. At this juncture, we provide a brief description of each the cases:

1. *Core Carrier Strategy.* The Core Carrier Strategy suggests that logistics organizations leverage their volume over a select number of capable carriers. Our objective in the study was to test the pattern concept in articulating how the strategy could be implemented. Based on observations as a member of a carrier management organization and later as a consultant, we examined the business implementations of the Core Carrier Strategy and formulated patterns of work. This approach was similar to methods suggested by Alexander (1977, 1979) as well as the pattern proponents in the

object-oriented programming community (Gamma et al. 1995; Rising 1998).

2. *Warehouse Management Software Company.* We were involved in a project to implement a product strategy for a Warehouse Management Software (WMS) Company. In this project, we worked closely with the WMS Company's senior management who were the authors of the product strategy. Their objective was to determine ways to effectively implement the product strategy. Our research goal was to examine how the pattern concept could be used to assist strategy implementation.

3. *Logistics Network Analysis and Design Training.* In this case study, we were involved in a project to provide Logistics Network Analysis and Design training to a management employee of a manufacturing company. The training objective was to improve the employee's capacity to perform this specialized type of analysis. Our research goal was to test the pattern concept as a training tool. Patterns were used to summarize and communicate the key aspects of performing network analysis.

These case studies will be discussed in detail in the later chapters. In the next chapter, we discuss the theoretical framework behind the concept of patterns.

.

CHAPTER III

THE THEORETICAL FRAMEWORK

Introduction

In Chapter II, we referred to *ways of working* as the practices, processes, procedures, and principles that people use daily activities. We also defined *patterns* as the explicit representations or expressions of the essential elements of ways of working. In this chapter, we will explain the theory behind the pattern concept. Also, we will establish the framework from which we conduct our research.

We discuss how the concept of patterns was developed by providing a historical account of the concept's evolution through three fields of study: (a) its introduction in architecture and urban planning; (b) its use in the object-oriented programming community; and (c) its emergence in management research.

We also discuss several concepts in field of cognitive science. We examine the relevance of schemas, mental models, and artifacts in our research on patterns.

23

Finally, we review knowledge management and the motivations for its pursuit. We believe that patterns could be a key component of a knowledge management initiative.

Patterns in Various Fields of Study

Patterns in Architecture and Urban Planning. Christopher Alexander (1977; 1979) initially introduced the concept of patterns as part of a design theory in architecture and urban planning. Alexander observed that there were recurring and fundamental characteristics of well-designed cities, towns, and buildings. He postulated that there were invariant principles behind the various design and construction processes that brought about the desirable qualities in the structures. According to his theory, these principles evolved from the design expressions that people across various cultures had used in constructing their surroundings.

Alexander suggested that the design principles could be made explicit as well as shared. To illustrate the theory, Alexander developed a hierarchical set of recurring design problems and solution techniques which he called *patterns:*

"Patterns describe a problem which occurs over and over again in our environment, and then describe the core of the solution to that problem, in such a way that you can use this solution a million times over, without doing it the same way twice." (Alexander 1979)

Alexander expressed the patterns in a structured format (see table 1). Each pattern addressed a specific design issue. Different patterns could be used together to guide the design of various structures. For example, table 2 shows a set of patterns for building a farmhouse

The design patterns were intended to capture intuitive principles of architectural design. Alexander (1979) believed that individuals could develop their own design capabilities through thoughtful reflection and expression of architectural design (via patterns).

In its first application, the concept of patterns was integrated in the campus planning process for the University of Oregon (Alexander 1975). Rather than using a "fixed image" master plan, campus development was guided by explicitly debated and approved basic policies (or "patterns"). The policy statements reflected the shared traditions and understandings of the

University community. Patterns continue to be part of the university's long

range campus plan (see

http://darkwing.uoregon.edu/~uplan/LRDPPlanFinal).

The use of patterns in architecture received mixed results (Gabriel

1998). Even Alexander himself noted how the some buildings constructed

based on his set of patterns failed to produce the features he described in his

theory (Grabow 1983). Nevertheless, his concepts continued to be part of

the study of architecture and planning (Lynch 1987; Patton and Sawicki

1986).

Patterns in Object-Oriented Programming. Object-oriented

programming (OOP) is a software development methodology that examines

the requirements of programs based on classes and objects (Jezequel

1996). A class is a user defined data type that aggregates different data

elements (possibly of different data types such as integers, real numbers,

and strings) and a set of operations to manipulate the data (Lippman 1991).

An object is the instantiation of a class and is the entity that takes up space

in a computer's memory (Jezequel 1996; Lippman 1991). An object exists in

time, may have a changeable state, and can be created or destroyed. If

properly applied, OOP provides a model for software development that

speeds the development of new programs, and improves the maintenance, reusability, and modifiability of software (Montlick 1995)

The concept of patterns appealed to the OOP community partly because the process of building structures was seen as analogous to the process of software development (Coplien 1998; Lea 1998). For instance, both processes involved a design phase and an implementation phase.

In the OOP context, patterns were descriptions of recurring programming design practices (Gamma et al. 1994). By definition, OOP patterns (also referred in the literature as 'design patterns'), systematically named, motivated, and explained a general design problem in object-oriented systems. Patterns described the problem, the solution, when to apply the solution, and its consequences. It also gave implementation hints and examples (Gamma et al. 1994). Similar to Alexander, a particular structure for documenting patterns for OOP was also used (see table 3).

Among OOP practitioners who adopted the concept, patterns offered a framework for documenting and sharing good programming practices. The goal for patterns was to capture design experience in a form that people could use effectively (Gamma et al. 1995). Expressing techniques in a

commonly-understood format would enable experts to share insights with developers of new systems. In addition, patterns provided reusable templates for designing software (Coad, North, and Mayfield 1995).

Interest in patterns had expanded after its introduction to the OOP community (Gamma 1991; Gamma et al. 1995), as evidenced by the growing body of literature on the subject (see Gabriel 1996; Buschmann et al. 1997; Rising 1998). The OOP community had also held a number of conferences on pattern languages in programming design (see Coplien and Schmidt 1995; Vlissides et al. 1996; Martin et al. 1997).

A significant portion of the published material in OOP patterns is technical. The majority of the written material focused on sharing a catalog of successful solutions to common software problems (Coplien and Schmidt 1995; Buschmann et al. 1996; Vlissides et al. 1996; Martin et al. 1997). The literature also provided accounts of the OOP community's experience with patterns, some which we summarized below:

- *Software Training.* Patterns were incorporated in the training material for software designers with positive results (Beck et al. 1996; Goldfedder and Rising 1998).

- *Software Documentation and Reuse.* Patterns provided a consistent framework to capture reusable software designs and implementations (Beck et al. 1996). This also facilitated reuse. In one large-scale project, patterns were used to migrate system software across computing platforms (Schmidt and Stephenson 1998).

- *Communication.* Patterns represented a mechanism for easily sharing design information within and among groups of software developers (Beck, et. al 1996; Schmidt and Stephenson 1998).

- *Organizational Development.* Researchers at the Pasteur Process Research Program at AT&T Bell Laboratories gathered data on software development organizations and concluded that most highly productive organizations exhibited similar characteristics (Coplien 1997). In an extended use of the concept, patterns of organizational structures were documented for the purpose of improving the prospects for success of future

software development organizations. Research on organizational patterns is still on-going.

- *Productivity Enhancement.* Quality improvements in code (Beck et al. 1998), reduction in development time (Ramirez 1998) and simplification in design (Schmid 1998) were attributed to pattern use in software development.

Most of the benefits cited in the literature were mainly based on the user accounts of the experience and not a result of systematic experimentation. One experiment that sought empirical evidence on the effectiveness of patterns was conducted by Preschelt et al. (1998). They concluded that pattern use in software design could be beneficial on complex problems but could also be detrimental if simpler alternatives were available.

Pattern development in the OOP community was mainly based on experience and observations of pattern authors (Coplien 1994; Gamma et al. 1995). Discussion was considered a key component of the pattern writing process (Coplien and Schmidt 1995; Gabriel 1996). Writing workshops were held during OOP conferences. The emphasis in the writer's workshops was on the communication of ideas (Rising 1998b).

Patterns in Management Research. Alexander's concept of patterns

also emerged as a subject of study in management and strategy. This was

the perspective from which we conducted our research.

In identifying opportunities for long-term competitive advantage,

Manheim (1996a) put forward the idea of a "Truly Productive Organization"

or TPO. A TPO had a number of distinguishing characteristics, including

customer-satisfaction focussed, disciplined yet innovative, stable yet

experimental, simultaneously global and local, committed to continuous,

rapid learning, simultaneous tight-loose, and focussed on the ways that

people work. He argued that building a TPO meant building an organization

in which patterns of work were managed as critical resources. A TPO was a

source of competitive advantage, because it was based on people skills

which are difficult and expensive to duplicate.

Manheim (1996a; 1996b; 1998) expanded the definition of patterns to

cover a much broader range of activities:

"From a behavioral perspective, patterns are the ways in which

individuals or groups of individuals think and act. When a new process

is implemented, one of the major tasks is to teach people the new

patterns of working (and ideally to revise the process design based on

what people learn about the workability and effectiveness of the new

patterns)... At the core, the role of patterns is to guide individual

thought and action." (Manheim 1998)

Manheim framed patterns as reusable templates which individuals could operationalize through instantiation. Consequently, the actual implementation of a pattern may vary depending on individual interpretation, circumstances, and application contexts. Table 4 lists some of the patterns considered as important to enhancing people's work (Manheim 1999).

There were also references in the literature indicating that people represented concepts and ideas in a structured form, similar to what is suggested in patterns. In his study of managerial thinking, Isenberg (1984) showed that effective managers maintained a library of mental templates that could be harnessed with minimal effort. He concluded that senior executives rely on the recall and performance of well-learned behavior sequences. A similar finding in another study indicated that managers and supervisors make decisions based on replicated information gained from previous experiences (Archer 1980).

According to Minzberg, Raisinghani, and Theoret's (1976) study,
although the processes used in decision making were not predetermined and
explicit, there was strong evidence that a basic logic or structure underlied
what the decision maker did and that this structure could be described by the
systematic study of his behavior. Newell and Simon (1972) concluded that
the decision-maker, when faced with a complex situation, sought to reduce
the decision into procedures and routines. It was postulated in this study that
decision-makers used familiar structural elements when they dealt with
unstructured situations. Melone's (1996) study suggested that senior
executive's mental representations allow for the storage and recall of
prototypes and analogies for problem solving.

There were also indications that the structured representation of ideas
could be relevant to individual and organizational learning. The process of
surfacing individual mental models and making them explicit could accelerate
individual learning (Kim 1993). Active sharing of mental models could also
expand an organization's capacity for effective, coordinated action. In Kolb's
(1984) experiential learning model, the process of formulating and
generalizing abstract concepts was integral to the translation of concepts to
concrete experience.

The reusable feature of patterns could also be significant in the learning process. Learning takes place only when new knowledge is translated into different behavior that is replicable (Argyris, and Schon 1978). Kim (1993) also emphasized the importance of replication and repeatability in the learning process.

Cognitive Science Dimensions

Three constructs in the field of cognitive science are relevant to our discussion: schemas, mental models, and artifacts. These concepts vary in the way they treat individual and shared cognition. However, these constructs share common threads with the way we conceptualized patterns.

Schemas. A schema is a dynamic mental representation of a type of a general object (physical or non-physical) that describes only the characteristics that define the type of object (Kellogg 1996). For example, the schema for a tree consists of attributes such as leaves, trunk, branches, leaves, bark, and root. Creating an instance of the schema (by providing values to the attributes) will define the type of tree. Various objects with the same attributes could be represented by the same schema.

Management research had suggested the role of schemas in people's ways of working (Manheim, 1996a). In his study of managerial thinking, Isenberg (1984) observed that effective managers maintained a library of schemas or mental templates that could be harnessed with minimal effort. The skills of effective managers could be described as the ability to store, retrieve, and adapt a large variety of schemas. Manheim and Isenberg (1987) later proposed a theory of computer support to human problem solving that featured the representation of the individual's conceptual structure as a network of schemas.

As inferred from Manheim and Isenberg (1987), schemas provide the cognitive basis for patterns (see also Hastie, 1981, 1986; Pennington and Hastie, 1985). Patterns were considered the explicit representation of mental schemas (Manheim 1996a; 1996b). Schemas and patterns also shared similar characteristics. The patterns cited in the architecture and OOP literature were propositional (i.e., an assertions that were understood and evaluated). This is one form of mental schematic representation (Gardner 1987; Kellogg 1996). Schemas were embedded in and consistent with people's background knowledge (Kellogg 1996). As shown by the use within the object-oriented programming community, patterns must relate well to the

cultural background of the users (Rising 1998). Schemas could also

represent routine activities that involve social interactions (Kellogg 1996).

The stakeholder pattern identified in table 4 (Manheim 1999) reflected how

patterns could guide an individual's interaction with a group.

Mental Models. Mental models are representations formed by a

person's view of the world, including explicit and implicit understandings (Kim

1993). Mental models are based on experience as well as current

observation and are more abstract representations of systems compared to

template schemas (Wilson and Rutherford 1989).

Like patterns, mental models play a role in the ways people

accomplish work. Individuals have a natural tendency to store processes

and retrieve information in terms of mental models against which information

is calibrated and used to solve problems (Leonard-Barton 1995). Kim (1993)

further asserts that there could be learning benefits in the act of surfacing

individual mental models and making them explicit.

Artifacts and Activity Theory. In cognitive science, artifacts were

defined as material objects that are products of human activity (Guralnik

1984; Gagel 1997). Artifacts include designed objects (such as tools and

control instruments), symbolic representations (like graphs, diagrams, text, plans and pictures), and features and landmarks in the physical environment (such as machines, signs, and buildings) (Pea 1993). Depending on the goals and setting, individuals use artifacts to interact with the world (Cole and Engestroem 1993). In addition to being sources of stimulation and guidance, artifacts were also considered vehicles of thought (Salomon 1993). Researchers have recognized the important role that artifacts play in the execution of work (Suchman 1995; Engestroem and Middleton 1996; Star 1996).

Activity theory is field of study that is particularly concerned with the ways in which tools, collectivities, and historical and material conditions together form actions and contexts of problem solving and knowing (Star 1996). According to this theory, artifacts mediate work activity in an organization (Cole and Engestroem 1993). Artifacts could come to embody the stable and structural in work practices (Engestroem and Middleton 1996).

Activity theory and the concept of artifact mediation were particularly relevant to our research. *We consider that the fundamental function of patterns is to guide thinking and action.* The literature in this field provided an alternative perspective to our conceptual framework on patterns.

In his treatise on action-taking and decision-making in office work, Hewitt (1986) concluded that beliefs, plans, goals, requests, and other activities could exist in the workplace as objects that can be explicitly mentioned and manipulated. He cited tree-structured charts as examples of objects that describe possible actions and their possible effects. He argued that the investment in developing and sharing these representations could facilitate cooperative work among participant actors in an organization.

In an examination of cooperative design in software projects, Kyng (1995) divided artifact representations of work into descriptions of relevant existing situations within the workplace and scenarios of future use of the systems under development. Kyng also suggested that the work could be represented through textual and graphical forms. Similar to Hewitt, the objective of studying artifacts was to support cooperative design.

Jordan, Goldman, and Sachs (1995) developed a set of tools for the collection and analysis of empirical data about various representations of work. For instance, one of the tools was designed to represent the relationships between people, artifacts, and systems as graphs or networks. Shared understanding was considered the key attribute of effective work

representations. Again, support for collaborative work was the primary motivation for the research.

The research in work representation shared common themes with our research on patterns. *From the perspective of activity theory, patterns could be considered as artifact representations of work.* In our viewpoint, patterns encapsulate practices, processes, procedures, and principles that are desirable for people to adopt. Functionally, patterns are intended to guide individual thought and action.

The small body of literature on the activity theory and design of artifacts to represent work reflects the emerging nature of this area of study. Through this research, we also hope to make a modest contribution.

