THE PROCESS HANDBOOK:
SUPPLY CHAIN REENGINEERING

by

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Bachelor of Arts in Economics
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(1989)

Submitted to the Sloan School of Management
in Partial Fulfillment of
the Requirements of the Degree of
Master of Science in Management

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ABSTRACT

Under the auspices of the MIT Center for Coordination Science (CCS), I studied and then helped expand upon coordination theory. This occurred in three phases.

First, I conducted a field study that applied coordination theory with the Process Handbook methodology to the supply chain management process at the Massachusetts Institute of Technology (MIT). I mapped and analyzed the procurement process in accord with the methodology which offers techniques to analyze a process by decomposing a flow of activities, listing alternate activities, describing dependencies between activities, as well as clarifying understanding of coordination mechanisms developed this process.

Second, I developed generic heuristics for the Process Handbook, performed post hoc analysis of the site and its reengineering plans, generated additional recommendations, and offered ideas to enhance the Process Handbook methodology. The analysis of the current process highlights several useful coordination mechanisms that shape the process: paper trails, signature authority policies, internal mail systems, and electronic requisitions. MIT’s role as an educational and research institution shelters it from most market pressures; however a recent budget shortfall inspired a re-engineering effort. As a result of reengineering efforts, MIT plans to introduce three techniques to improve the process: supplier consolidation, electronic commerce, and purchasing cards. In particular, the electronic commerce proposal is explored in detail since it represents a truly new application of information technology.

Third, I invested a substantial amount of effort with the Process Handbook software entering data and suggesting new features in order to create a useful tool for future researchers and practitioners.

Thesis Supervisor:
 Thomas W. Malone
 Patrick J. McGovern Professor of Information Systems
 Director, Center for Coordination Science
ACKNOWLEDGMENTS

Several groups helped make this thesis a reality. I would like to thank each group that provided the structure, the data, and the support to make this possible.

Kudos to the staff of the MIT Center for Coordination Sciences for their efforts developing the Process Handbook and training me in the methodology. Particular thanks go to: Professor Tom Malone, my thesis supervisor and the Center’s Director, for his coordinating the group research effort; John Quimby, a Research Scientist at the Center, for his guidance with the Process Handbook Software, George Wyner, a Doctoral Candidate at the Center, for his patience expanding on dependencies and providing feedback on this document, as well as my fellow researchers who shared their understanding of applying the Process Handbook methodology.

Many thanks to the members of the MIT Supplier Consolidation Team and personnel in Purchasing who took time from their work to explain the business processes and to help gather the artifacts used within the processes. Particular thanks to Diane Devlin for explaining the re-engineering efforts and Steven McCluskey for assisting in the iterative development of the process maps and activity lists.

I offer special thanks to my family for their support for all my endeavors at the Massachusetts Institute of Technology and in life.
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CHAPTER ONE -- INTRODUCTION
This chapter introduces the Center for Coordination Science whose Process Handbook methodology underlies my research, documentation and analysis of the supply chain management process at the Massachusetts Institute of Technology. The project began with research on the Internet itself and transitioned to a site undergoing re-engineering planning to incorporate the Internet as a coordination mechanism into their supply chain management process. The last sections explain the objective of the thesis and preview the remainder of this document.

Coordination Science
The Center for Coordination Science (CCS), a research center affiliated with the Massachusetts Institute of Technology (MIT), conducts multidisciplinary research to understand the opportunities new technologies provide for new ways of organizing human activity under the direction of Professor Thomas W. Malone. The CCS staff studies the methods of coordination used to facilitate production processes that create value. Professor Malone and his colleagues seek to develop a theory of coordination science and a methodology with the aim of improving the integration of work amongst individuals, groups, and firms. They intend to turn this academic research into a useful business tool by embodying it in the “Process Handbook” which researchers will populate with examples from field studies. It is hoped that organizations will be able to use the theory to develop techniques to achieve strategic results such as gaining economies of scale or improving control of suppliers via coordination.

The Process Handbook will offer techniques to analyze a process and compare a current paradigm to alternative “specializations” that accomplish the same goal. “The Handbook project, intended to provide a firmer theoretical and empirical foundation for such tasks as enterprise modeling, enterprise integration, and process re-engineering, includes:

(1) collecting examples of how different organizations perform similar processes, and
(2) representing these examples in an on-line "process handbook" which includes the relative advantages of the alternatives. The handbook is intended to help
   a) redesign existing organizational processes,
   b) invent new organizational processes that take advantage of information technology, and perhaps
   c) automatically generate software to support organizational processes.”

CCS currently sponsors research to develop an appropriate methodology as well as field studies to populate the Process Handbook with processes which embody new uses of technology and general best practices. CCS hopes to move the Process Handbook from a descriptive to a prescriptive tool. This thesis represents a part of this research effort.

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Process Overview: Supply Chain Management

The specialization required to produce products and services in today's complex environment compels most organizations to buy rather than make most of the inputs to their operations. Thus the supply chain management process inherently requires a high degree of coordination both on inter- and intra-organizational levels.

While conceptually, the supply chain extends from "dirt to dirt", i.e., raw materials to disposal, this research focuses on the procurement aspect. This serves a vital role as firms acquire inputs, either "direct" inputs to produce their output or indirect inputs to support their internal operations. Internally, this process involves resource allocation, a traditional source of tension in organizations. Organizations address this tension by designing control mechanisms that coordinate central objectives with decentralized needs and desires for inputs. This coordination costs organizations substantial amounts of time and money. Externally, this process encompasses the interface with other organizations especially relations with suppliers. Bhave cites four stages in the relationship with suppliers: confrontation, arm's length, goal congruence, and full partnership. Each successive stage involves greater coordination to reduce transaction costs.

Improvements in information technology permit new means of organizing the processes in a firm as well as in managing the interfaces with other firms. The site examined has already successfully implemented technology for some internal uses. The site's re-engineering efforts yielded plans to introduce new technology and to expand the scope of this implementation to include suppliers.

Site Overview: Massachusetts Institute of Technology's Purchasing & Stores

Founded in 1865, the Massachusetts Institute of Technology is an independent, coeducational university located in Cambridge, Massachusetts. The Institute is organized into five schools that contain twenty-one academic departments, as well as many interdepartmental programs, laboratories and centers whose work extends beyond traditional departmental boundaries. Success in these areas of MIT's mission overshadowed the need to seek the synergy that could result from coordinating the procurement activities.

MIT currently faces an annual budget deficit forcing a change in the historical treatment of procurement. This constraint inspired MIT to pursue re-engineering of its operations. The supplier relations and purchasing processes effort represents a particularly coordination intensive aspect of this re-engineering. The timing of my research coincided well with MIT's effort. Accordingly, this thesis documents the current process; it explains the changes proposed by reengineering; and, it analyzes these in light of coordination theory.

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The procurement process plays a large role in terms of the overall organization’s finances. MIT has an operating budget of more than $1.1 billion and a $10.1 million deficit.\textsuperscript{5} Collectively the groups at MIT purchased over two hundred and forty million dollars of supplies in the last fiscal year.\textsuperscript{6} Thus the financial scale is significant. Likewise the volume of transactions is large. According to Ms. Diane Devlin, Assistant Director of MIT Purchasing & Stores, “In the past two years, MIT has purchased goods from over forty thousand firms. In the last year, MIT issued purchase orders to 14,000 suppliers. About half (of the suppliers) are involved in one transaction only largely because of the specialized --often unique-- needs of Institute researchers.”\textsuperscript{7}

As a consequence of its fragmented purchasing process, MIT and its “subsidiary” organizations incur many direct costs well beyond the price of items purchased. These costs include substantial paperwork, time spent on paper shuffling, and maintaining internal supplies. Other inefficiencies were hidden; for example, the institute lacked the ability to capture volume discounts when each department or research group purchased independently. Thus MIT decided procurement was a candidate for “reengineering.”

\textbf{Reengineering at MIT}

Reengineering means, “the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical measures of performance, such as cost, quality, service, and speed.”\textsuperscript{8} MIT formed reengineering teams to improve productivity and reduce costs in several areas: Appointment Process, Custodial Services, Management Reporting and Financial Operations, Help Desk, Information Technology, Mail Services, Maintenance and Repair, Supplier Consolidation, as well as Training and Development.\textsuperscript{9}

This study focuses on the purchasing/paying process, i.e., procurement. Traditionally, each section of the MIT operates with large degrees of autonomy, consequently fragmenting purchasing into multiple uncoordinated instances of the procurement processes.

MIT Purchasing and Stores uses a heuristic approach that divides supplies based on the order frequency into three bundles: a white box of day to day items, a gray box of “spot” (for immediate as opposed to future delivery) order items, and a black box of unique items. The supplier consolidation team focused on three types of purchases (temporary help, scientific and office supplies and desktop devices) from the “white” box of commodities as reengineering targets. First, these purchases were chosen to pilot and generate easy wins. Second, these are high leverage areas exemplifying Pareto’s law.


\textsuperscript{6} Supplier Consolidation Re-engineering Team. \textit{Community Involvement Presentation}. March 27, 1995. pg. 4.

\textsuperscript{7} “MIT to re-engineer its ‘temp’ policy.” \textit{Tech Talk}. February 1, 1995. pg. 1.


\textsuperscript{9} “MIT Reengineering Teams.” URL http://web.mit.edu/afs/athena/org/t/reeng/www/teams.html
This law implies that a few primary items cause most of a given effect, i.e., the 80-20 rule. So a small number of supplies account for the greatest transaction and/or dollar volume. Finally, these types of purchases decompose into tasks that overlap with most other purchase processes.

What will happen to the process? The supplier consolidation team intends to streamline the purchasing process by consolidating suppliers to reduce the volume of paper flow and using technology, such as electronic catalogs and purchasing cards, as a coordination mechanism to eliminate steps in the process. Better coordination will also permit tracking of supplier performance and of consumer buying patterns.

Thesis Objectives

This thesis aims to utilize the Process Handbook methodology which is in turn based upon from coordination theory. Initially, this consisted of my learning the coordination theory supporting the Process Handbook methodology and understanding the practice of applying this methodology to organizational processes. My research focuses upon the process of purchasing, a component of the larger process of supply chain management at MIT. In particular, I attempt to elucidate effective mechanisms for coordinating dependencies between activities on a generic level from the specific site. I offer new suggestions for improving MIT’s process based on my analysis and analyze MIT’s prospective redesign which is based on three specific techniques: supplier consolidation, electronic commerce, and purchasing cards. My efforts also included work to test and to suggest refinements to a software application in development at CCS that maps processes into the Process Handbook’s format. Though this did not bear directly on the thesis it helped to clarify my understanding of the process and helped with the CCS’s mission to enable the Handbook to guide managers and consultants in creating or re-engineering business processes.

Ultimately, the preparation of this thesis created an opportunity for me to hone my research skills, to acquire a tool set to analyze business processes, and to explore business process re-engineering in a purchasing organization that acquires roughly a quarter billion dollars of supplies annually.

Overview of Document

The initial chapters lay a foundation. Chapter Two provides an overview of supply chain management at the site of the field study, the Massachusetts Institute of Technology. Chapter Three discusses the research methodology. The focus process of the field study appears in Chapter Four which describes the current procurement process in generic at MIT in generic terms as well as various specializations and related processes. Appendices A and B describe these in further detail.

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A pair of chapters analyze the current process which is then extended with analysis of the prospective, reengineered process and further scenarios I generated. Chapter Five offers an analysis of the current procurement process activities while Chapter Six offers an analysis of the coordination mechanisms managing the dependencies between activities in the current procurement process. Chapter Seven presents an analysis of the prospective process that will result from MIT's reengineering. Chapter Eight projects the process under several scenarios.

Finally, Chapter Nine concludes, highlighting possible areas to extend the Process Handbook, the key lessons derived from using the process handbook methodology, as well as from the specific tactics MIT will use. The Appendices include extra detail and supporting materials such as process maps, notes from interviews as well as selected artifacts from the current purchasing processes.
CHAPTER TWO -- PERSPECTIVE ON SUPPLY CHAIN MANAGEMENT

This chapter sets the context and bounds for the scope of the analysis in later sections. This begins with a broad description of the nature of supply chain management exploring the impact of organizational structures on coordination. The focus then narrows to describe the approach taken at the site studied.

Supply Chain Management

The supply chain can encompass a number of functions: suppliers produce and customers purchase. On a macro level, this means selecting suppliers, arranging transactions, and settling with suppliers. Managing the linkages between these functions plays a vital role in the quality, productivity and costs of an organization’s inputs. This paper targets inbound logistics and includes activities that range from determining suppliers to making payment. The case presented in chapter four maps these activities from the perspective of the buying organization. Organizations must manage acquisition of inputs since this process entails the allocation of a scarce resource -- money.

Is there a single ideal type of transaction? Probably not. Procurement transactions can occur via several processes with different task decompositions, flows, and dependencies. These reflect the nature of the input (price, physical characteristics, etc.), the immediacy of the buyers need, and the liquidity of the market. Transaction processes are shaped by two sets of structures: those between suppliers and the buyer as well as those within the buyer’s organization. This study omits more elaborate structures such as purchasing consortiums.

Taking a rationalist, economic perspective, price initially appears to be the key consideration. However, the total cost to the organization, not just the ostensible price of the item, must be taken into account, including the necessary transaction, transportation, and holding costs. Other important performance measures in supply chain management include: fewest defects, fastest cycle time, consistent performance, and protecting the organization’s assets. The design of structures attempts to permit the achievement of these measures by facilitating key components of coordination: communication, scheduling, and financial controls.

Inter-organizational Structures

Inter-organizational structures serve to harmonize exchanges between organizations. Interfaces introduce friction into physical systems. This holds true with individuals, groups, and organizations as well. The very specialization of production, inspired by Adam Smith’s division of labor, intended to optimize performance generates separation, and hence interfaces, that may hinder the performance of the larger system. To counteract this tendency, organizations create mechanisms and structures to bridge different goals and operating paradigms. This creation leads to markets, contracts, alliances, joint ventures, etc.

Open market transactions may lead to a short term, opportunistic focus with limited ability for redress or incentives for integration. Often the resulting transactions each consume more time and resources than would purchasing from a pre-established contract.
Contracts serve as a mechanism to further define market relationships and to lock-in specific rules to govern interaction for a length of time. The point of imposing structures is to reduce uncertainty surrounding transactions. The more ambiguity surrounding a transaction then greater use of coordination mechanisms is required to offer security. These set the basis for the type of interaction from an arms-length deal to a partnership. Contracts also add transaction costs to the cost of goods. “Transaction costs refer to the expenses incurred for writing and enforcing contracts, for haggling over terms and contingent claims, for deviating from optimal kinds of investments in order (to retain flexibility), to increase dependence on a party or to stabilize a relationship, and for administrating a transaction.”

Furthermore, negotiation cannot cover all contingencies due to inherent limitation of bounded rationality. For example, hidden information or actions on the by suppliers limits the effectiveness of short term deals. In order to reduce the resulting transaction costs, organizations enter long term relationships such as with contracts.

Market-based transactions imply certain types of transaction governance structures versus internal transfers in hierarchies, contractual trading partners, or amongst “partner” organizations.

The simplest transaction could be direct, e.g., Supplier - Buyer. The supplier designs and produces a product. The buyer exchanges cash for the product. This typically remains arms length for a single transaction; however, over multiple transactions the parties may move to a closer relationship.

Other transactions could be completely or partially indirect, e.g., Supplier - Intermediary - Buyer. An intermediary can increase transaction costs. This can occur directly as a percentage or per transaction “tax” as well as indirectly with inefficient coordination such as escalating paperwork. Examples of completely indirect transactions could include distributors or various layers in retail channels between the manufacturer and consumer.

In contrast, an intermediary can also decrease transaction costs first by reducing agency or imperfect information problems and second by offering lower cost through economies of scale. First in many transactions, banks serve as intermediaries to handle financial aspects of transactions such as payment instruction, actual fund transfers, as well as payment and credit acknowledgment. The latter can be seen in many outsourcing arrangements. In managing the supply chain, intermediaries can aggregate goods from a number of suppliers. For example, Ingram Micro orders software from thousands of suppliers, maintains regional inventories, and redistributes software to software retailers. This distribution role plays an important role if purchasers can not maintain sufficient scale of demand to establish direct relations with suppliers. Aggregators can also permit stock balancing across different manufacturers.

Selection of a particular transaction governance structure depends on the dimension of merit one wishes to optimize. For example, if the buyer requires immediate delivery upon recognition of need then speed should be optimized. This need encourages the

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selection of structures that reduce cycle time. Maintaining the input as stock in an inventory could offer an easy solution; however, the nature of the input may make this prohibitively expensive. The appropriate technology can establish an infrastructure to quickly deliver items. FedEx's infrastructure exemplifies this possibility.

**Intra-organizational Structures**

Within an organization, the structure that manages purchasing can be viewed as a continuum from centralized control to decentralized, local decision making. To guide the actions of the individual actors within a structure, organizations establish control policies.

**Centralized Purchasing**

Hierarchical organizations rely on complex structures of personnel to manage and control resources. Decisions flow from a central location down the bureaucracy to local levels. This structure permits efficiencies of scale and better monitoring of resources. However, centralization blunts opportunities for local innovation and responsiveness.

**Decentralized Purchasing**

In decentralized purchasing, low level demand in an organization triggers purchasing. The same low level handles the entire procurement process. In this case, market factors serve as the coordination mechanism for sourcing and pricing. This readily addresses dispersed demand. However due to lack of coordination, potential efficiencies of scale are lost.

**Control Policies**

Organizations create a host of control policies and supporting mechanisms to ensure smooth operations. For example, budgets serve to allocate resources before the procurement process begins. Internal financial controls serve to monitor misuse of resources. Organizations follow other policies, such as laws and accounting standards, in order to maintain the ability to participate in the larger market. Policies manifest in several nearly ubiquitous artifacts: creating positions to handle the external interface or act as checks and balances, using specific forms, assigning signing authority, and auditing expenditures. These artifacts serve to manage dependencies, i.e., forms for the flow of information and signature authority for the allocation of resources.

**Forms**

Paper is an excellent coordination mechanism to transfer information. Organizations take advantage of the print medium by preparing forms to hold various types of information. Forms create a paper trail for auditors. These also permit tracking of the commitment of funds.

**Signature authority**

Price is a primary dimension for the classification and control of supplies. The hierarchy of signing power for purchases reflects this dimension. Authorization covers different dollar amounts and types of purchases. If a person wishes to purchase an item of higher value, he or she must submit it for approval. The Purchasing Department inspects to verify appropriate approvals and prevent circumvention such as an item split into several requisitions.
Research Site Organizational Structures

Similar to many other organizations with long histories, MIT expanded by adding new departments, research centers and other groups each of whom often created new processes for purchasing. Two factors contributed to a lack of coordination. First, these groups often used unique information technology platforms. Second, groups set-up different types of internal account systems that run as shadows to the Institute’s system. Thus Purchasing must meet a number of different requirements when trying to coordinate procurement. On a positive note, the long history means the process has adapted to avoid most obvious failures.

This decentralization, even if composed of locally optimal purchasing rules, proved inefficient for the Institute as a whole. Inter-organizational relationships were fragmented into multiple parallel processes. This issue remained a low priority for MIT since supplies only serve as an adjunct to its primary role in generating and transferring knowledge. Given the MIT focus on supporting teaching and research operations, the organizational structures and procurement process at this site may not emphasis the same performance criteria, and hence structure and process, as other types of operations such as production, resale, or capital (property, plant, and equipment) acquisition.

