An Integrated Framework for Strategic Information Systems Planning and Development

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Information has emerged as an agent of integration and the enabler of new competitiveness for today's enterprise in the global marketplace. However, has the paradigm of strategic planning changed sufficiently to support the new role of information systems and technology? We reviewed the literature for commonly used or representative information planning methodologies and found that certain insufficiencies exist. There are six major such methodologies and all of them seem to lack an ability to connect IS strategy to corporate strategy or IS planning to IS development. An integration of strategy with planning and development through enterprise information resources - which capture and characterize the enterprise - will shorten the response cycle for employing and deploying IS to achieve competitiveness. A reference model and the outline of a methodology is towards that end is proposed in this work.

Background

For a long-time relationship between information system functions and corporate strategy was not of much interest to top management of firms. Information Systems were thought to be synonymous with corporate data processing and treated as some back-room operation in support of day-to-day mundane tasks (Rockart, 1979). In the 80's and 90's, however, there has been a growing realization of the need to make information systems a strategic asset to an organization. Consequently, strategic information systems planning (SISP) has become a critical issue. In many industry surveys, improved SISP is often mentioned as the most serious challenge facing IS managers (Pavri and Ang, 1995; Beath and Orlikowski, 1994; Martin, 1993; Porter and Miller, 1985). King (1995) in his recent article has argued that a strategic capability architecture - a flexible and continuously improv-

ing infrastructure of organizational capabilities - is the primary basis for a company's sustainable competitive advantage. In fact, the concept of core competence in corporate competitiveness has further highlighted the significance of Information Systems in a world that is increasingly relying on information technology (IT) , since IS has the promise of producing core competencies.

SISP is the analysis of a corporation's information and processes using business information models together with the evaluation of risk, current needs, and requirements. The result is an action plan showing the desired course of events necessary to align information use and needs with the strategic direction of the company (Battaglia, 1991). There is a growing realization that the application of IT to a firm's strategic activities has been one of the most common and effective ways to improve business performance.

In this paper, we review the existing methodologies for

SISP in an attempt to answer this question: how to move ahead and further improve the effectiveness of strategic planning for information-based enterprises? Review of the existing methodologies points to the need to develop a framework for more tightly linking information strategies with SISP and further with IS development in organizations. We have attempted to develop such a framework and a theory for strategic information systems planning and a methodology for implementing the framework. The framework consists of an analysis of opportunities for strategic use of IS/IT (Hsu, 1996) and a theory of information integration developed by Hsu and Rattner (Hsu and Rattner, 1993) . While extending these results, this research also develops a few matrices as a part of a methodology to conduct strategic information systems planning and link the planning to systems development.

In the next section, we review the evolution of IS planning from the perspective of the present day insistence on treating information systems as a strategic asset. Then we discuss six popular IS planning methodologies and point to what they individually and collectively lack. This is followed by a section in which we begin to lay the road map for integrating IS strategy planning and development. That section analyses the directions of using IS/IT for enterprise competitiveness. We go on to outline a reference model for information planning and particularize this reference model for manufacturing planning and control.Then we offer a methodology for linking the results of information systems planning with structured systems analysis. Finally, we summarize our conclusions.

The Perspective of Strategic Information Systems Planning

In order to put the planning for strategic information systems in perspective, the evolution of information systems according to the three-era model of John Ward, et al. (1990) is pertinent. According to this model, there are three distinct albeit overlapping eras of information systems, dating back to the 60's. The relationship over time of the three eras of information systems is shown in Table 1.

Applications in the overall Data Processing (DP), Management Information Systems (MIS) and Strategic Information Systems (SIS) area need to be planned and managed according to their existing and future contribution to the business. Traditional portfolio models consider the relationship of systems to each other and the tasks being performed rather than the relationship with business success. A portfolio model derived from McFarlan (1984) considers the contribution of IS/IT to the business now and in the future, based on its industry impact. Based on this model, applications are

Strategic Applications which are critical for future success. Examples: computer-integrated manufacturing, links to suppliers, etc.	**Turnaround** Applications which may be of future strategic importance. Examples: electronic data interchange with wholesalers, electronic mail, etc.
Factory Applications which are critical to sustaining existing business. Examples: employee database, maintenance scheduling, etc.	**Support** Applications which improve management and performance but are not critical to the business. Examples: time recording, payroll, etc.

Table 2: A Portfolio Model [McFarlan (1984)]

divided into four categories, as shown in Table 2.

Some characteristics of strategic IS planning are:
- Main task: strategic/competitive advantage, linkage to business strategy.
- Key objective: pursuing opportunities, integrating IS and business strategies
- Direction from: executives/senior management and users, coalition of users/management and information systems.
- Main approach: entrepreneurial (user innovation), multiple (bottom-up development, top down analysis, etc.) at the same time.

	ERA	CHARACTERISTICS
60s	Data Processing (DP)	Standalone computers, remote from users, cost reduction function.
70s & 80s	Management Information Systems (MIS)	Distributed process, interconnected, regulated by management service, supporting the business, user driven.
80s & 90s	Strategic Information Systems (SIS)	Networked, integrated systems, available and supportive to users, relate to business strategy, enable the business - business driven.

