APPLICATION OF SCIENTIFIC APPROACHES TO INTERNATIONAL FACILITY PLANNING*

by

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ABSTRACT

This paper examines behavioral patterns of management attitude toward the application of scientific approaches to the process of international facility planning. Multidimensional rationality of management behavior was used as a conceptual framework for the research. Four perspectives of a manager were: the corporation with an economic rationality; the hierarchical (vertical) suborganization with a political rationality; the departmental (horizontal) suborganization with an organizational rationality; and the individual manager with a personal rationality. Major causes of attitudinal differences of managers toward the application of scientific approaches to their planning processes were identified in the form of working hypotheses, and these hypotheses were tested statistically using the data from a questionnaire survey of 222 U.S.-based multinational corporations. The result of this research showed that management attitudes toward the application of scientific approaches were affected by (1) product diversity, (2) degree of competition, (3) level of technology, (4) planner/nonplanner identification,

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(5) product/area orientation, (6) foreign residency of managers, (7) number of subsidiaries, and (8) growth rate of the companies.

1. INTRODUCTION AND DEVELOPMENT OF PARADIGMS

There is a proliferation of literature dealing with the problems of industrial location decisions. Most of these studies, however, took into consideration aspects which were easily quantifiable such as transportation and labor costs. More subjective information involving individual values and judgments were commonly disregarded from the scope of these analyses. Indeed, such simplified and quantitative models proved useful in the field of domestic industrial location decisions where environmental characteristics were rather homogeneous among the prospective candidates for plant site without much difference in socio-cultural environments and political systems.

However, as most of the big companies started to go abroad for foreign production and/or marketing activities, political, economic, social, and cultural heterogeneities existing in the multinational business environment placed a limit on the usefulness of traditional domestically-oriented industrial location theories. Their approaches not only neglected the significance of divergencies from one country to another, but also failed to consider strategic implications of foreign venture as a part of the integrated corporate policy.

Some researchers attempted to treat this problem more systematically and provided managers of multinational companies with workable techniques by incorporating specifics of local environments with respect to various location factors and uncertainties into general and integrative frameworks. Pomper (4), for example, conceived the idea of using dynamic programming techniques for international facility planning and developed a computer model which was designed to assist management in evaluating worldwide implications of alternative facility investment proposals and in making

strategic decisions.

In order for such a scientific approach to contribute to business practice, it must be applied to real problems in the field, and implications of this application must be followed up. However, this application process is traditionally considered as a "black box" because of its dynamic and behavioral nature. Nonetheless, an understanding of this application process is a prerequisite for practitioners to be able to control the *managing* of strategic planning.

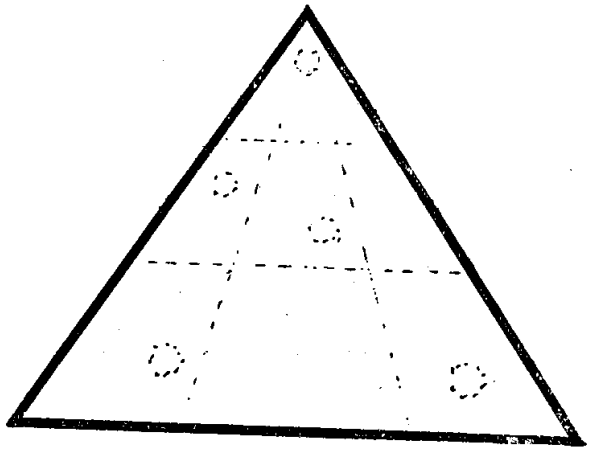
One useful way to investigate this process is to categorize the identities of managers according to their perspectives within the organization. To illustrate, suppose that two magnifying lenses with different degrees of power are available. Without either of these lenses, the organization of a business concern can be viewed as a huge black-colored box, while nothing inside is visible (Picture 1 of Exhibit 1). Using the less powerful lens, the seemingly black box can be penetrated. Now, several clusters of managers, such as top management and middle management, or product group and area group, can be seen. Yet, the first lens does not allow a clear look at each individual (Picture 2 of Exhibit 1). With the more powerful lens, the clusters of people go out of focus. Instead, the organization of the business concern can be seen as its microcosm, i.e., each individual person who is a component of the organization (Picture 3 of Exhibit 1).