At MIT, host of groups play a role in procurement: Endusers, Purchasing, Accounting, Receiving, and Property. This or a similar organizational structure prevails in most other organizations. Purchasing Department’s controls were primarily used to prevent misuse of funds and cost savings using cheaper suppliers rather than optimizing process effectiveness. Thus the department served as more of a watchdog than a sheepdog to coordinate procurement. This department also runs several internal suppliers such as the Office of Laboratory Supplies, a central campus inventory. These all operate on the basis of demand pull. MIT uses set policies to guide purchasing including a hierarchy of signature authorization and sets of forms. Please refer to Appendix D to see examples of typical forms.

The tradition of decentralization causes tension as Purchasing seeks to take a proactive role. “Significant change is difficult due to conflict among competing goals and norms: we want to distribute power and authority and yet we also want to improve control and coordination.”

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CHAPTER THREE -- METHODOLOGY
This chapter discusses the approach used to research, document, and analyze the site’s process. This section elaborates on coordination science, which serves as the theoretical foundation for the Process Handbook methodology. I also explain my experience with the developing Process Handbook software.

Center for Coordination Science
Chapter One described the mission of the Center for Coordination Science (CCS). The Center's work focuses on three project areas:

1. Organizational Structures, which studies how people work together and how this may change with new information technology;
2. Coordination Technology, which designs and studies innovative computer systems that help people work together in small or large groups; and,
3. Coordination Theory, which is the development and testing of theories about how coordination can occur in a variety of systems, such as human organizations, markets, and computer networks. Coordination theory draws upon a variety of fields, including economics, computer science, organizational theory, information systems, management science, and psychology.\(^\text{14}\)

Coordination Science
Coordination science is the interdisciplinary study of coordination in many kinds of systems. The Center hopes that by classifying dependencies between the individual activities within a process, patterns of coordination and resource utilization will emerge, upon which theories of effective dependency management can be based.

The means by which information technology creates new opportunities for coordination is of particular interest. To understand the effects of decreasing costs of coordination due to use of information technology on an organization, Malone and Rockart developed a predictive framework with three orders of effect:

1. Automation: the substitution of information technology for human coordination;
2. Increased Coordination: an increase in the overall amount of coordination used;
3. Coordination Intensive Structures: a shift toward the use of more "coordination-intensive" structures.\(^\text{15}\)

These effects result in the, “prediction that information technology should lead to an overall shift from internal decisions within firms (or vertical integration) toward use of markets to coordinate economic activity.”\(^\text{16}\) Extending this thought, the article argues that improved coordination mechanisms endanger intermediary organizations (such as stock brokers or distributors) that rely on market inefficiencies.

\(^\text{14}\) URL: http://www-sloan.mit.edu/ccs/research.html


The CCS research attempts to convert the current analysis of processes into a rigorous discipline that is, "systematized pursuit of knowledge involving recognition and formulation of a problem, the collection of data through observation (such as this field research) and the formulation and testing of hypothesis."\textsuperscript{17}

\textbf{Development of the Process Handbook}

In order to advance the study of coordination science, Malone and Crowston have developed methods for representing, classifying, and then analyzing processes in terms of their ability to coordinate, i.e., manage dependencies. This work formed the basis of the Process Handbook.

The first phase of development focused on the representational methodology and software support. Refinements in these areas continue. The second phase of the development focuses on collecting example processes from organizations. This latter phase generated this structured thesis project. By comparing these dependency managing processes and by having a catalog from which to chose established processes, CCS intends the Process Handbook to help create new processes, or to show how different processes might be applicable in new situations.

\textbf{The Process Handbook Methodology}

The Process Handbook attempts to represent and catalog varied business processes to achieve two goals: to help theoreticians imagine new organizations and to help consultants, managers, and others understand and redesign existing organizations. The key challenge is devising a notation or representation method for describing processes in such a way that they can be indexed and clearly understood. In order to do this, the process handbook leverages ideas of inheritance from software design and dependency management from coordination theory. The sections below elaborate on the terminology, representational tools and the analysis methods from the Process Handbook.

\textbf{Terminology}

The real value begins with a clear understanding of the terminology used in the Process Handbook methodology. The terms mix standard definitions with extensions to express the nuances of coordination. These distinctions capture how this methodology creates a more robust way to represent processes and their embedded dependencies than alternative approaches.

\textbf{Process}

A process means a set of activities to accomplish an objective. Hammer and Champy clarify by defining a process as, "a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer."\textsuperscript{18} Processes serve an important role in business since such routines provide consistent, stable environments.

\textsuperscript{17} \textit{Webster's Seventh New Collegiate Dictionary}. Springfield: G&C Merriam Company. 1971. pg. 771.

Decomposition
Decomposition means identifying discrete components and dividing an activity into component sub-activities for representation. This procedure can go through several iterations to further decompose sub-activities into their constituent activities. In general, decomposition of an activity represents Boolean "and" relationships. To complete an activity, each of its components must be accomplished. For example, the activity "pay for purchase" includes several sub-activities "determine amount" and "give amount to seller." Furthermore, the decompositions may yield generic sub-process, sets of activities which may occur in multiple processes. Using a software analogy, one may think of this as calling a common function in a program where the Process Handbook links to a common sub-process.

Inheritance
This term adopts the meaning used in traditional object-oriented computer programming. In this paradigm, different classes are created. Each class has a set of characteristics that are automatically "inherited" by any sub-class or specific object created under that parent class. Sub-classes start with the characteristics of the parent class yet may be modified with further characteristics to reflect a particular specialization.

Specializations
In general, specializations represent Boolean "or" relationships. Specializations offer alternative processes to accomplish the same activity. For example, the activity "pay for purchase" could be done at least by at least three specializations: pay with cash, pay with check, or pay with credit card.

A high-level activity may decompose into generic sub-activities. The specializations of the high-level activity each inherit a copy of the activity’s decomposition, i.e., the generic sub-activities. Thus each specialization starts with a basic decomposition. These become modified to reflect the unique characteristic sub-activities of each specialization. Thus in the "pay for purchase" example above each of the three specializations would inherit the two sub-activities "determine amount" and "give amount to seller".
<table>
<thead>
<tr>
<th>Dependency</th>
<th>Examples of coordination processes for managing dependency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared resources</td>
<td>“first come/first serve”, priority order, budgets, managerial decision, market-like bidding</td>
</tr>
<tr>
<td>Producer/consumer (Prerequisite constraints)</td>
<td>notification, sequencing, tracking</td>
</tr>
<tr>
<td>Producer/consumer (Transfer)</td>
<td>inventory management (e.g., “Just In Time”, “Economic Order Quantity”)</td>
</tr>
<tr>
<td>Producer/consumer (Usability)</td>
<td>standardization, ask users, participatory design, concurrent engineering</td>
</tr>
<tr>
<td>Simultaneity constraints</td>
<td>scheduling, synchronization</td>
</tr>
<tr>
<td>Task/ sub-task</td>
<td>goal selection, task decomposition</td>
</tr>
</tbody>
</table>

Table 3.1 Examples of common dependencies and alternative coordination processes

Dependencies
Dependencies describe the linkages from one activity that constrain the performance of another activity in a process. Of particular note, each dependency requires some method of coordination in order to be useful and used as a component of the larger process.

The table 3.1 displays the types of dependencies (shared resources, producer/consumer also known as flow, simultaneity constraints and task/sub-task) that have been identified by the Center to date.

Coordination Mechanisms
These link various activities by managing the dependencies. These links can be a resource (an actor or artifact) or yet another process. Examples appear in Table 3.1.

Representation Tools
In order to systematically document processes, the Process Handbook methodology offers some common tools. This section provides a brief overview of the basic tools: activity lists, process maps, and trade off matrices.

Activity Lists
An activity list is simply a chart that provides a structure for describing the activities and their attributes.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Actor</th>
<th>Goal</th>
<th>Artifacts</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.2 Sample Activity List

---

Table 3.2 shows a blank activity list. For my research, I expanded on this activity list to capture a more robust set of information for each activity. For each activity, I tracked Context and Dependency information. Context included the actor(s), skill(s) required, resources/artifacts, and the evaluation criteria. Dependency included type of dependency, activity upon which it depended, resources, and the coordination mechanism(s). Please refer to Appendix A to see the activity lists for MIT's processes.

Process Maps
These are graphical representations of processes, showing objects arranged in a hierarchical network with general activity categories at the top and increasingly specialized kinds of sub-activities as objects at lower levels. The lower level activities inherit the decomposition characteristics of the upper levels, and tend to be more specific actual activities, whereas higher level activities tend to describe components of objectives. Decompositions flow down the map. Solid lines represent this flow. Specializations flow to the right. Dashed lines represent this flow. A heavy arrow shows the dependency between sub-activities.

![Sample Process Map](image)

Figure 3.1 Sample Process Map
In Figure 3.1, the activity "pay for purchase" decomposes into two sub-activities "determine $" and "give $" as well as splits into three specializations: pay cash, pay check, or pay credit card. Items displayed in bold font have further decompositions. I show activities with specializations as shadowed boxes. Due to their nature, each specialization inherits the two sub-activities (though not shown in this diagram).

Process Map Hierarchy in the Handbook
The diagram below is the first screen displayed when entering the Process Handbook application. The goal is to be able to organize all processes to be mapped into four general top level categories, as shown.
My research explored certain specializations under "Acquire Inputs" in the "Do Business" division.

My main contributions to the database for the Process Handbook were adding the "make input" specialization, creating the decomposition of "buy input" to be inherited by all its specializations, and modifying the decompositions of selected specializations (the paper form process, the electronic requisition (EREQ) process, and the proposed electronic catalog (ECAT)). Please refer to Appendix A to see the decomposition of "buy input".

**Trade Off Matrices**
A trade off matrix refers to showing the relative advantages and disadvantages of various coordination mechanisms to manage a particular dependency. The dimensions of relative measure vary depending on what feature is selected for optimization and the level at which the process is examined. At the process level, the dimensions could include basic performance measures: cost per transaction, training time to learn mechanism, impact on cycle time, capacity to handle multiple instances of a process, etc.
**Analysis with the Handbook Methodology**

Documenting processes shows how resources are currently put together to operate. Analysis looks for and at best practices and speculates how people might work together differently with new kinds of information technology. Diagramming a process surfaces the dependencies between activities. Then the processes used to manage those dependencies can be identified and represented as well. The Process Handbook serves as a library to collect processes by providing a common taxonomy. After mapping a process, analysis of the activities or dependencies may reveal opportunities to improve the process’s effectiveness.

**The Process Handbook Software**

Researchers at the Center for Coordination Science have been working toward an application that will portray process maps including activity lists as well as description screens for each object (process, activity, specialization, or dependency) within the maps. Visual Basic, a Microsoft Windows development tool, serves as the development platform for this application.

Currently the software needs further refinement to offer a stable system. Beyond mere stability the feature set continues to expand as researchers, such as myself, push the envelop via rigorous use. As various processes are entered, representational issues often reflect the ambiguity in the still evolving theoretical framework as well. This product will require more development both in its own capabilities and in its reflection of coordination theory as that evolves, too.

**The Research Process**

The research undertaken for this thesis followed a traditional process of reviewing literature in the field, gathering data about the site, and conducting interviews.

**Literature Review**

General literature from several fields (in particular supply chain management, transaction cost theory, and reengineering) helped lay the foundation for the Purchasing Department’s role in an organization. I also sought articles describing the specific technologies underlying the process improvements (i.e. electronic commerce and purchase cards).

Initial research included locating documents published about the Re-engineering Supplier Consolidation Team’s work in campus publications. The team itself published explanations of its work on the World Wide Web.

**Interviews**

Initially, I met with the team leader and another member of the Re-engineering Supplier Consolidation Team. Several meetings were held with a Purchasing Agent to learn about the activities comprising the purchasing process. Please refer to Appendix B for notes from these interviews.

The initial interviews also yielded some documentation developed for the re-engineering effort. This documentation gave me a basic understanding of the issues in procurement. The discussions led to the selection of the temporary help process as the primary focus.
since the process fell within clear routine parameters. Purchasing of other categories of goods often contain exceptions from the basic process due to the nature of MIT’s unique needs.

The interviews began with open ended questions regarding the procurement process and the alternatives available to accomplish the same objectives at each level of detail. With rough process maps, I then asked specific questions for clarification, particularly emphasizing the fields on my activity lists such as the artifacts used in each activity.
CHAPTER FOUR -- CURRENT PROCESS
This chapter describes the procurement aspect of the current supply chain management process at MIT. I provide an overview of the key components of the procurement process and explore three specializations of the process for specific categories of purchases. To illustrate some of the overlap with other processes, this chapter briefly describes the budget control process as well.

Purpose of Purchasing & Stores Department's
The Department serves as a coordination mechanism for the organization to facilitate the allocation of a scarce resource, i.e., MIT’s budget. The Purchasing Department creates guidelines that coordinate decentralized local buying to capture scale benefits.

Supply chain management serves a number of purposes depending on one's perspective. From an economic perspective, the process should monitor funds. In procurement, this entails lowering the total cost of inputs. General tactics to accomplish this goal include: adjusting specifications (variety, quality, etc.), assuring competitive bidding, exploiting scale advantages, and reducing storage/distribution costs. While each of these tactics can be justified by pure economic in terms of cost benefit analysis, they also can be justified by coordination theory in terms of improving processes.

Description of Procurement Processes
The sections below step through the general procurement process then explain the unique features for three sets of purchases: temporary help, scientific & office supplies, and desktop devices. Reengineering starts with these processes as a pilot for other types of procurement. Appendix A presents different perspectives on the process: an outline list of all the steps, an activity list with specific characteristics of the steps and their relationships, and process maps in the Handbook style to graphically display the specializations and decompositions.

Procurement Process
The procurement process aims to provide goods and services to meet endusers’ needs. The supplier consolidation team decomposed the purchasing process into six high level components: identify need, source & price, approve (I include this in “create procurement requisition”), order (I include this in “process requisition”), receive, and pay. Shown in figure 4.1, these components occur sequentially without any parallel or overlapping activities. A priori this process will have much simpler coordination issues. I delved deeper than this level of abstraction. I focused on activities within Purchasing’s domain rather than the exogenous, control (budget and audit) aspects of procurement.

Figure 4.1 Top level Process Map of “Buy Input”

The supplier consolidation team did not go into further detail; however, interviews with Mr. McCluskey, a Purchasing Agent, developed the following process which further interviews collaborated. Please refer to Appendix C for interview notes.

The six sections below detail each of the key components of the process, "buy input". After describing this generic process, I will discuss how the process is tailored in three specializations based on the type of purchase.

Identify Need
The consumer (enduser) within the MIT community identifies the need for an item (input). Identification of a need may be proactive based on a forecast or reactive to a situation.

Find Source & Price
The Purchasing Department facilitates the search process with a list of potential suppliers that can meet the enduser’s need. The enduser selects a supplier using one process if the input costs less than $2,500 or another if it costs more.

Developing the list of potential suppliers involves researching the possible suppliers, receiving proposals and notifying the MIT community of the suppliers. Sending out the proposals uses the postal system as a mechanism to communicate. A Purchasing Agent acts to collate responses and draft a memo to the administrators in various groups within the MIT community. The administrators inform potential endusers of their options.

If the input costs less than $2,500, the enduser simply calls a supplier to get the purchase information. Alternatively, if the input costs more than $2,500, the enduser must complete a “Selection of Source” form which necessitates providing information from at least three suppliers as well as writing the justification for the selection of a particular supplier. Please refer to Appendix C for a sample of the form. Often endusers require the help of purchasing agents or simply rely on purchasing agents to complete the information.

Create Procurement Requisition
There are three sets of decisions in creating a requisition: a one time purchase order versus a blanket purchase order, a written versus an electronic requisition, for an amount below or above signature authority.

A requisition can be submitted for two types of purchase order (PO) numbers. Suppliers require a purchase order number before honoring an order. The PO number serves a
promise or proxy mechanism for the transfer of cash. A one time PO sets a specific amount to cover a single requisition. A blanket PO sets an upper cash limit to cover multiple requisitions for a range of time typically until the end of the fiscal year.

If the input costs less than the enduser’s signing authority, the enduser can submit a requisition directly to Purchasing for a PO number. Alternatively if the input costs more than the enduser’s signing authority then the enduser must get the requisition approved by someone who has the required level of authorization before submitting it to Purchasing. Here MIT uses managerial decision making to allocate the shared resources in the budget, since employees can always justify the need for their purchases.

A requisition can be either on paper or in electronic format. The paper forms are routed through MIT’s campus mail system or walked through the process. The electronic requisition (EREQ) system is available on the campus network. Once approved by someone with signing authority, the system automatically assigns EREQs for amounts less than $1,000 a PO number. EREQs over $1,000 are routed to Purchasing to receive PO numbers.

**Process Requisition**

When Purchasing receives a paper requisition, its processing begins. The receptionist reviews the authorization signature against official lists. The requisition is forwarded to a purchasing agent who reviews it versus policies, assigns a PO number, and informs the enduser of the PO number. The agent forwards the requisition to Data Entry who type it into the system and forward a copy to Accounting. Simultaneously, the requisition is executed either by the enduser (in which case Purchasing stamps the requisition “confirming”) or Purchasing (who mails an order or calls the supplier).

Purchasing uses an “alternative specialization,” i.e., a different approach, upon receiving an EREQ. When Purchasing receives EREQs over $1000, a purchasing agent who reviews it versus policies, assigns a PO number, and informs the enduser of the PO number. When an EREQ has a PO number, the requisition is executed either by the enduser (in which case Purchasing stamps the requisition “confirming”) or Purchasing (who mails an order or calls the supplier).

Purchasing sends the requisition form or a paper copy of the EREQ to Accounting.

**Receive Input**

The product or service worker arrives to perform a service for MIT.

Products arrive at receiving docks each of which covers a section of the MIT campus. Receiving starts a tracking form and then delivers the products to the appropriate location via campus mail.

Suppliers provide temporary workers with maps so they can arrive at the appropriate location. The temporary worker performs their service. The enduser or appropriate administrator signs the worker’s time card upon completion of the service. The supplier then uses this to create an invoice for MIT.
Pay for Input
The supplier sends an invoice to MIT. These go to the Purchasing Department. Purchasing logs the invoice and assigns a sequence number. Purchasing approves payment for invoices under $500 and on one time POs. Alternatively, Purchasing routes the invoice to the enduser for confirmation for invoices over $500 or on blanket POs. Invoices approved for payment go to accounts payable who process and batch the invoices before cutting checks. This “correct” process short circuits. Some suppliers know that Purchasing routes invoices over $500 to the departments. They attempt to save time by sending the invoices direct to the departments. However, the invoices have no record in purchasing and have a greater possibility of getting lost in the system.

This generic decomposition of the procurement process varies slightly depending on the required input. The next three sections discuss how some of these differences result in different specializations of the basic process.