Table 1: The Three Era Model of IS [Adapted from Ward (1990)]

Strategic Information Systems Planning in the present SIS era is not an easy task because such a process is deeply embedded in business processes. These systems need to cater to the strategic demands of organizations, i.e., serving the business goals and creating competitive advantage as well as meeting their data processing and MIS needs. The key point here is that organizations have to plan for information systems not merely as tools for cutting costs but as means to adding value. The magnitude of this change in perspective of IS/IT's role in organizations is highlighted in a *Business Week* article, 'The Technology Payoff' (June 14, 1993). According to this article, throughout the 1980s, U.S. businesses invested a staggering $1 trillion in information technology. This huge investment did not result in a commensurate productivity gain—overall national productivity rose at a 1% annual rate, compared with nearly 5% in Japan.

Using the information technology merely to automate routine tasks without altering the business processes is identified as the cause of the above productivity paradox. As IT is used to support breakthrough ideas in business processes, essentially supporting direct value adding activities instead of merely cost saving, it has resulted in major productivity gains. In 1992, productivity rose nearly 3% and the corporate profits went up sharply. According to an MIT study quoted in the above article, the return on investment in information systems averaged 54% for manufacturing and 68% for all businesses surveyed. This impact of information technology on redefining, reengineering businesses is likely to continue and it is expected that information technology will play increasingly important roles in future.

For example, Pant et al. (1994) point out that the emerging vision of virtual corporations will become a reality only if it is rooted in new visionary information technology. It is information technology alone which will carve multiple 'virtual corporations' simultaneously out of the same physical resources and adapt them without having to change the actual organizations. Thus, it is obvious that information technology has indeed come a long way in the SIS era, offering unprecedented possibilities, which, if not cashed in on, would turn into unprecedented risks. As Keen (1993) has morbidly but realistically pointed out, organizations not planning for strategic information systems may fail to spot the business implications of competitors' use of information technology until it is too late for them to react. In situations like this, when information technology changes the basics of competition in an industry, 50% of the companies in that industry disappear within ten years. Internet is one such technology which is likely to change the basics of competition at least in a few industries, the newspaper and the software industries to name two.

Issues in SISP Methodologies:

Methodologies

The task of strategic information systems planning is difficult and often time organizations do not know how to do it. Strategic information systems planning is a major change for organizations, from planning for information systems based on users' demands to those based on business strategy. Also strategic information systems planning changes the planning characteristics in major ways. For example, the time horizon for planning changes from one to three years or more. Development plans are driven by current and future business needs rather than incremental user needs. An increase in the time horizon is a factor which results in poor response from the top management to the strategic information systems planning process as it is difficult to hold their attention for such a long period. Other questions associated with strategic information systems planning are related to the scope of the planning study, the focus of the planning exercise - corporate organization vs. strategic business unit, number of studies and their sequence, choosing a strategic information systems planning methodology or developing one if none is suitable, targets of planning process and deliverables. Because of the complexity of the strategic information systems planning process and uniqueness of each organization, there is no one best way to tackle it. Vitale, et al. (1986) classify SISP methodologies into two categories: *impact* and *alignment*. Impact methodologies help create and justify new uses of IT, while the methodologies in the alignment category align IS objectives with organizational goals. Popular alignment methodologies reported in literature are Value Chain Analysis (Porter, 1984) and Critical Success Factor Analysis (Rockart, 1979) while popular "impact" methodologies are IBM's Business Systems Planning, Robert Holland's Strategic Systems Planning, James Martin's Information Engineering and Method/1 from Andersen Consulting. A brief comparative sketch of the six methodologies is given in Table 3.

Problems With SISP Methodologies

Lederer and Sethi (1988) surveyed 80 organizations to examine the problems faced by information systems managers when they attempt to implement one of three alignment methodologies, BSP, SSP or IE. Barlow (1990) has also examined the SISP methodologies and has provided some insights into their structure and implementation problems. Bergeron et al. (1991) examined the issue of application of two 'impact' methodologies, Porter's Value Chain Analysis and Wiseman's Strategic Thrust Methodology. These studies and the insights developed by us form the basis of this section which provides a critique of the existing methodologies.