The above analogy shows that the identity of a manager can be categorized by his affiliated corporation, his suborganization, or by his own individual identity. The suborganization, however, can be further classified into two: one is the hierarchical suborganization, i.e., the level of a manager's position within the organization from which his personal power and influence are generated; the other is the departmental suborganization by which his organizational goal is determined.

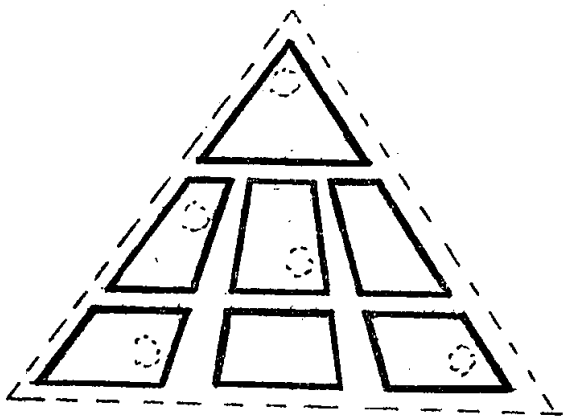
The immediately following questions from this categorization is how these identities of a manager affect his perspectives, and whether each

Exhibit 1
Picture of an Organization

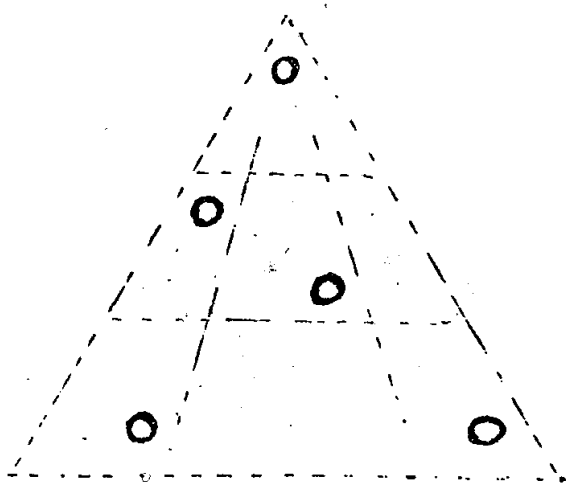
Picture 1



Picture 2



Picture 3



identity of a manager has its own rationality. Simon (5) defined rationality as the one which "is concerned with the selection of preferred behavior alternatives in terms of some system of values whereby the consequences of behavior can be evaluated."(1) According to this definition, all of the above four identities should reinforce rationality in a manager's choice of decisions. Perhaps the only way to clarify the difference among them would be to use the term "rationality" in conjunction with appropriate adjectives, as suggested by Simon.

The first identity of a manager (the corporation) explains the decision process of strategic planning as if he represented the corporation or the business entity itself. Legally, a corporation exists as an independent entity, and has the right as well as the responsibility to act on its own. Therefore, it can and does set up its objectives and make decisions accordingly. Typically these objectives are represented by economic terms such as maximization of profits or maintenance of market share. In this regard, the manager with a corporate perspective can be considered to have an "economic" rationality as its decision criterion.

The second identity of a manager (the hierarchical suborganization) explains the decision process of strategic planning by exploring his motivation to increase his power in the organizational hierarchy. Typically, the scope of authorities and responsibilities of a manager is defined by his position within the hierarchy of the company and so is the extent of his relative influence in the decision process. In order to increase his power, he would make decisions according to a "political" rationality.

The third identity of a manager (the departmental suborganization) explains the decision process of strategic planning as a rational choice of a manager to attain the goals and objectives of his affiliated organization. For example, the perspectives of the European Division are different from that of, for example, the Polyethylene Group in the same organization.

(1) See Simon (5), p. 75.

It is conceivable that a manager of the Europe Division would put his maximum effort to get the best transfer price from other regional divisions of the same company. This effort may improve the performance of his organization, but it has no effect on the corporate performance. Nevertheless, in order to be consistent with the orientation of his affiliated organization, he would make decisions with an "organizational" rationality.

The fourth identity of a manager (the individual manager) explains the decision process as a rational choice of a manager based on his own personal non-job-related values. His behavior is considered to be "personally" rational because he would look upon his own values more importantly than the goals of his affiliated organization or the company.