Acquire Clerical, Temporary Help
One of the clearest processes at MIT is that of acquiring temporary help to perform clerical work. MIT purchased $1.7 million in secretary and clerical temporary help in the last fiscal year. 21

The recent history of MIT relations with temporary agencies demonstrates a gradual process of consolidation. In the past, Purchasing researched and published a memorandum of all local suppliers. This year Purchasing issued a memorandum of six “recommended” suppliers, though ordering from alternates was permitted. Traditionally, the MIT community could select from this list or seek another source.

How does the current process work? At a high level, the process consists of a person (Enduser) in the MIT community identifying the need for temporary help. When the need occurs, the person who needs the help must gather the information to place an order. This entails finding a source (Supplier) of temporary help and the price. Then the person has a choice: create a paper or an electronic procurement requisition. The requisition is then processed which entails actually ordering the temporary worker. The temporary arrives at the appropriate location, completes the work, and receives sign-off on a timecard. Finally, MIT pays the supplier.

Acquire Scientific & Office Supplies
Procurement seeks to define the processes for a narrow set of commodities in this category. Due to the unique characteristics of some scientific items in this category, purchasers must follow a number of unique processes. For example, hazardous materials require additional steps in the procurement processes. Further, different hazardous materials (biological, radioactive, etc.) have unique policy and physical requirements.

The primary difference in the acquisition process of procuring scientific & office supplies from temporary help is the decomposition of the receiving activity. Products arrive at receiving docks and then are routed to their destination. Suppliers send invoices directly.

21 McCluskey, S. First Interview. in Appendix C.
Workers proceed directly to their destination. Suppliers send invoices based on

timecards.

Timing and storage represent other differences. Temporary help is an outsourcing
process to reduce stock of employees to maintain high utilization since people require
continuous pay. However products in this supplies category can be stored until needed
depending on acquisition costs (time delays, economic order quantities, etc.) versus
carrying costs. Within the MIT community, there exists a central inventory for many
common products, the Office of Laboratory Supplies (OLS). There also exist inventories
at local levels for frequently used items.

My study reveal processes for further exploration in other research include disposing of
obsolete or excess inventory, forecasting demand for stocking levels, and controlling
disbursement/re-orders. A comparison of the policies for procuring the various types of
hazardous materials may yield a best practice.

Acquire Desktop Devices

MIT processes large amounts of information requiring desktop devices such as
workstations, personal computers, laser printers, etc. Endusers can order these devices
following the generic purchasing process or using the MIT Computer Connection (MCC),
an internal supply organization within the MIT community.

The desktop devices acquisition process has the same differences with temporary help
acquisition. The two main differences are the receiving process and the ability to order
within the MIT community from the MCC. This process differs from the acquisition of
scientific and office supplies in terms of transaction structures. The OLS differs in that it
is run as a service while the MCC is run for a profit and must compete with external
suppliers. This market incentive promotes greater efficiencies within the MCC than in
the OLS.

Relation to Same Process at Other Sites

Muller’s study of tasks that purchasers perform across eight sectors (manufacturing -- US
& European, US Government/prime contractors, state & local government, institutional,
service, retail, and food) found that Purchasing Departments usually take a larger and
more active role than that performed by MIT’s Purchasing Department.\(^2\) The study
found that most purchasers were involved in sixty nine distinct tasks that fell into thirteen
categories. These categories were:

\(^2\) Muller, E.W. *Job Analysis Identifying the Tasks of Purchasing*. Center for Advanced Purchasing Studies. National
<table>
<thead>
<tr>
<th>Category</th>
<th>MIT (now)</th>
<th>MIT (prospective)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procurement Requisitions</td>
<td>Some</td>
<td>Some</td>
</tr>
<tr>
<td>Solicitation/Evaluation of Proposals</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>Supplier Analysis</td>
<td>None</td>
<td>Some</td>
</tr>
<tr>
<td>Negotiation Process</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>Contract Execution, Implementation, and Administration</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>Forecasting and Strategies</td>
<td>None</td>
<td>Some</td>
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<td>Material Flow</td>
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<td>None</td>
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<td>Inventory Management</td>
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<td>Some</td>
</tr>
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<td>Real Estate Function</td>
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<td>None</td>
</tr>
<tr>
<td>Enhancing Purchasing Performance</td>
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<td>Some</td>
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<tr>
<td>External/Internal Relationships</td>
<td>Some</td>
<td>Some</td>
</tr>
<tr>
<td>Administration of Purchasing</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Personnel Issues</td>
<td>Some</td>
<td>Some</td>
</tr>
</tbody>
</table>

Table 4.1 MIT Purchasing’s Scope versus General Industry

Table 4.1 shows MIT’s functional overlap with general industry under the current and post reengineering processes. Viewing this table, MIT’s process simply represents a specialization of a more general process. This more general process represents areas for future research. MIT’s role in education and research as opposed to some form of direct production probably accounts for this smaller role.

This study could be biased towards an ideal state of influential purchasers since this was done for the National Association of Purchasing Management.

**Description of the Budget Control Process**

Procurement intersects with a number of control processes. Thus budgeting and management aspects in MIT’s control process came under examination for re-engineering.

The sections below step through the current control process. Appendix B presents different perspectives on the process: an outline list of all the steps, an activity list with specific characteristics of the steps and their relationships, and Process Handbook representations of specialization trees and decomposition graphs.

**Control Process**

Many of the activities in the procurement process support objectives for other processes rather than the immediate objective of acquisition. One of these supporting processes is the control process. As part of the larger re-engineering effort at MIT, a team decomposed the financial control process into five high level components: define measures, set targets, collect and input data, rework and reconcile data, as well as report and analyze information.

The first two components control the spending approval decision in the procurement process. The next two components take information from the forms generated in the
procurement process. The last component provides feedback to adjust spending approval decisions and other information (such as aggregate trends) to improve the procurement process.

![Diagram of Control Finances process]

**Figure 4.2 Top level Process Map of “Control Finances”**

*Define Measures*
Currently, MIT does not systematically perform this activity.

*Set Targets*
Units within the MIT community develop their operational budgets. Administration aggregates the budgets up the institute’s hierarchy. The budgets get reviewed, reworked, and approved. Authorizations follow from the budgets.

*Collect and Input Data*
The data that flows from the procurement process enters the control process. Data is classified and entered into the control accounting system.

*Rework and Reconcile Data*
Due to the multiple exchanges involved in the flow of data, its integrity becomes suspect. This sub-process attempts to confirm data integrity with data audits, reviews, reconciliations, and adjustments. This activity provides another opportunity to check authorizations and enforce controls.

*Report and Analyze Information*
This activity involves compiling the information from various sources to create management and compliance reports. The reports then serve as a basis to assess performance and perform audits.

**Process Inter-relations**
While the Process Handbook methodology offers a way to analyze a process in static isolation, true understanding of a business transaction requires a bit more description, since most processes interact with other activities. For a seller, the flip side of the procurement process is the suppliers' sales to order fulfillment process. This involves marketing to facilitate the search process, receiving an order, checking credit, pulling inventory or producing goods, and shipping. Taking a larger coordination view implies that a buyer may want to help optimize processes for their supplier too. For a buyer, at least two other processes (budgeting and financial control) impact procurement. Financial control and managerial decisions serve as coordination mechanisms to manage the dependency between procurement and the budget. In another perspective the financial
control is itself a process. The redesigned information technology proposed by the reengineering effort will integrate the procurement and control processes; therefore, I have briefly introduced this. The budget serves as an exogenous factor.
CHAPTER FIVE -- ANALYSIS OF CURRENT PROCESS ACTIVITIES
The previous chapter simply described MIT’s current supply chain management process. Hammer and Champy allege this first step, the description of the status quo also undertaken when reengineering, can be a trap to “analyze a process in agonizing detail rather than attempting to understand it.”23 This chapter attempts to understand the processes.

I analyze the process maps and activity lists of the current process for opportunities to improve process effectiveness via better coordination. Then I focus on coordination mechanisms (external artifacts and policies, internal artifacts, and internal policies).

Analysis of Process Maps and Activity Lists
Hammer and Champy caution that, “when it’s finished the process map should not surprise anyone.”24 This may be true for actors who use the process; yet, analysis of the process maps should raise interesting issues. The Process Handbook Methodology does not currently offer a recipe or standard set of questions to analyze the process maps and activity lists. While CCS intends this to offer practitioners flexibility to uncover different insights, I believe a basic template would lend greater rigor via consistent criteria which could also facilitate more cross-process insights. Adopting a coordination theory perspective for my analysis, I attempted to uncover the surprises and leverage points. To this end, I found several heuristics useful:

- dangling items (activitie.., resources, etc.),
- alignment of evaluation criteria,
- classes of resources,
- path of resources,
- specializations’ rationale, and
- specialization usage rates.

These heuristics grew from questions I had when trying to complete activity lists and understanding the implications of particular activities.

Dangling Items
Dangling items refers to forms generated, activities performed, or data tracked that did not contribute directly to the procurement objective. These raise a warning flag for further exploration.

Some forms appear to have no apparent use, for example the third sheet of the receiving room form. Its present disuse indicates a possible breakdown in perpetuating organizational learning or at least a lack of introspection. Examination stops such dysfunctional perpetuation. Requisition forms also had a vestigial sheet attached. “We


couldn't find a good use for them," said Barry Rowe, Director of Purchasing and Stores. "So we decided to eliminate them (saving over 100,000 pieces of paper a year)."

Other activities or items, such as the filing of forms, appear dangle in the procurement process, but may actually be used by overlapping processes. Both the enduser and the Purchasing Department finish each procurement transaction with a set of files. While keeping both sets may be redundant since this paperwork costs in time and materials, one set may serve a purpose. These sets of documentation signal linkages to one or more other processes, in this case, the control functions of budgeting and auditing. Internal MIT auditors pull forms randomly on a daily basis from Purchasing's files. External government agencies use the forms as well to perform comprehensive audits, typically every two years.

Alignment of Evaluation Criteria
Alignment of evaluation criteria refers to how various groups within MIT judge the procurement activities successful. Different sub-units in an organization may have different goals that conflict such as accuracy versus speed.

Since divers coordination mechanisms optimize different characteristics, misaligned criteria hinder the optimization of the process objective in favor of local interests. Therefore, viewing the process from the perspective of each actor may help design alternatives that align or at least do not render objectives incompatible. For example, McCluskey stated that the Office of Sponsored Programs (OSP) takes several weeks to review a PO form versus the policy guidelines for a specific account. OSP values precision while other actors in the process value speed. If the actors were aware or motivated by aligned evaluation criteria, the process might use different coordination mechanisms to track the information that OSP needs to quickly render a decision. This would require further research into the nature of the processes occurring in OSP.

Classes of Resources
Classes of resources refers to bundles assets used to facilitate activities and the flow of the process. Resources seem to fall into three classes: single instance artifacts (forms, conversation, etc.), multiple instance artifacts (an internal infrastructure of computers, shared control resources/actors, etc.) and infrastructure (policy, phone systems or multiple instance artifacts outsourced to achieve scale such as mail).

<table>
<thead>
<tr>
<th>Resource</th>
<th># Instances</th>
<th>Decision</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Single</td>
<td>purchaser</td>
<td>internal</td>
</tr>
<tr>
<td>PC network</td>
<td>Multiple</td>
<td>manager</td>
<td>internal</td>
</tr>
<tr>
<td>Internet, phone</td>
<td>Multiple</td>
<td>policy</td>
<td>external</td>
</tr>
</tbody>
</table>

Table 5.1 Resources classes versus tasks

As Table 5.1 shows, classifying resources along the dimension of reuse across multiple instances or location relative to the firm enables the evaluation of alternatives. Each

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successive class encompasses the capabilities of previous classes for a given task. Another dimension could show a tradeoff cost per transaction. For example, costs drop by sharing resources across multiple instances as occurs with external infrastructure; yet, internal resources fit organization requirements better.

Path of Resources
Path of resources refers to the state in which and the procedure by which resources enter and exit the process activity flow.

The methodology does not clearly capture how either resources or artifacts generated by the process enter and exit the process flow. Where each of the resources comes from, how it gets used, and where it goes to after the activity occurs may play a role in considering alternatives. This helps define the process boundaries broadly enough to capture the relevant activities.

This boundary problem within an organization can be circumvented by using more effective coordination between units. For example, this procurement process generates a substantial amount of paper documentation: a requisition, possible supporting pricing information, a purchase order, a receiving form, and an invoice. Purchasing stores one set of this documentation on site for eighteen months. Then it is sent to off-site storage for another three years. Endusers retain other copies of the same forms. All this indicates an opportunity to reduce duplication and perhaps use a new medium -- digital formats.

Proliferation of Specializations
The process would be much clearer without multiple specializations to achieve the same objectives. Excepting triage with "if-then" alternatives for procurement of different classes (price levels, hazardous materials, etc.) of products, this would appear to lead to better coordination. Typically, triage connotes a simple set of exceptions rather than different routes within one complex process. Instead of selecting the best alternative, MIT simply layers new alternatives with the previous options. This inefficiency is a matter of political expediency based on the historical catering to departmental preferences. Thus there appears to be an opportunity to select and mandate specific processes.

Specialization Usage Rates
Specialization usage rates refers the percent of instances that follow particular specializations when comparing multiple instances of a process.

The Process Handbook process maps currently show alternate routes that can be followed yet do not indicate the number of multiple instances of the processes.

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26 McCluskey, S. Interview. in Appendix C.
Figure 5.1 Sample specialization usage rates

As Figure 5.1 shows, McCluskey noted that in the procurement process, users place 60% of all requisitions electronically via EREQs; 90% of the actual orders; while purchasing agents place 10% of the actual orders. Determining these usage rates leads to questions on preference and effectiveness of alternate specializations. These particular examples reveal a preference for faster cycle times. Thus prescription of alternatives should focus on mechanisms that optimize this dimension.

Contrary to most commercial firms that can require adherence to corporate purchasing policies in order to secure funding, the central MIT corporation can not always use resource allocation as a control mechanism. The individual schools, departments and research laboratories often have their own sources of funds to cover all or part of their operations. Politically, these groups have substantial clout with the MIT corporation. Consequently, Purchasing prefers incentives rather than mandates to enforce policy compliance unless absolutely necessary for reporting requirements.

This leads to odd effects on the percentage of people who select various specializations. While EREQs save at least several days over paper requisitions, endusers continue to submit 40% of the total requisitions manually since the introduction of this method in 1992, Diane Devlin gave several examples of other factors that impact this choice. For instance, the weather and the endusers physical distance from Purchasing have a very significant correlation with usage of EREQs. With good weather, more people walk their requisitions over to Purchasing. The transient nature of the enduser population of visiting researchers also biases toward specializations that are clear though slower or require little up front time investment.

**Beyond Process Maps and Activity Lists**

The Handbook tools, process maps and activity lists, served well to uncover the official process; however, the methodology did not account easily for breakdowns or non-routine activities. Perhaps these could be viewed as specializations of the official process. After building a rapport with the interviewees and uncovering the official process, I could ask questions to probe for breakdowns.

**Process Failures**

Even if the official process from a top-down analysis appears sound, one should confirm this with some bottom-up verification with the actual workers. When I verified the processes with endusers and a purchasing agent, they agreed my process decompositions were “correct”. I went further to also ask when and where in day to day operations the correct process tended to breakdown, exhibited bottlenecks, or required expediting. Breakdowns can be seen in the use of informal channels outside of the designated process. These coordination efforts require higher involvement due to their non-routine nature. What fallback mechanisms are used when the principle process breaks down?
These discussions revealed common breakdowns (coordinating supplier -- purchaser communication and incomplete or incorrect information) and responses to breakdowns, expediting.

**Coordinating supplier -- purchaser communication**

Endusers reported that gathering the information to fill the requisition and placing the actual order took too much time. This stemmed from “phone tag.” To illustrate this bottleneck, a brief purchasing scenario: An MIT research first locates a supplier’s phone number. The researcher calls the supplier but can only get the appropriate pricing from the representative for MIT. If the representative is otherwise occupied at the time of the call, then round of phone tag ensues. After the requisition is completed and processed with a PO number, the researcher must call the supplier back to place the actual order with the representative for MIT. A second round of phone tag ensues.

A communication error can occur with the invoice as well. From their past experience, some suppliers know MIT’s policy that the enduser confirm purchases over $500 and seek to prevent the several days spent by Purchasing before returning it to the enduser for confirmation. This circumvention of the official process can cause serious repercussions (non-payment) if the invoice is lost since Purchasing has no record of backup record.

**Incomplete or incorrect information**

Incomplete or incorrect information on forms requires rework. This can occur at each interface in the process. Purchasing must often either call the enduser to clarify the requisition or send the forms back to the originator via campus mail. Similarly, Receiving must identify the actual recipient for packages without clear destinations.

**Process Expediting**

If something goes wrong or the resource for an activity does not have sufficient capacity then the actor must decide to: a) adhere to the process and wait, b) use a less efficient mechanism, a work-around, or c) take the role of the proverbial “squeaky wheel”. The last approach takes the form of walking a requisition through the process, pressuring other actors to perform. This occurs especially for requisitions over the enduser’s signing authority. In another tactic, endusers go directly to Purchasing for expert assistance.

**Identified Process Opportunities**

MIT aims to reduce costs, increase speed, and improve accuracy. The MIT team identified several opportunities for reengineering: supplier consolidation, electronic commerce, and purchasing cards. Each opportunity stems from best practice sites though MIT’s plans to implement the electronic commerce will use a new type of technology and tie all three tactics together in a unique package. MIT will use pilot projects (which can be thought of as a type of a coordination mechanism for managing the transition to a new platform) to test acceptability and usability. Why did MIT focus on these three levers?

First, exogenous factors cause a high volume of transactions. The large number of suppliers with overlapping offerings presented an obvious target. “With 14,000-plus
suppliers (in the last year alone), MIT has more providers than personnel.27 Maintaining each supplier relationship requires time and paperwork from MIT.

Second, information technology can reduce transaction costs and a previous effort in this direction, the EREQ system, focused only on the steps within MIT whereas technology can potentially enhance communication with suppliers and others outside of the MIT community. This could permit the building of mechanisms that track the entire process. Information technology in the form of electronic commerce augments procurement as a tool to facilitate the communications. If coordination could be extended to tightly integrate with suppliers, then MIT could implement principles from the Just-In-Time (JIT) movement. With JIT, closer supplier relations diminish the need for purchasers to maintain inventory for their internal demands.

Third, improvements in financial software and systems permit “credit cards” to be tailored for specific users. Processing of small transactions can be reduced with a card system tied to the MIT preferred suppliers “Purchases of under $500 represent only three percent of MIT’s business but 80 percent of the paperwork required.”28

Other Potential Activity Opportunities

In addition to the three levers targeted by MIT, my analysis of the process maps and activity lists helped me identify several areas for potential improvement.

First, eliminate redundant records via electronic records. By storing data in electronic form, one set of data can serve both the enduser departments and purchasing. If audit activities accepted electronic data, this would avoid storage, search and retrieval costs.

Second, align criteria across departments’ activities through consensus meetings. The Office of Sponsored Programs (OSPs) wants the sponsored research groups to achieve their aims; yet, it needs to insure the groups fulfill the appropriate sponsor requirements. If sponsored workers knew OSP’s needs, perhaps a new format of documented requisitions might enable OSP to fulfill endusers’ fast cycle time preference from order to approval.

Third, implement mandates to force adoption of desirable specializations (i.e., EREQS). If compliance with the most productive specialization were complete, then MIT would not have multiple processes which required extra maintenance.