The detailed list of problems in implementing SISP methodologies has been classified by Lederer and Sethi as resource, planning process, or output related problem associated with the three methodologies. According to this survey, the most severe problem identified by IS managers is the failure to secure top management commitment for carrying out the final plan. The second most severe problem identified is the requirement for substantial further analysis after the

Methodology	Focus	Salient Feature	Strengths	Weaknesses
Value Chain Analysis	Impact	- A form of business activity analysis - Helps in devising information systems which increase profit - Concentrates on value-adding business activities	- Concentrates on direct value adding processes. - Is independent of organizational structure	- Doesn't address issues of systems development and implementation. - Doesn't define a data structure. -Difficult to apply to non-manufacturing firms.
Critical Success Factors	Impact as well as alignment	- Used for identifying key information needs of an organization and its managers.	- Focus on key information requirements	- Not comprehensive - Internally focused and analytical, not creative. - Ignores value adding aspects of Information Systems.
Business Systems Planning (BSP) (From IBM)	Alignment	- Combines top down planning with bottom up implementation. - Focuses on business processes. - Data needs and data classes are derived from business processes.	- An integrated method which combines top down analysis with bottom-up implementation. - IBM being the vendor, it is better known to the top management.	- Detailed, time consuming and costly. - Does not incorporate a software design methodology. - Requires a high degree of IT experience within the planning team.
Strategic Systems Planing (PROplanner)	Alignment	- A business functional model is defined by analyzing major function-al areas of a business. - Data architecture is derived from the business function model. - The above architecture is used to identify new systems and their implementation schedules.	- An integrated method which combines top bottom-up implementation.	- Detailed, time consuming and costly. - Requires a high degree of IT experience within the planning team.
Information Engineering (From James Martin)	Alignment	- Provides techniques for building enterprise, data, and process models. - These models are combined to form a comprehensive know-ledge base which is used to create and maintain information systems.	- A comprehensive methodology - Provides automated tools to link output to subsequent systems development efforts.	- Extensive user involvement - Lengthy - Difficulty in finding a team leader - Difficulty in securing top management support.
Method/1 (From Anderson Consulting)	Alignment	- A layered approach - Top layer is methodology, middle layer is techniques supporting methodology and the bottom layer has tools supporting techniques. - Techniques supported: DFD, Matrix Analysis, Functional Decomposition, Focus Groups and Delphi studies. - Supported by CASE tool FOUNDATION.	- Comprehensive - Provides automated support	- Expensive - Too detailed - Time consuming

Table 3: Comparative Features of SISP Methodologies

completion of the IS plan. Both these problems are related to the output of the planning process. Besides these top two, six of the next top eight problems are related to the resources required to carry out the strategic information systems planning (success of the plan depends on the team leader, difficulty in finding the team leader meeting the criteria specified in the study, methodology lacking computer support, planning exercise taking long time, etc.). Among the top ten problems encountered while implementing one of these methodologies (or, even while implementing an in-house methodology), three are common: difficulty in obtaining top management commitment for implementing the outputs, the re-

quirement of substantial further analysis and difficulty in finding a good team leader. The results of this survey suggest that IS planners are not particularly satisfied with their methodologies. If the objective of the SISP exercise is to align IS objectives with business goals, then detailed, lengthy, and complex SISP may be of limited value. Where the objective is to use IT to impact a business strategy, these methodologies may not generate useful ideas for that purpose. Bergeron et al. (1990), however, point out that the value chain analysis and Wiseman's strategic methodologies do help in achieving that purpose. Barlow (1990) suggests that the large number of methodologies that have been developed can often 'add confusion rather than clarity to the (IS) planning process.'

Analysis

- Although strategic information systems planning is a major concern, most organizations find it difficult to undertake it. Besides their lack of experience with SISP, absence of a comprehensive, structured, easy to use methodology may also be a main reason for it. It is possible that the advances in Information Technology and their applicability in organizations has outpaced all formal methodologies evolved in the 70s and 80s or evolved in 90s as marginally modified versions of the earlier methodologies, which were largely dominated by IBM's Business Systems Planning.
- Further, as pointed out by Barlow (1990) also, the overall success of an integrated business/technology architecture depends upon the organizational structure, the level of IT experience within the company, and the availability of information resources. Since these factors differ between firms, there may not be a single best way to view IT planning.
- A comprehensive methodology for SISP will need to incorporate both the 'impact' and the 'align' views. Method/1 incorporates Value Chain Analysis. IE supports Critical Success Factors Analysis. Even BSP now incorporates CSFs.
- Since it is difficult to find a team leader who meets the criteria specified in SISP methodologies, it is proposed that detailed guidelines on how to perform a SISP study by way of an automated tool will help. Such a tool will make the task more structured and less leader-critical. Some such tools for strategic business planning have been developed by the Search Technology, Inc. and are reported in Rouse and Howard (1993).

A conceptual framework for SISP is necessary both from a theory building perspective as also providing a basis for undertaking SISP. The latter is expected to answer some of the following questions frequently encountered by the practitioners in this area:

- What is involved in SISP and how to go about doing it?
- How to link the products of SISP to systems analysis,

design and implementation in a timely manner?
- Is one SISP methodology more suitable than another in a given context?
- How to evaluate alternative information systems plans?

The theory building perspective of SISP is expected to contribute to research in this area, which, being in its infancy, has been largely anecdotal.