2. THE SCOPE OF THE RESEARCH

One way of describing the elements associated with the management of enterprise is by identifying four basic components in the management of private business: MAN or decision makers, TASK or opportunities, TECHNOLOGY or resources, and ENVIRONMENT. Exhibit 2 illustrates the relations among MAN, TASK, and TECHNOLOGY, within the broader context of ENVIRONMENT. This general diagram may be converted into one with specific components substituting the original ones without losing the characteristics of the relations among them, as shown in Exhibit 3. Some of the branches of the sciences in business have been developed along these lines. For example, the link between TASK and TECHNOLOGY has been extensively studied under the names of management science, operations research, and industrial econmics. Works of scholars such as Anthony (1) and Bower (2) have been devoted to understanding the link between MAN and TASK. Management of technology or administrative systems relate TECHNOLOGY *to* MAN.

However, relatively few studies have been made on the behavioral issue

of how man perceives TECHNOLOGY, and more specifically, how decision makers perceive the modeling activities. None has been found by the author with respect to the question of "How do different groups of decision makers respond to technological models, and what causes such attitudinal differences?" As a means to answer this question, the following hypotheses were developed.

Exhibit 2
General Components of Management

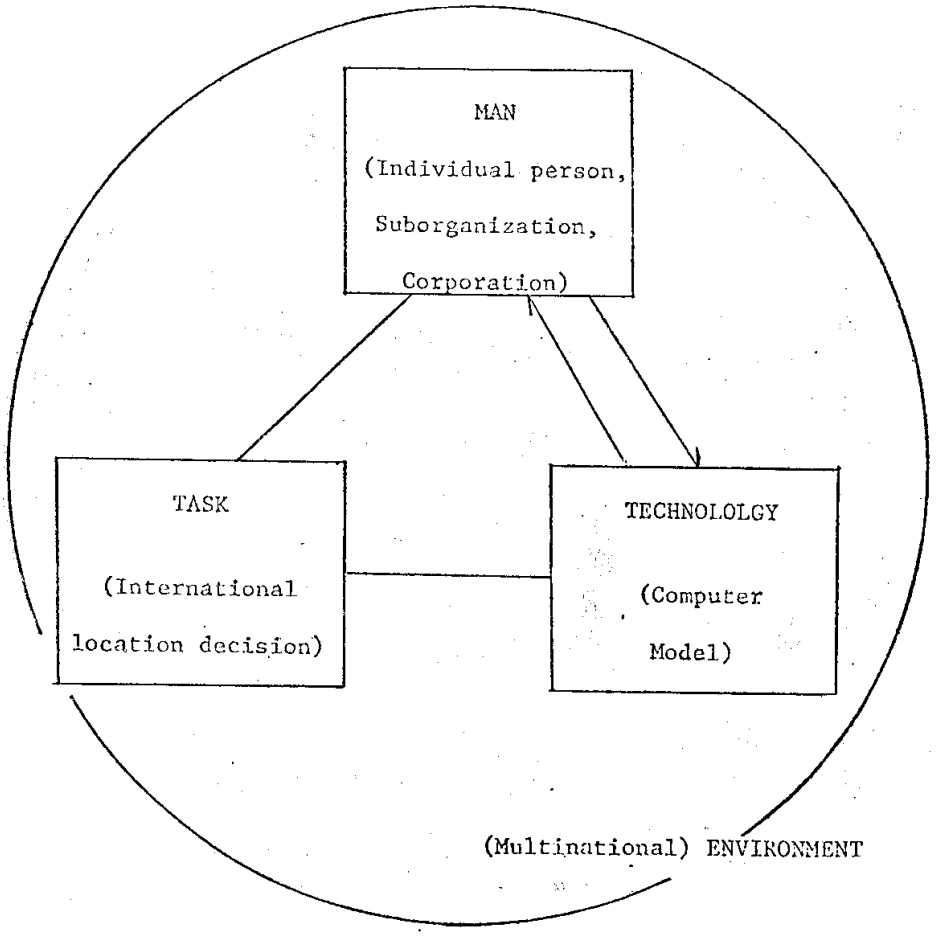
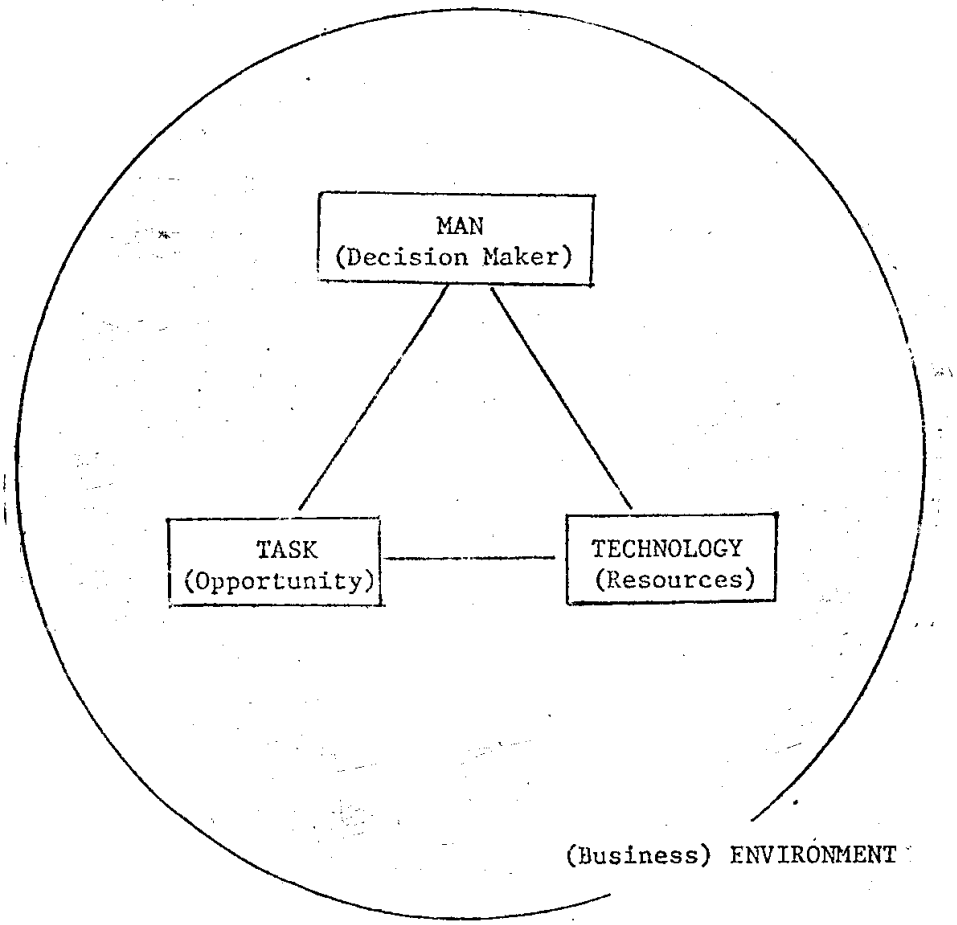