Fourth, improve shipping by issuing preprinted labels to suppliers. This would streamline product delivery by saving Receiving identification time and reducing returns.

These four ideas represent just a few ideas that could improve on the process activities. In addition to improving component activities in the process, other opportunities (described in Chapter Eight) exist for reframing the entire process to improve coordination.

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CHAPTER SIX -- ANALYSIS OF CURRENT PROCESS COORDINATION

Dependencies link activities that constrain the performance in a process. Due to their nature dependencies are intangible while the coordination mechanisms used to manage these dependencies offer a tangible, leverage point for improving the process. Thus this chapter focuses on the coordination mechanisms evident in the procurement process.

The process of attempting to complete the activity lists focused my attention on potential opportunities in dependencies' coordination to improve the process. Comparison with mechanisms used in other processes in the Handbook provided further insight.

Current Coordination Mechanisms

The type of coordination mechanism used to link across dependencies depends on the frequency, type of dependency, and the amount of contact needed. This section culls the coordination mechanisms from the current process and categorizes them as either external or internal relative to the organization. The mechanisms can also be tangible artifacts or intangible such as policies.

External Artifacts and Policies

The environment imposes certain external mechanisms to handle coordination with other organizations.

Infrastructure

Developed economies consist a network of organizations. Analogous to a multi-dimensional mesh of nodes and links, the integrity of our economy depends on the ability of organizations to coordinate with each other. Organizations within the United States benefit from a well-developed infrastructure which directly impacts the linkages in the supply chain. The postal and phone systems enable communication between various parties. The road network permits actual delivery. Other factors are less conspicuous. The legal framework and public services such as police offer a safety net that gives certainty by offering redress in market transactions.

Intermediaries

In addition to the general infrastructure, the commercial development in the United States creates a robust base of business intermediaries. This permits organizations to specialize in core businesses and rely on intermediaries thus optimizing their performance. For example, the financial system supports completion of transactions. MIT uses this system outsourcing many financial tasks to banks with greater economies of learning and scale. Likewise, retail distribution channels serve to mitigate search costs by improving coordination between producers and consumers.

Standards

Just as the Process Handbook provides standardized terminology for sharing databases of process information, organizations require common understanding to manage the supply chain process. Thus standards play a vital role in coordination by providing consistency that permits routine activities. On a fundamental level, our communications benefit from a shared language.
Industry and government create groups, such as the American National Standards Institute in the United States, that act as mechanisms to coordinate inter-organization transactions by defining standards. The International Organization for Standardization (ISO, the abbreviation is derived from the Greek isos, meaning "equal") is a worldwide federation of national standards bodies from some 100 countries. ISO defines standards as, “documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose.”

For example, MIT orders a "case", knowing this means 144 units, of standard types of pipettes, beakers, etc. which themselves measure according to common metric standards.

Standards aim to facilitate trade, exchange and technology transfer through:

- enhanced product quality and reliability at a reasonable price,
- improved health, safety and environmental protection, and reduction of waste,
- greater compatibility and interoperability of goods and services,
- simplification for improved usability,
- reduction in the number of models, and thus reduction in. costs,
- increased distribution efficiency, and ease of maintenance.

The generation of standards itself represents an interesting process for future study. ISO accomplishes this with a highly decentralized hierarchy of globally dispersed committees.

**Internal Artifacts**

**Forms**

Many activities depend on the transfer of information between two actors. Standard forms prompt an actor for required information and promote consistent retrieval of information. Please refer to Appendix D for sample forms used at MIT. The use of paper forms has a tradeoff in that costs rise linearly with volume whereas computer networks with electronic forms have a high initial cost and negligible marginal costs of carrying greater volume of traffic.

**Computer Network**

Another vehicle to transfer information at MIT is the network of campus computers. These reduce the time and costs associated with transferring paper via the campus mail system. Electronic Requisitions (EREQs) provide a way to reduce paperwork within the MIT community by automation, the first order effect from Malone and Rockart’s predictive framework. EREQs reside on a system is called MITVAPS, MIT VAX for Accounting, Purchasing and Stores. The system offers around ninety functions. That serves to provide information that previously required calling a designated contact.

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Designated Contacts
Liaisons are set within MIT; purchasing organization for various categories of inputs. Please refer to Appendix D, MIT Purchasing Offices and Agencies -- Locations and Contacts. Likewise, each supplier designates a single point of contact to be used for MIT. This mechanism serves a coordination function in that it establishes clear authority to make decisions.

Internal Policies
Similar to the external policies that enable inter-organizational coordination, organizations must establish mechanisms to manage dependencies within their own firm. These mechanisms set guidelines to facilitate transactions, document activities, set responsibility, and provide correction procedures inside an organization. The documentation and other aspects designed to protect the organization can actually add to internal costs impeding the process. Policies can be imposed as architecture through departments and positions or rules. Alfred Sloan developed policies to manage GM through, "increased autonomy and self-determination (decentralized operating responsibilities) on the one hand, uniform accounting (financial controls) and tight monitoring of performance (standard procedure manuals) on the other."

Most modern organizations use similar policies to align the objectives of their components. Policies impose artificial demands, generating information and forms for other, related processes which do not add value to achieving the immediate objective such as purchasing yet may help track funds for auditors reviews. Coordination theory implicitly advocates transparent policies. Transparent means the coordination mechanisms automatically perform the control activities so endusers only perform and perceive the value-added activities to reach the objective. For instance, a enduser creates a requisition then the coordination mechanism, a software program, can automatically filter and route the appropriate information to other actors such as accounting.

Organization Structure
Traditional transactions necessitated the development of bureaucracy as a rational policy response to the problems of monitoring and control without computers as coordination technology. The bureaucracy spawns specialized actors whose purpose is to convey information and control processes such as the task of managing the supply chain. Procedural and human gatekeepers filter information into the control channels.

Specialized actors who serve to coordinate the procurement process include: endusers, authorized signers, administrators, secretaries, MIT mail employees, purchasing personnel (receptionist, agents, and data entry), accountants, and auditors.

This division of labor works well for physical tasks such as in Adam Smith’s apocryphal pin factory. However as organizations continue to grow in scale and complexity, new coordination mechanisms may be required. Hammer and Champy point out two tradeoffs to division of labor. First, no one person is responsible for business processes. Second,

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the processes become error prone. Essentially, division of labor can lead to a lack of coordination that introduces diseconomies of scale.

With simple tasks, finding and training workers to perform activities is relatively easy. Finding workers to track accountability, coordinate activities or design processes is more difficult. Thus, as activities become more complex, the hiring process becomes correspondingly more costly.

In its the high level structures, MIT strikes a good balance in its purchase process between centralization in the form of the purchasing office and decentralization in the departments, research laboratories, etc. MIT thus captures some benefits of financial control with institute-wide purchasing policies while permitting local demands to be met.

Creating the Office of Laboratory Supplies (OLS) represented a step toward capturing some of the efficiencies of bulk ordering with an internal inventory. These inventories can serve as a buffer. Products with high usage join the stores of the inventories. With this system, an “internal store” should serves as a coordination mechanism; however in this case, the inadequate implementation and small percentage of total purchases using this resource resulted in inefficiencies which increased the average cost of items by 25%. This could stem from dysfunctional perpetuation, i.e., stock keeping units once added do not have a systematic mechanism to review their justification. The inventory proves useful for high turnover items; yet, other items languish unused. Of 6,700 stock keeping units (SKUs), less than 500 items account for 90% of the volume.

**Signature Authority**

Control is the issue behind the signature authority level policy to limit the issue of purchase order numbers. This hierarchical resource allocation method enables people in high level to approve or deny large purchases; yet, higher levels do not decide on every item, i.e., items below the spending limit. Perhaps the cost in terms of time would have been too high if every single item were submitted for approval. Clear lines of authority reduce ambiguity helping to prevent financial problems by ensuring accountability.

Price is a primary dimension for the classification and control of supplies since it directly impacts the dependency on shared resources, organizational funds. The hierarchy of signing power for purchases reflects this dimension.

MIT, for example, sets the highest level of signature authority then a trickle down hierarchy establishes local authority within each department. To control and maintain a record to coordinate this process, MIT uses signature authority cards. Each card lists the subsequent layers in the hierarchy, so if an enduser knows who to approach for various amounts and category of approval. Refer to attached Appendix D. There are two dimensions to signature authority, category and amount.

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35 Devlin, D. Interview April 7, 1995. in Appendix C.
There are four categories of signature authority:

1. *External Requisitions*: open a purchase order (PO) number. This may be done on a paper format or using an electronic requisition (EREQ). Paper takes two to three days longer than EREQs but may be expedited by physically walking it to the appropriate personnel.

2. *Internal Requisitions*: open a purchase order from an internal supplier such as Graphic Arts or the MIT Computer Center.

3. *Travel Signatures*: pay for expenses incurred while traveling. Note, this is different than travel vouchers that cover a single person. In Boston, a PO can be used; outside Boston a travel voucher must be used.

4. *Invoice Signature*: authorize accounting to cut a check to pay a supplier.

Authorization also covers different dollar amounts, such as up to $500, $1000, $25000 or unlimited. If a person wishes to purchase an item of higher value they must submit it for approval. Purchasing inspect to verify items are not split into several POs.

### Classification of Coordination Mechanisms

<table>
<thead>
<tr>
<th>Dependency</th>
<th>Examples of coordination mechanisms for managing dependency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared resources</td>
<td>signature authority, negotiations, audits, lottery</td>
</tr>
<tr>
<td>Producer/ consumer (Prerequisite constraints)</td>
<td>policy, verification</td>
</tr>
<tr>
<td>Producer/ consumer (Transfer)</td>
<td>distribution lists, EREQs, numbering systems (requisition, PO, invoice, etc.), email</td>
</tr>
<tr>
<td>Producer/ consumer (Usability)</td>
<td>pilot testing</td>
</tr>
<tr>
<td>Simultaneity constraints</td>
<td>location</td>
</tr>
<tr>
<td>Task/ sub-task</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.1 Dependencies and “new” coordination mechanisms from the site

For the basic dependencies, Table 6.1 displays the new coordination mechanisms I identified in this process that were not explicitly included in previous formulations, as shown in Table 3.1. I also found examples of potential new dependencies: search and approval. My curiosity with the initial establishment of the producer consumer dependency lead to a discussion with Fred Luconi, a visiting scholar at CCS, about a possible dependency, search. Search makes both parties aware of the other, i.e., producer’s capabilities and consumer’s needs. Initial coordination mechanisms to manage the search dependency for producers entail marketing and for consumers using indices or word of mouth. Other potential dependencies, such as an “approval”, are still in the process of being defined and incorporated as a part of the analysis. Thus far, the

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approval dependency has two possible reasons for existing: quality assurance and resource management.

**A Framework for Current Coordination Mechanisms**

The Process Handbook Methodology does not currently offer a recipe or standard set of techniques to analyze the suitability of coordination mechanisms or suggest alternatives. I found it useful to categorize the coordination mechanisms by:

- type of dependency the managed,
- ease with which mechanism permits the underlying resource to be shared,
- training time to learn to use a mechanism as a proxy for its usability, and
- costs (both initial cost and cost per transaction).

Table 6.1 applies these categories to the mechanisms used to manage the flow dependency of information in the procurement process. The table provides rough relative weights in each category. This should permit process designers to evaluate the characteristics of these mechanisms when developing new processes.

<table>
<thead>
<tr>
<th>Coordination Mechanism</th>
<th>Ability to Share</th>
<th>Training Time</th>
<th>Initial Costs</th>
<th>Cost per Transaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>requisition (paper)</td>
<td>low</td>
<td>low</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>requisition (electronic)</td>
<td>high</td>
<td>medium</td>
<td>high</td>
<td>medium</td>
</tr>
<tr>
<td>phone call</td>
<td>low</td>
<td>low</td>
<td>medium</td>
<td>high</td>
</tr>
<tr>
<td>purchasing files</td>
<td>medium</td>
<td>medium</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>catalog (paper)</td>
<td>low</td>
<td>low</td>
<td>low</td>
<td>medium</td>
</tr>
<tr>
<td>catalog (electronic)</td>
<td>high</td>
<td>medium</td>
<td>very high</td>
<td>low</td>
</tr>
</tbody>
</table>

Table 6.2 Tradeoffs between information flow coordination mechanisms

An organization must weigh the tradeoffs in Table 6.2 against its resource constraints and desired performance criteria. In this case, I deem a mechanism that has the ability to be shared leveraged, or replicated by a greater number of users as preferable in an organizational context. Training time could be a consideration in an organization with high turnover. Costs would need to be weighted versus budget and the expected process life time or volume of transactions. MIT already has the hardware infrastructure; thus, its costs for electronic media are low, since they just need software.

It is interesting to note that these mechanisms themselves decompose into processes and assume lower level coordination mechanisms such as a common language and alphabet.

<table>
<thead>
<tr>
<th>Type</th>
<th>Format</th>
<th>Coordination Mechanism</th>
<th>Condition(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>word of mouth</td>
<td>memory</td>
<td>person, phone</td>
<td>collocation actors (time and space)</td>
</tr>
<tr>
<td>print media</td>
<td>text</td>
<td>paper forms, fax, mail</td>
<td>linear costs as use increases</td>
</tr>
<tr>
<td>electronic media</td>
<td>multimedia</td>
<td>digital storage and access devices</td>
<td>compatible technologies, infrastructure cost</td>
</tr>
</tbody>
</table>

Table 6.3 Coordination mechanisms to transfer a meme
Table 6.3 aggregates coordination resources that manage the flow of information by type and categorizes them in light of the format transmitted, the required resources, and limitations. Also, the effectiveness of mechanisms varies in conveying information. A person can convey nonverbal, emotional queues as well as interactively correct while print lacks these capabilities instead have the characteristic that permits wide distribution.

The word of mouth mechanism in Table 6.3 raises a further issue that an actor who performs an activity may in fact be the coordination mechanism.

![Graph showing tradeoff costs between paper forms and electronic forms.](image)

**Figure 6.1 Tradeoff costs with alternate coordination mechanisms**

While precise scales may vary, Figure 6.1 portrays relative costs of managing information transfer between activities. Though the Handbook methodology does not yet account for the impact of volume on a process, Figure 6.1 demonstrates that the number of multiple instances plays an important role in the choice of coordination mechanism. Other tradeoffs exist too. For example, paper serves to simply transmit information while computers can process the information too.

By identifying classes of coordination mechanisms or similar types of dependencies in the process, a single coordination mechanism resource can be used to reduce the hand-offs. An example of this is apparent in the procurement process, many of the prerequisite flows depend on the transfer of common information. This lead to standard forms. These routine data architectures in turn make ideal candidates for automation.

**Optimization Depends on Perspective**

The optimal coordination mechanism may vary depending on the perspective of different actors who value different characteristics. For example, endusers and purchasing prefer to order via the phone for usability reasons while suppliers must weigh their preference for faxes or mailed orders to create a documentation trail against their desire to provide customer service.

**Identifying Coordination Mechanism Opportunities by Comparison**

Drawing parallels with other field studies and coordination mechanisms, permits me to identify better ways of managing dependencies within the procurement process. This
section presents analogies that may offer alternatives for coordination in each of the major components of the procurement process and presents alternative coordination mechanisms.

Identify Need
From factory floors, the Kanban system offers an alternative coordination mechanism. In this system an actor in a given activity looks downstream to the capacity of the buffer for the next activity. If it has open capacity, then the item is sent forward into the buffer. This could apply to MIT’s procurement system if the campus were to have local inventories, such as OLS, tied to a system that would give suppliers automatic notification for restocking to a prespecified level.

Find Source & Price
The search process resembles use of a pharmacological formulary, since Purchasing provides lists of recommended suppliers.

Create Procurement Requisition
From the medical world, the triage method offers an alternative coordination mechanism. Triage systems presort items then route them to different specializations of a process. This already apply to MIT’s procurement system since items are viewed by account number and object numbers. However the object numbers are out of date for example, the athletic department uses the fish code for javelins.

Process Requisition
From martial arts training, the principle of economy of motion yields coordination and conserves energy. Business process that only have value-added activities also exhibit coordination and reduced costs.

Receive Input
Receiving’s structure resembles the airlines’ hub and spoke system with several docks each covering several buildings.

Pay for Input
Purchasing uses a triage system to streamline the procurement process for items under $500.

Other Potential Coordination Mechanism Opportunities
Based on my analysis of the dependencies, MIT could take further steps for process improvement. I would recommend that MIT: use electronic instead of paper records, force completion of certain data fields on electronic forms to prevent usability failures in latter activities, limit or shift policy requirements from other processes, raise signing authority hurdles after successful audits, or use cross-functional teams with a purchasing agent, accountant, and an Office of Sponsored Programs employee or other audit official. This last option could mean co-location in teams to improve coordination; however, this may lead to collusion which the original separation was meant to curtail.

Other dependency opportunities arise across multiple instances of the process to achieve economies of scale. For example, MIT could take advantage of seasonal demand variability: research while uncovering the process of desktop device acquisition revealed
a tangential fact unrelated to the process flow performance that hinted at an opportunity to
design a more effective coordination mechanism. Despite maintaining consistent stock
levels of desktop devices in inventory, analysis showed that demand varied seasonally.
Thus utilization and overhead varied generating considerable inefficiencies. Analyzing
data on past purchasing revealed three peak purchasing periods:

1. end of fiscal year to spend since no rollover
2. back to school
3. end of calendar year

This dependency on the time of year could be exploited with policies that induce even
higher volume at these times and then negotiate for discounts with suppliers.
CHAPTER SEVEN -- PROSPECTIVE CHANGES
This chapter presents a description of MIT’s re-engineering process, describes generic reengineering tactics as well as the specific tactics under consideration by MIT, discusses the mechanisms as tactics justified by coordination theory, and hypothesizes as to the effect of these changes.

The Process Handbook facilitates the re-engineering process by offering a methodology to review the current processes, explicitly identifying the steps, dependencies and information requirements for each task. Coordination theory provides a justification for the tactics (supplier consolidation, electronic commerce, and purchasing cards) suggested by the consultants. The remainder of this chapter elaborates upon these tactics while the next chapter will seek to extend the theory to point to other areas of specific or truly innovative improvements.

MIT’s Procurement Reengineering
Traditionally, reducing costs in procurement came from adversarial negotiations or locating cheaper, often inferior, substitutes. Many factors have caused this to change. “As the world marketplace shrinks due to innovations in technology, communications, and transportation, the future challenge of purchasing is to devise strategies to seize opportunities presented by these changes.”37 Today, these recent innovations offer the ability to reengineer entire business processes into newer, more tightly integrated forms that cross traditional boundaries. A single panacea remains elusive; yet, several coordination mechanisms can clearly improve current processes.

MIT President Charles M. Vest wrote, “We persist in following systems and behaviors of a past age. Our administrative processes and systems are those of federal contractors from the ’50s and ’60s.”38 While the current processes have been gradually improving, business imperatives demand further changes -- reengineering.

To do this, MIT recently adopted a process view that crosses traditional boundaries to consider all the steps in the supply chain management from start to finish. MIT intends to improve key parameters such as cycle time, cost of supplies, and amount of paperwork. This process involves a number of functional groups: enduser, Purchasing and Stores, Office of Sponsored Programs, Central Accounting, Receiving, Property, and Accounts Payable.

