WORKING PAPER
ALFRED P. SLOAN SCHOOL OF MANAGEMENT

STRATEGY AND THE REPRESENTATION OF STRUCTURE

by

John D.W. Morecroft and James H. Hines, Jr.

WP-1721-85
Revised April 1986

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revised April 1986

An earlier draft of this paper was presented at the Fifth Annual Strategic Management Society Conference October 2-5, 1985, Barcelona, Spain

The authors are grateful to James P. Cleary for his support of the research project on which the paper is based, and for the input he provided on practical problems of organizational design.
This paper compares two representations of organizational structure -- the organizational chart and the policy structure diagram -- and shows how each representation provides unique insights into organizational design. The building block of the organizational chart is the responsibility center, usually a box showing reporting and authority relations. The design problem is to arrange responsibility centers in the chart to obtain a clear division of business responsibilities and a good balance of operational efficiency and market responsiveness. The building block of the policy structure diagram is the behavioral decision function showing the function's access to and processing of information. The design problem is to arrange for each decision function to receive and process appropriate information so that different managers' decisions (in pricing, capacity expansion, production planning, marketing, etc.) lead to actions that support and are consistent with the firm's strategic objectives.

The paper uses a case study of organizational design in a data communications firm to compare and contrast the two representations. The paper ends with suggestions on how the insights from the two representations might be combined to improve organizational design and the implementation of strategy.
TWO REPRESENTATIONS OF STRUCTURE

Background

Ever since Chandler's pioneering work *Strategy and Structure* (Chandler, 1962) researchers in the policy and strategy field have paid close attention to the relationship between an organization's administrative structure and its strategy. The 1960's and the 1970's saw a period of intense empirical work, as researchers collected data from many corporations, to trace the evolution of the organizations' structure in response to product diversification and geographical expansion (Wrigley 1970, Channon 1971, Stopford and Wells 1972, Rumelt 1974). This empirical work supported Chandler's thesis that 'structure follows strategy' and showed for example that companies following a strategy of product diversification are generally more successful if they adopt a multi-divisional structure, rather than a functional structure.[1]

It is only a short step from empirical observations about strategy and structure to the notion of organizational design. If some organizational forms are more effective than others, then it should be possible to help corporations design organizational and administrative structures that are well-suited to their product and geographical strategies. The area of design is attractive to both theoreticians and practitioners and a lot of interesting work has already been done.[2]
Most of the work on organizational design uses the organizational chart to represent the firm's structure and as the vehicle for discussing the merits of alternative designs. This paper presents an alternative representation of structure -- the policy structure diagram -- which is also very helpful for discussing organizational design. The policy structure diagram is particularly useful for understanding how the firm's administrative processes and procedures (its routines for 'doing business') influence the execution of new strategic moves. In the paper we will show how the two representations of structure are related and how each provides valuable insight into the organizational design process. We use a case study of a company in the datacommunications industry to illustrate the design issues one can address with each representation. We also show how the policy structure diagram is converted into a behavioral simulation model that allows one to experiment with alternative policies and procedures. We end with some reflections on how the two design methodologies might be used together to extend and deepen understanding of the relationship between strategy and structure.

Organizational Chart

When people in the policy and strategy field talk about structure they most often mean structure as shown by the organizational chart -- the set of reporting relationships, responsibilities and channels of authority depicted by the chart's boxes, names and interconnections.
A new structure is a new way of 'carving-up' business responsibilities and a new way of defining the flow of authority. The building block of the organizational chart is the 'responsibility center', the box showing the particular activity (such as marketing/sales or production) of chief concern to the individuals in that part of the organization. Figure 1 shows a typical responsibility center for marketing/sales, with an upward reporting relationship to high executive levels and several downward authority relationships to individuals and activities that support marketing/sales.

With the responsibility center as the building block, the representation of the organization is the traditional organizational chart, as shown in figure 2. The organization is visualized as a network of reporting relationships, a series of boxes interconnected by lines of authority and communication. The chart is a very powerful and convenient way of showing the organization's key players, what they're responsible for, how they communicate, and who they can influence. With it one can visualize design at the level of the whole corporation.

The design process, using the organizational chart, is a narrative/verbal discussion (among the company's executives and/or process consultants) to identify an 'effective' arrangement of responsibility centers. An effective arrangement here means an assignment of tasks and decision-making responsibilities that allows each center adequate autonomy (to get the local job done) while
Figure 1: Responsibility Center - Building Block of an Organizational Chart
Figure 2: Representation of Organization - Organizational Chart
providing sufficient coordination between centers to ensure that corporate (or business unit) objectives are pursued and met.

Obtaining a balance of autonomy and coordination is no easy matter, but the organizational chart can help executives and consultants by providing them pictures to focus their discussion. The reader is referred to Hax and Majluf (1984, Chapter 21) for an excellent example of the power of the organizational chart in catalysing discussion about organizational design and structure.

**Policy Structure Diagram**

The policy structure diagram represents an organization in terms of decisionmaking processes rather than responsibility centers. This way of visualizing a firm's structure comes from the field of system dynamics (Forrester 1961, particularly chapter 10 'Policies and Decisions'). Quoting from Forrester:

> ....we shall look upon the manager as an information converter. He is the person to whom information flows and from whom come streams of decisions that control actions within the organization....Viewing the manager in this way shows us immediately why we are interested in decisionmaking and information flow. An industrial organization is a complex interlocking network of information channels. These channels emerge at various points to control physical processes such as the hiring of employees, the building of factories and the production of goods. Every action point in the system is backed up by a local decision point whose information sources reach out into other parts of the organization and the surrounding environment.

The same kind of representation of the organization is also used by the Carnegie school. In *Administrative Behavior* Simon (1976) talks
about organizations in terms of distributed decisionmakers with bounded rationality. Similarly, Cyert and March (1963) see organizational structure as a set of decisionmaking units in a communication network. Their emphasis is on the actual decisionmaking process, the resolution of conflict, the coordination among units and the flow of information.

The building block of the policy structure diagram is the behavioral decision function. Figure 3 shows the business analyst's image of decisionmaking. Decisions lead to actions and the results of actions accumulate in 'levels' (Forrester 1961, chapter 6) [3]. Each decision function exists in a 'sea of information', but information is filtered by organizational structure (one's position in the organizational chart), by the firm's administrative procedures and routines, and by intangibles such as corporate culture, tradition and leadership (which together affect the importance one attaches to information). (Morecroft July 1985). Information is also filtered by individuals' cognitive limits and biases (Tversky and Kahneman 1974, Kahneman and Tversky 1982, Hogarth 1980). The information that passes through the two filters is the basis for decision and action at that particular point in the organization.