Based on the literature in this area and a careful study of the current methodologies, certain generic steps in a typical SISP formulation can be identified. These are:

- Study Internal Business Environment. This is a prerequisite to determining the business IS needs. The internal business environment is comprised of mission of the organization, its objectives, strategies and plans, business activities, the organizational environment, core competencies, its critical success factors and the internal value chain.
- Study external business environment. This helps an organization focus attention on the forces and pressure groups it encounters. These external forces exert a very strong influence on the business strategy of an organization. Factors to be considered here are the industry that the organization is in and that industry's critical success factors, competitive position of the organization in the industry, and its relationship with major buyers and suppliers.
- Study internal IS/IT environment. This is mainly comprised of the current and planned applications portfolio that supports the business. Other aspects to be considered here are the present IS organization, skills and attitudes of people in the organization, IT environment, and the IS/IT budgets.
- External IS/IT Environment. This consists of scanning the environment for available and emerging technologies and their business implications. An important aspect of this is to understand how the competitors are using information technology.

We now turn to a new framework of SISP developed in this research. This framework provides a structural compatibility with the common methodologies of systems analysis and design in the literature and practice. The first level of the framework is the concept of information strategies that on one hand, lead to granular corporate strategies and on the other hand, drive strategic IS planning.

A Conceptual Framework for Information Strategy

The full promise of IT can only be revealed in strategic thinking and yet this level of thinking would not necessarily present itself without a proactive review of IT in light of *yet*

developing competitive opportunities beyond the status quo. IT's promise of dynamic alignment and information integration have opened up new fundamental, strategic opportunities for enterprises. We derive several heuristics from past examples and theoretical analysis in order to facilitate new developments in IT planning and begin a concerted search for strategic IT opportunities. These heuristics are based on [Hsu, 1996] but are extended in this research.

(a) ***Managing External Environments*** The following heuristics focus on the direct, external application of IT on the market as a strategic weapon to gain competitive advantages. The principle is to manage uncertainty in the enterprise environment:

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- *Provide Information Services to Customers.* The idea is to lure and lock customers into the enterprise by investing in IT that provides unique and crucial services to them. The added value is in external orientation. For example, an organization develops IT primarily for facilitating its customers' business rather than for its own internal use. Classical cases include the American Airline's Sabre system for travel agencies and Citibank's Automatic Teller Machine (ATM) for individual customers. There are numerous obvious opportunities for an organization to develop new generations of information services for customers and reap the same in strategic benefits, especially given extended enterprise and information integration. Generalizing the ATM to an on-line, free-of-charge banking and other services network for customers would be a natural potential. Healthcare Management Organizations have begun to explore the unlimited possibilities following along this line of thinking.
- *Turning Information Services into Products.* We can extend the above notion of customer service to information products or information service profit centers. The Sabre system has become a major source of revenues for American Airlines since travel agencies pay significant fees for its extended services. As a matter of fact, the company later spun off the operation and expanded it into a significant travel information services company of its own. In a similar way, proprietary information technology and services that an enterprise develops can be turned into dedicated information services or spin-offs in the market. Electronic commerce and global information systems seem to be especially ripe for this type of opportunity.
- *Monitor the Market and Customer Behaviors.* Marketing databases have proven to be a potent weapon for gathering marketing intelligence and assisting in new product development. Their key is to exploit ubiquitous interfaces with customers (coupons, purchases, repairs, surveys, and the like) and turn them into intelligent information for strategic uses. Every organization by definition has numerous contacts with its customers throughout the

life-cycle of a product. The question is only whether or not the contact is used to benefit the organization's marketing intelligence. Background data repositories such as the census database complement direct contact data. Between these two sources, organizations have unlimited possibilities for marketing research to create innovative strategies.

A broader implementation of managing external environments would include not only the customer but also the supplier and other constituencies of the extended enterprise including external users of the IT. Analyzing the information needs of these external users within the context of their respective enterprises and employing IT to satisfy their needs will work to the organization's benefit. Basic strategic gains result when an organization is able to do more in the way of extended contact and use the feedback gained to improve internal and external business processes.

(b) ***Maximizing the Internal Networking of Processes and Resources*** The second set of heuristics is oriented towards improving the production function of an enterprise, thereby enhancing its productivity (measured through cost and quality). Linkages will be created across an enterprise to connect all stages of cycles, including: differing levels of granularity (product, production, and part); flows (information vs. materials); and businesses (administration vs. production). By connecting all stages of the business cycle, maximum channels of communications can be created to minimize the internal uncertainties facing an enterprise, and resources can be pooled and utilized throughout the extended enterprise. Globally optimized performance can result:

- *Employ and Deploy IT to the Core Production Processes.* A production system that delivers higher quality at lower cost than competitors is the most fundamental strategic advantage for any enterprise. IT is proven to be a key element in achieving this goal within manufacturing enterprises and many other operations-oriented enterprises (e.g., the mail and parcel delivery industry). However, this previous utilization of IT is merely the tip of the iceberg. IT would allow a manufacturing plant to acquire a logical layer that can define the (re-)configuration of an organization's systems in terms that would connect the part processing jobs directly to work order control, materials handling, in-process inspection, production scheduling, order entry, warehousing, process planning, and product design. Even more promising is the direct application of IT to the very production systems that are not traditionally considered production tasks, such as the medical functions of a hospital (e.g., diagnosis, surgery, treatment, and pharmacy) and the educating function of a university (e.g., lectures, assignments, and laboratories). Although IT has been increasingly employed in these functions — with examples rang-

ing from CATSCAN/MRI in medicine to studio style classrooms and World Wide Web-based virtual classes in education -- the majority of them are still isolated within a traditional paradigm where IT is limited to administration jobs. Deepening the role of IT in manufacturing and broadening it to more traditional enterprises promises to provide new and endless strategic opportunities for IT use.