Consultants from CSC Index helped guide MIT’s reengineering effort. CSC Index developed several successful generic tactics to streamline a process: eliminate tasks, integrate similar activities, use information technology to provide leverage, and outsource.

MIT Reengineering

MIT will use three tools to reduce the cost of the procurement process. First, MIT will reduce the number of its suppliers. This consolidation will permit MIT to streamline the number of nonvalue-added activities in the current process. Second, MIT plans to implement “electronic commerce” using information technology to augment the procurement process. On a basic level, automating the supply chain processes will render several tasks unnecessary.

Beyond merely “repaving the cow paths” MIT also seeks to fundamentally change the way the supply chain management processes occur. Information technology permits MIT to link various activities such as requisitioning, buying, paying, and tracking. This digitization will render many steps, especially extraneous documentation, in the current activity unnecessary. Third, MIT hopes to introduce purchasing cards to facilitate actual transactions by improving on the signature authority paradigm.

Reengineering Tactics in a Coordination Context

On the basis of anecdotal support, Hammer and Champy advocate a set of tactics for reengineering.39 This assortment of tactics does not have a common thread unless viewed with a coordination theory perspective. Assuming for the moment that these tactics actually add value, they can be placed into a Process Handbook methodology context as follows:

- Several jobs are combined into one.
  Fewer interfaces improves coordination. Effectively the worker serves as the coordination mechanism. Better coordination mechanisms reduce the need for separate jobs to manage coordination.

- Workers make decisions.
  Organizations can coordinate the delivery of information so anyone can access databases. This will permit workers to make decisions effectively expanding the availability of scarce managerial time.

- The steps in the process are performed in a natural order.
  This improves activity flow with better coordination mechanisms, i.e. natural producer -- consumer order and synchronization.

- Processes have multiple versions.
  Coordination theory permits specializations to tailor processes, such as with triage. Specializations used tailored activities saving processing instead of a generic set of activities that may contain unnecessary steps.

- Work is performed where it makes the most sense.
  This improves activity flow with better coordination mechanisms, i.e. location synchronization reduces time required for flow transfer dependencies.

- Checks and controls are reduced. Better usability and information technology can make these transparent to the users.
- Reconciliation is minimized. If coordination is improved, a process has fewer errors, reducing reconciliation and rework.

This section shows while reengineering may offer successful tactics. Coordination theory provides steps towards a common foundation. Knowing the theoretical foundation should provide grounds to extrapolate new tactical applications.

Reengineering Tactics at MIT

In the next three sections, I review each of the tactics MIT plans to implement as part of this reengineering effort. For each tactic, I describe: first the tactic itself, second its impact if any on each of the top level component activities of the procurement process, third tradeoffs made between the old system and the new tactic, and fourth alternatives that might accomplish the same objective. On the second point, I consider the impact, ceteris paribus, of each tactic though the tactics will also interact synergistically to improve the process. This synergy appears particularly between the ECAT and purchase cards both share electronic data.

Tactic One -- Supplier Consolidation

Supplier consolidation refers to Purchasing negotiating a contract with a sole supplier for commodities. Henceforth, Purchasing will recommend the sole source and issue a blanket PO accelerating the procurement process. Thus MIT plans to move procurement from a market mechanism of multiple suppliers where supply and demand govern prices to a hierarchy of selected suppliers where negotiation governs the transactions. This goes against predictions that electronic commerce will favor markets.\textsuperscript{40} Electronic commerce does not outweigh the economies of scale and the ability to streamline overlapping payment and control activities.

For example next year, Purchasing has designated a sole source, Sterling Office Services, for temporary workers. This first tier source will draw temporaries from three second tier suppliers as needed. If someone from the MIT community calls a second tier directly, then the supplier can provide the temporary directly but must arrange billing through the main supplier as pursuant to the prime contract.

Single sourcing offers numerous advantages. Sole sourcing involves an explicit contract with the supplier as opposed to simply taking market rates. This improves coordination by providing objectives, performance measures, responsibilities, and a time frame. The three year duration of the contract demonstrates commitment to foster investments instead of short term wins at the other's expense. This moves MIT towards greater coordination

along Bhotes four stages in the relationships with suppliers: confrontation, arm’s length, goal congruence, and full partnership.\textsuperscript{41}

In the last fiscal year, MIT offices spent at least one point seven million dollars on clerical, temporary help from twenty five separate suppliers.\textsuperscript{42} This generated a significant number of inefficiencies due to lack of coordination. According to Ms. Devlin, a sole source arrangement will give MIT "consistent quality and availability, price uniformity and competitive rates (reducing mark-ups from as high as 90% down to 28%), and better overall reporting capacity. This partnership arrangement with one firm has other benefits as well. The supplier will also coordinate billing (which should reduce the invoices from 290 last year to ideally one next year), and provide management reports with the detailed information needed for financial control and planning."\textsuperscript{43}

The selected trading partners benefit as well, with increased opportunity to participate in MIT acquisitions (via higher volume and long term contracts), savings on sending paper catalogs to MIT, improved billing, and faster payments.

\textbf{Impact of Supplier Consolidation on the Current Processes}

This section explains the impacts of supplier consolidation on the high level components of the procurement process.

\textit{Identify Need}

\textit{Find Source & Price}

This will reduce search costs by limiting the domain of recommended suppliers. Prices will be set and no longer require Selection of Source forms.

\textit{Create Procurement}

\textit{Process Requisition}

Purchasing agents will not have to look for lower cost alternatives to recommended suppliers, saving them time. Purchasing will not need to generate Purchase Orders for recommended suppliers since they will have blanket POs.

\textit{Receive Input}

\textit{Pay for Input}

MIT will receive consolidated invoices.

\textit{Related Processes}

Auditing will be easier with fewer suppliers to track and reconcile.

\textit{Tradeoffs of Supplier Consolidation}

Lowering search costs via consolidation also narrows the potential domain of suppliers. This may limit MIT’s flexibility two ways. First, suppliers could try to exercise holdup to


\textsuperscript{43} Tech Talk. "MIT to re-engineer its 'temp' policy." February 1, 1995. pg. 1.
raise prices if the threat of using alternate sources is unavailable. Second, suppliers could stockout without ready second tier suppliers. Other disadvantages could stem from lack of redress if service levels erode.

**Alternatives to Supplier Consolidation**

The only alternatives would be to either retain or expand the current supplier base -- both multi-sourcing options. Multi-sourcing offers advantages from flexibility such as an easy alternative in case of a stockout. This approach derives from the opinion that, multiple suppliers kept prices low, maintained supplier competition, and provided a safety valve if a major supplier could not deliver..."44 However, it holds disadvantages: suppliers are not motivated to adapt to the purchasers needs, variations in quality, loss of volume discounts, and higher indirect costs.

**Tactic Two -- Electronic Catalog**

Information technology can leverage workers, improve efficiency, and facilitate analysis of information previously too hard to gather. “Information technology increasingly enables companies to operate as though their individual units were fully autonomous, while the organization still enjoys the economies of scale that centralization creates.”45 These tools provide a versatility lacking in historical coordination mechanisms. The electronic catalog project exploits these strengths.

Information technology can perform automatic filters and references to reduce the number of decisions that are referred upward or to a person; thus, automation will increase the capacity of the organization to process information.

**MIT’s Electronic Catalog**

The electronic catalog refers to a program that will link the MIT community to approved suppliers directly over the Internet. MIT selected a robust system by SAP as the back-end and chose the Internet’s World Wide Web to serve as the communications interface. Approved suppliers will create databases of their products with MIT’s pricing and other options which the MIT community can access. Beyond simple price lists, the electronic catalog system will create procurement requisitions, handle basic filtering, track order information, and provide general access to information previously kept in purchasing or accounting.

**Impact of MIT’s Electronic Catalog on the Current Processes**

This section explains the impacts of an electronic catalog on the high level components of the procurement process. While the specialization option to use paper will remain, the electronic catalog will in general reduce the need for paper forms, reconciliation, basic filtering, and physical routing mechanisms.


Identify Need

Find Source & Price
Endusers in the MIT community will open the electronic catalog and select the items they need.

Create Procurement Requisition
When users select items from the catalog, it automatically creates a requisition.

Process Requisition
Software will handle the basic filtering. The orders will be placed electronically with the suppliers.

Receive Input

Pay for Input

Related Processes
The electronic catalog will generate much better information for the budgeting, accounting and auditing processes.

Tradeoffs of Electronic Catalog
Several potential downsides exist. First, not all users may have access to the technology platform or a link to the Internet. Second from a high level perspective, if each large purchasing organization were to create independent, proprietary systems, this would actually lead to greater inefficiencies. Third, if MIT’s purchasing volume does not justify supplier adoption and each organization decides to wait until other buyers join then the catalog’s diffusion could stall.

Alternatives to Electronic Catalog
Other digital networked solutions, such as Electronic Data Interchange and Value Added Networks, offer the only viable alternatives to an electronic catalog. Paper does not have the same versatility.

Electronic Data Interchange
Electronic Data Interchange (EDI) is the computer-to-computer exchange of routine business information in a standard format (basic transaction sets like a purchase order and common data descriptions such as the order of fields holding data in each record, product measurements, etc.). The standard formats used must be agreed to (coordinated) by the parties (trading partners) or selected from a set developed by a recognized standards body, e.g., American National Standards Institute (ANSI) or the International Standards Organization (ISO). The concept is simple: reduce human involvement by automating the interchange of business data to curtail administrative errors, reduce cycle time, and lower operating (particularly labor) costs. Purchase orders, quotations, invoices, and other paper forms have been successfully replaced with standard EDI transactions. 46

There are several successful examples of EDI used for commerce. “Bob Frank of Lawrence Livermore Labs has seen over one million EDI transactions pass over the Internet part of the Lab’s Electronic Commerce Through EDI Project, a government-funded activity that uses Internet services to pass government procurement information.”47 Another system, FAST Electronic Broker, under development by the University of Southern California’s Information Sciences Institute sponsored by the Advanced Research Projects Agency seeks to clarify issues in electronic commerce.48

Value Added Network
A Value Added Network (VAN) acts as an intermediary between trading partners. A VAN, a private third party, serves to coordinate between trading partners with multiple platforms or diverse protocols. Though useful, these services add an extra step that could be built-in to a superset or more robust communications package.

Systems can begin as proprietary networks and expand to larger roles in electronic commerce. SABER, American Airlines reservation systems, exemplifies this possibility.

Tactic Three -- Purchasing Cards
Purchasing cards refer to credit cards MIT will issue to employees who have signing authority. The cards will enable the employees to buy directly from approved suppliers. This process differs from the traditional purchasing process in that the purchaser does not complete a requisition form for items below their spending limits. The third party card provider automatically checks for compliance with applicable limits, arranges payment within two business days, issues a monthly report to card holders, and submits a consolidated bill to MIT.

While it may seem counter-intuitive to add another intermediary to the purchasing process, large credit card organizations, American Express in this case, have scale and infrastructure to deliver significantly lower costs as outsourced support organizations.

Cards benefit three groups: cardholders, their organization, and their suppliers. All groups benefit as cards eliminate paperwork for each transaction (requisition forms, purchase orders, invoices, checks, etc.) and the attendant paper shuffling.

Impact of Purchasing Cards on the Current Processes
This section explains the impacts of purchasing cards on the high level components of the procurement process.

Identify Need

Find Source & Price

Create Procurement Requisition
Users will not need a procurement requisition for items below their card limit; the necessary data will be digitally tracked.


Process Requisition
The orders will be placed electronically with the suppliers.

Receive Input

Pay for Input
American Express will pay suppliers within 48 hours, improving their cash flow.

Related Processes
MIT will gain tight control by setting per-transaction, per-month, supplier specific, and type of spending limits for each cardholder. Usage reports help organizations manage and analyze information. American Express, MIT's partner, even offers a "Reconciliation P" data file to post expenses electronically to General Ledgers.

Tradeoffs of Purchasing Cards
MIT will be exposed up to the cards' limits within a given period before someone reviews the spending reports.

Alternatives to Purchasing Cards
Alternatives to purchasing cards would be larger local inventories, petty cash, or checks. Though these would accomplish similar objectives, each of these other options commit greater funds and introduce greater coordination costs.

Aggregate Implications of MIT's Reengineering Tactics
Hindsight works to justify the reengineering recommendation in terms of coordination theory using the Process Handbook methodology.

Impact in Aggregate of Tactics on Current Process
These tactics move MIT's procurement from arms length market transactions with any supplier towards partnerships with selected suppliers. These tactics meet MIT's aims to reduce costs, increase speed, and improve accuracy.

Figure 7.1 Intersection of Reengineering Tactics and Process Activity Components

Find Source & Price
Activity becomes an on-line search with the new, electronic catalog (ECAT) system from selected suppliers. ECAT access becomes a condition for supplier selection.
The ECAT creates and places the order after an enduser selects items if the enduser has a purchase card; it also automatically generates an electronic document trail.

Create Procurement Requisition
Omitted with ECAT and purchase card use.

If the enduser does not have a purchase card, then they must use the old methods to get a PO number.

Process Requisition
Effectively omitted. Activity now automated coordination mechanism in the new system for most items, i.e., restricted items will still need approval.

Receive Input
This activity remains essentially the same. However, it will be easier to identify recipient with ECAT system.

Pay for Input
Outsourced to card provider. Fewer records due to consolidation of suppliers.

Relation to Needs Identified in Analysis
The supplier consolidation addresses the need to reduce the volume of transaction activity mentioned in Chapter Five. This will also reduce the flow of information and load on the coordination mechanisms.

The ECAT addresses the need to improve coordination mechanisms across all the activities. Chapter Six showed that EREQs only impacted two of the components of “buy input”. Benefits to MIT include lower costs enabled by greater scale via coordination as well as more accurate orders, reduced cycle time, and decreased paperwork by using electronic media. These benefits accrue mainly from information technology which serves to eliminate many tasks (sorting, photocopying, telephoning, mailing, data review, data reconciliation, data reclassification, checking authorizations, control enforcement, etc.), offer new possibilities in filtering and managing information, and reduce processing time. This even impacts the overlapping control processes improving the ability to monitor and track purchases will lead to more effective decision making.

The purchasing cards serve to eliminate activities, as per Chapter Five, and also improves coordination, as per Chapter Six in settling and tracking the financial aspects of transactions.
CHAPTER EIGHT -- PROCESS SCENARIOS

The previous chapter showed that post hoc analysis justifies the reengineering tactics with the Process Handbook methodology. It can be extended to propose new strategic and operational possibilities. There may be additional alternatives to managing the critical dependencies. Perhaps borrowing techniques from other sites could improve the process. Circumstances would differ with alternate mechanisms. Caplow suggests improving productivity with two targets: efficiency (high output in relation to input) and effectiveness (achieve intended objective).\textsuperscript{39} Coordination theory identifies areas to create these productivity effects.

This chapter goes beyond the proposed reengineering tactics and explores various scenarios to determine the impact of different uses of coordination on MIT’s procurement process. These scenarios stem from the “other opportunities” I identified at the end of my analysis of the activities in Chapter Five and the coordination mechanisms is Chapter Six.

Scenario One -- Information Technology

The electronic catalog signals the shift from paper to digital media. This eliminates many non-value-added activities. It also renders many activities “transparent” to the enduser since the enduser does not see the computer perform these background activities. If technology were not a constraint, then MIT could publish its catalog standards and let any supplier upload their catalog. The technology could lower transaction costs and coordinate electronic payment to a vast number of suppliers. To complement this, eliminating the current paper-based processes would reduce support needs and focus on the new system.

First, endusers could search the system for the items they need. The system could locate the best priced items and even account for other pertinent data. For example, the system could reveal data on past performance by the supplier, or users could enter feedback on suppliers and products that others could weigh in purchase decisions. If the products included thorough descriptions, then endusers could describe their needs and have the system conduct a search to find possible product solutions. Second, the system could create requisitions and purchase orders screening the items against budgets and other plans. The system could flag items for human review. Finally, the system could even be used to directly transfer payments. Thus extending the electronic catalog project to include an expert system of rules and payments could encompass most of the routine work by the Purchasing and Accounting departments, while providing endusers and managers access to more and higher quality information.

MIT’s proposed electronic catalog (ECAT) system omits the tracking of items; yet, information technology could address this too. MIT could tie the ECAT directly into the shipper’s electronic systems to track the products in transit. When the products arrive at MIT, this could be addressed by equipping the Receiving staff with handheld devices could eliminate their forms and make tracking information directly available to the endusers. Further extending this logic, an ideal system could make queries to the

databases of the delivery services so users could track the transit. This would permit endusers to time their work based on the knowledge of when new materials will arrive.

Scenario Two -- Eliminate Nonvalue-added Activities

Examining the goals of various activities one can question their necessity. For example, why use requisitions, purchase orders, and signing authority in the first place? If the nonvalue-added activities were eliminated then the process would improve. Each of these mechanisms serves to audit for proper conduct. While the activities that check, balance and document purchases hinder the process, they serve integral roles in overlapping control processes. While it is unlikely this could be entirely eliminated, perhaps not everyone constantly requires this audit.

An employee could earn trust by consistently passing cleanly through audit mechanisms. After a period or certain number of transactions, the employee could be granted higher signing authority or just do transactions without as much review. This would integrate well with a software system that scans for errors backed by periodic human review.

Scenario Three -- Proactive Suppliers

MIT could develop a partnership with suppliers for proactive shipment of standard items. The partnership could take two approaches. First, the suppliers could send items based on historical usage rates. Then the users throughout the MIT community could simply call Purchasing and Stores, drawing from a central inventory. Second, the suppliers could send replacement items to endusers based on product life expectancy. Accounting could create a streamline specialization to pay for replacement items.

Suppliers could also work with MIT to see how their products actually get used. This could lead to joint design of an item that would have a lower lifecycle cost for MIT.

With this system, endusers would only need to go through the basic procurement process once for standard items. Subsequent transactions would be transparent since they would be handled directly by the supplier and the Accounting Department.

Scenario Themes

Each of these scenarios enhances the process. The first extends information technology's role as a coordination mechanism even further than the electronic catalog. The second streamlines the process by eliminating or skipping activities in many cases. The third shifts the burden of initiating the process from within MIT to its suppliers.

These all address the issues identified in the analysis of the current process' activities and coordination mechanisms from Chapters Five and Six. The pattern tends to focus the actors' energies on value-added activities that pursue the process objective, finding alternatives (eliminate, render transparent, or outsource) to nonvalue-added activities, and improving the coordination mechanisms that manage the dependencies between activities.
CHAPTER NINE -- CONCLUSION
MIT’s procurement process offered a wealth of detail for study. Studying this process resulted in a number of ideas for refining the Process Handbook methodology. The methodology in turn enabled me to provide a justification based on coordination theory for the tactics selected to redesign the process as part of MIT’s reengineering effort as well as to speculate on additional possibilities to improve the process.

Process Handbook Methodology
This section offers interesting areas for further research, refinements to the methodology, and refinements for the software.

Interesting Areas for Further Research
This methodology implies that more efficient coordination mechanisms provide the greatest benefit to all actors by streamlining activities and improving management of dependencies. As information becomes a resource and a product in our business environment, other incentive concerns actually push for inducing artificial scarcity with mechanisms to limit coordination. For instance, intellectual property laws or passwords on computer systems, limit replication rights to permit charges to recover production costs for otherwise negligible reproduction costs of information resources.