Exhibit 3
Specific Components of Management



3. DEVELOPMENT OF HYPOTHESES

Regarding the Corporate Perspective

A number of variables are likely to affect the degree to which business corporations use scientific approaches. They are the size of a corporation, the degree of multinational involvement, and the growth of a corporation.

Regarding the question of whether the size of a corporation has anything to do with the use of scientific approaches in strategic decision processes, it is hypothesized that larger-sized corporations can afford more formal and established mechanisms because of the economy of scale required for the

institution of planning groups and a management information system. Another reason might be the increase in the number of strategic decisions as the size of a corporation grows.

Hypothesis One:

The larger the size of a corporation, the more likely the idea of applying scientific approaches to strategic decisions will be accepted by the corporation.

Vernon (7) used a number of overseas manufacturing subsidiaries as one of the two criteria for selecting multinational enterprises (the other was listing in *Fortune's* 500). Considering that the need for planning of multinational business activities in a company increases along with the increase in the number of its overseas manufactuirng subsidiaries, the following hypothesis is suggested:

Hypothesis Two:

The more manufacturing subsidiaries a corporation has overseas, the more likely the idea of applying scientific approaches to strategic decisions will be accepted by the corporation.

The maturity of products is one of the aspects which govern the characteristics of management in any business concern. According to the product life cycle theory, the economics of manufacturing a typical product is a less important factor than other factors such as market penetration and customer orientation, when the product is in its early stage of development. Once the product reaches a stage of maturity and mass production begins, then competition becomes significant and profit margins of the product are squeezed. Therefore, well-concerted planning and control programs are given higher emphasis at that stage. There is a problem, however, as to whether or not a company, especially a large, multinationally oriented and diversified corporation can be easily identified by a single product. Even if this problem can be resolved by the selection of a "representative" product, assessing the current stage of such a product is another difficult issue to

resolve. Since the concept "the maturity of products" is highly subjective, a proxy variable can be considered which most closely reflects the maturity of a product. The growth rate of consumption has been used by Stobaugh (6) to explain the maturity of markets. Based on his conclusion that the growth rate has an inverse relation with the maturity of the market, growth rate of the revenue of a corporation is used as a variable to determine the maturity of products manufactured by the corporation.