- *Create Forward and Feedback Linkages for All Cycles.* An enterprise has three basic cycles: part, production, and product. The product cycle includes everything from marketing and product planning to recycling used materials; the production cycle satisfies the customer's orders and demands; and the part cycle processes the individual elements involved in producing a product. Previous visions of IT tend to focus only on a single cycle apart and aside of the other two, primarily integrating the forward stages into a connected sequence in the cycle, but without closing the cycle through feedback. Forward linkage allows some jobs in the later stages to be performed simultaneously with earlier jobs; or, at least, the requirements of the later stages can be explicitly considered early in the product cycle. Both forward and feedback linkages are needed to complete a cycle. Furthermore, all three cycles are interwoven in a truly agile enterprise. Therefore, new strategic opportunities for IT will arise from creating feedback to complete a cycle and from connecting all cycles through forward and feedback linkages. Both forward and feedback set the stage for dynamic alignment in its fullest potential.
- *Connecting Administration Systems with Production Systems.* IT has been historically applied to business administration functions of an enterprise first. Then, when it is also employed within production, the two sides are kept as separate functions. Information Integration allows and asks that the walls separating administration from production come down, just as IT bridges information flow with material flow. An interesting example showing the significance of this connection is activity-based costing and management, in which the classical administrative function of accounting is conducted on the basis of monitoring the alignments of resources around activities. This monitoring certainly can be and should be made on-line and in real time. Total Quality Management (TQM) is also based on performance information cutting across administration and production. Calibrating and aligning administration with production on an on-line, real time basis produces the ultimate decision-making information within an agile, lean, and productive enterprise.

(c) ***Transforming into a Three-Dimensional Enterprise.*** The following three sets of heuristics provide some proactive guidelines for high-level IT planning towards en-

terprise integration and modeling. They expand the scope of enterprise from the traditional view into both extended enterprises and information enterprises.

- *Think Extended Enterprise.* All the discussions pertaining to the internal production systems and administration of an enterprise are applicable to the virtual systems of an extended enterprise. Strategic opportunities for streamlining operations across organizations by way of Electronic Data Interchange (EDI), Just In Time (JIT) and Concurrent Engineering (CE) are practically unlimited. The health care industry for example is a fertile ground for this concept. Many opportunities are implicit in connecting insurers, hospitals, physicians, patients, government agencies, and research institutes through information integration . Other industries have similar opportunities.
- *Establish/Expand to Information Enterprises.* Traditional business thinking focuses only on the material enterprises of products, resources, and the marketplace. Running parallel to the material enterprise is an equally large world of information enterprises in cyberspace that can utilize the same enterprise thinking. For example, a virtual medical center could be constructed by using personal medical instruments located in patients' homes and linking them with doctors and researchers through multimedia telecommunication systems. A third-party information server/clearing house could provide pooled inventories and other resources to its client organizations through information integration in an extended enterprise manner. An Army/Defense logistics system could be integrated in cyberspace with visualization, simulation, and global information management capabilities. A studio-style virtual classroom could result from combining virtual laboratories, multimedia courseware, and the World Wide Web to enable distance learning. This kind of electronic commerce and global information enterprise opportunities can often be uncovered by retaining familiar paradigms, but only transforming the perspective.
- *Evaluate IT on Micro-Economic Bases.* Mundane applications of IT are usually motivated by and justified on the basis of cost/expenditure savings. To move beyond this rationale looking for strategic opportunities, the valuation criteria must change. An enterprise can evaluate IT on three micro-economic criteria: transaction cost reduction, utility improvement (value/benefit added), and organizational design. In theory, the best representation of the role of IT is its impact on the basic production function of the enterprise. IT evaluation may not be specific enough to quantify the value of IT in operational terms. Nonetheless, they can be sufficiently substantive to shed light on qualitative investigations for IT planning.

A Reference Model for Strategic Information Systems Planning

The above heuristics are extended to derive a reference model for strategic information systems planning. The idea here is to break down the strategic goals derived from the above analysis into sub-goals, sub-sub-goals (where required) and so on, down to concrete objectives and information requirements for implementing those objectives. Essentially here we are digging deeper into the question: what is involved is strategic information systems planning ? In the process of answering this question, we also partially answer the question: how to go about doing strategic information systems planning ? That partial answer lies in developing a reference model for doing strategic information systems planning.