As a service organization that uses inputs only indirectly, MIT’s procurement process encompasses a fraction of the activities performed in manufacturing industries that directly use inputs in traditional production. This latter process represents an opportunity to expand on the process I documented. These industries also address the issues of improving supplier quality and joint design in external relations with suppliers. These relations require tight coordination which bodes well for generating further progress in developing coordination theory.

The Center for Coordination Science researches information technology since it offers new possibilities to coordinate activities. The development of Electronic Document Interchange (EDI), on expression of information technology, should help expand understanding of both how firms coordinate for establishing standards and using technology to facilitate transactions.

Refinements to the Handbook Methodology
As with any new set of ideas, coordination theory and the Process Handbook methodology it supports require further refinement, research, and application to actual processes that will test its bounds. When attempting to apply the methodology, I encountered several issues that were not yet fully resolved.

First, each instance of the process “buy input” actually depends on all the other instances since this process runs relative to an exogenous budget constraint, a shared resource dependency. The Handbook has yet to incorporate tracking and analysis of dependencies between multiple instances of a process. This could capture the impact of the total number of instances of the process upon the coordination mechanisms and resources. Just as a cable runs out of bandwidth the structure to perform a process may be overwhelmed by multiple instances of the process. The Handbook should also address
fluctuations in the flow of multiple instances. For example, the Handbook could explore the “meta-coordination” mechanisms which balance resource usage over time within a specific process or across multiple processes instead of the simpler management of dependencies within a single process.

Second, timing plays an important role in coordinating the interaction of related processes. The various aspects of an organization’s mission follow different timelines. For many business processes, certain steps only need to be performed on a periodic basis though the remainder of the process operates continuously. In this case, procurement occurs continuously throughout the year while planning the budget for the control process occurs less frequently. Selecting and approving suppliers only ought to be done when establishing a process, when creating a new fiscal budget, after poor performance, etc. Likewise, the auditing control process currently occurs on a periodic basis due to the cost of gathering the information. The handbook could address this issue with a frequency counter or clock for processes. Then activities could have a data field stating when it occurs: every transaction, every fifty transactions, once a year, etc.

Third, the degree of depth in analyzing a process remains unclear. The methodology does not state how many levels of decomposition should be pursued. This presents a problem since lessons may unfold at different levels. A corollary to this point is the frame of reference to the process. In particular, the coordination mechanisms used by an actor in one process may in fact be production processes from the perspective of other actors. For example, the mail carried by the postal system serves to transfer information, such as product orders. While this is clearly a coordination device to the purchaser and seller, a postal worker views picking up, sorting, transporting and delivering mail as a production process.

Fourth, the methodology relegates the design and repair of processes to an invisible hand. All processes should have a precursor explanation of their structural design. This might reveal trends in effective design of coordination mechanisms. Once designed, the process mapping ought to include a designation for specializations used only in the case of process failures and for other informal expediting functions. Classes of coordination mechanisms may have similar remedies in case of failure.

Fifth, the process handbook methodology requires complementary disciplines that currently it does not address. Coordination theory necessitates a truly interdisciplinary approach to analysis of processes. Other useful disciplines include: organizational psychology, economics, and “reengineering”. Organizational behavior explains issues like compliance of the actors to the activities and coordination mechanisms. Cost economics provides analytical tools to rationalize trade-off matrices. Reengineering provides a set of prescriptive techniques for process improvement. As coordination science develops it should build on the ideas from these and other complementary fields.

**Prescriptive Scenario Generation**

Though in a nascent stage of development, the Process Handbook Methodology offers a good analytical tool. When populated with cases, it should offer alternative ways to structure and link activities. For prescriptive measures to redesign processes, the Handbook can complement other theories and existing work. For example, MIT used
classic reengineering which resulted in tactics that fit in the Handbook methodology. Other examples work too such as Lynch’s framework that identifies five broad mechanisms for improving processes:

1. **Rules and Policies**: Increase number and clarity of rules, policies, and written procedures to deal with a new situation.
2. **Hierarchy**: Funnel decisions into existing chain of command to avoid confusion.
3. **Planning and Information Systems**: Create centralized planning and computer analyses, centralized files, and up-to-date sources of information.
4. **Excess (slack) Resources**: Provide more people or machinery to fill the voids in staffing or production.
5. **Lateral Relations**: Make more effective use of lower-level expertise; create better communications between lower echelons.  

The first four are types of coordination mechanisms while the last is a dependency that could use more coordination. Thus further literature review could uncover areas that should be considered when developing alternative designs for a process. Assembling existing frameworks and examples would complement the Center for Coordination Science’s field studies.

**Refinements to Process Handbook Software**

The software undergone substantial development over the course of this project in terms of basic stability and expanded features. Using actual field data helped push the software to develop more robust ways to store and document processes.

The development efforts need to target a further goal, transform this static process representation into an analytical tool. The trade-off matrix concept could be extended to make this a more powerful tool to justify reengineering. The user should set rules, such as the heuristics I identified in Chapter Five, that the software follows to automatically flag activities for scrutiny.

Beyond analytics of the static process, the software could evolve to a simulation package run scenarios and graphically show the cycle time, resource commitment levels and other trade-off results. To support this the software would need to associate a duration with each different activity, specialization, and coordination mechanism so the process map could be converted into different timelines.

**Field Study Site Revisited**

My field study of procurement process in MIT’s supply chain management exemplifies how the Process Handbook methodology of analysis reveals process inefficiencies that can be ameliorated by applying techniques that follow from coordination theory. Several key techniques are: focusing on value-added activities, finding alternatives (eliminate, render transparent, or outsource) to nonvalue-added activities, and improving the coordination mechanisms that manage the dependencies between activities. The first key

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forms the basis to design radically new processes that accomplish the same objective while the latter two offer areas to optimize the existing process.

**Focus on Value-added Activities**

The process maps and activity lists showed which activities actually worked toward the objective of procurement. These represented only a portion of the process. Ideally, the enduser should only ask for an input and tell the organization to pay.

**Find Nonvalue-added Activities**

Finding nonvalue-added activities enables one to decide alternatives: eliminate, render transparent or outsource. Eliminating activities or rendering many activities transparent to the enduser, both are possible through improved information technology as with MIT’s proposed system.

Outsourcing seems counter-intuitive since intermediaries add more interfaces typically impeding coordination. However, some intermediaries offer economies of scale, scope, and learning that lower total costs. Intermediaries also remove some of the problems associated with incomplete contracts. The financial service industry offers an excellent example of this for the settling of transactions. In MIT’s case, an intermediary reduces costs by eliminating paperwork, leveraging its existing infrastructure for general purpose credit cards.

**Improve Coordination Mechanisms**

Consolidation of suppliers to a select few introduces scale economies. Where MIT’s Purchasing previously treated procurement as a series of independent transactions, it now builds relationships with selected suppliers. This improved coordination trades flexibility from multiple sources for lower prices, potentially customized product, and better services such as payment mechanisms as well as reducing the volume of paperwork across multiple transactions.

Information technology improves the management of dependencies between activities. The electronic requisition system shows a step toward how information technology can reduce cycle time, cut paperwork, and reduced enduser queries. Real benefits appear when technology provides information to actors throughout the entire process instead of just to the traditional “elite”. MIT avoided the initial infrastructure investment since it already had the Athena computer network. In general using technology as a coordination mechanism is a long term strategy which yields benefits over time as the process runs through multiple instances. The prospective process’ electronic catalog expands the use of information technology to cover all the components of the purchase from finding suppliers to payment.

Further study would be interesting since the new ECAT system will enable much more comprehensive coordination than in the past. This may have implications on future development pace and feature criteria via feedback mechanisms since “organizations value what they measure.”

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summarize, store and synthesize data about the procurement process. The downside may be sheer information overload.

Reflections
The field study of MIT's purchasing process provided an opportunity to put the Process Handbook methodology into practice. The process maps and activity lists enabled me to surface the activities and various specializations in the current procurement process. I developed a set of heuristics to identify opportunities from inefficiencies in the current process. I justified the proposed tactics from MIT's reengineering effort in a coordination context. Beyond these proposed tactics, I proposed scenarios to further improve the process based on the opportunities from my analysis. The rigor of applying the methodology to a field study caused me raise several issues with the underlying coordination theory framework as well as the Process Handbook software. Further research on these issues will lead to more robust tools to analyze processes in the future.
APPENDIX A: PROCUREMENT PROCESS HANDBOOK ENTRIES
The following structures require an understanding about the current instantiation of terms or decomposing terms, such as "dependency," into their constituents. Please refer to chapter three for explanations of the Process Handbook Methodology and chapter four for text descriptions of the process. The forms below are derived from Malone & Crowston (1993) and Malone, Crowston, Lee & Petland (1993).

Current Process Map
Activities appear in bold if the have decompositions. Shadows signify specializations exist. The figures include arrows for specializations with dotted lines, decompositions with solid, straight lines, and dependencies with solid curve lines. The dependencies represent flow of prerequisites and transfer of information (and artifacts). All subsequent activities also depend on completion of data fields (paper or electronic) in a usability dependency.

Buy Input
For the next level of process decomposition, please refer to the maps that follow.

The activity “Buy Input” has two specializations both of which inherit the decomposition shown in the above figure. I decided to incorporate the media specialization to the top level since these signified fundamentally different coordination mechanisms. In particular, the EREQ system takes advantage information technology to improve flow (transfer and usability) as well as overlapping processes such as tracking and queries. The decompositions of “Buy Input” inherited by the media specializations only receive modifications in two ("Create Procurement Requisition" and "Process Requisition") of the six steps. This demonstrates the opportunity to introduce information technology as a coordination mechanism across other steps in this process.

For further process decomposition, please refer to the maps and activity lists that follow.
Find Source & Price
For further process decomposition, please refer to the activity lists that follow.

Create Procurement Requisition
The decomposition of “Create Procurement Requisition” differs between the high level process specializations “w/paper” and “w/EREQ” since the requisition is created in one media or the other. The next level of specialization is to create a one time or a blanket purchase order. The final level of activities shown here is the same for each specialization. Each activity in the figure below inherits this high level choice.

For further process decomposition, please refer to the maps and activity lists that follow.

Process Requisition
Interestingly, the decomposition of “Process Requisition” has only one extra activity under the process specialization of “Buy Input: MIT with EREQs”. Purchasing actually prints the EREQ then processes it.

For further process decomposition, please refer to the activity lists that follow.
**Receive Input**

These specializations depend on the nature of delivery as discussed in chapter four.

Taking this down two levels, yields the following figure. For further process decomposition, please refer to the activity lists that follow.

**Pay for Input**

For further process decomposition, please refer to the activity lists that follow.
Current Process Descriptive Flow and Activity Lists

This process list flow down the activity order. Activities appear in bold if they are specializations.

Acquire Input
  Make Input
  Buy Input
    IDENTIFY NEED
    FIND SOURCE & PRICE
    Create Potential Vendor List
      Determination of Potential Vendors
      Solicitation of Proposals
        Write Solicitation
        Mail to Potential Vendors
        Collect Responses
      Notify Endusers of Potential Vendors
        Write memo
        Copy memo
        Distribute memo
    Select Vendor if < $2500
      Determination of Potential Suppliers
      Get Purchase Information
        Check Files
        Call for Info
    Select Vendor if > $2500
      Determination of Potential Suppliers
      Get Purchase Information
        Check Files
        Call for Info
          Call Potential Suppliers
          Get Purchase Information
          Repeat as Necessary
    Prepare Selection of Source
  CREATE PROCUREMENT REQUISITION
  Create Req. for One Time PO
  Create PO < $ Signing Authority
    Create Paper Requisition
      Get Form
      Write Order Description
      Sign Approval
      Keep Local Record
      Send to Purchasing
  Create Electronic Requisition
    Logon to EREQ System
    Write Order Description
Automatically assign PO #, if <$1K
Send

Create PO > $ Signing Authority
Create Paper Requisition
Get Form
Write Order Description
Send to Person With Signing Authority
Make Approval Decision
Sign
   Keep Local Record
   Send
Deny
   Send back to Enduser

Create Electronic Requisition
Logon to EREQ System
Write Order Description
Send to Person With Signing Authority
Make Approval Decision
Sign
   Keep Local Record
   Automatically assign PO #, if <$1K
   Send
Deny
   Send back to Enduser

Create Req. for Blanket PO
Create PO < $ Signing Authority
Create Paper Requisition
Get Form
Write Order Description
Sign Approval
Keep Local Record
Send to Purchasing
Create Electronic Requisition
Logon to EREQ System
Write Order Description
Automatically assign PO #, if <$1K
Send

Create PO > $ Signing Authority
Create Paper Requisition
Get Form
Write Order Description
Send to Person With Signing Authority
Make Approval Decision
Sign
   Keep Local Record
Send to Purchasing

Deny
Send back to Enduser

Create Electronic Requisition
Logon to EREQ System
Write Order Description
Send to Person With Signing Authority
Make Approval Decision

Sign
Keep Local Record
Automatically assign PO #, if < $1K
Send to Purchasing

Deny
Send back to Enduser

PROCESS REQUISITION
Process Paper Procurement Requisition
Review Signature Authorization
Send to Purchasing Agent
Review Requisition
Complete Review
Route for Other Approval

Route to OSP
Make Approval Decision

Sign
Keep Local Record
Route to Central Accounting
Send to Purchasing

Deny
Send back to Enduser

Route to Central Accounting
Make Approval Decision

Sign
Keep Local Record
Send to Purchasing

Deny
Send back to Enduser

Create PO
Enter Info
Route Copies
Route White to Vendor
Route Blue to Enduser
Route Green to Property
Keep Pink in Purchasing

Attach PO & requisition
Assign PO #, if needed
Sign to Confirm Review
Process Actual Order

**Order by Enduser**
- Call Enduser with PO #
- Mark PO "Confirming"
- Call Supplier
- Give Order Data

**Order by Purchasing**
- Mail PO to Vendor
- Call Vendor
- Send to Data Entry
- Enter in Purchasing System
- File Copy of PO and Requisition
- Send PO to Accounting

**Process Electronic Procurement Requisition**
- Review Requisition, if > $1K
- Edit as necessary
- Complete Review
- Route for Other Approval

**Route to OSP**
- Make Approval Decision
  - **Sign**
    - Keep Local Record
    - Route to Central Accounting
    - Send to Purchasing
  - **Deny**
    - Send back to Enduser

**Route to Central Accounting**
- Make Approval Decision
  - **Sign**
    - Keep Local Record
    - Send to Purchasing
  - **Deny**
    - Send back to Enduser

Print EREQ
Create PO
- Enter Info
- Route Copies
  - Route White to Vendor
  - Route Blue to Enduser
  - Route Green to Property
  - Keep Pink in Purchasing
- Attach PO & requisition
- Assign PO #, if > $1K
- Sign to Confirm Review
Process Actual Order

**Order by Enduser**
- Call Enduser with PO #
- Mark PO "Confirming"
- Call Supplier
- Give Order Data

**Order by Purchasing**
- Mail PO to Vendor
- Call Vendor
- Enter in Purchasing System
- File Copy of PO and Requisition
- Send PO to Accounting

**RECEIVE INPUT**

**Receive Product**
- Receive by Organization
  - Receive Box(es)
  - Sign Delivery Board
  - Take Delivery
  - Complete Receiving Info
- Sort Boxes
- Identify Recipient

**Address Complete**

**Address Incomplete**
- Look-up Recipient Name
- Look-up Previous Orders
- Call Supplier

**Get Recipient Info**

**Request Call Tag**

- Prioritize
- Batch
- Deliver Boxes

**Receive by Enduser**
- Receive Box(es)
  - Sign Receiving Room Receipt
  - Take Delivery
  - Open Box(es)
- Verify Contents
- Act on Contents

**Use**

**Return**
- Call Supplier
- Request Call Tag
- Return to Receiving Dock

**Receive Service**
- Receive Temporary
Explain Task
Perform Task
Monitor Performance
Complete Time Card
Deliver Time Card to Supplier