Even at the level of the behavioral decision function there is a visible relationship between organizational structure and policy structure, as figure 3 shows. If the organizational chart changes (say as a result of changing from a functional to a divisional
Figure 3: Behavioral Decision Function - Building Block of the Policy Structure Diagram.
structure), one would expect the information content of important policy functions like capacity planning, pricing, and sales control to change. Conversely, figure 3 also shows that changes in the organizational chart may leave untouched many vital aspects of a firm's policy making. For example, a redefinition of business responsibilities may have little or no effect on a firm's competitive behavior in a fast growing market, if its business planning procedures are dominated by conservative traditions built up through decades of company history and experience. (Consider Zenith's capacity expansion policy during the growth of the color television market during the mid 1960's, HBS Case Services 1973).

With the behavioral decision function as the building block, the representation of the organization is the policy structure diagram, as shown in figure 4. The organization is visualized as a network of distributed behavioral decision functions, interconnected by information flows and by 'levels' that accumulate the actions initiated by decisionmakers. This is a 'feedback' representation, because one is able to trace around the information network and find closed feedback paths where decisions lead to actions which change the system's levels, and where the levels in turn provide the information on which future decisions are based. The policy structure diagram gives the business analyst another way to grasp the organization as a whole and to visualize the process of design (this time the coordination of decisionmaking rather than the assignment of responsibilities).
Figure 4: Representation of the Organization - Policy Structure Diagram
The design process, using the policy structure diagram, is a narrative/verbal discussion of the firm's decisionmaking structure to identify situations in which policies may be acting at cross purposes and inadvertently defeating corporate or business unit objectives (Morecroft October 1985). Dysfunctional behavior is a common feature of complex organizations in which decisionmaking is decentralized and shared between many actors in the firm and its markets (Forrester 1975a; Hall 1984 and 1976; Morecroft July 1985; Morecroft and Paich 1984). Diagrams of policy structure are also converted into mathematical models and simulated on a microcomputer to understand policy interactions and to identify 'effective' decisionmaking procedures (Forrester 1975a and 1961). The simulation model becomes a 'learning laboratory' to aid the intuition of participants in the modeling process and to deepen the discussion of policy design (Richmond 1985).

RELATIONSHIP BETWEEN ORGANIZATIONAL AND POLICY STRUCTURE --

THE MASSACHUSETTS BUSINESS MACHINES CASE

To show how organizational structure and policy structure are related we use an example from a project with a datacommunications firm. For the sake of confidentiality we refer to the company as Massachusetts Business Machines, or MBM for short. MBM is a player in the growing, but highly competitive, market for advanced electronic office equipment. Like many other players in this market its products include microcomputers, electronic workstations, minicomputers, switching systems (private branch exchange or PBX systems and
smaller key systems), voice terminal equipment (telephones) and networking systems (to hook all the components together).

At the time the research project began MBM was undergoing a major internal reorganization. At the same time the company was experiencing major business problems -- sales of many of its product lines were much lower than planned, some product lines had delivery intervals of 15 to 18 months, much higher than the industry average. The reorganization and business problems produced a need for simultaneous (though independent) studies of MBM's organizational structure and its policy structure. In other words the project provided the rare opportunity to compare the two representations of the organization -- the organizational chart and the policy structure diagram. The following sections examine the design issues considered important by one of MBM's managers who was involved in both the organizational design project and the business policy modeling project.

Carving up the Business -- The MBM Organizational Design Problem

There were a number of historical reasons why MBM felt an urgent need for reorganization. For many years the company had been organized functionally, but with regional sales and service divisions. Manufacturing was centralized and so was R&D. Each of the regional sales divisions had its own independent sales and service force and sold all the product lines produced by the factories. Many executives in the firm felt that this functional organization
was inadequate in the increasingly competitive and complex market for
datacommunication equipment. A chief weakness was in sales and marketing.
The existing structure required marketing executives, product managers, sales
managers and salespeople alike to be informed about all the firm's products,
which ranged from small, inexpensive telephone sets to complex
microprocessors, networking systems and advanced electronic switching systems.
Moreover, the company was introducing many new products, of increasing
technical sophistication.

MBM needed an organizational structure that allowed its marketing executives,
sales managers and salespeople to be better informed about products and to be
closer to customers. To address this need a group of MBM's top executives
worked with a major strategy consulting firm over a period of a year to review
the merits of alternative organizational designs [4]. The consultants
recommended that MBM should segment its market. Then people in
marketing/sales could focus their attention on a subset of the company's broad
product line. A segmentation into large and small systems seemed logical,
because there is little overlap between customers who buy large switching
systems (usually large corporations) and customers who buy small switching
systems (small service firms, lawyers and doctors). Naturally, the
segmentation was not completely 'clean'. Corporations order microcomputers
and data/voice terminal equipment, which MBM classifies as small systems, and
they often require small switches for local distribution of voice and data
messages. But despite the overlap in product size and account size, the
large/small system segmentation appeared to be a sensible simplification to relieve the information overload on marketing/sales [5].

Design 1 — Independent Business Units

Having agreed on a market segmentation, MBM's executives and consultants then turned their attention to organizational design. How much should the company's functions be segmented to match the market segmentation? The simplest design is independent business units, as shown in figure 5. Each business unit has entirely separate functions for marketing/sales and for manufacturing. (One might also imagine separate R&D functions, but to avoid undue complexity in the diagram the R&D function has been omitted). Under marketing/sales there are many areas of responsibility. There are managers and staff responsible for sales planning and for market support. There are others responsible for sales administration and control (making sure that corporate sales objectives are communicated and met), for compensation planning and for force planning. Each business unit has its own salesforce. Under manufacturing there are separate factories (or separate manufacturing units within factories) for large and small system products. Each business unit has its own managers and staff responsible for planning and scheduling, purchasing, materials management and factory administration. With this organizational design each business unit operates like a self contained firm.