Hypothesis Three:

The lower the growth rate of the net revenue of a corporation during the last ten years, the more likely the idea of applying scientific approaches to strategic decisions will be accepted by the corporation.

Regarding the Hierarchical Perspective

The level of hierarchy is an important factor in determining the nature and degree of authority and responsibility of a manager within an organization. As a political creature, he is naturally concerned about his power to influense decision making processes. If scientific approaches such as a computer model are considered to enhance the power of a manager in the decision process, he will more likely respond favorably to the idea of applying it to strategic planning. On the other hand, if the computer model is considered to shrink his power, he will more likely respond less favorably to the same idea. Therefore, it is conceivable that a manager's attitude toward the computer application will be determined by his position in the hierarchy which directly affects his political power within the organization.

Hypothesis Four:

Attitudes of managers to the idea of applying scientific approaches to strategic decision are dependent upon their corresponding levels of organizational hierarchy.

Another factor in the hierarchy which may affect a manager's attitude toward the application of scientific approaches is whether or not his job is in the capacity of a planner. Typically, the responsibilities of planners are

different from those of nonplanners in two respects. First, planners are relatively free from the outcome of what they plan, at least in the short run, and therefore are not penalized in the way field managers with specific line responsibilities would be. Second, one of their jobs is to provide field managers with the frames of reference or mechanisms with which the field managers can develop and evaluate their own business projects. In this context, planners are considered to be leaning more toward systematic and structural approaches.

Hypothesis Five:

Attitudes of planning managers to the idea of applying scientific approaches to strategic decisons are favorable regardless of their positions within the organizational hierarchy.

Regarding the Departmental Perspective

A typical multinational corporation is organized by either product or area or a combination of both. The concept of an area-oriented organization is commonly adopted when the operating effectiveness of a company is dependent upon delegation of responsibilities to local managers who are attuned to, and therefore, can respond quickly to particular local conditions. On the other hand, the concept of a product-oriented organization is commonly adopted when the characteristics among the products are so heterogeneous that it is critical for the managers to pay attention to each product over the range of markets with an emphasis on global coordination. In this context, the following hypothesis is suggested:

Hypothesis Six:

Product-oriented managers have more favorable attitudes toward the idea of applying scientific approaches to strategic decisions than area-oriented managers.

Regarding the Individual Perspective

Regarding the personal characteristics of managers, the following issues are discussed; intellectual inclinations, staff/line experience, and the period

of residency abroad.

It is likely that a quantitatively oriented manager has better understanding and knowledge of scientific approaches, and therefore, has a more favorable attitude toward the idea of applying them to strategic decisions than a nonquantitatively oriented manager. Here, a manager with quantitative orientation is defined as the one who has had more quantitative education and experience than nonquantitative ones. Using this term "education and experience" as a proxy variable to reflect the intellectual inclinations of an individual manager, the following hypothesis is suggested:

Hypothesis Seven:

> Quantitatively oriented managers have more favorable attitudes toward the idea of applying scientific approaches to strategic decisions than nonquantitatively oriented managers.

Another aspect of a manager as an individual is his staff versus line experience. Traditionally, line managers are given the power for decision making, while staff members provide information and suggest their recommendations to line managers. However, an adoption of scientific approaches such as computer modeling of strategic decisions may well change the power relations between line and staff people. The authorities of decision making by line managers are due to their judgmental ability in a complex situation. Therefore, if a new technique such as computer modeling is supposed to supplement, if not supplant, their judgment, it may become a potential threat to these line managers. On the other hand, staff people have different perceptions of this change. They often believe that they are more intellectual than line mangers. At the same time, they may have been experiencing constant frustrations as they see their seemingly bright suggestions and recommendations defeated and ignored by the line managers. Now, with the scientific model, the staff people can be more influential in the decision making. They usually know the techniques inside and out, and if they will, they can change the outcomes of the model simply by

submitting different data. Therefore, the following hypothes is is considered:

Hypothesis Eight:

Managers with more staff experience have more favorable attitudes toward the idea of applying scientific approaches to strategic decisions than managers with more line experience.