PAY FOR PRODUCT
Receive Invoice
Log Invoice
Assign Sequence #
Approve Payment

Do if < $500 & One Time PO
Return Dept if > $500 or Blanket PO

Approves Invoice
Adjusts Encumbrance on Local System
Returns to Accounts Payable

Process Invoice for Payment
Batch Invoices
Cut Checks
Send Checks
<table>
<thead>
<tr>
<th>Activity</th>
<th>Context</th>
<th>Skill(s) Required</th>
<th>Resources</th>
<th>Evaluation Criteria</th>
<th>Dependency Type</th>
<th>Dependency Upon</th>
<th>Coordination Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIND SOURCE &amp; PRICE</strong></td>
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<td>Purchasing</td>
<td>Research</td>
<td>past vendors, offers</td>
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<td>Identify Need</td>
<td>enduser desire &amp; purchasing</td>
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<td>Research</td>
<td>Request for Pricing</td>
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<td>Determine RFQ</td>
<td>form (paper)</td>
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<td>Writing</td>
<td>PC &amp; printer</td>
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<td>Mail to Potential</td>
<td>index (database)</td>
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<td>Solicitation</td>
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<td>Writing</td>
<td>Memorandum</td>
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<td>flow (req.)</td>
<td>Copy memo</td>
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<td>memo, phone book availability</td>
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<td>Identify Need</td>
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<td>flow (req.)</td>
<td>Choose Vendor</td>
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<td>Selection of Source</td>
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<td>Get Purchase Information</td>
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<td>phone book, past availability, price</td>
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<td>Call Potential</td>
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<td>form (paper)</td>
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<td>Purchasing Match Details</td>
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<td>flow (trans) Review Sign</td>
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<tr>
<td>Route for Other Agency/Approver</td>
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<td>sensitive or restrict</td>
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<td><strong>Route to OSP</strong></td>
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<td>Make Approver</td>
<td>OSP Authority</td>
<td>policies</td>
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<td>policies (sponsors)</td>
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<td><strong>Sign</strong></td>
<td>OSP Authority</td>
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<td>Keep OSP</td>
<td>OSP Authority</td>
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<td><strong>Deny</strong></td>
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<td>policies</td>
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<td>policies (sponsors)</td>
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<td><strong>Route to Central</strong></td>
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<td>policies (FASB)</td>
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<td><strong>Sign</strong></td>
<td>Central Acc Authority</td>
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<td>Keep Central Acc</td>
<td>keep yellow copy PO form</td>
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<td>Send Central Acc</td>
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<td>Create PO</td>
<td>Purchasing Agent</td>
<td>Purchase Order Form</td>
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<tr>
<td>Enter Info</td>
<td>Purchasing Agent</td>
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<td>Purchasing Agent</td>
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<td>Route White to</td>
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<td>mail (US)</td>
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<tr>
<td>Route Blue to E</td>
<td>MIT Mail</td>
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<td></td>
<td>mail (campus)</td>
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<tr>
<td>Route Green to</td>
<td>MIT Mail</td>
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<td>mail (campus)</td>
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<tr>
<td>Attach PO &amp; requisition</td>
<td>Purchasing Agent</td>
<td>Order and Purchase Order Forms</td>
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<td>Print R/P forms</td>
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<td>Assign PO # if needed</td>
<td>Purchasing Agent</td>
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<tr>
<td>Sign to Confirm Review</td>
<td>Purchasing Agent</td>
<td>Signature Authority</td>
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<td>amount</td>
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<tr>
<td>Process Actual Order</td>
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<td><strong>Order by Enduser</strong></td>
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<tr>
<td>Call Enduser</td>
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<td>Call Supplier</td>
<td>Enduser</td>
<td>phone</td>
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<tr>
<td>Give Order Date</td>
<td>Enduser</td>
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<td><strong>Order by Purchase</strong></td>
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<td>Mail PO to Vendor</td>
<td>Purchasing Agent</td>
<td>US Mail</td>
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<td>print (trans) Sign to Aut</td>
<td>mail (US)</td>
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<td><strong>Call Vendor</strong></td>
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<td>Send PO to Accounting</td>
<td>Purchasing Data Entry</td>
<td>MIT Mail</td>
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<td>Activity</td>
<td>Context</td>
<td>Actor(s)</td>
<td>Skill(s) Required</td>
<td>Resources</td>
<td>Evaluation Criteria</td>
<td>Dependency Type</td>
<td>Dependency Upon</td>
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<tr>
<td>Process Electronic Procurement</td>
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<tr>
<td>Review Requisition, if needed</td>
<td>Purchasing Agent</td>
<td>PC, Network</td>
<td>policies</td>
<td>flow (req)</td>
<td>Create Proc form (electronic)</td>
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<tr>
<td>Edit as necessary</td>
<td>Purchasing Agent</td>
<td>PC, Network</td>
<td>policies, name vs. acct #</td>
<td>flow (req)</td>
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<td>Complete Review Knowledge</td>
<td>Purchasing Agent</td>
<td>PC, Network</td>
<td>policies, name vs. acct #</td>
<td>flow (req)</td>
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<tr>
<td>Route for Other App</td>
<td>Purchasing Agent</td>
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<td>sensitive or restricted</td>
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<tr>
<td>Route to OSP</td>
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<td>also acct # 6-9</td>
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<tr>
<td>Make Appro</td>
<td>OSP Authority</td>
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<td>policies (sponsors)</td>
<td>flow (track)</td>
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<td>Sign OSP Authority</td>
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<td>Dependency Upon</td>
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<td>label</td>
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<td>Resources</td>
<td>Evaluation Criteria</td>
<td>Dependency Type</td>
<td>Dependency Upon</td>
<td>Coordination Mechanism</td>
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<td>Skill(s) Required</td>
<td>Resources</td>
<td>Evaluation Criteria</td>
<td>Dependency Type</td>
<td>Upon</td>
<td>Coordination Mechanism</td>
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<td>invoice</td>
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<td>Batch Invoices</td>
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<td>Cut Checks</td>
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<td>money, bank account</td>
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<td>Send Checks</td>
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<td>Create Monthly Statement</td>
<td>Accounting</td>
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<td>Monthly Statement</td>
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<td>form (paper)</td>
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<td>Send to Departments</td>
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<td>flow (trans)</td>
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<td>Create Monthly Statement, mail (campus)</td>
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Prospective Process Map
Activities appear in bold if the have decompositions. Shadows signify specializations exist. The figures include arrows for specializations with dotted lines, decompositions with solid, straight lines, and dependencies with solid curve lines.

Buy Input
The reengineering process will offer a new specialization of the “Buy Input” process. Since MIT does not mandate methods, it will maintain the previous specializations as well. Though the new system will use information technology to eliminate or improve the speed of many activities. The three prospective changes are supplier consolidation, an electronic commerce catalog (ECAT), and purchasing cards.

Find Source & Price
Activity becomes an on-line search with the new, electronic catalog (ECAT) system from selected suppliers. ECAT access becomes a condition for supplier selection.

The ECAT creates and places the order after an enduser selects items if the enduser has a purchase card; it also automatically generates an electronic document trail.

Create Procurement Requisition
Activity omitted with ECAT and purchase card use.

If the enduser does not have a purchase card, then they must use the old methods to get a PO number.

Process Requisition
Activity now automated coordination mechanism in the new system for most items, i.e., restricted items will still need approval.

Receive Input
This activity remains essentially the same. However, it will be easier to identify recipient with ECAT system.

Pay for Input
Activity outsourced to card provider. Fewer records due to consolidation of suppliers.
Prospective Process Descriptive Flow and Activity Lists
Activities appear in bold italics if they are specializations.

Buy Input
IDENTIFY NEED
FIND SOURCE & PRICE
Logon to ECAT
Search ECAT for Input(s)
Tag Desired Input(s)

ORDER INPUT
Order < Authorization
Enter Purchase Card Information
Place ORDER

Order > Authorization
Route to Authorized Person
Make Approval Decision
Sign
Send to Purchasing
Place ORDER

Deny
Send back to Enduser

PROCESS REQUISITION
Review Requisition
Route for Other Approval

Route to OSP
Make Approval Decision
Sign
Place ORDER
Route to Central Accounting

Deny
Send back to Enduser

Route to Central Accounting
Make Approval Decision
Sign
Place ORDER

Deny
Send back to Enduser

Send Copy to Accounting

RECEIVE PRODUCT
Receive by Organization
Receive Box(es)
Sign Delivery Board
Take Delivery
Complete Receiving Info
Sort Boxes
Identify Recipient
Address Complete
Address Incomplete
Check ECAT
Prioritize
Batch
Deliver Boxes
Receive by Enduser
Receive Box(es)
  Sign Receiving Room Receipt
  Take Delivery
  Open Box(es)
Verify contents
Use
Return
  Call Supplier
  Request Call Tag
  Return to Receiving Dock

RECEIVE TEMPORARY LABOR
  Receive Temporary
  Explain Task
  Perform Task
  Monitor Performance
  Complete Time Card
  Deliver Time Card to Supplier

PAY FOR PRODUCT
  Receive Invoice
  Process Invoice for Payment
  Create Statement
  Import Statement into Records
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APPENDIX B: CONTROL PROCESS HANDBOOK ENTRIES

Several control processes intertwine with the activities in the procurement process. Control processes set the budget against which purchases must be approved as well as take the information generated by the purchase process to feedback into the planning cycle. The lists below provide a simple understanding of this ancillary process before and after the reengineering effort.

Current Process Map

```
Control Finances
  ↓
Set Targets
  ↓
Collect and Input Data
  ↓
Report & Analyze Info
  ↓
Rework and Reconcile Data
```

Current Process Descriptive Flow List

Activities appear in bold italics if they are specializations.

Manage Information Processes
  Define Measures (not done regularly)
  Set Targets
    Develop Unit Operational Budgets
    Assess Previous Performance
    Aggregate and Review Unit Budgets
    Set Financial Assumptions
    Communicate Financial Assumptions
    Rework Budgets
    Review and Approve Unit and Institute Budgets
    Set and Record Budgets and Authorizations

Collect and Input Data
  Enter Data
  Classify Data
  Authorize Transactions

Rework and Reconcile Data
  Review Data
  Reconcile Data
  Reclassify Data
  Identify and Resolve Data Problems
  Make Adjustments
  Check Authorizations
Audit Data
   Assess Accuracy
   Enforce Controls
Report and Analyze Information
   Summarize and Report
   Assess Performance
   Create and Provide Management Reports
   Provide Compliance Reports
   Perform Audits
   Understand Business and Management Issues
Prospective Process Map

Prospective Process Descriptive Flow List
Activities appear in bold italics if they are specializations.

Define Measures
- Identify Indicators of Success
- Develop Specific Measures
  - Set Definitions
  - Create Data Stores
  - Design Collection and Reporting Methodology
- Refine and Develop New Measures

Set Targets
- Set Financial Assumptions
- Communicate Financial Assumptions
- Set High-level Performance and Financial Targets
- Communicate High-level Performance Targets
- Develop Unit Operational Budgets
- Assign Unit and Individual Accountabilities

Collect and Input Data
- Enter Data
- Validate Data
- Classify Data

Report and Analyze Information
- Summarize and Report
- Assess Performance
- Create and Provide Management Reports
- Provide Compliance Reports
- Perform Audits
- Understand Business and Management Issues
APPENDIX C: INTERVIEW NOTES

Interview: Supplier Consolidation Team
Friday April 7, 1995 1 to 2:15 p.m.
Diane Devlin, MIT Purchasing & Stores, Rm. E18-360, x3-7035,
ddevlin@mit.edu
Peter Roden, MIT Information Systems, Rm. E40-355, x3-0147, roden@mit.edu

Determine rationale
Refer to the attached literature, and:
Consolidation of suppliers will increase the volume and enable volume discounts.
Plan to gather data on purchaser satisfaction.

Determine focus
DD - Weight potential benefits versus redesign complexity to determine areas of potential success. A key consideration is to minimize organizational disruption and build consensus buy as they try to establish new processes.

PR - An analogy is that each professor is a company, the companies operate in many isolated countries (departments) each of which has its own rules and culture.

DD - Three types of goods:

<table>
<thead>
<tr>
<th>white box</th>
<th>gray box</th>
<th>black box</th>
</tr>
</thead>
<tbody>
<tr>
<td>day to day items</td>
<td>“spot” items</td>
<td>unique items very high at MIT</td>
</tr>
<tr>
<td>typically supplier’s loss leaders</td>
<td></td>
<td>always general purchasing</td>
</tr>
</tbody>
</table>

White box items are bought direct by users 75% of the time and 25% through Office of Laboratory Supplies, OLS. OLS marks up items to cover their overhead. OLS maintains 6,700 SKUs though 500 SKUs account for 90% of the business.

Selected three target areas: temporary help, desktop devices and scientific supplies (which consists of scientific supplies, office supplies, gas cylinders, and furniture).

Determine best practices
DD - First, we prescreened our suppliers to determine who we could provide the best services. Then, we approached them and asked which of their clients had the best systems. This was difficult because MIT has so many diverse functions and needs. An example that was found was a partnership between a supplier and E.I. DuPont’s research facility (130 buildings and greater dollar volume) in Delaware. CSC also provided some data from previous client work.
**Determine measures**

PR - We set different standards for different items and industries. For example, temporary help should arrive within thirty minutes while commodity scientific equipment should arrive within 4-24 hours. We target 95% delivery in these service times.

**Miscellaneous**

Temporary help is interesting since the same temps are available from multiple agencies, i.e. agencies sell the same product. A goal is to reduce the mark-up charged by the agencies over what the pay the temporary worker.

Savings from the new processes go to the departments not to the central purchasing groups. What is there incentive?

Processes will vary if you have signature authority or not. Standards for signature authority vary by department, but institute wide are hierarchical for larger amounts of money.

Accounts Payable receives 17,000 invoices per week. Process is to send blanket PO items back to department for approval with letter of transmittal then returns to accounting. People often use blanket POs even if item <$500 though they could avoid this process.

Despite having to maintain constant margins and overhead many items are seasonal. They notice for desktop devices three peak purchasing periods:

1. end of fiscal year to spend since no rollover
2. back to school
3. end of calendar year

**Potential New Specializations**

**Electronic catalog on the Internet**

Suppliers will create and maintain on-line catalogs specifically for MIT. These will tie directly into the order fulfillment and American Express billing systems. It will permit MIT to track purchase history.

Benefits to the suppliers to: reduces catalogs by 80% sent to MIT, enables modification of items & prices (saves $70k annually at MIT), creates a single bill for MIT, reduces mistakes (typically 3% to .5% with each individual error costing several hundred dollars to remedy), etc.

**Purchasing card**

Relationship with American Express. Could restrict the card to certain suppliers and dollar amounts. Descriptive literature to be provided.

**Next Steps**

Interview with Steve McCluskey Monday April 10, 1995 at 9 a.m.
temporary help process description
AP process for blanket POs

Get publications
management reporting vision
American Express's view of cards
artifacts: PO, transmittal letter, etc.

Interview with Peter Roden regarding future of purchasing processes
irrelevance of aggregators and catalogs

Contact National Association of Purchasing Management
detailed data on transaction costs
Tempe, AZ (800) 888-6276
Interview: Purchasing Agent  
Monday April 10, 1995 9 to 10 a.m.  
Steven McCluskey, General Purchasing Office, Rm. E18-360, x3-8348,  
smcluskey%mitvaps@mitvma.mit.edu

Issue
MIT purchased $1.7 million in secretary and clerical temporary help in the last fiscal year. MIT save an estimated $.25 million, or 14.7%, by simply consolidating the suppliers. Consolidation creates a higher volume with reduces the mark-up by the temporary help supplier. It also lowers the volume of paperwork with multiple suppliers.

Temporary help agencies charge MIT a mark-up over what they pay temporary workers. This mark-up was quoted an average of 30%; yet an audit revealed actual mark-ups were over 50%. Previously departments held responsibility for auditing charges.

Determine Old Process
Supplier selection process
Mail annual Request for Proposal (RFP) to all local suppliers to ask their best rates in five categories. purchasing

Publish list of all suppliers and their quotes. Open letter to institute sent out internally. purchasing

Endusers free to chose any supplier.

Buy / pay process
Identify need for temporary worker. enduser
Send request for a PO. Department/enduser
method
paper
EReq with account number, person, and requisition number
type
one time PO: ex. good for one week
blanket PO: ex good for certain period of time often fiscal year
multiple blanket POs are required if not sure which supplier planned

Grant PO. signature authority??
Order a temporary. enduser
Give PO to supplier
Arrival. temporary worker
Work. temporary worker
Complete temporary’s time card. enduser
Return time card to agency. enduser or temporary worker
Invoice MIT accounting. supplier
or invoice to Department. supplier
Post into tracking system. MIT accounting
Send to Department/enduser for review & approval. MIT accounting
Review & approval. *Department/enduser*
Return to MIT Accounting. *Department/enduser*
Sign invoices. *signature authority*
Batch Invoices with others from same firm. *MIT accounting*
Cut checks. *MIT accounting*
Mail to supplier. *MIT accounting*

**Determine Semi-new Process**

*Supplier selection process*
Mail annual Request for Proposal (RFP) to all local suppliers to ask their best rates in five categories.

Publish list of six recommended suppliers and their quotes. Open letter to institute sent out internally.

Clients still free to chose any supplier.

*Buy/pay process*
SAME

**Determine New Process**

*Supplier selection process*
Develop contract four pages. Term is three years with annual renewals and 30 day termination clauses. *legal, personnel, purchasing, departments*

Mail annual Request for Proposal (RFP) to all local suppliers to ask their best rates in five categories.

Select a single supplier (Sterling). *purchasing*

Select three subcontractors (Office Specialists, Adia, Skill Bureau). *supplier*

Selected such that the three and prime contractor currently cover 70% of MIT’s needs.

*Buy/pay process*
Identify need for temporary worker. *enduser*
Create EREQ automatically routed to approved, primary supplier. *Department/enduser*
Arrival. *temporary worker*
Work. *temporary worker*
Complete temporary’s time card. *enduser*
Return time card to agency. *enduser or temporary worker*
Invoice MIT accounting with computer tape and hard copy. *supplier*
Split items. *MIT accounting*

if <$500 then

Cut check. *MIT accounting*
Mail to supplier. *MIT accounting*

-- OR --
if >$500 then Send to Department/enduser for review & approval. MIT accounting
Review & approval. Department/enduser
Return to MIT Accounting. Department/enduser
Cut check. MIT accounting
Mail to supplier. MIT accounting
Issue reports weekly, monthly, quarterly to MIT on status. supplier
Buy / pay process (exception)
Call sub-contractor directly to order temporary worker. enduser
Call prime contractor to notify. sub-contractor
Work. temporary worker
Complete temporary's time card. enduser
Return time card to agency. enduser or temporary worker
Invoice MIT accounting with computer tape and hard copy. prime supplier

Determine Prospective Process
Supplier selection process
Buy / pay process

Blanket Purchase Orders
Blanket Purchase Orders (BPO) last for the entire fiscal year from July 1 to June 30. BPOs are given an estimated dollar amount which is not set aside or allocated until invoices are received. BPOs are specific to a single supplier.

However, a BPO can be charged to another account during the review and approval process.

Signature Authority
Signature authority separated into a hierarchy within each department. These are tracked on a signature authority card. Refer to attached Exhibit. There are two dimensions to signature authority, category and amount.

There are four categories of signature authority:

1. External Requisitions: open a purchase order number. This may be done on a paper format or using an electronic requisition (EREQ). Paper takes two to three days longer than EREQs but may be expedited by physically walking it to the appropriate personal. There is weekly training offered on using the EREQ system.
2. Internal Requisitions: open a purchase order from an internal supplier such as Graphic Arts or the MIT Computer Center.
3. Travel Signatures: pay for expenses incurred while traveling. Note, this is different than travel vouchers which cover a single person. In Boston, a PO can be used; outside Boston a travel voucher must be used.
4. Invoice Signature: authorize accounting to cut a check to pay a supplier.
Authorization also covers different amounts such as up to $500, $1000, $25000 or unlimited. If a person wishes to purchase an item of higher value they must submit it for approval. Purchasing inspects to verify items are not split into several POs.

**Miscellaneous**

If an expense is over $2,500 then a form must be completed in order to explain why the supplier was chosen and why the price is reasonable. Refer to attached Exhibit.

Random audit of 290 POs last year with 3,000 invoices by calling suppliers to ask their pay rate to determine the mark-ups. The mark-ups averaged 55%; some were even up to 90%.

*Temporary Workers outside Contract Categories*

Pay is negotiated directly between Department/enduser and supplier.

*Costs*

MIT incurs a cost of $40 per PO and $10 per invoice according to a study by CSC Index.

*Benefits to approved supplier*

Last year Sterling sold MIT only $11,800 of temporary help on 4 POs. In the first three months of this year Sterling has sold $82,000 on 21 POs. Currently negotiating single, MIT blanket PO. Sterling splits mark-up when subs provide labor.

In the current system, suppliers must pay temporaries on a weekly basis; yet, MIT pays net thirty creating potential cash flow issues for suppliers. In the prospective system, payments will be made with MIT American Express Cards.
Interview: Purchasing Agent
Monday April 14, 1995 9 to 9:30 a.m.
Steven McCluskey, General Purchasing Office, Rm. E18-360, x3-8348,
smccluskey%mitvaps@mitvma.mit.edu

Issue
This meeting reviewed the process map of the old system created after our initial meeting. This elaborated and corrected the flow. The review covered the old process since this the current process just abstracts a simplified subset from this process map.

This represents an idealized process things can and do get skipped or done out of turn leading to rework. The bulk of the process is similar for other types of goods. Blanket Purchase Orders can not be used to acquire equipment. 80% of orders are less than $500.

New system will have Sterling down to 28% mark-up. Also might switch current voucher pay roll employees to temporaries since they receive no benefits yet MIT must pay 34% taxes for benefits while Sterling would pay 22%. Voucher employees are typically technical and limited to under 1000 hours per year.

Mr. McCluskey also provided further artifacts used in the process.
Interview: Purchasing Agent
Friday April 28, 1995 10 to 11 a.m.
Steven McCluskey, General Purchasing Office, Rm. E18-360, x3-8348,
smccluskey%mitvaps@mitvma.mit.edu

Issue
This meeting reviewed the process map of the old system created after our previous meetings. This elaborated and corrected the flow. The review covered the old process since this the current process just abstracts a simplified subset from this process map.