The advantage of the independent business unit design is in the focus that marketing/sales and manufacturing can achieve in planning and making their
Figure 5: Design 1 - Independent Business Units

(Small System Business Unit is Identical to Large)
products and bringing them to market (Skinner, 1974). The disadvantage lies in the costly duplication of planning staff, salesforce, administrative procedures, factory equipment and materials management. In MBM's case, its executives felt that complete separation of large and small system manufacturing was impossible and undesirable. The product lines shared both components and capacity in common, so that splitting materials management, purchasing and scheduling would be very difficult and disruptive. Separation of marketing/sales responsibilities looked easier and desirable (because a chief motivation for the organizational redesign was to focus marketing/sales activities). But even here, independent salesforces for large and small systems were not considered practical or cost effective. In particular, the large systems salesforce would always find themselves selling small systems (computers, terminals and key systems) as part of a large system 'package'. Moreover large account customers might be confused if, while placing a single large system order, they found themselves dealing with different salespeople. For these reasons and others, MBM's executives rejected the independent business unit design.

Design 2 -- Distinct Business Units, Independent Sales Planning and Control, Shared Salesforce and Shared Manufacturing

The consultants proposed a second design -- distinct business units with shared salesforce and shared manufacturing, as shown in figure 6. Under this arrangement the large and small system business units are distinct because sales planning, market support, sales administration and control and
Figure 6: Design 2 - Distinct Business Units, Independent Sales Planning and Control, Shared Salesforce and Shared Manufacturing
and compensation planning are separate for large and small systems. The business units are not independent though, because they share a salesforce and they share capacity and components in manufacturing. The new design overcomes the costly duplication of manufacturing planning, administration and salesforce that diminished the appeal of design 1. The new design also addresses the fundamental problem of information overload in marketing/sales. The planning, administration and control of large and small systems is independent, allowing marketing/sales managers and staff to focus their attention on a subset of MBM's broad product line. The design's only apparent drawback is that it doesn't relieve the information overload on the salesforce. Salespeople must still be familiar with all products, because large account customers order a mix of large and small systems.

Coordinating Policies and Procedures -- The MBM Policy Design Problem

The organizational chart shows how the firm's selling and manufacturing responsibilities are assigned to different individuals and groups. It provides insight into the coordination of responsibility centers and the information load of executives and managers. But it doesn't provide much insight into the likely time pattern of the firm's orders, production, salesforce, revenue and profit. Is design 1 (independent business units) likely to lead to better sales performance than design 2 (distinct business units with shared manufacturing and shared salesforce)? What are the operational difficulties encountered as a result of sharing the salesforce
between the large and small system business units, under design 2? One can of course speculate on these questions using the organizational chart. One might sense that a shared salesforce could lead to conflict between business units and that independent salesforces are easier to manage. But what is the nature of the possible conflict and how would it affect the growth, revenue and profit of a business unit?

The policy structure representation of the organization is particularly effective at addressing questions about performance over time. It shows the decision rules and procedures that business units are using to plan and control sales and to plan and schedule manufacturing. In this section we describe two policy structures that correspond to the organizational charts mentioned earlier. We also examine, using a system dynamics simulation model, the business behavior that these alternative policy structures generate.

Policy Structure of Independent Business Units

Figure 7 shows the policy structure of an independent business unit with its own dedicated management, planning staff and salesforce [6], [7]. To keep the diagram clear we have chosen to omit manufacturing and to focus on marketing/sales [8]. Below there is a description of each behavioral decision function that identifies the different "players" whose actions and choices regulate sales. There are quite a few of them -- salespeople, customers, business planners and compensation planners. The description examines their responsibilities, their goals and incentives and the sources of information
Figure 7: Policy Structure of Sales Planning and Control in an Independent Business Unit
that attract their attention -- all with the intention of understanding the
logic behind their choices and actions.

Let's begin in the center left of figure 7 with sales planning and
objectives. Sales planning is a complex procedure that consolidates
information and judgement from market analysts, salespeople, product
managers, product schedulers and manufacturing planners. Although a great
deal of information is used in sales planning, a most important input is
the recent history of customer orders. Planners use the volume and trend
of customer orders to compute a base estimate of demand. Executives
usually increase the base estimate by a 'stretch margin' to arrive at the
business sales objective. For example, suppose the sales force sold 1000
PBX's last year. If the stretch margin is 10 percent then, after applying
the stretch, the sales objective for the coming year would be "100 PBXs.
The stretch margin is a simple, but powerful, way for executives to set
challenging sales targets in an environment of great uncertainty about
future demand and salesforce productivity. The objective requires sales
managers to continually increase sales volume, by holding them accountable
for an objective that is greater than last year's (or last quarter's)
sales.

Next, in a counterclockwise direction around figure 7, there is
compensation planning which provides an interface between sales objectives
and the salesforce. Compensation planners look at each product line's
performance against objective and decide how to adjust product 'points'
(which ultimately translate into dollars) to encourage salespeople to sell
products in the quantity called for by the objective. So if sales of a particular product line are below objective, compensation planners will increase the points value of the product, making it more attractive to sell. On the other hand, if sales of a product line exceed the business sales objective, planners will maintain, or possibly decrease, its points value. In practice it is much easier to increase points than reduce them, because salespeople strongly resist any attempt to lower their compensation.

Sales effort (the number of hours per month the salesforce spends making customer contacts) depends on compensation planning and the size of the salesforce. Changes in the compensation plan affect salespeople's pay and therefore (usually) the amount of effort they put into selling. An increase in compensation leads to an increase in sales effort. Similarly, an increase in force size resulting from hiring leads to an increase in sales effort.

A distinctive feature of the policy structure representation (by comparison with the organizational chart) is that it often reaches outside the organization's boundary to the behavioral decision functions of customers, suppliers and competitors. In this case the policy structure includes the customers' ordering policy. A principal influence on ordering is sales effort. Few purchasers of complex electronic office equipment will place an order spontaneously without first seeing a demonstration and talking with salespeople. Very often it is salespeople who initiate the customer's interest and make them aware of the existence of the product and its
features. Even if a customer knows precisely which product he wants, he is unlikely to be able to place an order without first contacting a salesperson. Once a customer is aware of the product, a variety of criteria such as price/performance, delivery interval and quality may influence the ultimate decision to place an order. Each customer has his own perception of these factors and sensitivity to them. But in general, if availability of the product is low, or if price is high, salespeople will take a long time to find willing customers - in other words the time to make a sale will be high. Conversely, if the product is readily available, or the price is low, the time to make a sale will be low.