Knowledge Management

There were several definitions for the term 'knowledge management' in the literature (see table 5 for a sampling). Although there were some shared threads, it was apparent that there was no consensus on a common definition. However, there appeared to be consensus on its importance among organizations. Earl and Scott (1999) discovered an agreement among

company executives that knowledge today is a source of sustainable competitive advantage and is displacing capital, natural resources, and labor as a basic economic resource. They also suggested that companies were generally not good at articulating and managing knowledge.

Knowledge management originated from three business movements (Silverstone 1999). First, *total quality management,* which provided the human dimension of the workplace. Second and equally important was *information resource management* , which entails focusing on information rather than technology. Third was the *human capital movement,* which acknowledged that people are the firm's most valuable asset.

Many argue that knowledge management should be an integral part of the current way of doing business. Leonard-Barton (1995) asserted that companies are knowledge institutions and compete on the basis of their ability to create and utilize knowledge. Hence, managing knowledge should share similar prominence as managing finance and other functional areas of a firm.

There were several broad trends that motivated firms to adopt knowledge management programs. These included (1) pressures on

adaptability, innovation, and process speed brought about by a globalized

economy; (2) the awareness of the value of specialized knowledge in coping

with these pressures; (3) the awareness of knowledge as a distinct factor of

production; and (4) declining cost of networked computing (Prusak 1997). In

a study of knowledge management initiatives (De Long, Davenport, and

Beers 1998), the researchers identified several business imperatives used to

justify knowledge management initiatives, including reduced cycle time,

reduces costs, reuse of knowledge assets, and creation of new products and

services. They also concluded that it is too early to judge the success or

failure of most knowledge management projects.

The software and services industry has also focused attention on

knowledge management. A number of software vendors and consulting firms

have entered the market to provide 'knowledge management' products and

solutions. A significant number of providers focus on managing information

at the enterprise level (Wainwright 1998a), featuring search/retrieve functions

from corporate databases as well as document management and work flow

technologies.

Various technologies had been associated with knowledge

management, including document management, workflow, data mining, on-

line analytical processing, automated data capture, electronic messaging,

decision support and business process design (Moore 1998c). The growing

number of product and service providers that were eager to be part of this

new market fueled concerns on the possible over-extension of the term

knowledge management (Wainright 1998b). Academics and industry

practitioners raised concerns over the misconceptions that could arise

regarding the over-emphasis on the technologies (Silverstone 1999;

Wainright 1998b).

One of the most contested areas in knowledge management involves

codification, i.e., the process of putting knowledge in forms that could be

leveraged and transferred (Ruggles 1997). We believe that the concept of

patterns has the potential to make a significant contribution to this area. We

submit that patterns codify knowledge on ways of working and could be used

as entities in a knowledge management system. We explore this proposition

in detail in the next chapter.

Chapter Summary

In this chapter, we provided the theoretical background on the

development of the concept of patterns. Alexander defined a pattern as an

expression of the essential elements of the solution to a design problem under a particular context. In this thesis, we follow Manheim's (1996a) extension of the definition to cover not just design problems but ways of work in general. We defined patterns as the explicit representations or expressions of the essential elements of ways of working.

We reviewed the concept's evolution from its inception in architecture and urban planning to its use within the OOP community and through its emergence in management research. We also discussed relevant concepts in cognitive science. We showed how schemas, mental models, and artifacts shared common conceptual features with patterns. We also reviewed the literature on knowledge management. We submitted that patterns could be a useful form for codifying knowledge on ways of working.

In the next chapter, we examine the relationship between the pattern concept and knowledge management.

1	A picture that shows the archetypal example of the pattern.
2	Introductory paragraph that sets the context.
3	Headline that describes the essence of the problem.
4	Body of the problem, describing the empirical background, evidence for validity, and range of manifestations.
5	Description of the solution, stated in the form of an instruction.
6	Diagram of the solution with labels to indicate major components.
7	Description of how the current pattern is related to other patterns.

Table 1. Alexander's Pattern Format
(Source: Alexander 1997)

North-South Axis
West Facing Entrance Down The Slope
Two Floors
Hay Loft At The Back
Bedrooms In Front
Gardens To The South
Pitched Roof
Half-Hipped End
Balcony Toward The Garden
Carved Ornaments

Table 2. Patterns For Building a Farmhouse
(Source: Alexander 1997)

1	Name & Classificaiton	8	Collaborations (Between Participants)
2	Intent	9	Consequences (Support For Objectives)
3	Also Known As (Aliases)	10	Implementation (Pitfalls, Techniques)
4	Motivation	11	Sample Code
5	Applicability	12	Known Users
6	Structure (Graphical Representation)	13	Related Patterns
7	Participants (Objects & Classes)		

Table 3. Pattern Format For Object-Oriented Programming
(Source: Gamma, Helm, Johnson, and Vlissides 1994)

Patterns For Managing Personal Effectiveness (JAIGAP Pattern)
o Make *Jottings* or personal notes; o Identify *Areas* of interest and concern; o Formulate and manage a set of *Issues*; o Formulate and manage a set of *Goals*; o Formulate and manage *Action* items; o Manage relationships with *People*. **Pattern For Stakeholder Management** o Identify key stakeholders; o Identify likely perspectives - what is known about their possible positions, reactions, questions, concerns; o Summarize; o Prepare possible responses.

Table 4. Examples of Patterns in Management
(Source: Manheim 1999)

Definition	Source
"..the ability to balance creative activities that cultivate the raw materials of the mind with the disciplined execution needed to transform good ideas into valuable goods."	Graham, A. B. and Pizzo, V.G. (1996).
"From a strategic perspective, knowledge management is the ability to expect the best decisions and actions possible from your people at any time, by providing them with the best information possible from any source. From the tactical and deployment presepective, knowledge management is the perfect balance of people, the processes they participate in and the information technologies the use to support decisions and take action. From the vendors (perspective)..., knowledge management systems search for, capture, organize, share and publish information throughout the organization (to accomplish the (strategic and (tactical goals))."	Moore, Andy (1998b)
"Knowledge Management.. effectively creating, capturing, sharing, and using company-wide knowledge." "Knowledge management means that knowledge, and the power that comes with it, is more readily transferred and made accessible to inviduals throughout the organization."	Seeman, Patricia (1998)
For Sollac, a sheet steel company... knowledge management means managing skills or validated operational know-how.	Velker, Lee (1998)
"Knowledge management must link information to the human cognition process. Knowledge management is leveraging collective wisdom and experience to accelerate innovation and reponsiveness."	Frappaolo, Carl (1998)
"The strategic aim of a knowledge enterprise is to extract value from organizational information and intellectual assets."	Strong, Karen (1998)
"Knowledge management.. is a set of business practices that focus on the intelligent capture and reuse of information and knowledge held by employees."	Watson, James & Jennifer Harty (1998)

Table 5. Knowledge Management Definitions

CHAPTER IV

THE ROLE OF PATTERNS IN KNOWLEDGE

MANAGEMENT

Introduction

In this chapter, we present our view on the role of patterns in the field of knowledge management. We discuss our arguments through two sets of propositions. In the first set, we submit our perspective on knowledge management. In the second set, we outline an approach to knowledge management that is based on the pattern concept.

Perspectives on Knowledge Management

In this section, we provide a set of propositions that embody our perspective on knowledge management.

It is difficult to discuss knowledge management without addressing the issue of its definition. As suggested in table 5, there appeared to be no consensus on a common definition. There is even a level of vagueness and ambiguity that surrounded some of the definitions for the term (Leonard-

48

Barton 1995; Earl and Scott 1999). Although it may be a semantic argument, it is enough to raise concern among academics and industry practitioners regarding possible misconceptions (Silverstone 1999; Wainright 1998b).

Most firms that sought to define knowledge management defined the term by identifying its component ideas, practices, and technologies (O'Connor 1999). From our standpoint, the issue is not in the 'management' aspect of the concept but in defining the 'entities' that are being managed (i.e., how can you manage something that you do not understand?). Given the software and service offerings available in the market, there is no shortage on management functionality (Moore 1998c; Wainright 1998a). The same cannot be said regarding the understanding of knowledge entities. In their study of knowledge management initiatives, De Long, Davenport and Beers (1998) indicated that most managers struggled with defining and understanding this entity.

Instead of presenting another definition for knowledge management, we will focus our efforts in developing an understanding of entities that codify knowledge. We believe that codifying knowledge is a key objective of a knowledge management program. By addressing entities, we can also view the existing definitions in a clearer context. This leads to our first proposition:

Proposition 1: Knowledge is not an entirely crisp, tangible, codifiable entity. There are both tacit and explicit components to knowledge. In addition, knowledge, at best, can only be imperfectly articulated. Portions will always remain tacit.

This proposition is inferred from Polyani's (1966) work on classifying knowledge entities as either of two types: tacit knowledge and explicit knowledge. As discussed in Nonaka and Takeuchi (1995), tacit knowledge "is personal, context specific, and therefore hard to formalize and communicate." On the other hand, explicit knowledge is "codified knowledge... transmittable in formal, systematic language." Graham and Pizzo (1996) made similar arguments when they refer to the balance between the 'fluid' and 'institutional' domains of organizational knowledge.

The concept of tacit and explicit forms of knowledge is further explored in Nonaka and Takeuchi's (1995) model of knowledge conversion. In this model, knowledge is created through the interaction of tacit and explicit forms of knowledge in four modes: *(1) socialization*, a process of sharing experiences and creation of tacit knowledge such as mental models and technical skills; *(2) externalization*, a process of articulating knowledge

into explicit concepts, taking the shape of metaphors, concepts, hypotheses, or models; *(3) combination*, a process of systemizing concepts into a system, such as an educational program or a computing network; and *(4) internalization*, a process of embodying explicit knowledge into tacit knowledge. Figure 2 illustrates the conversion model and the interplay between tacit and explicit knowledge forms.

In proposition 1, we postulated that a key activity in knowledge management is the process of articulating the explicit portions of knowledge. Only the individual can perform this activity. In fact, the individual plays a much more significant role in our view, as indicated by our next proposition:

Proposition 2: Knowledge begins and ends with the individual. Therefore, knowledge management is first and foremost an activity and responsibility of the individual.

In a listing of leading knowledge management software vendors (Wainright 1998), there were numerous references to enterprise databases and corporate archives. We do not necessarily disagree with this approach. However, proposition 2 suggests an alternative functional design. In stressing the individual's knowledge management responsibility, we imply

that *the portfolio of knowledge entities should be maintained at the individual level.* Software designed for personal action management (Manheim 1998; Manheim and Medina 1999) is an example of an implementation using this functional view. This also has significant implications to the design of enterprise systems. Instead of maintaining centralized databases, the widespread approach in traditional knowledge management systems (Anderson 1998), enterprise applications may need to administer individually managed, potentially geographically dispersed portfolios. This is analogous to hypertext links implemented in World Wide Web pages (i.e., the links lead to web pages not necessarily maintained on the same server).

The third proposition states our view on the core objective of knowledge management:

> *Proposition 3: The core objective of knowledge management is to enhance the individual's capability for effective personal action.*

The general theme of this proposition is not new. This proposition was drawn from the simple principle in the management strategy literature: *enhance the ways in which people work* (Manheim 1996a, 1998).

Although we emphasized the role of the individual, we also recognize that knowledge management has organizational implications. Hence, we present the next proposition:

Proposition 4: An effective knowledge conscious organization consists of a loose network of empowered individuals - a network of empowered knowledge managers.

This proposition underlines the obvious: *the effectiveness of an organization is greatly dependent on the capabilities and contributions of individuals.* This is especially true in developing an effective knowledge conscious organization. Manheim (1998) described the need to build a "Truly Productive Organization", an organization that is committed to enhancing individual and collaborative work. Leonard-Barton (1995) argued that knowledge-building for an organization occurs by combining people's distinct individualities with a particular set of activities. Managing people's activities also imply consideration for the innovation potentials that individual actors bring to the process.

A Pattern-Based Approach

In the previous section, we imply that knowledge management is about providing empowered support to the individuals within an organization. It should enable individuals to be effective both as suppliers and consumers in the knowledge generating process. One way to support and guide personal action is through a portfolio of work *patterns* that can be rapidly instantiated and customized for implementation.

Articulating and managing patterns of work are central to our perspective on knowledge management. In addition to the initial four propositions discussed earlier, we now present additional postulates that outline the role of patterns in a knowledge management framework. The first proposition addresses the tacit dimension of previously learned ways of work.

Proposition 5: An individual's action is guided by previously learned ways of thinking and acting - i.e., previously learned 'ways of working.'

We find support for this proposition in past studies on the behavior of effective managers. Archer's (1980) study of decision making approaches by managers and supervisors indicated that more successful managers make business decisions in a multi-step process that included the development of alternative courses of action. In his study of senior executives, Isenberg (1984) observed that these managers rely heavily on a mix of intuition and disciplined analysis by which they synthesize isolated bits of data and experience into an integrated picture. They rely on intuition to perform well-learned behavior, where intuition refers to the smooth automatic performance of learned behavior sequences. Melone's (1996) research findings also revealed that senior executive's mental representation allowed for the storage and recall of familiar, previously used prototypes and analogies for problem solving.Similarly, Nonaka and Takeuchi (1995) referred to an experiential knowledge base that operators use in dealing with future activities.

The next proposition states our view regarding the explicit dimension of ways of working:

Proposition 6: The essential components of ways of working can be articulated, though imperfectly, in a structured form (i.e.,

patterns). Patterns can serve as templates that can be rapidly instantiated, customized, and re-used under different situations and contexts.

In this proposition, we postulate a pattern creation process by which tacitly known ways of working can be *externalized* into explicit forms. Its relevance to knowledge management is summarized in the next two propositions:

Proposition 7: Personal action can be enhanced by managing a portfolio of patterns that can be rapidly instantiated and customized. Management activities include articulating, sharing, discussing, archiving, recalling, and evolving patterns of work. Also implicit in the management activity are roles for group based action.

Empirical evidence suggests that individual effectiveness could be enhanced by maintaining a rich portfolio of work patterns (Manheim and Isenberg 1987). In his study of how senior managers think, Isenberg (1984) observed that managers repeatedly used well-learned behavior patterns. In a study of business decision making, Archer (1980) observed that managers, in developing alternative solutions or courses of action, tended to use

information and practices gained from experiences. Similarly, Minzberg,

Raisinghani, and Theoret noted the use or modification of ready-made

solutions in strategic decision making.

In the last proposition, we outline the individual and organizational

roles within a pattern-based knowledge management culture:

Proposition 8: Knowledge management, at the individual level,

implies the maintenance and utilization of a portfolio of patterns as

personal assets. Knowledge management, at the organizational level,

implies providing the supporting tools and institutions that can

empower individuals to effectively manage their personal portfolio of

work patterns.

In this proposition, we argue that knowledge management is primarily

the responsibility of the individual. The organization's role is to provide the

necessary institutions and infrastructure for empowered knowledge

managers to thrive.

Chapter Summary

In this chapter, we explained our perspective on the role of patterns in knowledge management through a set of propositions. The propositions were partly supported by empirical research. We believe that knowledge, at best, could be imperfectly articulated and suggested that patterns could be the surrogate entity for knowledge. We argued how pattern management and knowledge management share common objectives of enhancing the ways in which people work. We also suggested that the individual is responsible for knowledge management and that the organization is responsible for supporting an environment where empowered knowledge managers to thrive.

In the next three chapters we discuss the three case studies conducted. In addition to achieving the research objectives, we also look in these cases for empirical support for the propositions in this chapter.

	Tacit Knowledge	Explicit Knowledge
Tacit Knowledge	Socialization	Externalization
Explicit Knowledge	Internalization	Combination

Figure 2. Knowledge Conversion Model
(Source: Nonaka and Takeuchi 1995)

CHAPTER V

THE CORE CARRIER STRATEGY CASE STUDY

Introduction

In this study, we test the pattern concept through the review of a particular logistics strategy and articulate the patterns of work observed in its implementation. This is a descriptive use of the concept. We base the patterns on observations of a transportation organization, personal reflection, and the literature on the subject. This approach is also what Alexander (1977, 1979) and authors in object-oriented programming community (Gamma et al. 1995; Rising 1998) suggest for pattern development.