290 Purchase Orders for Temporary Help in the last year. Ideally this will go to one per year.

Mr. McCluskey brought up OSP, Office of Sponsored Programs, and government sponsored work both of which must be reviewed if a sensitive or restricted purchase. These account numbers start with the digit 6, 7, 8, or 9. Sensitive means fun like food, gifts or entertainment. Restricted means items like hypodermic needles.

Also if an enduser wants to expand or alter an order the can submit a change order. If the purchase goes over a limit, they must get the appropriate signatures.

Accounting permits a small variance factor to balance requisitions and actual invoice amounts.

Up to 45 suppliers give unsolicited bids for temporary help. 34 are on file in paper while 6 are in the computer system. This will go to the single supplier.

Potential problems with system: no PO # on invoice, wrong supplier on requisition (accounting will not pay if invoice and requisition are not identical), and transposed #s.

Purchasing calls user if a better price is available elsewhere. This saves money for the user but there is no apparent incentive to do so for purchasing.

OLS is an internal department. MCC is independent.

Black box items use RFQs with specs attached.

Next Steps
Refer to Mike and Bob, Receiving Dock Managers in E-19, Peggy McGrath x3-8366 in Purchasing's computer system group, Al Harrington, Assistant Comptroller same bldg. room 545.
Interview: Receiving Manager
Friday April 28, 1995 11 to 11:30 a.m.
Mike, Receiving Manager, Rm. E19-1, x3-

Issue
This meeting gathered information on the activities performed in the receiving and distribution coordination mechanism. I collected a copy of the form used in this process. Interestingly, this form had three pages: one for Receiving’s records, a second for the recipient, and a third with no purpose. The form did not hold enough fields for the data collected. He mentioned that at some point in the future Receiving might merge with the campus mail group. Though the mix of letters and boxes will likely cause difficulties.

To have returns, users call the supplier to collect a defective or unwanted item. The supplier must then call UPS to issue a call tag to collect the item. Meanwhile the item sits in the receiving dock. After two weeks the receiving dock calls the enduser to have them remind the supplier about getting the call tag issued. If UPS is not used then the package must go through the main receiving dock in building 20 with Mike Walsh.

A process improvement that just went in two years ago (after two years of requests) was a computer terminal with access to the MITVAPS system to track orders and locate endusers.

Process
Sign deliverer’s board
write up
  save white forms for three years, if dispute on payment can verify delivery
  often problems with delivery information must determine
  check name or last similar order in computer
  call 800 number for supplier and ask if they can read the details
  use directories or call personnel
deliver daily usually within two hours except low priority buildings twice a week
  enduser keeps yellow copy of form
not use campus mail
Interview: Assistant Director of Purchasing & Stores
Monday May 1, 1995 10 to 11 a.m.
Diane Devlin, MIT Purchasing & Stores, Rm. E18-360, x3-7035,
ddevlin@mit.edu

Miscellaneous New Information
I received more artifacts: the organization charts and a purchase order form.

Purchasing Agents' evaluations track cost savings. This means savings beyond what the user listed as cost. Thus this function adds value by looking for better sources.

Industry standards say requisitions cost $150 to process. EREQs cost about $35. The proposed system may push this down to under $10. MIT processes 17,000 requisitions per week. 54% of the total are EREQs. Miscellaneous fact -- 87% of paper work for less than 3% of purchase cost.

The supplier database is purged every eighteen months. This usually cuts it from 55-60K to 45K. Suppliers are kept a year past the last transaction invoice. Though initial PO can be up to five years old due to multi-year contract work. Last year 14K suppliers were granted POs. Devlin hopes to bring the number of suppliers for standard items under 1K.

EReq system
In month of April, the system did 22,000 transactions. The number of requisitions entered is approximately equal to the number of requisitions printed (3.2 versus 2.9 K thus still keeping local paper copy but decreasing trend). The system also permits users to find information on orders; this saved 2,300 calls to Accounting and 3,000 calls to Purchasing. The system is three years old. It started with $25K prototype then rolled out on the full scale. Specifically chose VT100 terminal emulation since very low tech; everyone on campus could access it without buying additional hardware.

Training occurs on a daily basis. Purchasing Agents teach the classes. Due to the mobile nature of the researchers and graduate students, training must occur on an on-going, weekly basis. This is advertised in several areas including the MIT new employee safety orientation which is mandatory for all.

Usage dips in good weather and rises in good weather, since people may opt to walk in a requisition. Devlin has positive high correlation reports that show this. Akin to this, the closer an enduser's physical proximity to Purchasing the less likely they are to use EREQs.
APPENDIX D: PROCESS ARTIFACTS

This section contains:

MIT Purchasing Offices and Agencies -- Locations and Contacts
Memo: Suggested Suppliers for Temporary Help (Old Way, Multi-Source)
Memo: Sterling Skill Codes (New Way, Single Source)
Signature Authorization Card
Requisition
Selection of Source
Purchase Order
Receiving Room Receipt
PURCHASING OFFICES AND AGENCIES
LOCATIONS AND CONTACTS
**Director's Office: 50 Ames Street, Room E18-311**

Barry Rowe
Director of Purchasing and Stores
253-7243

Jennifer Zanetos
Assistant to the Director for Affirmative Action Procurement Programs
253-8369

**General Purchasing Office: 50 Ames Street, Room E18-360**

Diane Devlin
Assistant Director for Purchasing and Affirmative Action Procurement Programs Coordinator
253-8380

Kay Arthur
Purchasing Agent - Chemicals, Lab Apparatus and Supplies
253-8341

Gerry Greenhow
Senior Purchasing Agent - Electronic, Mechanical, Electrical and Computer Components, Supplies and Equipment (equipment under $10K), Software (Minor), Video Equipment
253-7251

Steve McCluskey
Purchasing Agent - Office, Microfilming and Computer Supplies and Services, Temporary Help, Books, Subscriptions, Facsimile Machines
253-8348

Michael McNamara
Senior Purchasing Agent - Office Equipment: Word Processing, Photographic, etc. Typewriter, Mail Machine and Computer Service and Maintenance Contracts, Machine Shop and Pattern Shop Services, Maintenance and Repair (Housing Dept), Freight, Moving, Rigging
253-7247

**Subcontracts and Major Equipment Acquisitions Office: 50 Ames Street, Room E18-301**

Robert Bloomberg
Assistant Director for Subcontracts and Government Relations
253-7260

Arthur Forrester
Senior Subcontract Administrator - Subcontracts, Consultant Arrangements, Professional Services, Major Software and Rental and Lease of Equipment
253-8395
Subcontracts and Major Equipment Acquisitions Office (cont'd):

William Najjar
253-3820
Senior Subcontract Administrator - Subcontracts, Consultant Arrangements, Professional Services, Major Software and Rental and Lease of Equipment

Peter Roggeveen
253-7253
Senior Purchasing Agent - Major Equipment (over $10K): Mechanical, Electronic, Scientific, Computers and Peripherals, Motor Vehicles, Liquid Nitrogen, Helium, Oxygen, etc. - Bulk Purchase Contracts

Office of Laboratory Supplies: 350 Brookline Street

Stephen Kellogg
253-4959
Associate Director for Stores

Barry Roberts
253-0239
General Manager

Nancy Hannula
253-8373
Purchasing Agent - Furniture and Furnishings - Furniture, Carpeting, Drapery, etc.

Thomas Morgan
253-8372
Purchasing Agent - Chemicals, Compressed Gas, Electronics, Lab Apparatus, Office and Computer Supplies

Purchasing Field Office: (National Magnet Laboratory/Plasma Fusion Center) 150-170 Albany Street, Room NW14-1213, 253-5460

Thomas Egan
Manager*
Gary Boilard
Subcontract Buyer*

*all purchased items required by Laboratory

Research Laboratory of Electronics: 50 Vassar Street, Room 36-413, 253-2520

John Peck
Purchasing Agent - all purchased items required by Laboratory
Center for Space Research: 70 Vassar Street, Room 37-274, 253-6116
Dan Dangler Purchasing Agent - all purchased items required by Laboratory

Laboratory for Nuclear Science: 77 Massachusetts Avenue, Room 26-516A, 253-5162
Mark Damian Manager*
Clifford Peacock Buyer*
*all purchased items required by Laboratory

Graphic Arts: 211 Massachusetts Avenue, Bldg. N42, 253-4765
Richard Frye Manager*
Jean Caloggero Buyer*
*printing and supplies, paper stock, related items

Physical Plant: 50 Ames Street, Room E19-107, 253-5166
Tammy Doyle Buyer*
*all purchased items required by Plant

Lincoln Laboratory: 244 Wood Street, Lexington, MA 02173, 862-5500 X621
Daniel Coakley Manager
Numerous Buyers all purchased items required by Laboratory
From: Diane Devlin, Assistant Director
       General Purchasing

To: Administrative Officers

Date: July 15, 1994

Subject: Suggested Vendors for Temporary Help

The Institute expends a substantial sum each year for the services of temporary personnel. Most of our temporary needs are for secretarial and clerical services, which are acquired under blanket purchase orders. In the interest of obtaining the best possible temporary help at the most favorable rates, we invited agencies wishing to do business with MIT to submit rates and a company profile. These rates apply to business placed July 1, 1994 through June 30, 1995.

After comparing rate information, references and other services, the following six companies are our suggested agencies. Their rates for six of the most common skill categories are listed on Table A (over).

Kelly Temporary Services 482-8833 Jennifer Reback
John Leonard Agency 423-6800 Jeanne Kim
Office Specialists 354-7215 Jeanine Pace
Skill Bureau 423-2986 Jean McCarthy
TAC Temps 354-5202 Janet Flanders
*Temp Xpress 451-5105 LaVerne Freeman

Please understand, we are not limiting departments to these agencies. We realize that others may fulfill your requirements. Our analysis shows, however, that these agencies offer MIT the best value.

Should you have any questions or need additional information regarding this matter, contact Steven McCluskey at 3-8348, or Joanne Jones at 3-8350.

*Minority & Woman-Owned Company
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<tbody>
<tr>
<td>RECEPTIONIST</td>
<td>10.88 - 11.96</td>
<td>11.78</td>
<td>10.95 - 12.75</td>
<td>10.00 - 11.45</td>
<td>8.89 - 10.48</td>
<td>9.25</td>
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<tr>
<td>STAT/TECH TYPIST</td>
<td>12.82 - 15.22</td>
<td>14.43</td>
<td>12.25 - 14.50</td>
<td>13.60 - 15.00</td>
<td>12.70 - 13.34</td>
<td>12.95</td>
</tr>
<tr>
<td>DATA ENTRY</td>
<td>12.88 - 12.33</td>
<td>10.89</td>
<td>11.25 - 12.95</td>
<td>11.10 - 12.15</td>
<td>9.53 - 10.80</td>
<td>10.57</td>
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<tr>
<td>WORD PROCESSING</td>
<td>15.25 - 16.68</td>
<td>15.97</td>
<td>15.50 - 16.50</td>
<td>15.75 - 17.90</td>
<td>13.33 - 14.60</td>
<td>14.80</td>
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<td>SECRETARY</td>
<td>14.50 - 15.95</td>
<td>15.34</td>
<td>15.50 - 17.50</td>
<td>15.75 - 17.90</td>
<td>12.70 - 13.97</td>
<td>15.20</td>
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*MINORITY & WOMAN-OWNED COMPANY
MEMORANDUM

To: Joanne Jones  
From: Joe Allen  
Date: February 7, 1995  
Re: Skill Codes  
cc: Steve McCluskey, Kathleen Quinn Votaw

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<tr>
<th>POSITION</th>
<th>CODE</th>
<th>DESCRIPTION</th>
<th>Bill Rate</th>
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<tbody>
<tr>
<td>Clerk, Receptionist</td>
<td>CLK. REC</td>
<td>Assists with general office duties (filing, copying, collating, stuffing envelopes, running errands, delivering mail, etc.). Answers telephone, has knowledge of large switchboards as well as smaller systems. Takes accurate and detailed messages and performs general office duties.</td>
<td>$9.25</td>
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<tr>
<td>Data Entry, Word Processing</td>
<td>DEO.  WPR</td>
<td>Proficient in various PC and MAC databases, and experienced in different types of data entry. Typing at 65+ wpm. Strong understanding of complex functions, formatting, and statistical/technical typing.</td>
<td>$12.45</td>
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<tr>
<td>Secretarial, Clerical</td>
<td>ADA</td>
<td>Able to handle many tasks at once. Process letters, memos, proposals and other text on PC or MAC software. Schedule appointments and meetings, and perform various other administrative duties. May require interaction with executive level, possibly on a sensitive level. Excellent written and verbal skills a must.</td>
<td>$13.41</td>
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</tbody>
</table>

ACC* Someone who possesses some or all of the fundamental knowledge and skill of accounting practices and principles.  
ADA Administrative Assistant. This is someone who works in a support capacity and possesses typing, word processing, and general secretarial skills.  
CLK Clerk. Someone who is capable of following instructions to complete tasks where very little decision-making and/or analytical skills are required.  
CRR* Client Relations Representative. An individual with customer service experience in an office environment, acting as a liaison for the client regarding a product or services.  
DEU Data Entry Operator. Someone who enters information into a terminal’s predefined screens at a specific number of keystrokes per hour.  
DTP* Desk Top Publisher. This person creates graphics, layouts and presentations on a computer.  
MIS Management Information Systems. This is the code for all Metrosystems employees and work orders.  
REC* Receptionist. Someone who answers phones and greets visitors.  
WPR* Word Processor. Someone who will only produce documents via terminal ≥ 50% of the day.

Note: * Indicates skill category not outlined in the proposal but are often asked for. These bill rates will differ per our discussion of specific skill categories.
1. Complete one line below for the Account Supervisor and each person being authorized for this account number. Enter:
   - $ AMOUNT - if a person's authority to sign (approve) for a category* is limited to a dollar amount
   - NO LIMIT - if a person's authority to sign for a category is not limited to a dollar amount
   - NONE - if a person is not authorized to sign for a category
   - CREATE (under SUPPORT) - if a person is not authorized to sign, but is authorized to create electronic requisitions and to view account activity
   - READ (under SUPPORT) - if a person is not authorized to sign, but is authorized to view account activity
   - COPY (under SUPPORT) - if a person is designated to receive an electronic copy of each electronic requisition submitted to Purchasing or to an Internal Provider
   - APPROVE (under APPROVE) - if a person is authorized to approve electronic requisitions created by others (to the limit of the approver's signature authority)
   - DELETE (in the SIGNATURE space) - for any person to be deleted. Indicate name and enter ID#.
   - CHANGE (in the SIGNATURE space) - for a change to a person's previous authorization. Indicate name and enter ID# and new authorization(s).

2. Indicate E for Employee, S for Student, or O for Other (e.g. visiting professor). MIT ID No. not required for "Other."

*Categories: EXTERNAL REQUISITIONS applies to purchases from sources outside the Institute; INTERNAL REQUISITIONS applies to purchases from *Internal Providers within the Institute (Lab Supplies, MIT Computer Connection, Physical Plant, etc.). TRAVEL DOCUMENTS and INVOICES apply to approval of these for payment.

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<tr>
<th>NAME (Type or Print)</th>
<th>E/S/O</th>
<th>MIT IDENTIFICATION NUMBER</th>
<th>EXTERNAL REQUISITIONS</th>
<th>INTERNAL REQUISITIONS</th>
<th>TRAVEL DOCUMENTS</th>
<th>INVOICES</th>
<th>SUPPORT</th>
<th>APPROVE</th>
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Purchasing Use

Date Entered ________ Initials ________

VOID

Signature of Account Supervisor

If additional space is required, complete another form and staple it to this form.
MIT

SELECTION OF SOURCE

REQUISITION $2,500 AND HIGHER - REQ. NO.: ______________________

MIT and Federal policies require that for a requisition $2,500 and higher for which the vendor has been specified by the requisitioner, a Selection of Source form must be completed by the requisitioner. Information provided will be reviewed by MIT and Federal auditors and by the Office of Naval Research, regardless of the account number charged.

1. SUMMARY OF BIDS RECEIVED - attach copies of all written quotations to this form (mandatory if $5,000 or higher)

Enter the Total Price quoted by One or More sources:

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<tr>
<th>COMPANY</th>
<th>TOTAL PRICE</th>
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<td>1)</td>
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</table>

(continue on reverse side if necessary)

2. BASIS FOR SOURCE SELECTION (check one)

a) [ ] Lowest Bidder selected - no further explanation or price justification required.

b) [ ] Other than Lowest Bidder selected - explanation and price justification required. Explain the reasons for selecting other than the lowest bidder in the space below. An existing document which contains this information may be attached instead. Use the check-off sheet on the reverse side to indicate your basis for determining that the price to be paid is reasonable.

c) [ ] Sole Source selected - explanation and price justification required. Indicate in the space below other sources, if any, that were or could have been considered, why they cannot be used, and the reasons why this source is the only one that can satisfy the requirement. An existing document which contains this information may be attached instead. Use the check-off sheet on the reverse side to indicate your basis for determining that the price to be paid is reasonable.

These rates have been negotiated with each supplier of temporary help and documented on a master listing, which is maintained by The General Purchasing Office.

Hourly billing rates are considered fair and reasonable when compared to rates offered by other temporary agencies, and are in the best interest of the Institute.

(continue on reverse side if necessary)

3. DETERMINATION OF REASONABLE PRICE - use the check-off sheet on the reverse side to indicate your basis for determining that the price to be paid is reasonable.

Form 2.6A (7/94) (CONTINUED ON REVERSE)
DETERMINATION OF REASONABLE PRICE

Select the statement(s) below which reflect your basis for determining that the price to be paid is reasonable, or use OTHER to provide your own statement.

☐ Catalog or list price (or less) for STANDARD commercial item.
☐ Price for NONSTANDARD item to our specifications which is consistent with in-house estimate.
☐ Price compares favorably to price paid for the same item or similar item of like complexity under a previous PO (enter previous PO number under OTHER below).
☐ Price compares favorably with catalog or list price for similar item of like complexity (enter description and price of similar item under OTHER below).
☐ OTHER - Enter your own statement, if needed, and/or information on discount, donation, or negotiation if related to your statement or the statement you selected/provided above.

________________________________________________________________________

Requisitioner’s Signature

________________________________________________________________________

Buying Agent’s Signature

(continuation space)
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
DEPARTMENT OF PHYSICAL PLANT
RECEIVING ROOM RECEIPT / TRUCKING REQUEST

DATE RECEIVED ______________________

RECEIVED FROM ____________________________________ CONTAINER DAMAGED [ ] YES

RECEIVING ROOM NO. ______________ RECEIVED BY ___________________ NO. OF PIECES ______________

DELIVERED BY: [ ] UPS [ ] HUB [ ] RPS [ ] THEIR OWN [ ] OTHER __________________ Specify

MARKED FOR __________________________________

____________________________________________________________________________________

DELIVERED TO BUILDING/ROOM ________________________________________________ BY __________________

DATE DELIVERED: _______________________________ RECEIVED BY ____________________________

(IF NO PERSON IS AVAILABLE TO SIGN FOR MATERIAL, INDICATE WHERE IT WAS LEFT).

MIT P.O. NO. __________________ ACCOUNT NO. ____________________ REQ./JOB NO. ____________________

TRUCK NO. __________________ DRIVER __________________ COMPLETION DATE ___________________
BIBLIOGRAPHY


*Tech Talk.* “Team finds surplus of suppliers” October 19, 1994