A description of sales planning and control would be incomplete if it ignored force planning and hiring. In figure 7, force planning is driven by the budget. Given the budget and the average compensation of the salesforce, planners compute the authorized salesforce. If the authorized force exceeds the current force then hiring takes place and the salesforce grows. Conversely, if the current force exceeds the authorized force then layoffs take place and the salesforce contracts. The business unit's budgeting policy is a complex process which the model only outlines. The important point is to capture the inertia and myopia that characterize budgeting in most large organizations. Major budget items (such as advertising expense, R&D expense, sales and service expense) rarely change dramatically from year to year as a proportion of the total budget. New
budgets are often just incremental adjustments to old budgets, because organizational politics cannot cope with radical change and because it is complicated and time consuming to justify every budget item from scratch each year. The budgeting policy captures these incremental, inertial adjustments. The budget for the salesforce is represented as a fraction of total sales revenue (revenue itself is the product of customer orders and average product price). The fraction is 'sticky' (slow to change) though not rigidly fixed.

Figure 7 shows not only the major policies and procedures in sales planning and control, but also how they are linked. Sales planning, compensation planning, sales effort and customer ordering form a closed feedback loop that regulates orders and sales effort. If a business unit's orders are below objective, compensation planners increase the points (dollars) that salespeople receive for winning an order, and so encourage more sales effort. More effort results in more orders (ceteris paribus) and therefore better performance against the sales objective.

Budgeting, force planning, salesforce, sales effort and customer orders also form a closed feedback loop that can generate growth in the business unit's orders, revenues and salesforce. If the salesforce increases, sales effort expands leading to an increase in customer orders. More orders bring in more revenue which allows the salesforce budget to grow. With a larger budget the salesforce increases still more. (A similar feedback loop is described in Forrester 1968).
Dynamic Behavior of Independent Business Units

What is likely dynamic behavior of business units that follow the sales planning and control procedures described above? How will their orders, revenue, sales objectives and force size vary over time? How will these indicators change if the business units share a common salesforce? The policy structure diagram and corresponding behavioral simulation model enable us to examine these questions [9].

Imagine first the following scenario. MBM has independent business units for large and small systems. Each business unit has a well balanced portfolio of products. The products are attractive to customers, so that salespeople are able to generate enough orders to satisfy the business sales objective. Because the business units have focused product responsibilities, planners are able to adjust the compensation scheme (product points) so that each product receives an adequate share of the salesforce time. How will the business unit's sales and revenue evolve over time? Figure 8 shows a simulation of the scenario, for the large system business unit [10].

Orders for large systems start at 108 units per month and grow exponentially to 170 units per month during the 24 month simulation. In the same period revenue increases from $10.8 million/month to $17 million/month. Figure 9 shows how the growing revenue stream fuels expansion of the salesforce. The salesforce budget grows exponentially as a fraction of revenue. As a result the authorized salesforce grows, so there is continual pressure to hire new salespeople.
Figure 8: Orders, Sales Objective and Sales Revenue for Large Systems

Figure 9: Budget and Salesforce for Large Systems
The independent business unit's dynamic behavior is quite simple to understand. With a well balanced portfolio of products that are attractive to customers, and priced to generate a profit, the business unit grows. Growth is easy to manage, because the salesforce is dedicated to the business unit and because the compensation scheme accurately adjusts sales effort to achieve the business sales objectives.

Policy Structure of Distinct Business Units With a Shared Salesforce

When the large and small business units share a common salesforce an important change takes place in the organization's policy structure. Figure 10 shows the new arrangement of behavioral decision functions. The difference is in the salesforce time allocation. Salespeople must now decide how to allocate their time between the two business units. Sales planning, compensation planning, budgeting and force planning remain the same as in figure 7, because the business units plan and control sales independently, just as they do in the independent business unit design.

Figure 11 shows the factors influencing the salespeople's time allocation. An important consideration is the number of points awarded for the sale of each business unit's products, because salespeople's salary and bonus increase with the number of points they accumulate during the year. But points alone do not dictate how they spend their time. Large systems always carry many more points than small systems, but they usually take much longer to sell. Salespeople must spend a lot of time with the customer.
Figure 10: Policy Structure of Sales Planning and Control in Business

Units that Share a Salesforce
explaining product features and options, and arranging installation. From their field experience salespeople estimate the time per sale of large systems and small systems. Knowing points and time per sale they can judge, roughly, the payoff, in terms of points per hour, to selling either a large system or a small system. For example, suppose salespeople earn 25,000 points for each PBX they sell and 5000 points for each workstation. Also, suppose it takes, on average, 60 hours to sell a PBX (the total time spent with a customer from first contact to final delivery and installation— including time lost with those customers who choose not to buy) and 15 hours to sell a workstation. Given the terms of the compensation scheme, the payoff for selling PBXs is 25,000/60 or 416 points per hour and the payoff for selling workstations is 5000/15 or 333 points per hour. Therefore, in this case, salespeople will want to devote more of their time to selling PBXs.

But salespeople don't switch in a single day to selling the most attractive product line. They have a variety of contracts already underway which they are obliged to complete. Their time allocation changes only gradually, depending on the new selling opportunities available, existing commitments and the current payoff for alternative products. The process is dynamic. Conditions change from day to day and week to week. The compensation scheme may be modified. The time to sell a system will change as the relative prices and delivery intervals of each product line vary. New
Figure 11: A Closer Look at Salesforce Time Allocation
products may be introduced whose selling time one can only guess. Despite these complexities, salesforce time allocation is logical and quite predictable, once the points and time per sale are specified. Salespeople will gradually shift more and more of their time to the product line which, in their judgement, gives the biggest payoff.

It is interesting to notice that salespeople operate in an 'engineered' decisionmaking environment. To make intelligent use of their time they have only to know the details of the compensation scheme and the estimated time per sale of large and small system products. They do not have to know corporate sales objectives, the company's goals for revenues and units sold, or whether sales goals are being attained. They do not have to know manufacturing schedules, planned pricing actions, or the marketing plans of competitors. Conversely, marketing/sales managers and planners do not have to know the precise time allocation of the salesforce in order to regulate sales (and in practice managers never do know this information accurately).