We present the case study in four sections. We first provide an overview of the case. Then, we provide a narrative of the case study, focusing on the pattern development. Then, we assess the case experience. We provide a summary in the last section.

Case Overview

The Core Carrier Strategy suggests that, during carrier selection, logistics organizations leverage their shipping volume to a select set of service providers. In doing so, shippers improve their negotiating positions. The strategy also refocuses the transportation management function from transactions (i.e., the mode characterized by daily determination of which carrier carries each load) to service (i.e., managing carrier performance) (Copacino 1997). Use of the strategy has the potential to reduce transportation cost and improve service (Commiskey and Kowalski 1994; Copacino 1997).

Carriers also benefit from the strategy by obtaining a larger portion of the business. Given the increased volume that they service, carriers are also given the incentive to dedicate technology and personnel to the logistics organization that would otherwise be uneconomical in lesser service volumes. The strategy is also the basis for developing partnership agreements between logistics organizations and carriers (Commiskey and Kowalski 1994; Copacino 1997; Harps 1999).

Case Narrative

In this study, we examined how the Core Carrier Strategy was implemented across various functional groups within a logistics organization. We made explicit observed ways of working by developing text descriptions of key activities related to the strategy. We also took note of the tools used in implementing the strategy. Figure 3 illustrates the patterns developed for this case study.

As implied above, the theme of the strategy is to leverage volume across a small number of carriers. We stated this theme as in the form of a proposition:

> *"Concentrate services to a select number of capable, high performing service providers."*

We examined the implications of this pattern of work to the three workgroups in the organization: the Carrier Relations Group, the Transportation Managers Group, and the Vendor Relations Group.

The Carrier Relations Group. The Carrier Relations Group is responsible for the logistics organization's interaction with the carrier. This included carrier selection and relationship management. During carrier selection, "concentrate services to a select number of capable, high performing providers" meant that the Carrier Relations Group should have the objective and judgmental basis to determine which carriers are capable and high-performing. We described below the pattern of work that members of the Carrier Relations Group followed:

"Select carriers based on management vision, financial health, operational expertise, willingness to share risks, and past performance."

We identified a number of tools that the Carrier Relations Group used in executing this pattern:

- *Financial Spreadsheet Templates.* Carrier financial models were captured in spreadsheet templates. When supplied with the appropriate information, these templates yielded indicators and measurements for evaluating the carrier's financial condition.

- *Checklist of Carrier Capabilities.* Either in paper or electronic form, this checklist identified the carrier's capability to perform tasks that logistics organizations required or anticipated. The capabilities included electronic data interchange, shipment tracking, electronic payments, and others.

- *Interview Instruments and Meeting Agenda.* In major transactions, the Carrier Relations Group, on behalf of the logistics organization, interviewed the carrier's management team to discuss the potential expanded role in the business. To maintain consistency between carrier meetings, the Carrier Relations Group used a common interview instrument and meeting agenda.

In managing the relationship between the carrier and logistics organization, "concentrate services to a select number of capable, high performing providers" implied, among other things, that the Carrier Relations Group executed the following:

"Maintain constant contact with the carrier's management team to assess operations and share emerging strategies and initiatives."

We observed two subordinate activities that resulted from this pattern of work:

- *Maintain Quarterly Quality Meetings.* Operational in nature, the quarterly meeting provided an opportunity for the logistics organization to discuss the events in the previous quarter and review plans for the upcoming quarter.

- *Regularly Conduct Executive Management Roundtables.* Organized by the Carrier Management Group, the roundtable meeting provided an opportunity for the representatives from the different carrier's senior management to meet with the logistics organization's senior management and discuss various issues.

The Transportation Managers Group. The Transportation Managers Group is responsible for the day to day operations involving transportation. Typically having regional responsibilities, each manager regularly communicated with carriers (core and non-core) to resolve transportation issues. To this group, "concentrate services to a select number of capable, high performing providers" reflected a shift of work emphasis. Given a smaller but committed carrier base, the transportation managers were

concerned less on searching carriers for particular loads and concentrated more on insuring achievement of performance goals (e.g., on-time performance). This pattern of work is reflected in the following proposition:

"Set standard and systematic measures of performance among all core carriers."

In performing this pattern of work, we observed the Transportation Managers Group used the following tools:

- *Textual Definitions and Descriptions.* Definitions and descriptions of factors to consider in monitoring carrier performance, including definition of controllable and non-controllable late deliveries, performance standards for regular lanes and performance standards for time-sensitive lanes.

- *Lists in Text Form.* The lists provided additional definitions by enumeration, such as standard list of situations that is covered under of 'Acts of God' clause in contracts and standard list of causes for carrier performance failures.

- *Policy Documents.* An example was the document on incentive programs for consistent performance.

- *Software.* Statistical process control model templates were used to monitor carrier performance.

The Transportation Managers Group communicated with carriers on a daily basis. In this activity, we observed the following pattern of work:

"Develop standard processes between partner organizations."

This pattern of work was represented in a set of procedural flow charts (potentially operationalized by workflows), including the following:

- *Communications.* Included procedures for reporting and communicating irregular operations as well as the protocol for higher-level management involvement.

- *Approvals.* Included procedures for approval of premium, emergency, and other non-routine transportation requests. The procedures also included approval limits.

- *Scheduled Discussions.* Regularly scheduled discussions with carriers and the Transportation Managers Group regarding operational issues. (weekly, monthly, and quarterly).

The Vendor Relations Group. In addition to being a shipper, the logistics organization could also be a consignee of shipments from its vendors. The strategy applied to shipments inbound as well as outbound of the logistics organization's facilities. The Vendor Relations Group is responsible for communicating the strategy and insuring its execution on the inbound portion of the freight traffic.

For the Vendor Relations Group, "concentrate services to a select number of capable, high performing providers" meant that the guidelines and support should be in place to execute the strategy among the vendor organization. One pattern of work we observed was the following:

"Develop standard processes for managing non-compliance to shipping and routing guidelines."

We observed at least two sets of tools that the group uses:

- *Procedural Flowcharts.* Outlined procedures for handling and responding to incidence of non-compliance with the strategy. Procedural templates were also available for assisting vendors in developing corrective actions.

- *Software.* Statistical process control templates were also used to monitor vendor compliance.

Between the shipper and the carrier, the shipper was responsible for forecasting the transportation assets for moving the freight. The Vendor Relations Group was in the position to provide this information for segments inbound to the facilities. The next pattern of work we identified related to this exchange of information:

"Provide transportation managers and carriers with timely forecasts of asset requirements and shipping volume."

The Vendor Relations Group used several tools in this pattern of work, including the following:

- *Schedules.* Schedules existed in either text or electronic form and were useful in gathering the most up-to-date information. Examples included sales forecasting schedules, transportation planning schedules, and vendor production schedules.

- *Software.* Transportation forecasting required the translation of freight volume forecasts into asset requirements. The Vendor Relations Group used models to perform the translation. They also used forecasting model templates, such as time series models, to develop the forecasts.

- *Directories.* A considerable amount of communication between people from various functional groups was involved in forecast development. The Vendor Relations Group maintained a directory of contacts for this activity. The different functional groups that could be involved included forecasting managers for different product lines, carrier contacts in the field, transportation manager and the vendors.

Assessment

We first review the process that emerged for developing patterns.

Then we discuss key insights and observations. We summarize the patterns

developed for this case in table 6.

Pattern Development Approach. This case study showed a

descriptive use of the pattern concept that is grounded on observations and

literature. We documented, sharpened, and refined the patterns that were

implicit or semi-explicit in the work practices that the line organizations had

evolved. In documenting and formalizing the pattern approach in this case,

we also discovered that the same approach could also be a useful strategy

for the design of a set of patterns from the start. However, we have not

tested the design approach in this case study.

The pattern development approach we took in this study had the

following steps (see also figure 7):

1. *Assess the strategy, core processes and key issues.* (e.g.,

issue: cost and service impacts of a large carrier base).

2. Develop the patterns that summarize the thrusts of the strategy or provide the theme for formulating solutions to the key issues. (e.g., pattern (thematic): "Concentrate transportation services to a select number of capable, high performing service providers.")

3. Identify the process participants or stakeholders (e.g., carrier relations Group; national transportation managers; vendor/shipper relations Group).

4. In a descriptive mode, make observations of activities that are consistent with or supportive of the thematic pattern. In a design mode, develop the set of patterns that each participant or stakeholder needs for executing the higher level pattern. For example:

Strategy: Core Carrier Program

Overall High-Level Pattern: *Concentrate services to a select number of capable, high-performing service providers.*

Pattern for Carrier Relations Group: *Select carriers based on management vision, financial health, operational expertise, willingness to share risks, and past performance.*

Pattern for Transportation Managers Group: *Set standard and systematic measures of performance among all core carriers.*

Pattern for Vendor Relations Group: *Develop standard processes for managing non-compliance to shipping and routing guidelines.*

Under a design mode, there is a fifth step that we propose to be a part of the process. To our knowledge, this fifth step was not implemented in the subject organization.

5. *Deploy, monitor, and evolve the work patterns.* The work patterns should evolve with the ever changing nature of the problem and the business environment.

Observations and Insights. We observed that patterns suggested action in two ways. Some patterns provided "themes" for developing lower-

level patterns of work. A good example is the high level pattern of work for the Core Carrier Strategy (i.e., "Concentrate services to a select number of capable, high performing service providers."). As part of the pattern's interpretation and implementation, new patterns of work that were more relevant to each work group emerged.

Some patterns were more specific in the action it suggests. These patterns defined in more detail the suggested actions, as in, for example, the specific procedure or method on how to solve a particular problem. Implementation templates and tools were more important components in patterns of this type.

The patterns and implementation forms we identified in the study formed a hierarchical set, where we observe operational (lower level) patterns of work suggested how high level, thematic pattern could be executed. The set formed a cluster of patterns - a group of inter-related patterns partially structured together by a common theme to form a transient process. As shown in figure 3, the pattern cluster went across various groups within the logistics organization.

From the strategy perspective, the evidence of a clustering

phenomena for patterns is significant. The success of strategy

implementation is dependent on people's ability to translate strategies into

action. In order to be effective, people within an organization must interpret,

understand and execute the strategy consistent with the strategy's intent

(Manheim 1998, 1999). *The cluster in figure 3 demonstrated how patterns*

could be used to develop a consistent understanding of the strategy's

message across multiple levels of the organization. In executing the strategy,

each level of the organization could apply a subset, an interpretation, and/or

an instance of the patterns as it related to their individual areas of influence.

We concluded that patterns could support effective strategy

implementation by providing guides to thinking and acting at multiple levels of

the organization. By sharing a common set of patterns, the organization

shared the underlying strategy message.

Chapter Summary

In this chapter, we examined a logistics strategy ("Core Carrier

Strategy") and identified the key patterns of work related to its

implementation. We developed the patterns from the perspective of three operating groups within the logistics organization.

The case study demonstrated a practical application of the pattern concept in a descriptive mode. The results also suggested new insights. In addition to identifying task-relevant patterns, we also observed inter-relationships between the patterns. On one perspective, the pattern set was hierarchical, where lower level patterns provided the detailed implementation of higher level patterns. We also observed that the patterns could be structured in clusters, where each cluster represented a working group's ways of working that were relevant to the strategy.
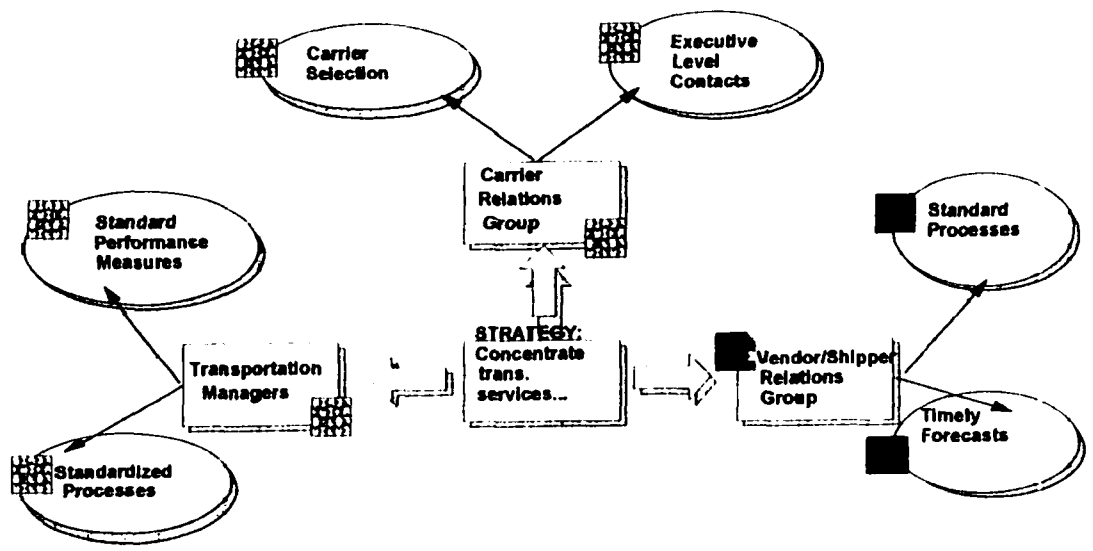
Figure 3. Core Carrier Strategy Patterns

Pattern:
- **(A) Select carriers based on management vision, financial health, operational expertise, willingness to share risks, and past performance.**
- **(B) Maintain constant contact with senior management of carriers to share emerging strategies and initiatives.**

Pattern (A):
- → Spreadsheet templates to evaluate carrier financials;
- → Checklist of carrier capabilities (EDI, shipment tracking, electronic payments, etc.);
- → Interview instrument as a starting point of discussions with carrier senior executives;
- → Regression models for cost estimation..

Pattern (B):
- →Quarterly quality meetings;
- →Management roundtables;
- →Monitoring and opportunistic scheduling (e.g., conferences, trade shows).

Carrier Relations Group

Figure 4.
Patterns for the
Carrier Relations Group

Pattern: ▪ **(A) Set standard and systematic measures of performance among all partner carriers.**

▪ **(B) Develop standard processes between partner organizations.**

Pattern (A):

→ Standard list of situations that is covered under of 'Acts of God' clause in contracts;

→ Standard list of causes for carrier failures.

→ SPC model templates for monitoring carrier performance.

→ Incentive programs for consistent performance.

Transportation Managers

Pattern (B):

→ Procedures for reporting and communicating irregular operations;

→ Procedures for approval of premium and other non-routine transportation requests;

→ Regular discussions regarding operational issues (weekly/monthly/quarterly).

**Figure 5.
Patterns for the
Transportation Managers
Group**

Pattern: ■ (A) Develop standard processes for managing non-compliance of shipping and routing guidelines.

■ (B) Provide transportation managers and carriers with timely forecasts of shipping volume.

Pattern:

→ Procedures for handling and responding to non-compliance incidents.

→ Assessment templates for assisting vendors in developing corrective actions.

→ SPC templates for measuring compliance.