Hsu and Rattner (1993) developed a theory of information integration in CIM environment. This theory developed a concept of parallel paradigm of integration which asserts that by the sharing of information between processes interdependent decisions are pooled into concurrent processes. This parallel formulation of processes is a major change from the traditional sequential formulation of processes. In traditional CIM formulation, functions are supported by isolated decision spaces. That is, only the information pertaining to that decision is handled as a variable. Other information is inherited as a constraint. For example, the part cycle inherits the information processed by the production cycle as a constraint which in turn is constrained by the information processed at the product development cycle. One can look at the degree of non-integration as the number of constraints a decision space inherits. The extent to which these constraints can be converted into variables represents the degree of integration. For instance, the design function in sequential formulation will constraint the process planning function. Because of the isolation of decision spaces, a mere interfacing between these two functions will require repeated iterations. Integration of the functions will, however, provide for real-time interaction between these functions. From an enterprise point of view, parameterized decision spaces are fragmented and their existence prevents the associated set of functions from operating as an information-processing and decision-making whole, since results reflect a sequence of discrete decisions. Hsu and Rattner's work suggests that while such functions operate as though they are using local variables, they are in fact tightly coupled (through, perhaps second or third order relationships) to many other apparently local variables.

Major functional categories used by Rattner (1990) in her reference model for major manufacturing functions are design, forecast and plan, schedule production and procurement, produce and ship orders, and analyze/refine production factors. The modeling scope, although restricted to the following scenario, is broad enough to be considered generic for most manufacturing functions: an order has been received for a new product — a product that requires no major new investment in productive capacity and which generally fits into the demand forecast for the planning horizon. The order, then, will be incorporated into the existing production plan and will be processed by the design, resource and capacity planning, and shop floor control functions. The design function is further broken into two sub-functions, namely, design/revise part, and determine process plans and routings.

Design/Revise Part

Tasks associated with this sub-function are identified as:

Refine product functional specification.
Choose design principles.
Initiate basic design, analysis, and test.
Specify preliminary materials.
Identify assemblies and subassemblies (BOM).
* Select first/next part to be designed.
Retrieve previous (similar) designs.
Modify design specifications to meet requirements.
Specify part number, geometry, material, nominal dimensions and tolerances.
Return to * and repeat steps until all product subassemblies and components have been designed.
Release final geometry, material, nominal dimensions and tolerances for the part.

Data

Part header.
Part geometry.
Part features.
Part dimensions.
Feature/dimensional tolerances.
Product functionality.
Engineering change history.

In summary in this section we have:

(a) outlined a method to derive strategic goals for IS in an organization

(b) given one example of how these goals can be broken into objectives

(c) used one existing reference model (Rattner, 1990) to further map one objective to its information requirements and data and knowledge classes.

Essentially this constitutes the outline of a methodology for developing industry specific reference models for strategic information systems planning. In the future course of this research, we propose to develop at least one complete industry specific reference model and test it in an industrial setting.

Prioritizing Objectives and Linking Them to Systems Development

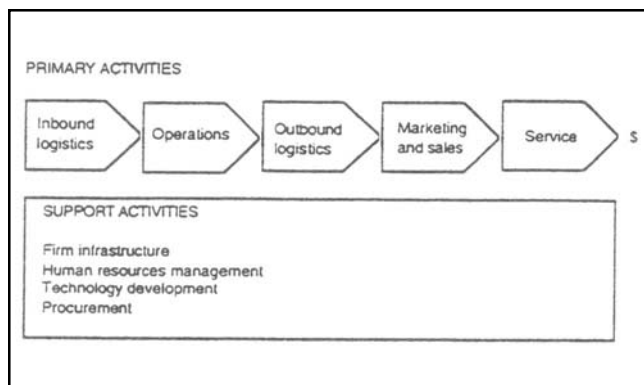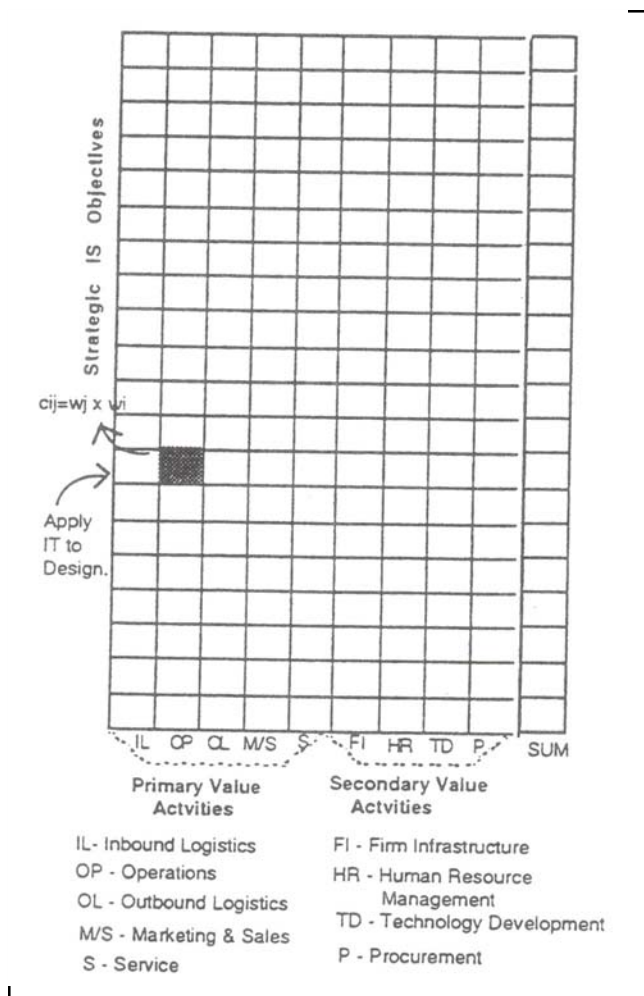Besides using a reference model to get the objectives

Figure 5: Porter's Value Chain

Figure 6: Matrix #1

objectives.