Finally, it is likely that the experience of living in foreign countries has a certain impact on one's perception toward managing international business. The heterogeneity in foreign environments is greater than one can imagine at home. Therefore, it is conceivable that experience in foreign countries would affect a manager's way of thinking against scientific approaches such as the global planning mechanism which may not be able to pay its full attention to all the specific circumstances of foreign environment.

Hypothesis Nine:

Managers with extensive experience of living in foreign countries have less favorable attitudes toward the idea of applying scientific approaches to strategic decisions than those with limited experience.

4. ANALYSIS OF THE QUESTIONNAIRE

A questionnaire was designed to collect data on the attitudes of managers toward a value of the computer model which was developed by Pomper and subsequently revised by the author. The questionnaire was composed of two main parts (Exhibit 4). The first part was a brief description of the computer model. Upon reading this description, a respondent was expected to answer the questions in the second part. He was asked to consider an application of the computer model to one of the international facility planning projects in which he was or had been involved. This second part had three sections. They were: the nature of influences on the location decision; the assessment of the computer model; and the information on the

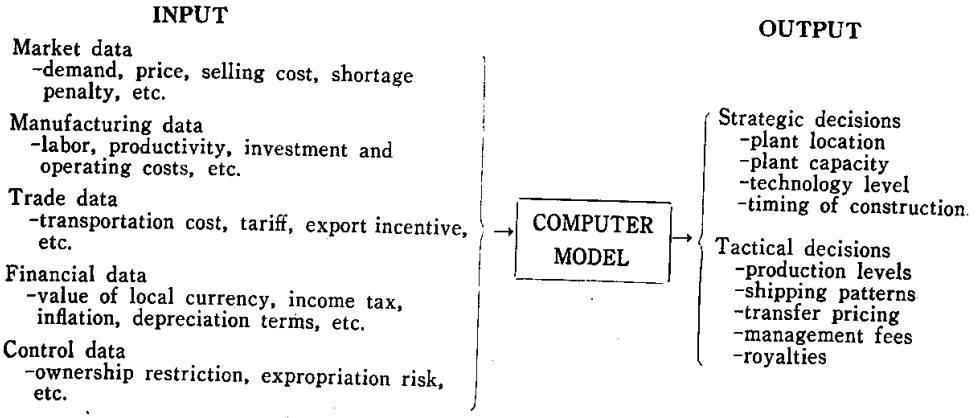
respondent himself.

Decision makers, task, technology, and environment were previously considered as four major components of the management of business. In the questionnaire survey, these four components were treated as follows. First, the technology was defined by the computer model. By asking respondents to consider the application of the computer model, an attempt was made to maintain the homogeneity of the technology within the sample base. The environment was also treated as a precondition, by selecting respondents from a group of multinational corporation in the U.S.(2) Third, the tasks, however, were treated as variables because each respondent had different

Exhibit 4
Questionnaire
Computer Model on International Facility Planning

Recently a team of researchers at the Harvard Business School developed a computer model which is designed to assist managers of internationally oriented companies in their facility planning.

The model considers a product manufactured and marketed in several countries. It assumes that managers can assess future uncertainties in various political and economic conditions of each country in terms of probabilities of their occurrence. With the relevant information on each prospective location, the model selects the strategic and tactical decisions which would maximize the sum of discounted cash flows from the business during the planned time horizon.



(2) It should be pointed out here that multinational corporations do not operate in the same environment. The only characteristics common to them would be that each of these corporations operates in multiple, diversified environments.

The model is designed to facilitate use on a computer console by managers concerned with international facility planning. It also permits sensitivity analyses on a number of variables such as tariffs, taxes, export rebates, costs, price, sales volume, and dividend policy.

The model is presently in operation at the Harvard Business School Computer System in Boston, and is available to any corporation managers for their own use.

Questionnaire (cont.)

Please consider the application of the above-described computer model to one of the international site selection projects which you are presently or have recently been involved in. Answer the questions by circling the number which most closely expresses your view. Thank you.