Vendor/Shipper Relations Group

Pattern:

→ Activity schedules.
→ Directory of contacts.
→ Data filtering model.
→ Time series model templates
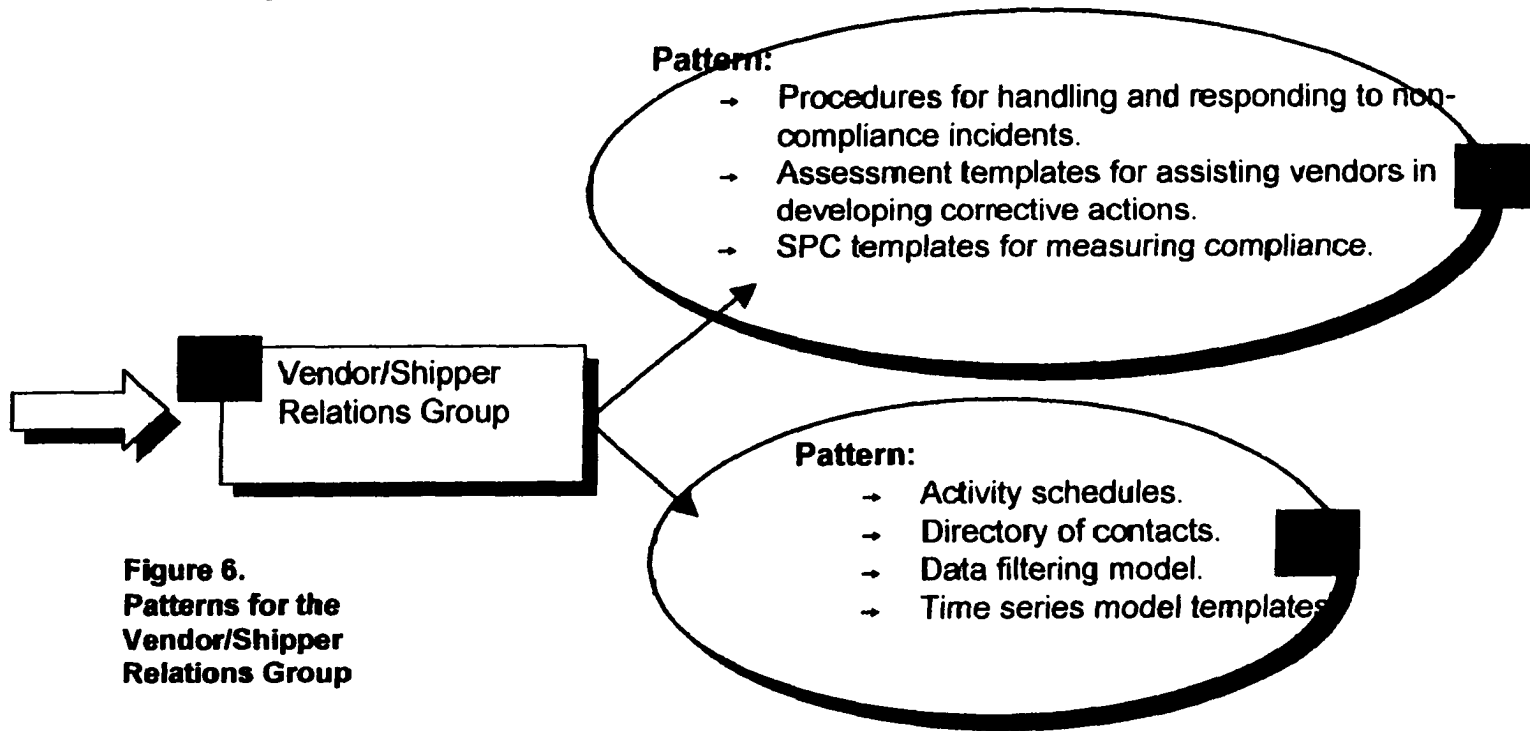
**Figure 6.
Patterns for the
Vendor/Shipper
Relations Group**

80

Strategy Assessment

> Assess the strategy, *core* process(es) and key issue(s).

Pattern Formulation

> Develop the pattern that summarizes the thrust of the strategy.

> Identify the process participants or stakeholders

> Formulate the set of patterns that each stakeholder can use to execute the higher level pattern.

Pattern Evolution

> Deploy, monitor, and evolve the work patterns.
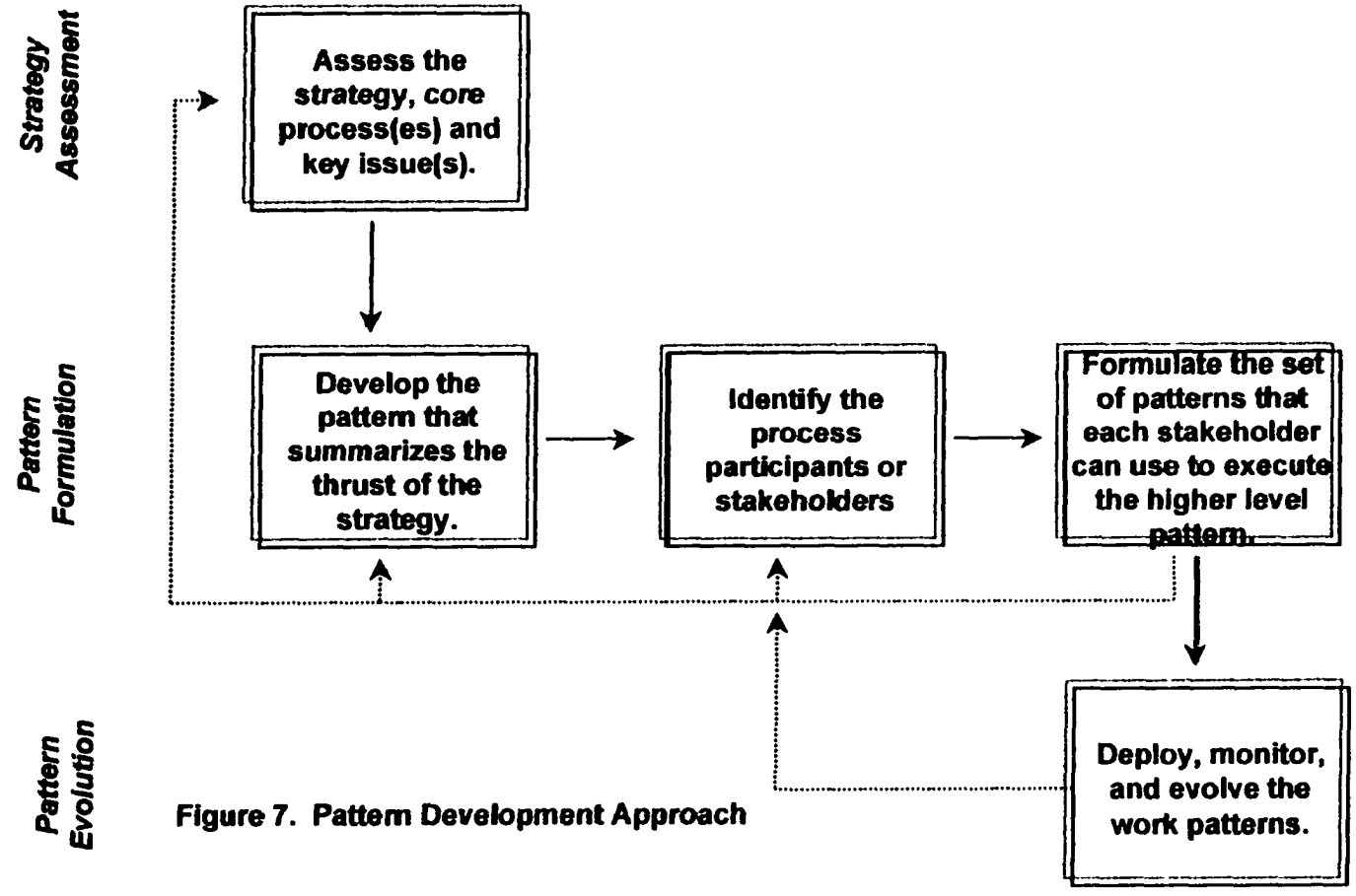
Figure 7. Pattern Development Approach

| Work Group	Pattern	Content Type	Implementation Form
ALL	Concentrate services to a select number of capable, high performing service providers.	Proposition.	Text
Carrier Relations Group	Select carriers based on management vision, financial health, operational expertise, willingness to share risks, and past performance.	Financial models, checklists, instructions, interview instruments, and meeting agenda.	Text (paper and electronic), spreadsheets, documents.
	Maintain constant contact with the carrier's management team to assess operations and share emerging strategies and initiatives.	Proposition.	Text
	Maintain Quarterly Quality Meetings	Meeting agenda, directory of contacts	Text
Transportation Manager's Group	Regularly Conduct Executive Management Roundtables.	Meeting agenda, directory of contacts.	Text
	Set standard and systematic measures of performance among all core carriers.	Performance factors, operating policies, statistical process control models.	Text, lists, documents, software
	Develop standard processes between partner organizations.	Instructions, procedures, agendas.	Text, procedure manual (paper and electronic)
Vendor Relations Group	Develop standard processes for managing non-compliance to shipping and routing guidelines.	Instructions, procedures, statistical process control models.	Text, procedure manual (paper and electronic), software
	Provide transportation managers and carriers with timely forecasts of asset requirements and shipping volume.	Schedules, directories, forecast models.	Text, procedure manual (paper and electronic), software

Table 6. Summary of Patterns Developed for the Core Carrier Strategy Case Study

CHAPTER VI

THE WAREHOUSE MANAGEMENT SOFTWARE

COMPANY CASE STUDY

Introduction

In this chapter, we discuss a field application of the pattern concept. In collaboration with a logistics software provider (referred in this chapter as Warehouse Management Software Company or the WMS Company), we used the pattern concept to implement components of a product strategy. A three-person research team from Northwestern University worked with senior executives and operations managers from the WMS Company for a period of six months.

We present the case study in four sections. We first discuss the overview of the case. Then, we provide a narrative of the case study, focusing on the pattern development. Then, we assess the case experience. We provide a summary in the last section.

83

Case Overview

A product of a recent merger, the WMS company is a provider of global supply chain execution software. It is a major player in the software field of enterprise-wide inventory and warehouse management, with $60M to $90M in sales at the time of the study. Its product offerings run on multiple computing platforms and its customer base cross industry lines. During the period of study, the WMS company had more than 600 installations with 625 employees worldwide. They operated in North America, The Middle East, Europe, and Asia.

Over the years, there was an increased awareness across industries of the value of logistics. Logistics had become essential to the growth and profitability of various business units. This resulted in increased expectations from logistics software providers like WMS Company. For instance, WMS Company's customers were more demanding and critical of the systems that supported the logistics functions. The same customers developed supply chain partnerships that demanded an extended enterprise view and required integrated solutions. In addition, the technological environment was also

rapidly evolving, from the computing platforms that WMS Company's products were installed to the systems that these products interacted.

In response to industry pressures, WMS company developed a vision of creating a unified, scalable, enterprise-wide solution capable of running on multiple platforms and interoperable across platforms. Based on this vision, WMS company designed an overall strategy of migrating its product line to a single product offering that would incorporate the best features and functions from all existing systems (see figure 8).

According to senior management, there was also a need to redesign WMS Company's processes. In addition to providing the software, WMS Company was also involved in installing and configuring the product for its customers. The WMS Company typically implemented its products in coordination with multiple products from other software vendors. Integration implied complex messaging protocols and extensive system interface development (see figure 9). However, there was no organized effort to document what was learned from each customer engagement. As a result, extensive customization and re-invention was common during software implementation.

The WMS company considered the management of organizational knowledge as a key to implementing its product strategy. The WMS company also recognized that its organizational knowledge is embedded in the methods and practices employed in product deployment. Hence, *managing knowledge at the WMS company implied managing people's ways of working with the software product line.* This was the basis of using a pattern-based approach to implementing the product strategy.

Case Narrative

The objective of the project with the WMS Company was to develop explicit patterns of work that reflected the key elements of the product strategy. From a research perspective, we also wanted to document the pattern development process that emerged out of the case experience.

We initiated the study by fully understanding the WMS company's product strategy and the fundamental issues that the company wanted to address. After a series of discussions with the WMS company's senior management, we formulated the following four patterns that reflected the themes for implementing the strategy:

1. Clarify and structure the selling and implementation

process.

2. Accurately assess the needs of potential clients at each

stage of the fulfillment process.

3. Manage knowledge about interfaces between systems.

4. Develop mechanisms for sharing knowledge among

relevant groups.

We examined each of the patterns above and formulated patterns that

were more specific regarding the actions to be taken (this hierarchical set of

patterns is illustrated in figure 10). In pattern (1), we recognized the

importance of creating a common view of the core selling and

implementation process. The result was the mapping of a four-step product

delivery process (see figure 11).

In pattern (2), we expressed the importance of the interactions with

the customer during the product delivery process and identified customer

information that was relevant and feasible to collect at each stage in the process.

In pattern (3), we examined the relationship of the WMS Company product with the different internal systems of a customer. As an outcome, the WMS Company defined the requirements for data exchange between systems, identified vendor products that customers commonly use, and developed the templates for coding the data exchange between software modules. Subsequently, the company organized a team responsible for managing this process.

For pattern (4), we examined the alternatives for sharing these and other developments. We identified electronic discussions and an electronic library of model implementations as possible mechanisms.

We also examined how the WMS Company could deploy these patterns to the organization. One way was to present the patterns as operating principles for the managers. The second method was to use the pattern set as functional specifications for the development of software for managing the product delivery process. The WMS Company chose to do both.

As part of the study, we implemented a prototype of the software in Lotus Notes. The application covered three functional areas:

1. Customer Assessment: This application area focused primarily on guiding the collection of customer information. It was comprised of forms and checklists that solicited relevant information at each stage of the product delivery process. This application also included modules for tracking the evolution of a customer and evaluating of their technical requirements as status changed from lead to active.

2. Interface Dialogues: Interface dialogues were function and format specific messaging between the WMS Company's product and the customer's internal systems. This part of the software application maintained a library of standard implementation templates of interface dialogues. Support for version control and discussion was also incorporated in this application.

3. Experience Repository: Similar to an experience library, this application served as a reference during system design and

implementation. The repository was to contain past implementations that could serve as models for future projects. The repository was also intended as a research tool that the WMS Company could use to leverage the organization's experience.

Assessment

We present the assessment of the case experience in two parts. First, we examine the process we took in developing patterns for the WMS Company. Then, we review the key insights regarding the concept that was generated from the study. The patterns developed in this study are summarized in table 7.

Pattern Development Approach. In this case study, we took a three-staged approach to pattern development:

1. Process and Issue Surfacing:

1.A. Review the vision, the overall business strategy, and the strategy elements. The WMS company's vision was to develop a unified solution across industries. The strategy was directed towards evolving

the software line to a single product that was "the easiest software to use." The WMS Company also made explicit the key elements of its business strategy.

1.B. Identify the core processes. The process could be existing or yet to be developed. After a series of discussions with the WMS company's management, we developed a model that represented the WMS company's product delivery process.

1.C. Review each stage in the process and determine the key issues relative to the strategy. We examined the relationship between the strategy elements and the core process. For example, one issue in product installation was that the procedure was oftentimes customer specific and had the tendency to drive high levels of customization of the software. We addressed the question of how lead qualification (a process stage) could expedite product implementation (a strategy element). We also identified the main stakeholder groups that were primarily involved at each process stage.

2. Pattern Development:

2.A. Formulate themes for addressing the issues. The thematic patterns represented the 'solution guides' to addressing the key issues. For example, one issue was regarding implementation delays due to unexpected complications in interface development. To address this issue, we developed the following thematic pattern: *"Appropriately assess the needs of potential clients and customers at each stage of the selling and fulfillment process."* This pattern suggested the systematic collection of interface-related information during the fulfillment process.

2.B. Assess the themes and develop patterns that are more operational and provide more specific directions. This allowed for a more consistent interpretation of the initial themes. In this study, we formulated a hierarchical set of patterns that served as working principles for the managers and as functional specifications for the development of the software application.

2.C. Identify and assess deployment methods. Deployment methods depended on what final form the patterns took and how we expected the patterns to be put to action. In this study, the patterns took

the form of propositions in text and diagrams. The software application represented the tool we envisioned for executing the patterns.

3. Organizational Acceptance and Deployment:

3.A. Present the patterns to the stakeholders within the organization for discussion and feedback. Organizational acceptance was a key component of deployment. The patterns we developed were presented to the WMS Company's management team during a strategy meeting.

3.B. Given acceptance, implement, monitor, and possibly evolve the patterns. Given the time constraints, we were not able to perform this final step. In this study, the WMS Company took responsibility for this task.

<u>Observations and Insights.</u> The WMS Company case study was a first attempt at using the pattern concept in a deliberate process of supporting business strategy implementation. There were two significant outcomes of this particular research engagement:

(A)   Demonstrated use of patterns in strategy

implementation: We formulated a set of patterns for implementing the

WMS company's product strategy. These patterns were the basis for

developing a software application for managing the company's

product delivery process and for organizing a team primarily

responsible for maintaining interface competency. By accomplishing

this, *we demonstrated how the pattern concept could be effective as a*

tool to translate strategy into action.