As mentioned earlier, value chain analysis of Porter (1984) is a popular SISP methodology. According to Porter, every firm is a collection of activities that are performed to design, produce, market, deliver, and support its product. All these activities can be represented using a value chain. A typical value chain is shown in Figure 5.

Once the value chain is charted, executives can rank order the steps in importance to determine which departments are central to the strategic objectives of the organization. Also, executives can then consider the interfaces between primary functions along the chain of production, and between support activities and all of the primary functions. This helps in identifying critical points of inter-departmental collaboration.

What we are proposing here is a matrix to rank order the strategic IS objectives against all the activities, primary and secondary, in the value chain. This is done by creating a matrix of the type shown in Figure 6.

Different strategic objectives will correspond to different value chain activities. An organization's information intensiveness may lie along different parts of the value chain. For example, for some organization, more value might be created in marketing and sales than in actual production. This might happen if the firm produces a high cost, low volume product like jewelry. While for low cost high volume products, more value will be added at the production than at the marketing and sales stage. The purpose of creating the above matrix is to rank order the strategic IS objectives in accordance with the value adding activities of the organization. For example, if an organization ranks 'very high' the objective 'apply IT to production' and 'operation' is that part of the value chain where maximum value is being added in the firm, the score of the cell lying at the intersection of 'apply IT to production' and 'operation' will be $c_{ij}=w_j \times w_i$ where w_i is the weight assigned to the objective 'apply IT to production' and wj is the weight assigned to the primary value activity 'operation'. Σc_{ij} for all j will give the total score for the ith strategic objective.

The next step is to take the above list of prioritized strategic IS objectives and map them against the organizational processes by way of creating a matrix like the one given in Figure 7.

The purpose of this step is to identify the processes in the organization which contribute more towards achieving the strategic IS objectives. The sum of the cell scores over each column will give the relative importance of a firm's processes in meeting its strategic IS objectives. These processes can then be highlighted on a DFD, by using different colors for example. A decomposition diagram of the manufacturing system derived from the analysis carried out by Rattner (1990) is given in Figure 8. Two lower levels, 1.1 and 1.2 and 1.1.1 to 1.1.9 detail the processes which comprise the design subsystem. Developing DFDs from the decomposition diagram of Figure 8 is straight forward. Data require-
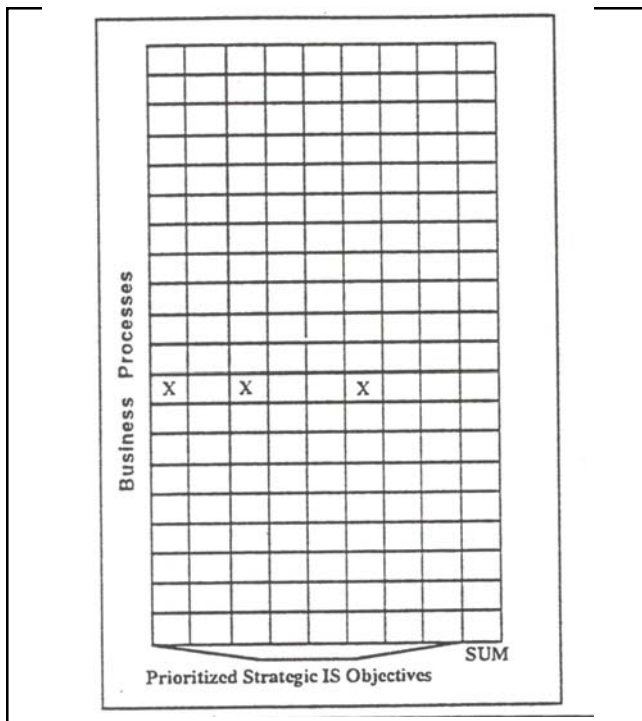
and map them on to information requirements and proceeding with the task of developing IS in an organization, two important tasks remain: (a) we need a methodology to map the objectives on to organizational realities and priorities and (b) need some mechanism to prioritize parts of the overall information system being developed. We use Porter's Value Chain Analysis and develop two matrices towards achieving these

Figure 7: Matrix #2

ments which accompany processes of the previous section further facilitate the job of structured systems analysis. The matrix of Figure 7 can be deployed towards prioritizing the subsystems that comprise the manufacturing system and/or the processes which make up a subsystem.