Given the rather myopic, self-interested way in which the salesforce chooses to spend time, how can business unit executives be sure of achieving their sales objectives? The answer is that compensation planners must provide the correct incentives for the salesforce, so that when salespeople act in their own self-interest they also satisfy business sales objectives. The task of providing the correct incentives is difficult when business units share a
common salesforce, but do their sales planning and control independently, for the decisions and actions of any one business unit are geared to achieving its local business objectives. When a business unit has a dedicated salesforce the task of providing the correct incentives is easier (though not necessarily always simple).

Dynamic Behavior of Distinct Business Units With Shared Salesforce

Imagine the following scenario. The large system business unit has a well balanced portfolio of products. It is the dominant business unit because, traditionally, large systems have generated most of the company's revenues. As a consequence, most of the salesforce time is allocated to large system sales (90 percent at the start of the scenario). The small system business unit has a changing portfolio of products. In particular its products include new key systems, microcomputers and workstations. These new products promise to generate plenty of revenue. Moreover, MBM is anxious to strengthen its position in the integrated office system market and is therefore trying to encourage sales of the new products. How will each business unit's sales and revenue evolve over time? Figure 12 shows a simulation of the scenario for small systems.

Orders for small systems start at 70 units per month and grow rapidly for 5 months to a peak value of more than 100 units per month. In month 5, orders begin to decline, and fall to a minimum of 75 units per month by month 10. Then orders recover and go through another (diminished) cycle of growth and decline between months 10 and 20. By the end of the 24 month simulation, orders for small systems are still fluctuating slightly, but are clearly
settling at about 90 units per month, almost 30 percent higher than at the start of the simulation. The business sales objective for small systems rises, but only gradually because it is an average of recent customer orders. As a result of this inertia, orders for small systems exceed the sales objective during (and immediately following) any period of rapid growth in orders -- for example in months 0 through 7, and again in months 12 through 19.

The growth of orders makes sense in the context of the scenario. One would expect orders for small systems to increase, because small systems are attractive to customers, and because they generate more revenue per sales-hour than large systems (by assumption). However the fluctuation of orders is somewhat surprising and certainly disrupts factories' production planning. But what causes the fluctuation? It was not a feature of the behavior of independent business units. Previous simulations showed steady growth in orders and revenue. Also, what is the impact of the fluctuations on the other business unit's behavior?

Figure 13 shows orders and the business sales objective for large systems. The figure also shows the combined sales revenue of the two business units. For ease of comparison, figure 13 uses the same scales for orders and revenue as figure 8 (the simulation of the independent large system business unit). One can see a very slight fluctuation in orders for large systems. But the most striking feature of the simulation is that orders and revenue are almost constant. Orders for large systems start at 108 units per month (the
Figure 12: Customer Orders and Business Sales Objective for Small Systems

Figure 13: Customer Orders and Business Sales Objective for Large Systems
same as in figure 8), but by the end of the 24 month simulation they are only 110 units per month. By contrast, orders rose to 170 units per month during the same time interval in the independent business unit scenario. But why should the business unit’s growth be halted when its product portfolio and its methods of planning and controlling sales are identical in both scenarios? The answer must lie in the operational difficulties stemming from a shared salesforce, since this is the only factor that distinguishes the two scenarios.

A close look at the conditions surrounding salespeople’s time allocation gives insight into the puzzle. Figure 14 shows compensation per hour for large systems and for small systems. Initially compensation per hour is greater for small systems than for large systems. In other words, salespeople find it more attractive to sell small systems than to sell large systems, because they are better compensated (they receive more points) for each selling hour. The imbalance arises because the small system business unit has an attractive compensation plan to encourage the sale of its new products, and because the products yield more revenue per selling hour to the company than large systems. Salespeople start allocating more time to selling small systems. As figure 15 shows, they begin by allocating 10 percent of their time to small systems, but they increase their allocation to 13 percent after only 4 months, as this new allocation serves their self-interest best (remember that salespeople are not held directly accountable for a business unit's sales objective). The 3 percent increase in sales effort allocated to small systems causes a 30
Figure 14: Compensation per Hour for Large and Small Systems

Figure 15: Fraction of Sales Effort Allocated to Small Systems
percent increase in orders! By itself, the salesforce time reallocation is quite appropriate since it is economically desireable for MBM to sell a bigger proportion of small system products. However, the sales planning and control procedures of the two business units respond to the time reallocation by competing for sales time.

The reader can trace the competition for sales time in figures 12, 13, 14, and 15. The story begins in figure 14. Compensation per hour for small systems exceeds compensation per hour for large systems, thereby causing a shift in sales effort to the small system business unit. As a result, orders for small systems increase unexpectedly, above the business sales objective, while orders for large systems dip unexpectedly, below the business sales objective. Because each business unit's planning and control is independent (a feature of the organization's chosen design) its compensation planners make separate adjustments to product points in order to correct the sales variance. In the large system business unit, planners increase points to win back salespeople's time and thereby boost sales. In the small system business unit, planners reduce points -- though not very much for fear of seeming to 'cheat' the salesforce. The result is shown in figure 14. Compensation per hour for large systems rises during months 0 through 6 while compensation per hour for small systems fall. Shortly after month 4, large systems begin to look more attractive to the salesforce than small systems. Between months 4 and 9 salespeople reallocate their time increasingly in favor of large systems, as figure 15 shows. Orders for small systems decline while orders for
large systems increase. By month 10 the sales variance situation is entirely reversed -- small system sales are now below objective (the variance problem is compounded because the business sales objective for small systems has been revised upward due to the initial sales success) and large system sales are above objective. The compensation planners of the two business units then engage in another round of points adjustment in their quest to bring orders in line with objective.

The competition for sales time has two dysfunctional effects on business unit performance. First, sales effort allocated to each business unit fluctuates, playing havoc with manufacturing schedules (though these effects are not addressed specifically by the model, because it does not include a manufacturing sector). Second, the average compensation of the salesforce rises. Each round of the competition for sales time bids up the firm's selling expense, because compensation planners are more willing to increase points than they are to decrease them. The increase in selling expense stifles growth, by reducing the growth rate of the salesforce, as shown in figure 16. As salespeople's compensation rises, the existing force absorbs an increasing proportion of the sales budget, thereby leaving less for force expansion. The process reinforces itself. With lower force expansion, revenue growth is suppressed and the sales budget itself grows less quickly.
Figure 16: Budget and Salesforce
New Insight Into Strategy and Structure

The net result of the system's adjustment is quite curious. The small system business unit introduces some attractive new product lines that have the potential to earn the company more revenue per sales hour than existing products. But the products' success creates competition for salesforce time between the two semi-autonomous business units. The competition for time, which occurs inadvertently through the business unit's independent sales planning and control procedures, causes an inflation of selling expense that overwhelms the revenue advantage of the new product lines. Expense rises more rapidly than revenue. As a result the distinct business units with shared force grow more slowly than independent business units which, by virtue of their independent salesforces, are immune from the problem of competition for salesforce time and escalating selling expense.