(B)   A field-tested, structured process for pattern formulation:

Another outcome of this research effort was a structured process for

formulating work patterns. Unlike the one used in the Carrier

Management case study, this process emerged under field settings

After the study's conclusion, a senior executive of the WMS Company

acknowledged the contribution of using the pattern concept. According to the

senior executive, the implementation of the concept had a significant impact

on the company's bottom line. However, he did not mention exact

measurements.

Given company sponsorship of the project, one may argue about the bias of such claims of effectiveness. The research team did not have the resources to measure pre-and post intervention effects. Also, as the business environment was dynamic, there were multiple initiatives occurring simultaneous to our intervention. It would have been difficult, at best, to isolate the direct effect of the intervention on costs and performance.

Our research hypothesis was that the pattern concept is an effective tool for strategy implementation. There were two alternative ways to validate the hypothesis. We could assess the hypothesis by identifying and reviewing two types of indicators: (1) surrogate indicators supporting the hypothesis; and (2) indicators that support a rival hypothesis (i.e., the implementation of the pattern concept did not have a substantial impact). In the case study literature, the investigation of rival outcomes is considered an acceptable and valid evaluation method whenever direct measures are unavailable (Layder 1993; Yin 1994).

In addition to senior management testimony, the surrogate indicators that supported the hypothesis included relevance of the intervention and acceptance of the concept within the organization. The patterns continued to be relevant to the WMS company's business. The prototype software was

eventually integrated into the internal support system that guided how the company staff engaged the customer during the product delivery process. Organizational changes also resulted from the process (i.e., formation of the 'Interface Competency Team').

Indicators that supported a rival outcome included no perceivable action taken regarding recommendations, implementation of business processes that are contrary to recommendations, and negative impact on the internal champion's position within the organization. We had not observed any instances of these indicators. The senior executive who sponsored the study continued to hold his position for a significant period of time after the study.

Chapter Summary

In this chapter, we discussed a field application of the pattern concept. Together with a Warehouse Management Software Company, we formulated patterns for implementing the company's product strategy. The patterns served as working principles for line managers. The patterns were also used as functional specifications for the development of a prototype application

that guided strategy implementation. We also reviewed the three-staged pattern development approach used in the study.

Providing quantitative measures of effectiveness was neither feasible nor practical in this case. Instead, we sought surrogate indicators. Three indicators suggested that the intervention added value: (1) the positive testimony of a WMS Company senior executive, (2) the software prototype was integrated as a corporate application, and (3) organizational changes consistent with our recommendation were implemented.

Thematic Pattern	Operational Pattern	Content Type	Implementation Form
Clarify and structure the selling and implementation process.		Proposition	Text, diagrams
	Design the core process as a value chain of activities	Process design, user interface navigators	Text, diagrams, Software
	Assess the roles of the stakeholders in the process	Assessment tools, stakeholder archetypes.	Text, diagrams
Assess the customer needs at each stage of the fulfillment process		Proposition	Text, diagrams
	Assess the customer needs while at the pre-sale stage.	Requirement information	Text, forms, check lists
	Assess the customer needs during the sales process	Requirement information	Text, forms, check lists
	Assess the customer needs during implementation	Requirement information	Text, forms, check lists
	Evaluate the risks for pursuing a lead	Methods, general information	Text, diagrams
Manage knowledge about interfaces between systems		Proposition	Text, diagrams, forms
	Define the dialogue interface requirements.	General information, specifications, rules	Text, diagrams, forms, software
	Identify complementary vendors and applications	Listings, general information	Text, diagrams, forms, software
	Develop templates for interface implementations	Software implementation templates, background information, client history'	Text, diagrams, forms, software
	Create the responsible team.	Qualifications	Text, diagrams
Develop mechanisms for sharing knowledge among groups		Proposition	Text, diagrams
	Use electronic discussions	Functional requirements, general information	Text, diagrams, forms, software
	Develop a library of model implementations	Functional requirements, general information, specifications	Text, diagrams, forms, software

Table 7. Summary of Patterns for the Warehouse Management Software Company Case Study

Elements Of WMS Company's Product Strategy

Evolve Existing Products	Facilitate Inter-Operation	Build Component Systems	Provide Dynamic Inventory Mgt	Support Distributed Operations & Open DB's	Expedite And Simplify Installation

Figure 8. Elements of the WMS Company's Product Strategy

Figure 9. Messaging Between Business Processes

Vision: Develop A Unified, Scalable Product That Incorporates The Best Functions And Features Of Existing Systems

STRATEGY ELEMENTS

| Evolve Existing Products | Facilitate Inter-Operation | Build Component Systems | Provide Dynamic Inventory Mgt | Support Distributed Operations & Open DB's | Expedite And Simplify Installation |

THEMATIC

| Clarify & Structure The Selling & Implementation Process | Assess Customer Needs At Each Stage Of The Fulfillment Process | Manage Knowledge About Interfaces Between Systems | Develop Mechanisms For Sharing Knowledge Among Groups |

PATTERNS

OPERATIONAL

| Design the core process as a value chain of activities | Assess Needs While In Pre-Sales | Define The Dialogue Interface Requirements | Use Electronic Discussions |

| Assess the roles of stakeholders in the process | Assess During The Sales Process | Identify Complementary Vendors & Apps. | Develop A Library Of Model Implementations |

| | Assess During Implementation Planning | Develop Templates For Interface Implementations | |

Figure 10. The WMS Company's Pattern Set

| | Evaluate Risk For EXE In pursuing a lead | Create Responsible Team (Interface Competency Team) | |

101

Issue Surfacing

| Review the vision, the overall business strategy, and the strategic thrusts. | → | Identify and map out the key process(es) | → | Review each stage in the process and determine the key issues relative to the strategic thrusts |

Pattern Development

| Develop the initial set of work patterns that reflects the themes for addressing the issues | → | Develop action-focused work patterns that will guide the implementation of the business strategy |

Organizational Acceptance & Deployment

Figure 11. Pattern Development Process: The WMS Company Case Study

| Present the patterns to the stakeholders within the organization for discussion and feedback | → | Given acceptance, implement, monitor, and update the patterns. |

102

CHAPTER VII

THE LOGISTICS NETWORK ANALYSIS AND

DESIGN TRAINING CASE STUDY

Introduction

Logistics network analysis and design (LNAD) involves the

mathematical formulation of a company's logistics processes and network

infrastructure. Vendors, facilities, and customers are represented as nodes

in the network connected together by transportation links. Manufacturing,

material handling, and other processes are also represented as

mathematical functions. The network model is used to support strategic and

tactical decision making, such as determining:

- the number and location of plants, warehouses, and
other facilities;
- the optimal sourcing of raw materials; and
- the economically efficient market territories and service
areas.

Optimization algorithms are used to solve for the network arrangement that provided minimum cost or maximum profit.

In this chapter, we discuss how we used the pattern concept to support a one-on-one training program. The overall goal of the training was to improve the expertise of a newly hired manager in performing LNAD. Our research objectives were two-fold:

- To identify patterns in the analytical domain of logistics work

- To test the usefulness of the concept as a logistics training tool.

As with previous chapters, we present this study in four sections. We start with an overview of the case. Then, we provide a narrative of the case study, focusing on pattern development. In the following section, we assess the case experience. We provide a summary in the last section.

Case Overview

A manufacturing company retained our services to provide LNAD training for a newly-hired manager. The researcher previously provided consulting services to the company in a number of strategic and tactical logistics network projects. The manager's position was created to develop in-house the capabilities that the researcher was providing to the company on a consulting basis. The objectives of the training program (see table 8 for the excerpt of the proposal letter) was to enable the manager to:

- Understand supply chain concepts in relation to network analysis;

- Understand previous supply chain projects and be familiar with the models and the supporting data bases;

- Be in a position to participate as a productive member of the manufacturing company's analysis team in future network design projects.

From a technical standpoint, the training program had to cover specific topics in network analysis. However, since part of the training's objectives was to rapidly familiarize the manager with the company, a substantial

portion of the training time spent was also dedicated to discussions of the business practices and emerging business issues within the manufacturing company. This was reflected in patterns that we developed.

Patterns were not originally part of the training agenda. However, after preliminary discussions, the manager agreed to include patterns as part of the training program. Patterns were defined simply as ways of working made explicit. There was no agreed upon structure for patterns nor were there attempts on our part as a researcher or the part of the manager to prepare patterns beforehand. The patterns were to be purely a product of the discussions. In addition, if the process of pattern development impeded the attainment of our training objectives, we would stop its use.

We took the approach of documenting apparently useful patterns in analytical work as they emerged during the course of the technical training and discussions. At the end of the training, the patterns were compiled as part of the training notes. The objective was to use the patterns as reminders and guide to analyzing the company's logistics network in the future.

Case Narrative

The training program followed a specific agenda (see table 9). We met with the manager for seventeen days over a period of three months. During each session, we reviewed specific topics in network analysis. Whenever appropriate, we took notice of patterns of work that we both judged of value and non-trivial. Patterns were written on a flip chart and summarized after each session. At the start of each session, we also reviewed patterns identified in the previous session. In between sessions, the manager attended to his day-to-day responsibilities with the company.

We organized the patterns identified in the study and classified them under the following five pattern clusters:

(1) Project Planning. Project planning patterns guided activities to be performed prior to or at the start of each network analysis project. The patterns we developed in this category included the following:

"Clearly articulate the scope and boundaries of the project." The template for this pattern is a checklist of questions for assessing the project, including the following:

- What questions are we trying to answer?

- What questions are out of scope?

- What are the deliverables?

- What are the measures of project success?

"Identify principal stakeholders and obtain (as well as maintain) buy-in." Because of the nature of the decisions it influences, network analysis projects involve and affect a broad set of stakeholders across the organization. Archetypes include the following:

- *Client or Decision Maker.* Determines the scope of the project.

- *Data Owner / Gatekeepers.* Validates data and its context.

- *Operations Expert.* Assesses the representation of the existing network.

"Perform a high-level assessment of the current network." The assessment could significantly influence the breadth of the model (e.g., how to aggregate products in the logistics network, what segments of the supply chain to omit).

"Use a network analysis project template to guide project

planning." The template contained the general activities for

developing a network analysis project plan (see figure 11).

(2) Presentation. In logistics network projects, a significant portion of

the work-load involved presentations and discussions with various

stakeholders, such as to provide an overview of network modeling, to request

data, or to summarize results. The following patterns related to presentation

were identified:

"Develop templates for communicating the scope of the

project." Templates for this pattern included:

- Schematic chart of the supply chain.

- Data collection diagrams.

- Maps of customers, facilities, competitors.

"Communicate results from different perspectives."

Stakeholders had shown interests in different aspects of the analysis.

For instance, senior management looked for executive summaries and

business perspectives while people with operational and technical

responsibilities emphasized methodologies. Data sources and its

validation were important to both in varying degrees. Presentation

methods that had been effective in previous engagements included:

- Pareto analysis.

- Top 25 / 50 / 100 (e.g., customers, vendors,

service providers, products).

- Map of pockets of high demand.

- Density maps and other visual means of

displaying demand distribution.

"Maintain templates for summarizing results." Portions of the

results of logistics network optimization were well-defined and suitable

for template tables, as illustrated in figure 13.

(3) Roles and Relationships. In addition to the technical aspects of

network analysis modeling, we also identified patterns of work specifically

related to the manager's position. In retrospect, we discovered that these

patterns were also applicable to contexts other than network analysis.

"In discussions with management from subsidiaries, be familiar with their operations and be receptive to possible opportunities." This pattern reflected expectations on the manager's level of contact and exposure within the company.

"Keep communication channels open by providing regular updates. Develop a template for project updates." Table 10 provides a template of an update document that includes information requested in past projects.

"Manage the expectations of participants and stakeholders." This pattern is similar to Manheim's (1999) stakeholder assessment pattern. Assessment of stakeholder needs and expectations are key components of the manager's role in the projects. We identified stakeholder archetypes and possible approaches, among which were:

- *Client / Sponsor:* Keep them updated regularly; schedule weekly update meetings; use a template document for regular updates, so they see the same format every time.

- *Decision Maker:* May use the same approach as in client/sponsor. The decision maker may be provided with less frequent updates at the start of the project and more frequent updates in the later phases.

- *Data Owners / Gatekeepers:* Speak their language. Know their reporting relationships and find ways to make their participation beneficial to them personally.

- *End-user / Consumer:* make sure you ask their opinion on the project. Articulate their needs and insure that those needs are explicitly addressed by the project objectives.

- *Subject Matter Experts.* People who have approval authority over methods and data interpretations. Harness their expertise and be aware of their reporting relationships. Develop the presentation templates in a form that they can easily understand.

- *Consultants / Service Providers:* Establish a relationship and clearly identify their role and stake in the project.

- *Nay Sayers / Skeptics.* Avoid arguments. Present your case based on facts and well accepted methodologies. Use the project's potential value as a way to counter internal resistance. Evaluate the value of their active participation. Look for their underlying concerns, which they themselves may not be explicit about.

- *Supporters / Champions:* Solicit their input and ideas.

(4) Technical Subjects. The patterns related to technically-oriented activities of LNAD fell into this category. We identified the most number of work patterns in this category. The patterns addressed activities in data management, cost estimation, model formulation, and scenario analysis. The patterns we identified included the following:

"Create a data inventory checklist." The checklist could vary slightly depending on the software tool used.

"Use a (computer) directory structure that reflects the components of the network model." The directory structure separated the data files related to the different network entities (e.g., facilities, demand, transportation costs, processes, products, scenarios, etc.).

"Use a template model for calculating demand based on usage rates." We introduced an industry-specific template model for calculating the usage rate for the manufacturing company's products.

"Maintain a set of models for estimating transportation, facility operations, and other cost elements." Regression models could be used to estimate logistics costs based on transaction data.

"Be aware of the factors that affect the network model's complexity." In their order of influence, these factors include the number of open/close decisions (exponential), the number of links (linear), and the number of tiers or levels in the supply chain. When simplifying a model, one should consider these three factors first.

"Consider the upper and lower bounds in developing

scenarios." Developing upper and lower bound scenarios could

provide insight into the behavior of the network model and assist in its

validation. For example, in a service sensitive network, consider

comparing the lower bound or tightest constrained scenario with the

upper bound or loosest constrained scenario.

(5) General Guidelines. Based on the manager's background and

experience, we also identified general guidelines and principles. These

patterns of work were personal in nature and included the following:

"Follow principles from experience in the military." The

manager shared the following working principles:

- A leader's primary job is to identify and formulate
objectives of the effort.

- To successfully lead a group, there must be a
consensus on the objective.

- There has to be unity of effort.

- The root of failure: uncoordinated attack/defense;

weak points in organization.

- Coordination is important.

Assessment

We present the assessment of the case experience in two parts. First, we examine the approach we took in pattern formulation during the training program. Then, we review the key insights that emerged from this study. Table 11 summarizes the patterns developed for this case study.

Pattern Development Approach. The approach taken in this study differed from the previous cases. We took an *opportunistic approach* to pattern development; i.e., during the course of the training, we formulated patterns as we encountered relevant ways of working.

We did not adopt a formal pattern development methodology for the study. However, we maintained awareness for patterns while engaged in the training program and developed patterns as the opportunity arose. At each task or procedure encountered, we articulated the problem being solved and the business issue being addressed. Whenever applicable, we also identified

the specific actions, models, or methodologies involved in each task.

Whenever we encountered a specific solution (e.g., transportation cost model

using linear regression), we stressed the general approach (e.g., cost

estimated in two components - fixed and variable). We also used a

discussion of patterns of work as a way to summarize each phase of the

training program.

Observations and Insights. In this study, we demonstrated how a set

of patterns could represent ways of working in LNAD. In addition to the

analytical patterns, we also revealed relevant ways of working in the areas of

project, change, and relationship management.

The role of the researcher in this case study was that of a catalyst-

facilitator. In this role, the researcher elicited, crystallized, and documented

the technical, social, and managerial aspects of LNAD. The catalyst-

facilitator could be a key role in a knowledge-conscious organization.