Conclusions

Information-based enterprises must be planned in an integrated way whereby all stages of the life cycle are engaged to bring about agility, quality, and productivity. This integration is similar in nature to the integration of product life cycle for an enterprise. The existing strategic information system planning methodologies, however, tend to support information planning as an island separated from the wealth of the enterprise's information resources. A needed new approach would tap into these resources which capture and characterize the enterprise to allow for integration of the planning stage with information systems development stages and support a shortened and adaptive cycle. The need for such a framework is established by the existing problems in implementing SISP methodologies and also by what these methodologies themselves lack. In this paper we have outlined a framework and a theory for strategic information systems
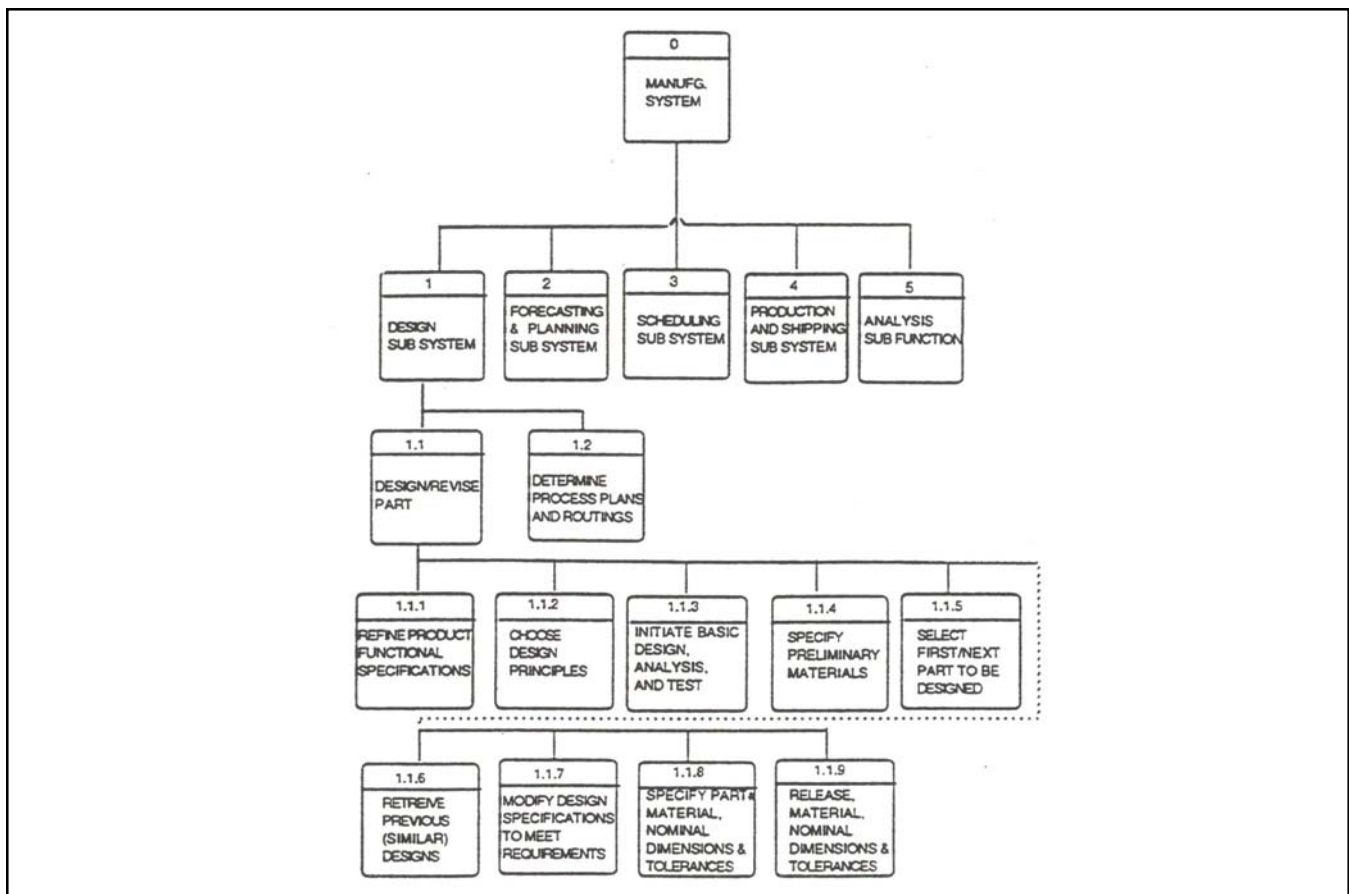

Figure 8: Decomposition Diagram Of A Manufacturing System

planning and a methodology for linking the reference model to an organization's value chain by using a matrix. Another matrix is developed for mapping the prioritized IS objectives against business processes and/or subsystems in an organization. This step is expected to prioritize these processes and add extra depth to structured analysis in the organization. One example is used to demonstrate how the reference model for strategic IS planning can be used to demonstrate the use of the reference model for strategic IS planning in getting information requirements for prioritized IS objectives and, thereby, aid structured systems analysis.

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