Nature of Influences on the Location Decision	(agree) (disagree)	Is it an important factor to your location decision? (yes) (no)
The project concerns a business with low product diversification. (A single product line constitutes the total or major portion of sales.)	6 5 4 3 2 1	6 5 4 3 2 1
Markets are homogeneous. (Integration of marketing activities among several market-countries is possible.)	6 5 4 3 2 1	6 5 4 3 2 1
Competition is very intense.	6 5 4 3 2 1	6 5 4 3 2 1
Technology is relatively stable and products are mature.	6 5 4 3 2 1	6 5 4 3 2 1
Other:_____	6 5 4 3 2 1	6 5 4 3 2 1

Assessment of the Computer Model	(agree) (disagree)	Is it an important factor to your assessment of the model? (yes) (no)
The assumption (that managers can assess future uncertainties with numbers) is valuable and doable.	6 5 4 3 2 1	6 5 4 3 2 1
The scope of the model is well-conceived to aid in strategic decisions (with long-range impact on business operations).	6 5 4 3 2 1	6 5 4 3 2 1
The scope of the model is well-conceived to aid in tactical decisions (with short-range impact on business operations).	6 5 4 3 2 1	6 5 4 3 2 1
The objective (to maximize the sum of discounted cash flow) is acceptable.	6 5 4 3 2 1	6 5 4 3 2 1
Design of the model for use on a computer console by managers is necessary.	6 5 4 3 2 1	6 5 4 3 2 1

Name:_____ Title:_____

Department:_____ Corporation:_____

How many organizational levels is your position from that of the chief executive officer (counting one for a vice president reporting to a chief executive officer, and so on)? _____levels

Is your department oriented toward product or area? _____Product _____Area

Ratio of quantitative vs. non-quantitative courses and activities in your education and experiences:

_____100-0 _____80-20 _____60-40 _____40-60 _____20-80 _____0-100

Ratio of staff vs. line experience:
_____100-0 _____80-20 _____60-40 _____40-60 _____20-80 _____0-100
Number of years you have lived abroad on business: _____years

projects which varied from those of the others with respect to the nature of products, markets, and competitions. Fourth, the decision makers were treated as independent variables. In fact, the heterogeneity of decision makers within the sample was considered as a key factor in explaining the management responses to the computer application. Consequently, the technology and the environment were treated as preconditions, and the tasks and the decision makers as independent variables in the questionnaire survey.

The list of 187 multinational firms originally identified by the Multinational Enterprise Project at the Harvard Business School was updated to include 222 firms. This revised list was used as the sample base for the mail survey. The firms included in the sample are listed in the Appendix. One hundred and eight responses were received within two months after the questionnaires were mailed. Statistical analyses were performed with these 108 responses.

In order to derive a dependent variable for the regression analysis, the assessed value of each component of the computer model was multiplied by its corresponding importance, and the resulting five figures were added. This value was then scaled down by dividing it by five and finding its square root value, resulting in a single value with a theoretic range of one to six.

Nine working hypotheses were previously developed. All of the hypotheses except the one on hierarchical level were in the form of "The more X_i is, the more Y becomes." Since such relationships could be represented by straight lines, one independent variable was required for each of these hypotheses. A single exceptional case was the hypothesis regarding the hierarchy of organizations which considered a possible curvilinear relation

between the hierarchical level (X) and the management response (Y). In order to accommodate this possibility in the regression model, an extra variable was added which was a squared value of the hierarchical level (X_8 in Exhibit 5). The questionnaire in Exhibit 8-1 included four dimensions of the tasks which would vary by respondents. These four dimensions were also regarded as independent variables. Consequently, the above 14 independent variables were considered in the tests. The list of these variables appears in Exhibit 5.

Using all of the 14 independent variables, the following regression equation could be constructed:

$$Y=3.004-0.082X_2-0.000X_3+0.119X_4+0.127X_5+0.301X_6+0.022X_7$$

Exhibit 5

The Set of Variables

No.	Name	Unit of Measurement	Nature
1	Dependent variable	Subjective (6: very favorable, 1: very unfavorable)	
2	Product diversity	Subjective (6: low diversification, 1: high diversification)	
3	Market homogeneity	Subjective (6: homogeneous market, 1: heterogeneous market)	Tasks
4	Competition	Subjective (6: intense competition, 1: no competition)	
5	Level of technology	Subjective (6: stable technology, 1: changing technology)	
6	Planner/nonplanner	Binomial (1: planner, 0: nonplanner)	
7	Level of hierarchy	The number of hierarchical levels between him and the Chief Executive Officer	Decision Makers (Suborganization)
8	(Level of hierarchy)^2	Squard value of Variable 7	
9	Product/area orientation	Binomial (1: product-oriented, 0: area-oriented)	
10	Quan./qual. inclination	Binomial (1: quantitative, 0: qualitative)	
11	Staff/line experience	Binomial (1: staff, 0: line)	Decision Makers (Individual person)
12	Foreign residency	Number of years	
13	Size of corporation	The 1975 net revenue in $10 million	
14	Number of subsidiaries	Number of overseas manufacturing subsidiaries	Decision Makers (Corporation)
15	Growth rate	Annual growth rate during 1966~1975 in percent(%)	