There were other aspects of this study that made it unique compared

to previous cases. The study was not about strategy implementation. This

study was an example of how the pattern concept could be integrated in an

operational process. Unlike in previous studies, pattern development was a background activity in this study and subsidiary to the training activity.

The manager's response and the sustained use of the concept throughout the program indicated that patterns were helpful in achieving the training objectives. Patterns essentially became one of the tools used in documenting the training sessions. Patterns were also used to summarize key concepts at each stage of the program. However, given the narrow scope of this study, we could not make further generalizations regarding the concept's effectiveness in training.

We developed patterns in this study without giving explicit attention to clusters (i.e., a logical grouping of patterns with a common theme; the concept of pattern clusters was introduced in the previous case studies). The opportunistic approach lent more to identifying individual, task level patterns. However, after a review, the patterns we identified fell into natural clusters, as shown in the case narrative.

Chapter Summary

In this chapter, we discussed a case where we integrated pattern development with a training program for Logistics Network Analysis and Design (LNAD). We took an opportunistic approach that involved formulation of patterns as relevant ways of work were encountered during the training program. In addition to analytical tasks, we also identified patterns on project and relationship management. As with the previous studies, we also observed how patterns fell into clusters. In this study, we also demonstrated how a set of patterns could represent the various activities involved in LNAD.

Date, 1998

Mr. ------------------------------
Vice President - Supply Chain
Supply Chain Group
MFG Company, Incorporated
9999 N. Street
Anytown, State 12345

Mr. -------:

----------- is pleased to submit this proposal for Network Analysis Training. The goal for the project is to develop and conduct a training program to enable Mr. Manager to:

- Understand Supply Chain concepts in relation to Network Analysis;
- Understand previous MFG Company supply chain projects and be familiar with the models and the supporting data bases;
- Be in a position to participate as a productive member of the analysis team in future network design projects.

We propose a fixed fee of $X, plus direct costs related to travel expenses, estimated at $Y. The fixed fee covers on-site training as detailed in the attached schedule and as-needed telephone support over a period of nine weeks. Please find enclosed a detailed cost estimate and a proposed work calendar.

We appreciate the opportunity to present this proposal and look forward to your response. If you have any questions, please do not hesitate to call.

Sincerely,

B. Benjamin V. Medina
Consulting Company

Table 8. Excerpt from the Training Proposal Letter

Network Analysis Training For Manufacturing Company
Training Agenda

1. Kick-Off
   Goal Setting
   Opportunity Assessment

2. Overview: Supply Chain Network Modeling
   Concepts and General Approach
   Decision Support Tools
   Project Management

3. Data Collection
   Data Management
   Data Sources

4. Subsidiary Techniques and Models
   Scenario Development and Evaluation
   Demand Models
   Transportation Cost Models
      Truckload
      Less-Than-Truckload
      Ocean
      Pick-Up And Delivery
   Facility Cost Models
      Manufacturing Plant
      Warehouse
   Inventory Cost Models
      Raw Materials
      Finished Goods

5. Review Of Past Projects
   Project 1
   Project 2
   Project 3

6. Model Building
   Best Practices
   Goal Evaluation
   Opportunity Assessment

Table 9. Training Program Agenda

Logistics Network Strategy Project

Weekly Project Report

Period: From XX To XX, 1998

Project Objectives:

Project Schedule:

Baseline Completion Date	Weeks Ahead or (Behind)	Estimated Completion Date

Plan Completion, as of this pd.	Actual Completion, as of this pd.	Variance

Remarks:

Project Budget:

Budget Hours	Plan: [This Pd] / [To Date]	Actual: [This Pd] / [To Date]	Variance %

Travel Expense Budget $	Planned, as of this period	Actual, as of this period	Variance %

Remarks:

Highlights This Week:

•

Issues, Action Items, and Other Comments:
•

Planned Schedule Next Week:

## Table 10. Weekly Progress Report Template
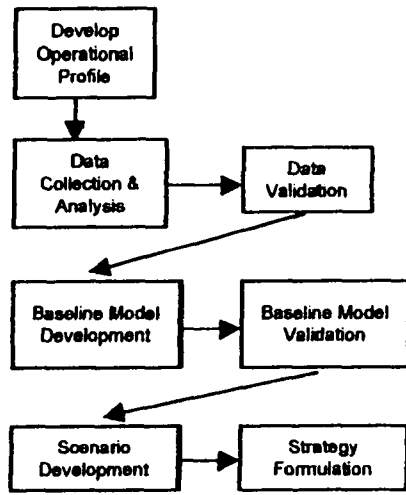
Figure 12. Template Project Plan For LNAD

Cost Category	Scenario A
Inbound Transportation	$
Interplant Transportation	$
Outbound Transportation	$
Sub-Total Transportation	$
Fixed Costs	$
Variable Costs	$
Handling Costs	$
Duties Paid	$
Inventory Carrying Costs	$
In-Transit Carrying Costs	$
Sub-Total Operating Costs	$
Total Suppy Chain Costs	$

Figure 13. Template Table for LNAD Results

Category	Pattern	Content Type	Implementation Form
Project Planning	Clearly articulate the scope and boundaries of the project	Checklists, questions	Text, diagrams
	Identify principal stakeholders and obtain (as well as maintain) buy-in	Stakeholder archetypes, roles	Text, diagrams
	Perform a high-level assessment of the current network	Questions, general information	Text, diagrams
	Use a network analysis project template to guide project planning	Project plan	Text, diagrams, software
Presentation	Develop templates for communicating the scope of the project	Schematics, data flows, maps, general information	Text, diagrams, presentation slides
	Communicate results from different perspectives	Stakeholder archetypes, presentation models, visual aids	Text, diagrams, presentation slides, software
	Maintain templates for summarizing results	Spreadsheets, maps	Software, diagrams
Roles and Relationships	In discussions with management from subsidiaries, be familiar with their operations and be receptive to possible opportunities	General information, anecdotes	Text, diagrams
	Keep communication channels open by providing regular updates. Develop a template for project updates	Reporting techniques, general information	Text, diagrams, forms, software
Technical	Manage the expectations of participants and stakeholders	Stakeholder archetypes, roles, action plans	Text, diagrams
	Create a data inventory checklist	Data sources, data structures, data tables	Checklist, text, diagrams
	Use a (computer) directory structure that reflects the components of the network model	Data structure	Text, diagrams, software
	Use a template model for calculating demand based on usage rates	Mathematical model	Software
General Guidelines	Maintain a set of models for estimating transportation, facility operations, and other cost elements	Mathematical models	Software, text, diagrams
	Be aware of the factors that affect the network model's complexity	Modeling approach, general information, examples	Text, diagrams
	Consider using a spectral approach in developing scenarios	Modeling approach, general information, examples	Text, diagrams
	Follow principles from experience in the military	Principles	Text

Table 11. Summary of Pattern for the Logistics Network Analysis and Design Training Case Study

CHAPTER VIII

SUMMARY OF RESEARCH FINDINGS

Introduction

In this chapter, we summarize the key findings of the research relative to our objectives. The objectives of this thesis were three-fold:

1. *Test the applicability and usefulness of using the pattern concept to guide activities in logistics.*

2. *Examine the role of patterns in knowledge management.*

3. *Contribute to the body of knowledge on the pattern concept within management research by:*

   3.a. Examining the theoretical basis for the concept of patterns.

   3.b. Describing the properties of patterns.

   3.c. Exploring alternative ways to develop and deploy patterns in practice.

125

Objective 1: Test the Significance of Patterns in Logistics

The results of the case studies indicated how the concept of patterns could be used to support logistics activities. In the Core Carrier Strategy case, we showed how the roles, activities, and processes related to a strategic initiative could be depicted as clusters of patterns. We also illustrated how a strategy could be presented as a set of inter-related patterns across multiple groups within an organization.

In the WMS Company case, we demonstrated that patterns could be used to guide strategy implementation and support change throughout an organization. We also showed how patterns could assist in the development of tools such as software. A senior executive from the company acknowledged the significant contribution of pattern use. This testimony was supported by implementation of recommendations based on the patterns of work we formulated.

In the Logistics Network Analysis and Design (LNAD) Training case, patterns were used to communicate and reinforce key ideas related to a set of analytical tasks. We also illustrated how we could opportunistically formulate patterns as we go about the normal course of activities.

From the case study results, we demonstrated the feasibility of using the pattern concept to guide logistics activities. We concluded the effectiveness of pattern use based on observations of outcomes and user testimonies. Although not based on statistics, the narrative approach to evaluation is a valid model and can sometimes be richer than corresponding mathematical models (Larson and Kaplan, 1981). However, we did not make comparisons on whether similar outcomes could be achieved by using 'existing' approaches (i.e., the status-quo approach used by the WMS company or traditional training methods for LNAD). Hence, we could not make generalized conclusions on the effectiveness of the pattern-based approach to other organizations.

Our research showed how patterns could support the development and implementation of logistics strategies. Focused on people's ways of working, these strategies could be a source of sustainable competitive advantage for logistics organizations (Manheim 1996a). We hope that these findings serve as catalysts for future research on the role of patterns in enhancing individual and organizational effectiveness. In the next chapter, we present one avenue for future work in this area.

Objective 2: Patterns and Knowledge Management

Codification of knowledge is one of the most contentious area in knowledge management (Ruggles 1997). In this thesis, we presented an alternative framework for knowledge management that is based on the concept of patterns. We submitted that patterns codify knowledge on ways of working and could be used as entities in a knowledge management system.

We also presented a set of propositions that formed our perspective on a pattern-based knowledge management approach. These propositions were partly supported by the literature. We also found empirical support from the case studies. We summarize these propositions below:

Proposition 1: Knowledge is not an entirely crisp, tangible, codifiable entity. There are both tacit and explicit components to knowledge. We defined patterns as the explicit representations or expressions of the essential elements of ways of working. In essence, we used patterns during the case studies to codify previously-tacit ways of work.

Proposition 2: Knowledge begins and ends with the individual.

Therefore, knowledge management is first and foremost an activity

and responsibility of the individual. Patterns were always developed

from the perspective of the individual. Even when the context was

strategic (as was in the WMS Company case), the pattern's intent was

to guide individual action in a manner consistent with the strategy.

Proposition 3: The core objective of knowledge management is

to enhance the individual's capability for effective personal action.

The core role of patterns is to guide individual thought and action

(Manheim 1998). In the case studies, there were indications that

patterns contributed to enhancing effective action. In the WMS

Company case, the pattern templates were integrated into the

company's internal systems to support the product delivery process.

In the LNAD Training case, patterns became the tool used to

summarize key concepts in the training.

Proposition 4: An effective knowledge-conscious organization

consists of a loose network of empowered individuals - a network of

empowered knowledge managers. As we indicated in Proposition 2,

all the patterns we developed were targeted at the individual. In

addition, we also showed in the WMS Company case how we could

deploy the same patterns to support the work of a group of people.

Proposition 5: An individual's action is guided by previously

learned ways of thinking and acting - i.e., previously learned 'ways of

working.' This proposition is consistent with our definition of patterns.

The case studies showed how patterns could represent people's ways

of working.

Proposition 6: The essential components of ways of working

can be articulated, though imperfectly, in a semi-structured format

(i.e., patterns). Patterns can serve as templates that can be rapidly

instantiated, customized, and re-used under different situations and

contexts. This is the focal point of the thesis and the general

conclusions of our research effort supports this proposition.

Proposition 7: Personal action can be enhanced by managing a

portfolio of patterns that can be rapidly instantiated and customized.

Management activities include articulating, sharing, discussing,

archiving, recalling, and evolving patterns of work. The arguments we

made in Proposition 3 also apply to this proposition. In the case

studies, we also examined the various components of patterns, including formats and templates. Knowledge of these structures would be instrumental in developing tools for managing patterns.

Proposition 8: Knowledge management, at the individual level, implies the maintenance and utilization of a portfolio of patterns as personal assets. Knowledge management, at the organizational level, implies providing the supporting tools and institutions that can empower individuals to effectively manage their personal portfolio of work patterns. Combined together, all the arguments that we presented in the previous propositions would culminate in support of this final proposition.

Objective 3: Contribute To The Study of Patterns Within The Field Of Management Research

In this section, we summarized the contribution of the research towards the enrichment of the general concept of patterns. We focused on contributions to the theoretical foundation of the pattern concept, relevant features of the pattern entities, and methods for pattern formulation.

Objective 3.a: Examine the Theoretical Basis for the Pattern Concept.

We traced the evolution of the pattern concept, from its origins in architecture and urban planning and its adoption within the OOP community to its emergence in management research. Following Manheim's (1996a; 1996b) observations on the schematic basis of patterns, we also explored linkages between the pattern concept and theories in cognitive science.

We discovered linkages between the concept of patterns and activity theory (Star 1996). We concluded that, from a cognitive science perspective, patterns could be considered as artifacts that guided individual action. This idea of artifacts mediating action had been a well-established (see Cole and Engestroem 1993).

From the point of view of artifacts, our approach to the study of patterns was less commonly taken. In contrast to the anthropological approach of analyzing existing artifacts, we have taken a design approach where we developed artifacts. In all applications of the concept, patterns were proactively created and were not an incidental outcome of another process.

In our treatment of patterns from multiple perspectives, we intended to provide the theoretical foundation for firms to make decisions on using the concept and for academics to embark on further research. We hope that this intention was modestly accomplished

Objective 3.b.: Describe the Properties of Patterns. In order to understand the pattern as an entity, we examine some of its key features. Understanding the structural, relational, and behavioral properties of information objects were considered key to the understanding of general concepts (Parsons 1996). Also, basing the insights on case study observations is considered a valid form of inquiry (Yin 1994)

We examine the types of patterns, the formats for expressing patterns, the implementation templates, the dimensional features, and the attributes of good patterns.

Types of Patterns. Based on the review of the pattern literature and our case experience, we identified the following three types of patterns:

1. *Descriptive.* Descriptive patterns are based on empirical observations of effective work practices. One example would be

the set of patterns identified in the Core Carrier Strategy case.

The patterns of work in that study were based on observations of a

retail logistics organization that implemented the strategy.

2. *Normative.* Normative patterns are developed based on

commonly-recognized or proposed principles of effective behavior.

In the Warehouse Management Software Company case study,

the company's senior management and the research team

recognized the value of creating a common view of the selling and

software implementation process. Similar to best practices,

normative patterns could also be based on comparisons of work

practices of various organizations.

3. *Constructive.* Constructive patterns are based neither on

direct observations or best practices. Constructive patterns can be

based on effective practices that evolved from individual

experience and considered effective on a personal level.

Constructive patterns reach for improvement over current ways of

working (Manheim 1999). For example, the patterns developed

during the LNAD case study came out of reflections on practices

from the trainer's project experiences.

Given our empirical methods, we cannot claim that the normative /

descriptive / constructive comprise a general typology of patterns.

Pattern Formats. The format defined the structural shell for

expressing patterns. Two formats were suggested in the literature.

Alexander's (1997) patterns were composed of seven parts that were divided

in three sections (Introduction, Main Body, Ties to Other Patterns). Gamma

et al. (1995), referred to four basic elements of patterns (i.e., Name, Problem,

Solution, and Consequences). Their full specification for a pattern had

thirteen parts.

In the case studies, we found the following three-part format useful

when articulating patterns of work:

1. *Action Statement.* The action statement served as an

identifier as well as a one- sentence summary of the pattern's

message. In the pattern literature, the selection of an identifier was

considered an important part of the process of developing patterns.

Identifiers played a crucial role in the process of recognizing and

sharing patterns (Alexander 1979; Gamma et al. 1994; Rising

1998).

2. *Main Body.* The main body is the part the contained the details necessary to understand the pattern. For example, the main body could contain a discussion of the problem and solution. In others, the main body could simply contain explanations and diagrams.

3. *Template.* The templates were used to create an instance of the pattern for actual use. This portion should also be flexible to accommodate templates in various media, including text, diagrams, and software objects.

These three parts represent the primary elements of the pattern format. There are secondary elements, such as categories and keywords, that were useful when we created a catalogue.