By studying MBM's design through the policy structure representation one obtains new insights into the strengths and weaknesses of the independent and distinct business unit designs. Distinct business units that share a salesforce have a design weakness. They can readily start competing for salestime -- and it is difficult to prevent the competition because each business unit plans and controls its sales independently. Curiously, the more successful a given business unit's products are, the more intense the ensuing internal competition for salestime. Any competition slows the company's growth rate (relative to a company with independent business units that has
equal selling expense [11]). Particularly severe competition for salestime, stemming say from the introduction of an extraordinarily successful product line, has the potential to destroy a company's growth momentum and send it spinning into decline.

These new insights into business performance indicate how business problems can arise from the firm's structure. But they are 'food for thought', not rigid predictions. Knowing how competition for salestime arises, one can review with executives and managers the firm's sales planning and control procedures to discover how (or whether) the procedures avoid the problem. Equally important, one can use the simulation model to design policy changes that ease the conflicts arising from a shared salesforce [12]. The ultimate objective of policy redesign is to make the business units with shared salesforce behave as if they had independent salesforces.

IMPLICATIONS FOR ORGANIZATIONAL DESIGN

We have discussed two representations of organizational structure -- the organizational chart and the policy structure diagram. We conclude the paper with some thoughts on how the two representations might be used together to help in the complex and challenging task of organizational design.
First some observations on the value of different representations for problem solving (recognizing that design is a special kind of problem solving). Simon (1982) provides the following illustration:

That representation makes a difference [in problem solving] is a long familiar point. We all believe that arithmetic has become easier since arabic numerals and place notation replaced Roman numerals (p153)...[and in social systems] an appropriate representation of the [social] problem may be essential to organizing efforts toward solution and to achieving some kind of clarity about how proposed solutions are to be judged. Numbers are not the name of this game but rather representational structures that permit functional reasoning, however qualitative it may be. (p169)

Different representations are commonly used in complex engineering design problems. Consider for example the design of a nuclear power station. Designers use architectural drawings to design the power station's buildings. But the architectural drawings alone are not enough to ensure an effective power station. Designers also use engineering drawings and computer simulation models (totally different representations of the power station) to understand how the station's power generating components will interact over time. What power loads will the station handle? How well will the station's safety mechanisms work in the event of an explosion, a component failure, or some other emergency?

It is clear that different but complementary representations can help solve complex design problems. But how does one use different representations in the analysis of organizational design? When in the
analysis does one use the organizational chart, and when the policy structure diagram? Here we suggest that the organizational chart is the natural lead-in, and the policy structure diagram the follow-up, to design problems in organizations undergoing radical change. By contrast, the policy structure diagram (and behavioral simulation modeling) is the natural lead-in, and the organizational chart the follow-up, to design problems in organizations that are faced with a recognized business problem (declining market share, stagnation in sales, low productivity in manufacturing or sales).

Radical Change -- Organizational Chart Then Policy Structure Diagram

The organizational chart is a good starting point for addressing design problems in organizations undergoing radical change. It matches the way people think about organizations more closely than the policy structure diagram. Hence, it allows one to represent more quickly several quite different organizational designs and to select among them.

For entrepreneurs who are launching a new business enterprise, the organizational chart allows them to visualize the layout of the new firm's fledgling functions, just as the architectural drawing enables one to visualize the layout of the power station. For executives of an established firm which is introducing new products, or acquiring subsidiaries, or expanding into new geographical markets, the organizational chart helps them to visualize how the functions and responsibility centers of the existing organization might be adapted to support the new strategic thrust.
In this first stage of design the organizational chart enables one to study the layout of the organization's responsibilities. It focuses one's attention on conflicts between responsibility centers, on the information load (or overload) of executives and managers, and on the coordination of people's activities.

In the second stage of design, business analysts and executives draw diagrams of the policy structure implied by the organizational chart and then discuss how the policies are linked. The discussion provides new insight into the way a business unit interacts with other business units and with its environment, in much the same way that engineering drawings and simulation models help power station designers understand the station's likely operating behavior.

Business Problem -- Policy Structure Diagram Then Organizational Chart

The policy structure diagram (and behavioral simulation modeling) is a good starting point for addressing design problems in organizations with a recognized business problem, but not necessarily a recognized structural problem. (It is also the traditional way of starting a system dynamics policy project, Richardson and Pugh 1981, chapters 1 and 2; Randers 1980). The diagram helps one to visualize the firm's key actors and their decision functions (for example pricing, capacity planning, sales planning and control), to see how decisions and actions are coupled in feedback loops, and to understand (using simulation) how the system's feedback structure generates its dynamic behavior (or business problems).
For executives of a company with a business problem, the process of diagraming policy structure and making simulations helps stimulate debate and discussion of business operations (Morecroft, Summer 1985). For example, the MBM policy structure study was motivated by a business problem - high delivery intervals and lower-than-expected sales of some product lines. The project team examined the firm's policies and procedures for sales planning and control. They used the policy structure diagram to see how the different business units compete internally for sales time. Simulations revealed how this competition for time led to escalating sales expense and suppressed sales growth.

The second stage of design for business analysts and executives is to experiment with policy changes that alleviate the problem. Sometimes the policy changes can be implemented within the existing organizational structure. For example, one solution to MBM's dysfunctional competition for sales time might be to review business objectives more frequently and adjust points more gradually -- policy changes that can be introduced without modifying each business unit's autonomy in sales planning and control. Sometimes however, the policy changes will point to the need for changes in organizational structure. In other words, design changes discovered using the policy structure representation might lead to changes in the organizational chart [13]. For example, another solution to MBM's dysfunctional competition for sales time might be to integrate responsibility for
compensation planning in a single staff group that is shared between large and small systems.