Implementation Templates. Templates provide the concrete ways by which patterns could be implemented. Previously, the templates had been expressed solely in text and diagrams (Alexander 1977; Gamma et al. 1994). As we explored a broader set of work activities, we discovered templates that were expressed in alternative media, such as spreadsheets, presentation

slides, workflow, and user interfaces. Table 12 lists the various content forms and the templates used to represent them. Although not comprehensive, the list reflects technology support and information are becoming integral parts of how workers in logistics execute their tasks.

Dimensional Properties. We could also describe patterns in terms of themes, contexts, and explicitness:

1.   *Thematic / Operational.* Patterns that are highly thematic stimulate thinking about how to solve problems, address issues, and accomplish work. They could be considered as high-level patterns that provide a theme for developing more operational patterns. For example, the top-level pattern in the Core Carrier Strategy case study (i.e., *"Concentrate services to a select number of capable, high performing service providers."*). Operational patterns are suggestive of particular actions, processes, or methods on how to solve problems, address issues, and accomplish work. These patterns would have implementation templates as important components.

.

2.   *Contextual.* The level by which a pattern is applicable for specific context or can be generalized across multiple contexts.

Context specific patterns are applicable to specific situations, industries, or businesses while general patterns are applicable across various contexts. For example, Manheim's (1999) stakeholder pattern is applicable to a more varied compared to the data analysis patterns in the LNAD case study.

3.   *Explicitness*. The level by which the courses of action were made explicit. One can imagine a spectrum, from highly-explicit patterns such as algorithms to those that are more implicit, such as guiding principles.

Pattern Clusters. People's work is complex and involves multiple tasks. Work complexity was reflected in the cases through the *clustering of patterns* - groups of inter-related patterns partially structured together by a common theme to form a transient process. Clusters were evident in strategy implementation, as shown by the Core Carrier Strategy and the WMS Company cases. The translation of strategy to action involved the assembly of clusters of inter-connected patterns, from high-level thematic patterns representing working principles to a set of action-oriented patterns that outline the implementation plans. Although the thematic patterns presented valuable ideas, their usefulness and effective implementation

depended on the formation of clusters that include a set of lower-level operational patterns.

Attributes of Good Patterns. Pattern evaluation had been rarely addressed in the literature. In pattern writing workshops for OOP, there is no judgement made on the quality of patterns (Rising 1998). Consequently, no guidelines or criteria have been established to evaluate patterns.

In the process of cataloguing the patterns for this study, we identified several attributes of what we perceived as good patterns and offer these observations as guidelines for assessment.

One characteristic of a good pattern is in the manner the pattern invokes a familiar experience. In Chapter III, we alluded to the connection between patterns and previously-learned ways of working. We suggested that a pattern's message can be better understood if the user can recall previous experience (e.g., successful use) or recognize potential positive experience (e.g., "I can imagine how I can use this...") related to the pattern's use. Alexander (1977) mentioned this recognition process in less specific terms (i.e., 'feels good'). Goldfedder and Rising (1998) implied that

programmers could recognize a good pattern's usefulness without examining the associated code.

Another characteristic is that good patterns should cause the reader to reflect. Good patterns should provide profound insights and represent ideas that are not obvious. It should stimulate, not constrain thought. Good patterns could also lead the reader to challenge existing thought on issues and reflect on alternative views.

The experiential and reflective attributes of patterns are also consistent with the modes of cognition deemed essential for human performance (Norman 1994).

In addition, clarity, simplicity and conciseness are also desirable attributes. Well-articulated patterns are brief and concise, yet are easily recognizable. Good patterns communicate effectively by facilitating recall of a broader set of ideas, processes, and philosophies. In the literature, clarity is also associated with completeness. According to Corfman (1998), a pattern is complete when it can stand on its own and not raise questions from readers. The economy in demand-for-audience-attention (associated with

simplicity) is also become increasingly important attributes as the catalogs of patterns grow (Sieloff 1999).

Good patterns are also either actionable on their own or directive to feasible courses of action. This attribute is related to a pattern's utility in accomplishing goals, addressing issues, solving problems, and yielding results. We are unsure as to whether consistency in interpretation is desirable. On one hand, consistent interpretation could have advantages when implementing strategies using patterns (i.e., having a common interpretation of a strategy across the organization). On the other hand, there is also a risk of ignoring more appropriate interpretations. However, it is important that patterns be implemented in a dialectic, dialogue environment, where alternative perspectives are entertained and patterns of work evolve.

Other attributes mentioned in the literature included flexibility (i.e., ability to modify the form), extensibility (i.e., applicability to other problem contexts) and reusability (Vlissides 1998). These were considered properties of good software that equally applied to patterns.

Objective 3.c: Explore Alternative Ways to Develop and Deploy

Patterns: Based on the case study experiences, we propose a process for

developing patterns that has three stages: assessment, formal development,

and deployment. We inferred this process from the case studies. During this

process, individuals involved in pattern development assessed situations and

engaged in self-reflection and dialogue. These were similar activities that

Boland, Tenkasi, and Te'eni (1996) suggested in developing an

understanding of situations that entail action and decision making.

Assessment and Selection of Development Approach. During this

stage, we evaluated the factors that motivated pattern development.

We could develop patterns of work in response to observations of

effective actions, principles, or processes. Observations could be based on

personal reflection and experience (i.e., by actual performance or personal

involvement as part of a team or an organization) or from secondary sources

(e.g., literature, other people's actions). In the Core Carrier Strategy case,

the patterns developed resulted from the researcher's personal involvement

in logistics carrier management as well as observations of a retail logistics

organization. The patterns in architecture, planning, and object-oriented programming were also based on observations and interpretations (Alexander, et. al 1977; Alexander 1979; DeLano 1998). A common thread is the observer's recognition of effectiveness (i.e., recognition that something is actually useful or potentially useful).

Another motivational factor was the surfacing of issues or problems and the need their resolution. In this instance, the formulation and development patterns became part of the problem-solving process. In the WMS Company case, patterns (that led to the development of Lotus Notes application) were the tool used to address strategic management issues.

The review and documentation of key processes was another factor. In the LNAD case, we opportunistically identified the relevant patterns of work that would reinforce understanding of the subject matter.

Other factors that could initiate pattern development include reviews of lessons learned, outcomes of discussions, or even active solicitation (e.g., interviews, surveys).

Formal Development. At this stage, we formally developed the patterns using the three-part format outlined above.

The different case studies provided insights into different aspects of the formal development of patterns. In the Core Carrier Strategy case study, we described experiences and observations on effective ways of executing tasks and of representing meaningful concepts and ideas. We constructed patterns that were imbedded in work activities and processes.

We took a normative approach in the WMS Company case study where we proposed desirable ways of action that were consistent with the company's vision and product strategy. We outlined and reviewed the key processes, determined the relevant issues, and developed thematic patterns that addressed the issues. In turn, the thematic patterns guided the development of operational patterns that represented an action plan for implementing the strategy.

The approach we took in the LNAD case study was opportunistic in nature, i.e., we developed patterns as the opportunity arose during the training program. We drew from personal knowledge and experience to

develop constructive patterns for logistics network analysis. We exercised pattern consciousness during the training process.

A significant portion of the patterns we developed underwent a number of revisions. The WMS Company case study illustrated an elaborate example, where the patterns derived from the strategy evolved from thematic propositions to action statements and eventually to software. This evolutionary and iterative nature of the development process was also evident in the experiences of the object-oriented programming community (Rising 1998).

Dialogue and discussion was present throughout the entire pattern development process for all cases. In the WMS Company case, the research team had several opportunities for face-to-face discussions with senior management. This was in addition to the electronic and other forms of interaction (e.g., email, voice). Similarly, the Network Analysis case involved numerous discussions between the researcher (as trainer) and the manager (the trainee) on the pattern's adequacy, form, and utility. The importance of a feedback mechanism was evident in our research experience as well as experiences in other domains (Gamma et al. 1995). This aspect of pattern evolution also supports organizational learning by providing opportunities for

individuals to make rich representations of their understanding, reflect upon those representations, engage in dialogue about them with others, and use them to inform action (Boland, Tenkasi, and Te'eni 1996).

Deployment. The value of patterns can only be realized with their deployment. Deployment could simply be a matter of publication and release for assimilation. When patterns are designed to effect a broader set of actions (as in strategy implementation), a more formal approach to deployment is appropriate. Based on the research case experience, we recommend a phased approach:

Phase 1: Gain Acknowledgement: Acknowledgement from principal sponsors or leadership that a pattern approach is suitable and pertinent to achieving the objectives.

Phase 2: Pilot: Selection of the first initiatives to pursue and development of the initial patterns artifacts. Initial artifacts may be in the form of application prototypes, as was in the WMS Company case.

Phase 3: Reformulation: Review the impacts of the pilot. Revise the action strategy, explore alternative formulations, and make recommendations.

Phase 4: Strategic Implementation: Given satisfactory pilot implementation, develop and deploy in a broader setting. Cycle through stages 3 and 4 as necessary.

Chapter Summary

In this chapter, we summarized how we accomplished the three main objectives of the thesis. Through three case studies, we demonstrated the potential for using the pattern concept to support logistics activities. We discussed how patterns could be the basis of a knowledge management implementation. We also outlined the contribution towards current work on patterns in management research. We examined the theoretical basis for patterns, including linkages to cognitive science concepts.

As evidenced by the case studies, we acknowledged the viability of implementing the pattern concept to support logistics activities. We then outlined the contributions of the research towards the enrichment of the

concept, specifically in building the theoretical foundation for the pattern concept, revealing important features of the pattern entities, and providing insights into the pattern formulation processes. We described several properties of patterns and suggested a method for developing and deploying patterns.

In the next chapter, we present several avenues for future research on patterns.

Content	Form of Implementation
Contact Persons, Subject Matter Experts	Directories
Cost Estimation, Forecasting, Data Analysis Models, Algorithms	Spreadsheets, Mathematical Formulations, Charts
Instructions, Policies and Procedures, Designs	Documents, Flow Charts, Numbered Lists, Workflows, Images, Drawings, Sketches
Interview Questions, Inquiries	Interview Instrument
Meeting Agendas, Discussion Topics	Agendas
Project Plans, Schedules	Planning Charts, Calendars
Propositions, Themes, Strategic Thrusts	Text Propositions
Reports, Presentations, and Other Project Deliverables	Documents, Presentation Slides, Images
Selection Criteria, Stakeholder Lists, Business Imperatives, Service Provider Capabilities, Performance Measures, Project Objectives	Lists, Checklists
System Interfaces, Customer Requirements	User-Interface Forms

Table 12. Pattern Content and Implementation Forms

CHAPTER IX

POTENTIAL FOR FUTURE RESEARCH

This thesis represented initial explorations into the use of the pattern concept as a management tool. More work remains to be performed to realize the full potential of the concept.

Manheim (1996a) argued that, in a Truly Productive Organization, patterns of work are managed as critical resources. We also asserted that individuals in a knowledge conscious organization maintain portfolios of patterns as personal assets. In order for individuals to manage patterns, tools for developing and maintaining personal libraries of patterns are needed (e.g., pattern authoring tools). In addition, systems could be developed to support the sharing and discussion of patterns within an organization or among a community that has common interests.

We discussed the role of patterns in knowledge management, an emerging area of research. Although we provided initial directions, there is still potential for further explorations on pursuing the theory as well as developing practical implementations.

150

Pea (1993) noted that electronic tools - such as jogger pulse meters, automatic street locators, and currency exchange calculators - carried patterns of previous reasoning and could be used with little awareness of the struggle that went into their design. He further noted that new learners take advantage of the knowledge encapsulated in these artifacts through three ways: (a) observations of other people's use (and attempts to imitate it); (b) through discovery in solitary activity; and (c) through use in participation with knowledgeable others. We see parallels in use between these electronic tools and patterns. One avenue of study is to determine whether new learners could take advantage of patterns as they do with these electronic tools.

In this thesis, we suggested that effective ways of thinking and acting could be represented through well-designed patterns and templates. We envision an organizational culture in which patterns of work are routinely formulated, shared, discussed, and debated. Exploration into a pattern-based work culture is another area for future research.

In this culture, individuals maintain and manage their portfolios of patterns as intellectual assets. Personal pattern portfolios could represent toolkits that individuals in an organization use to augment skills and

competencies. To achieve this vision, more work is needed in developing the tools to formulate, catalogue, and manage patterns.

The field of logistics is a promising application area for building and refining a pattern-based knowledge management framework. Our limited case studies indicated that the logistics field could be a rich source of research material for developing this framework. From the patterns we compiled, we discovered that the logistics pattern library would include high level thematic patterns that proposed working principles and low level operational patterns. We also showed that spreadsheets, analytical models, possibly workflow and other templates were important components of the library. However, we only addressed a narrow portion of supply chain management. Other areas in this field, such as forecasting, order management, distribution, and inventory management, were fertile subjects for pattern study. The results of this research could provide the initial foundation for further development of pattern-based knowledge management in logistics.

REFERENCES

Alexander, Christopher. 1975. *The Oregon experiment*. New York: Oxford University Press.

_____. 1977. *A pattern language*. New York: Oxford University Press.

_____. 1979. *The timeless way of building*. New York: Oxford University Press.

Anderson, D., Britt, F., and Favre, D. The seven principles of supply chain management. *Supply Chain Management Review*. Cahners Publishing.

Anderson, Howard. 1998. A little knowledge is a dangerous thing. *Network World*, Nov 16.

Archer, Earnest R. 1980. How to make a business decision: An analysis of theory and practice. *Management Review*, February.

Argyris, Chris. 1982. *Reasoning, learning, and action*. San Francisco, CA : Jossey-Bass, Inc.

Argyris, C and D. Schon. 1978. *Organizational learning: a theory of action perspective*. Reading MA: Addison-Wesley

Barnes, L.B. 1964. Organizational change and field experiment methods. *New perspectives in organizational research*, Vol. 79, ed. M. Cooper, H. Leavitt, and M. Shelly II. New York, NY: Wiley.

Beck, K., J. Coplien, R. Crocker, L. Dominick, G. Meszaros, F. Paulisch, and J. Vlissides. 1996. Industrial experience with design patterns. *Proceedings of ICSE*. Berlin, Germany: IEEE.

Bleicher, J. 1980. *Contemporary hermeneutics: Hermeneutics as method, philosophy and critique*. Boston, MA: Routledge and Kegan Paul.

Boland, Richard, Ramkishnan V. Tenkasi, Dov Te'eni. 1996. Designing information technology to support distributed cognition. *Cognition Within and Between Organizations*, ed. James R. Meindl, Charles

153

Stubbart, and Joseph F. Porac. Thousand Oaks, CA: Sage Publications, Inc

Buschmann, F, R. Meunier, H. Rohnert, P. Sommerlad, and M. Stahl. 1997. *Pattern-oriented software architecture: A system of patterns.* New York, NY: John Wiley and Sons.

Cain, B.G., Coplien, J. and Harrison, N. B. 1996. Social patterns in productive software development organizations. *Annals of Software Engineering* 2, pp. 259-286

Coad, P., D. North, and M. Mayfield. 1995. *Object Models: strategies, patterns and applications.* Englewood Cliffs, NJ : Prentice-Hall

Cole, Michael and Engestroem, Yrjo. 1993. A cultural-historical approach to distributed cognition. *Distributed cognition,* ed. Gavriel Salomon. New York, NY : Cambridge University Press.

Commiskey, J. and G. Kowalski. 1994. Emery Worldwide and General Motors: Partners in global transportation. *Annual conference proceedings, Council of Logistics Management.* Oakbrook, IL: CLM.

Copacino, William. 1997. *Supply chain management: The basics and beyond.* Boca Raton, FL : St. Lucie Press.

Coplien, James. 1994. Generative pattern languages: an emerging direction in software design. *C++ report,* vol. 18 no. 22, July, pp. 66-67.

_____. 1997. Organizational patterns. http://www.bell-labs.com/cgi-user/OrgPatterns/OrgPatterns?CoplienOrganizationPatterns

_____. 1998. Foreword to *The patterns handbook,* ed. Linda Rising. New York, NY : Cambridge University Press.

Coplien, James and Douglas Schmidt, eds. 1995. *Pattern languages of program design.* Reading, MA: Addison-Wesley

Corfman, R. 1998. An overview of patterns. *The patterns handbook,* ed. Linda Rising. New York, NY: Cambridge University Press.