**Conclusion -- The Importance of Research in Organizational Design**

Organizational design is perhaps one of the most challenging and interesting areas for research in the policy and strategy field. The prospect of helping to create superior business organizations (and superior social organizations) -- organizations with 'administrative advantage' -- is very appealing. This paper adds to the growing interest in organizational design and, we hope, points to a promising new style of research for matching strategy and structure [14].
FOOTNOTES


[2] Williamson's well-known research examines the theoretical underpinnings of business efficiency as influenced by organizational design (Williamson 1975, 1981). By analysing the cost of transactions, Williamson argues, for example, that for large firms operating in diverse businesses, the multi-divisional structure is a more effective means of allocating capital in order to maximize profit, than either the functional organization or the holding company. Using the results of empirical studies, Galbraith (1973, 1977) suggests that different organizational structures arise in response to the information processing requirements of the environment. He identifies both the divisional and matrix structures as designs for coping with information overload. More recently Malone and Smith (1984) have developed an analogy between information processing in organizations and in complex computer networks as a means for exploring effective designs. Drawing on contingency theory, Hax and Majluf (1984, Chapters 20 and 21) have developed an interesting and practical methodology for helping corporations design an organizational structure that supports their intended strategy. In addition a number of major strategy consulting
firms, most notably McKinsey and Co., have developed frameworks that help their business clients think through the relationship between strategy and structure (Waterman 1982).

[3] Decision functions do not always generate action; sometimes they generate commands (information). Then they are connected to other decision functions rather than to flow regulators and levels.

[4] The authors did not see the consultants' final report. However, the authors were able to discuss the design alternatives with one of MBM's senior managers who had been briefed about the consultants' recommendations.

[5] The large/small system segmentation is simpler than MBM's actual segmentation. The simplification is made in part to disguise the company's identity and in part for conciseness.

[6] The large circular symbols in figure 7 represent behavioral decision functions, but their information filters have been removed to avoid undue visual complexity. However, in reading about the assumptions of each decision function, it is useful to imagine the filters in place. The small circular symbols in figure 7 represent external constants.
[7] The reader will notice that the responsibility centers of the organizational chart (see figure 5) map quite well into the behavioral decision functions of the policy structure diagram, though this easy mapping may not always occur.

[8] A policy structure diagram and model representing MBM's manufacturing policies has, in fact, been constructed (Morecroft 1986a). But the diagram that includes both manufacturing and sales is complex -- much more complex than the corresponding organizational chart. This added complexity makes policy structure diagrams more difficult to use than organizational charts. However, visual complexity is the price one pays for reaching deep into business operations and for trying to portray the firm's formal and informal communication network instead of its lines of authority and reporting.

[9] Documentation of the model is provided in the appendix. The model is written in an innovative new simulation language STELLA (Richmond 1985) which allows the business analyst to create a model hierarchically, first as a diagram (similar to the policy structure diagram but more detailed) and then in equations. The diagram, once created, guides the analyst's equation writing.

[10] The independent business unit simulation is produced with a model
that includes both large and small system business units -- in fact the same model used for simulating distinct business units with shared salesforce. The two business units behave as though they are independent (salespeople allocate a constant proportion of their time to each business unit throughout the simulation) if the model is parameterized so that the salesforce finds each business unit's products equally attractive, and so that each unit is meeting its sales objective. The parameter conditions are: 1)expected time per sale of small systems XTSSS=15 hours/system; 2) time per sale of small systems TSSS=15 hours/system. Conditions 1 and 2 ensure that the time per sale of small systems is just the right amount to make small systems as attractive to salespeople as large systems (large systems are assumed to take 75 hours each to sell, but they carry 5 times the points of small systems). In addition the initial value of base orders for large systems BOLS is set equal to sales effort to large systems SELS divided by expected time per sale of large systems ETSLS. This initialization ensures that the large system business unit's orders are exactly equal to the sales objective at the start of the simulation.

[11] The simulation experiments assume that when business units are independent, their selling expense is identical to the business units with shared salesforce. The assumption favors an independent business unit design, since the independent units gain all the advantages of independent salesforces with no
greater expense. In a fairer test, the independent business units might be simulated with an indirect salesforce expense that is higher than the indirect expense of business units with shared salesforce. The higher indirect selling expense would reduce the growth rate of independent business units. But total selling expense (direct and indirect) would likely end up smaller than for the business units with shared salesforce, because there is no competition for salesforce time to drive-up compensation.

[12] One can imagine several ways to ease the conflicts arising from a shared salesforce. The business unit's sales objectives might be reviewed more frequently and adjusted upward or downward to account for changes in salesforce time allocation. Compensation planners might adjust points more slowly in response to sales variances. Salespeople might be conditioned to the idea that product points are reduced if sales exceed objective. All these measures are intended to moderate inflation of selling expense by reducing the 'competition' for salesforce time between the business units. Alternatively one might think of ways to increase total sales effort quickly, so that an increase in sales effort to an attractive product line is achieved with overtime or hiring, instead of at the expense of other product lines. Simulations of some of these policy changes are described in Morecroft (1986b).
[13] The sequence of analysis, policy structure then organizational chart, is very similar to the sequence followed by duPont executives in their redesign of the company's organizational structure. A business problem prompted them to study closely the operation of the company's new paints and varnishes business (Chandler 1962, pp 91-96). DuPont had diversified into paints and varnishes in order to use excess capacity from the explosive powder factories, as powder demand declined at the end of World War I. Although the strategic move made sense, the paints and varnishes business ran at a loss during its first three years. By studying business operations, DuPont executives were eventually led to an important structural redesign -- the creation of an independent business unit for paints and varnishes.

[14] The decisionmaking/information processing perspective on organizational structure has led to a number of provocative articles on organizational design. In his Sciences of the Artificial Simon (1980), provides a wide ranging discussion of the 'science of design' (chapter 5) and 'social planning' (chapter 6). Forrester (1975b), provides a thought provoking discussion of principles for a 'New Corporate Design'. (The principles have been used by executives of several medium sized firms in the U.S.). Kiefer and Senge (1984), building on Forrester's work, explore the organizational design factors that help create challenging and highly motivating work environments in business firms.
Appendix: Model Documentation
STELLA Diagram of Sales Planning and Control for Large Systems
STELLA Diagram of Revenue Procedures
STELLA Diagram of Sales Planning and Control for Small Systems
STELLA Diagram of Budgeting and Hiring
(Also showing performance Indicators)
acoss = acos + coss
INIT(acoss) = 0

asr = asr + casr
INIT(asr) = (coss*apss)*(cois*apls)

bols = bols + cbols
INIT(bols) = ((tse*.5)+(sels*.5))/etsls

boss = boss + cboss
INIT(boss) = sess/tsss

frs = frs + cftrs
INIT(frs) = .2

fsess = fsess + cfess
INIT(fsess) = .1

pls = pls + cplps
INIT(pls) = 25000

pss = pss + cpss
INIT(pss) = 5000

sf = sf + csf
INIT(sf) = 60

acs = tsc/sf
apls = 100000
apss = 20000

asf = bsf/acs
bsf = asr*frs
bols = bols*(1+sm)
bsoss = boss*(1+sm)
casr = (sr-asr)/tasr
cbols = (cois-bols)/tecso
cboss = (coss-boss)/tecso
cftrs = (frs-frs)/tebf
cfess = fsess*cfpa*(1-fsess)

chls = phls*dvp
chss = phss*dvp
cols = sels/tsls
coss = sess/tsss

STELLA Equations for Salesforce Time Allocation Model
\[ \text{cp} = (\text{ipl} - \text{pls}) / \text{tcp} \]
\[ \text{cps} = (\text{ipss} - \text{pss}) / \text{tcp} \]
\[ \text{cs} = (\text{es} - \text{sf}) / \text{tasf} \]
\[ \text{dvp} = \text{INIT}(b) / ((\text{INIT}(c) * \text{INIT}(p)) + (\text{INIT}(c) * \text{INIT}(p))) \]
\[ \text{etsls} = \text{tsls} \]
\[ \text{etss} = \text{tss} * \text{wts} + \text{xtss} * (1 - \text{wts}) \]
\[ \text{igb} = 0.1 \]
\[ \text{ipl} = \text{pls} * \text{mpp} \]
\[ \text{ipss} = \text{pss} * \text{mpp} \]
\[ \text{p} = (\text{pss} / \text{etss}) / (\text{pls} / \text{etsls}) \]
\[ \text{pl} = \text{pls} / \text{etsls} \]
\[ \text{phss} = \text{pss} / \text{etss} \]
\[ \text{p} = \text{cols} / \text{bsols} \]
\[ \text{p} = \text{coss} / \text{bssos} \]
\[ \text{r} = \text{rh} / \text{ch} \]
\[ \text{rcr} = \text{rhss} / \text{chss} \]
\[ \text{rf} = \text{tsc} / \text{sr} \]
\[ \text{r} = \text{apls} / \text{etsls} \]
\[ \text{rhss} = \text{amp} / \text{etss} \]
\[ \text{sel} = \text{tse} * (1 - \text{fsess}) \]
\[ \text{sess} = \text{tse} * \text{fsess} \]
\[ \text{shsm} = 150 \]
\[ \text{sm} = 0 \]
\[ \text{sr} = (\text{coss} * \text{apss}) + (\text{cols} * \text{apls}) \]
\[ \text{tasf} = 3 \]
\[ \text{tasr} = 6 \]
\[ \text{tcp} = 3 \]
\[ \text{tebf} = 24 \]
\[ \text{tecso} = 6 \]
\[ \text{tsc} = ((\text{coss} * \text{pss}) + (\text{cols} * \text{pls}) * \text{dvp} \]
\[ \text{tse} = \text{sf} * \text{shsm} \]
\[ \text{tsls} = 75 \]
\[ \text{tss} = 13 \]
\[ \text{xtss} = 13 \]

STELLA Equations for Salesforce Time Allocation Model — Continued
D-3773-1

\[ \text{cfpa} = \text{graph(pass)} \]
\[ 0.0 \rightarrow -2.500 \]
\[ 0.200 \rightarrow -1.700 \]
\[ 0.400 \rightarrow -1.100 \]
\[ 0.600 \rightarrow -0.600 \]
\[ 0.800 \rightarrow -0.250 \]
\[ 1.000 \rightarrow 0.0 \]
\[ 1.200 \rightarrow 0.250 \]
\[ 1.400 \rightarrow 0.600 \]
\[ 1.600 \rightarrow 1.100 \]
\[ 1.800 \rightarrow 1.700 \]
\[ 2.000 \rightarrow 2.500 \]

\[ \text{mppls} = \text{graph(pols)} \]
\[ 0.500 \rightarrow 1.500 \]
\[ 0.600 \rightarrow 1.450 \]
\[ 0.700 \rightarrow 1.400 \]
\[ 0.800 \rightarrow 1.250 \]
\[ 0.900 \rightarrow 1.100 \]
\[ 1.000 \rightarrow 1.000 \]
\[ 1.100 \rightarrow 0.960 \]
\[ 1.200 \rightarrow 0.930 \]
\[ 1.300 \rightarrow 0.910 \]
\[ 1.400 \rightarrow 0.900 \]
\[ 1.500 \rightarrow 0.900 \]

\[ \text{mppss} = \text{graph(poss)} \]
\[ 0.500 \rightarrow 1.500 \]
\[ 0.600 \rightarrow 1.450 \]
\[ 0.700 \rightarrow 1.400 \]
\[ 0.800 \rightarrow 1.250 \]
\[ 0.900 \rightarrow 1.100 \]
\[ 1.000 \rightarrow 1.000 \]
\[ 1.100 \rightarrow 0.960 \]
\[ 1.200 \rightarrow 0.930 \]
\[ 1.300 \rightarrow 0.910 \]
\[ 1.400 \rightarrow 0.900 \]
\[ 1.500 \rightarrow 0.900 \]

\[ \text{wts} = \text{graph(acoss)} \]
\[ 0.0 \rightarrow 0.0 \]
\[ 100.000 \rightarrow 0.095 \]
\[ 200.000 \rightarrow 0.200 \]
\[ 300.000 \rightarrow 0.335 \]
\[ 400.000 \rightarrow 0.500 \]
\[ 500.000 \rightarrow 0.800 \]
\[ 600.000 \rightarrow 0.970 \]
\[ 700.000 \rightarrow 1.000 \]
\[ 800.000 \rightarrow 1.000 \]
\[ 900.000 \rightarrow 1.000 \]
\[ 1000.000 \rightarrow 1.000 \]

STELLA Equations for Salesforce Time Allocation Model -- Continued
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Definitions of Variable Names
Definitions of Variable Names -- Continued
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