Cunningham, J. B. 1993. *Action research and organizational development.* Wesport, CT: Praeger

DeLano, D. 1998. Pattern mining. *The patterns handbook,* ed. Linda Rising. New York, NY: Cambridge University Press.

De Long, David, Davenport, Tom, and Beers, Mike. 1998. *What Is a Knowledge Management Project?* Research Note.

Earl, Michael J. and Ian A. Scott . 1999. What is a chief knowledge officer? *Sloan Management Review,* vol. 40, no. 2, pp. 29-38.

Eisenhardt, K.M. 1989. Building Theories from Case Study Research. *Academy of Management Review,* vol. 14, no. 4, pp. 532-550.

Elden, M. and Chisholm, R.F. 1993. Emerging varieties of action research: Introduction to the special issue. *Human Relations* vol. 46, no. 2, pp. 121-142.

Engestroem, Yrjo and David Middleton. 1996. Introduction: Studying Work as Mindful Practice. *Cognition and Communication at Work,* ed. Engestroem, Yrjo and David Middleton. New York, NY: Cambridge University Press

Fischer, Laura, ed. 1998. *Excellence in Practice: Innovation and Excellence in Workflow and Imaging, Vol. II.* Lighthouse Point, FL: Future Strategies, Inc.

Fowler, Martin 1997. *Analysis patterns: reusable object models.* Menlo Park, CA: Addison-Wesley.

Frappaolo, Carl. 1998. Document management's role in knowledge management. *KMWorld,* Sep 1998.

Gabriel, Richard. 1996. *Patterns of software: Talks from the software community.* New York, NY: Oxford University Press.

Gabriel, Richard. 1998. The failure of pattern languages. *The patterns handbook,* ed. Linda Rising. New York, NY: Cambridge University Press.

Gagel, C. 1997. Literacy and technology: Reflections and insights for technological literacy. *Journal of Industrial Teacher Education,* vol. 34, Spring, pp. 6-34.

Gamma. Erich. 1991. Object-oriented software development based on ET++: design patterns, class library, tools (in German). PhD thesis, University of Zurich Institut für Informatik.

Gamma, Erich, Richard Helm, Ralph Johnson, and John Vlissides. 1994. *Design patterns: elements of reusable object-oriented software.* Reading, MA: Addison-Wesley.

Gardner, H. 1987. *The minds new science.* New York, NY: Basic Books.

Gertz, C. 1973. *The interpretation of culture.* New York , NY: Basic Books.

Glaser, B.G. and A. L. Strauss. 1967. *The discovery of grounded theory: strategies for qualitative research.,* New York, NY: Aldine Publishing Company.

Goldfedder, Brandon and Linda Rising. 1998. A training experience with patterns. *The patterns handbook,* ed. Linda Rising. New York, NY: Cambridge University Press.

Grabow, S. 1983. *Christopher Alexander: The search for a new paradigm in architecture.* Stocksfield, UK : Oriel Press.

Graham, A. B. and Pizzo, V.G. 1996. A question of balance: Case studies in strategic knowledge management. *European Management Journal,* vol. 14 no 4.

Gummesson, Evert. 1991. *Qualitative methods in management research.* Newbury Park, CA : Sage Publications, Inc.

Hamel, J., S. Dufour, and D. Fortin. 1993. *Case study methods.* Newbury Park, CA : Sage Publications.

Harps, L. 1999. Selecting 3rd Party Logistics Partners. *Inbound Logistics,* July, pp. 49-58.

Hastie, Reid. 1981. Schematic principles in human memory. *Social cognition: the Ontario symposium on personality and social psychology,* ed. E. T. Higgins, C. P. Herman, and M. P. Zanna. Hillsdale, NJ: Erlbaum Associates.

Hastie, Reid. 1986. A primer of information processing theory for the political scientist. *Political cognition,* ed. Law, R., and D. Sears. Hillsdale, NJ: Erlbaum Associates.

Hewitt, C. 1986. Offices are open systems. *ACM Transactions on Office Information Systems,* vol 4., no.3. July, pp. 271-287.

Huber, G. 1991. Organizational learning: the contributing processes and the literatures. *Organization Science,* vol. 2, no. 1, pp. 88 - 115.

Hutchins, E. and Klausen, T. 1996. Distributed cognition in an airline cockpit. *Cognition and Communication at Work,* ed. Yrjo Engestroem. New York, NY : Cambridge University Press.

Isenberg, Daniel J. 1984. How senior managers think. *Harvard Business Review,* Nov-Dec. Boston, MA: Harvard Business School Press.

Jezequel, J. M. 1996. *Object-oriented software engineering with Eiffel.* Reading, MA: Addison-Wesley.

Jonassen, David H. and Barbara L. Grabowski. 1993. *Handbook of individual difference, learning, and instruction.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Jordan, B., R. Goldman, and P. Sachs 1995. Representations of work: Tools for the workplace. *Communications of the ACM,* vol. 38, no. 9, Sept, pp. 42.

Kellogg, Ronald. 1996. *Cognitive Psychology.* Thousand Oaks, CA: Sage Publications Inc.

Kim, Daniel. 1993. The link between individual and organizational learning. *Sloan Management Review,* Fall.

_____. 1994. Managing organizational learning cycles. *Reflections on creating learning organizations,* ed. Kellie T. Wardman. Cambridge MA: Pegasus Communications Inc.

Klein, David. 1998. *The strategic management of intellectual capital.* Woburn, MA: Butterworth-Heinemann.

Kock Jr., Nereu F., Robert J. McQueen, John L. Scott. 1997. *Can action research be made more rigorous in a positivist sense? The contribution of an iterative approach.* http://www.cis.temple.edu/~kock/

Kolb, D. A. 1984. *Experiential learning: experience as the source of learning and development.* Englewood Cliffs, NJ: Prentice Hall.

Kyng, M. 1995. Representations of Work: Making Representations Work. *Communications of the ACM*, vol. 38, no. 9, pp. 46-55.

Larson, Richard C & Edward H. Kaplan. 1981. Decision oriented approaches to program evaluation. *Evaluation of complex systems*, ed. Ronald J. Wooldridge. San Francisco, CA: Jossey-Bass Inc.

Layder, Derek. 1993. *New Strategies in Social Research.* Cambridge, UK: Polity Press.

Lea, Dough. 1998. Christopher Alexander: An introduction for object-oriented designers. *The patterns handbook*, ed. Linda Rising. New York, NY: Cambridge University Press.

Leonard-Barton, Dorothy. 1995. *Wellsprings of knowledge.* Boston, MA: Harvard Business School Press.

Lippman, Stanley. 1991. *C++ primer.* Reading, MA: Addison-Wesley.

Lynch, Kevin. 1987. *Good city form.* Cambridge, MA: The MIT Press.

Manheim, Marvin L., 1996a. Cognitive informatics: Theory and implications for a people-based enterprise information architecture. *Proceedings PRIISM 1996 conference*, ed. Donald Amoroso. Colorado Springs, CO: Pacific Research Institute for Information Systems in Management, University of Colorado, Colorado Springs.

_____. 1996b. Opportunities for competitive advantage in logistics through information technology. *Proceedings 29 the annual Hawaii international conference on system sciences.* Los Alamitos, CA: IEEE Computer Society Press.

_____. 1998, Beyond groupware and workFlow: The theory of cognitive informatics and its implications for a people-based enterprise

information architecture. *Excellence in practice: Innovation and excellence in workflow and imaging vol 2*, ed. Layna Fischer. Lighthouse Point, FL: Future Strategies, Inc.

_____. 1999. *Managerial cognition and action: A multi-layer perspective*. Working Paper. Evanston, Illinois: Management and Strategy Department, J. L. Kellogg Graduate School of Management, Northwestern University.

Manheim, Marvin L. and Daniel Isenberg. 1987. A theroretical model of human problem solving and its use for designing decision support systems. *Proceedings of the 20th Hawaii International Conference on System Sciences*. Honolulu, HI: HICSS.

Manheim, Marvin L., and B. Benjamin V. Medina. 1997. *Translating logistics strategy to effective action: A pattern-based approach*. Working Paper. Evanston, Illinois: Strategic Informatics Project, Management and Strategy Department, J. L. Kellogg Graduate School of Management, Northwestern University.

_____. 1999. Beyond supply chain integration: Opportunities for competitive advantage. *Global Logistics and Distribution Planning - 3rd Edition*, ed. Donald Waters. Boca Raton, FL: CRC Press.

Martin, P.Y. and Turner, B.A. 1986. Grounded Theory and Organizational Research. *The Journal of Appled Behavioral Science* vol. 22 no. 2, pp. 141-157.

Martin, Robert. 1998. Patterns: ploP, ploP, fizz, fizz. *The patterns handbook*, ed. Linda Rising. New York, NY: Cambridge University Press.

Martin, R, D. Riehle, and F. Buschmann, ed. 1997. *Pattern language of program design 3*. Reading, MA : Addison-Wesley.

McGill, Michael E and Slocum, John W. Jr. 1994. *The smarter organization: How to build a business that learns and adapts to marketplace needs*. Toronto, Canada: John Wiley and Sons, Inc.

Melone, Nancy Paule. 1996. Reasoning in the executive suite: the influence of role/experience based expertise on decision processes of corporate executives. *Cognition within and between organizations*, ed. James

Meindl, Charles Stubbart, and Joseph Porac. Thousand Oaks, CA: Sage Publications Inc.

Minto, Barbara. 1996. *The Minto pyramid principle: logic in writing, thinking, and problem solving.* London, UK: Minto International Inc.

Minzberg, H. , D. Raisinghani, and A. Theoret. 1976. The structure of unstructured decision processes. *Administrative Science Quarterly*, vol 21, no. 6, pp. 246-275.

Moore, Connie. 1998. Process knowledge. *Excellence In practice: innovation and excellence In workflow and imaging, vol II,* ed. Layna Fischer. Lighthouse Point, FL: Future Strategies, Inc.

Moore, Andy. 1998a. Model making in the late '90s. *KMWorld,* September.

Moore, Andy. 1998b. Document management in knowledge management: case examples. *KMWorld,* September.

Moore, Andy. 1998c. The three segment model for the KM systems marketplace. *Supplement to KMWorld,* Fall and Winter 1998/99.

Montlick, T. 1995. *What is Object-Oriented Software?* http://www.soft-design.com/softinfo/objects.html.

Myers, Michael D. 1997. *Qualitative research in information systems.* http://www.misq.org/misqd961/isworld/.

Newell, Allen and Herbert Simon. 1972. *Human problem solving.* Englewood Cliffs, NJ: Prentice Hall.

Nonaka, Ikujiro and Takeuchi, Hirotaka. 995. *The knowledge creating company.* New York, NY:The Oxford University Press.

Norman, D. 1994. *Things that make us smart.* Addison-Wesley:Reading, MA.

Nutt, Paul C. 1996. The formulation processes and tactics used in organizational decision making. *Cognition within and between organizations,* ed. James R. Meindl, Charles Stubbart, and Joseph F. Porac. Thousand Oaks, CA: Sage Publications, Inc.

O'Connor, Mark. 1999. Six keys to the knowledge domain. *Knowledge Management* , February. Malibu, CA: Curtco Freedom Group.

Orlikowski, Wanda J. 1993. CASE tools as organizational change: investigating incremental and radical changes in systems development. *MIS Quarterly*, vol. 17, no. 3, pp. 309-340.

Parsons, Jeffrey. 1996. An information model based on classification theory. *Management Science*, vol. 42, no. 10, pp. 1437 - 1453.

Patton, C. and D. Sawicki. 1986. *Basic methods of policy analysis and planning.* Engelwood Cliffs, NJ : Prentice Hall.

Pea, Roy. 1993. Practices of distributed intelligence and designs for education. *Distributed cognitions*, ed. Gavriel Salomon. New York, NY : Cambridge University Press.

Pennington, Nancy, and Reid Hastie. 1985. *Causal reasoning in decision-making.* Working paper. Dept. of Psychology, Northwestern University.

Prechelt, L., B. Unger, and W. Tichy. 1998. *A controlled experiment in maintenance comparing design patterns to simpler solutions.* Working Paper. Fakultät für Informatik, Universität Karlsruhe, Karlsruhe, Germany.

Prusak, Laurence. 1997. Introduction to series: why knowledge, why now?. *Knowledge in organizations*, ed. Lawrence Prusak. Newton, MA: Butterworth-Heinemann.

Radnitzky, G. 1970. *Contemporary schools of metascience.* Goteborg: Scandinavian University Books.

Ramirez, R. 1998. A design patterns experience report. *The patterns handbook*, ed. Linda Rising. New York, NY: Cambridge University Press.

Rising, Linda, ed. 1998a. *The paterns hndbook.* New York, NY: Cambridge University Press.

Rising, Linda. 1998b. Pattern writing. *The patterns handbook*, ed. Linda Rising. New York, NY: Cambridge University Press.

Raeithel, A. 1996. On the ethnography of cooperative. *Cognition and communication at work*, ed. Yrjo Engestroem. New York, NY: Cambridge University Press.

Ruggles, Rudy III, ed. 1997. *Knowledge management tools*. Newton, MA: Butterworth-Heinemann.

Salomon, Gavriel. 1993. Editor's introduction. *Distributed cognition: psychological and educational considerations*, ed. Gavriel Salomon. New York, NY : Cambridge University Press.

Sanford, N. 1976. Whatever happened to action research? *Experimenting With Organizational Life*, ed. A. Clark. New York, NY: Plenum Press.

Schmid, Hans. 1998. Design patterns to construct the hot spots of a manufacturing framework. *The patterns handbook*, ed. Linda Rising. New York, NY: Cambridge University Press.

Schmidt, D, R. Johnson, and M. Fayad. 1996. Software patterns. *Communications of the ACM, Special Issue on Patterns and Pattern Languages*, vol. 39, no. 10.

Schmidt, D. and P. Stephenson. 1998. Using design patterns to evolve system software from UNIX to Windows NT. *The patterns handbook*, ed. Linda Rising. New York, NY: Cambridge University Press.

Seeman, Patricia. 1998. Real-world knowledge management: what's working at Hochmann-LaRoche. Research Note.

Sherman, Richard. 1994. ECR vision to reality: creating innovative strategies to astonish customers. *Annual conference proceedings, Council of Logistics Management*, pp 137-155. Oak Brook, IL: Council of Logistics Management.

Sieloff, C. 1999. Is knowledge draining our attention? *Knowledge Management*, vol. 2, no. 7, pp. 87-100.

Silverstone, Stuart. 1999. Visual thinking with Larry Prusak: a pictorial interview. *Knowledge Management*, vol. 2, no.1.

Star, Susan L. 1996. Working together: symbolic interactionism, activity theory, and information systems. *Cognition and communication at work* , ed. Yrjo Engestroem and David Middleton. New York, NY: Cambridge University Press.

Stringer, Ernest. 1996. *Action Research*. Thousand Oaks, CA: Sage Publications, Inc.

Suschman, L. Representations of work: making work visible. *Communications of the ACM*, vol. 38, no. 9, pp. 56-61.

Velker, Lee. 1998. Summit plants seeds: KM market leaders share their thoughts. *KMWorld*, Sep.

Vlissides, J., J. Coplien, and N. Kerth, ed. 1996. *Pattern languages of program design 2*. Reading, MA: Addison-Wesley .

Wainright, Phil. 1998. Gold rush. *Global technology business*. Mountain View, CA: Global Technology Business Publishing.

Watson, James and Jennifer Harty. 1998. Major vendors pushing KM infrastructure. *KMWorld*, Oct.

Wilson J.R. and A. Rutherford. *Mental models: theory and application in human factors*. Human Factors, vol. 31, no. 6, pp. 617-634.

Yin, Robert K. 1994. *Case study research: design and methods, 2nd Ed.* Thousand Oaks, CA : Sage Publications, Inc.

Zmud, R. W. Editors comments. *MIS Quarterly*, vol. 19, No. 1, pp. v-viii