$$-0.003X_8+0.353X_9+0.047X_{10}-0.002X_{11}+0.017X_{12}-0.000X_{13}$$
$$+0.004X_{14}-0.020X_{15} \qquad \text{(Equation 1)}$$

Inclusion of all the independent variables in the above equation was considered not desirable, because some variables might not have any significant correlation with the dependent variable while reducing the degrees of freedom of the equation. Therefore, it was necessary to construct regression equations with fewer numbers of independent variables. First, reducing one independent variable resulted in the regression equation with 13 independent variables. The regression equation excluding X_3 was considered to be the best among the 14 possible variations. Following this procedure of reducing the number of independent variables one by one, the best regression equation for each given number of independent variables was identified, and tabulated in Exhibit 6.

The next step was to find the best regression equation among the 13 regression equations in Exhibit 6. Using the minimum value of the estimate of residual standard deviation (Est. Res. Sd. in Exhibit 6) as the decision criterion, the following equation which included eight independent variables was selected.

$$Y=3.245-0.082X_2+0.116X_4+0.124X_5+0.298X_6+0.346X_9$$
$$+0.015X_{12}+0.004X_{14}-0.020X_{15} \qquad \text{(Equation 2)}$$

These eight independent variables are listed in Exhibit 7. The rightmost column in the exhibit shows that the probability of the true beta having the same sign as its estimate was more than 90% for each and every independent variable. The coefficient of determination (R_2) of Equation 2 was 0.322, implying that these eight independent variables explained 32.2% of the variation of the dependent variable.

Among the eight independent variables listed in Exhibit 7, the signs X_6, X_9, X_{14}, and X_{15} were consistent with their corresponding hypotheses, while the sign of X_{12} was contrary to its hypothesis. Predicting the directions of X_2, X_4, and X_5 was beyond the scope of this research, and therefore, no

Exhibit 6

The Best Regression Equation

For Each Given Number of Independent Variables

Model Equation: $Y=b_0+b_iY_i$

Sample Size: 108

Number of Ind. Var's.	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Degree of Freedom	93	94	95	96	97	98	99	100	101	102	103	104	105	106
Est. Res. Sd.	0.628	0.625	0.621	0.618	0.615	0.612	0.610*	0.612	0.617	0.625	0.631	0.643	0.659	0.682
R^2	0.325	0.325	0.325	0.324	0.324	0.324	0.322	0.309	0.293	0.267	0.245	0.208	0.161	0.093
b_0	3.004	3.003	3.001	3.014	3.028	3.061	3.245	3.377	3.470	3.460	3.197	2.881	3.439	3.883
b_2	−0.082	−0.082	−0.083	−0.083	−0.082	−0.084	−0.082	−0.085	−0.091	−0.088	−0.085	—	—	—
b_3	−0.000	—	—	—	—	—	—	—	—	—	—	—	—	—
b_4	0.119	0.119	0.119	0.119	0.119	0.116	0.116	0.116	0.114	0.111	0.118	0.133	—	—
b_5	0.127	0.127	0.126	0.126	0.127	0.126	0.124	0.121	0.126	0.134	0.130	0.103	0.110	—
b_6	0.301	0.301	0.300	0.304	0.304	0.299	0.298	0.280	0.260	—	—	—	—	—
b_7	0.022	0.022	0.024	0.006	—	—	—	—	—	—	—	—	—	—
b_8	−0.003	−0.003	−0.003	—	—	—	—	—	—	—	—	—	—	—
b_9	0.353	0.353	0.353	0.353	0.355	0.360	0.346	0.357	0.333	0.385	0.392	0.407	0.446	0.450
b_{10}	0.047	0.047	0.046	0.047	0.048	0.043	—	—	—	—	—	—	—	—
b_{11}	−0.002	−0.002	—	—	—	—	—	—	—	—	—	—	—	—
b_{12}	0.017	0.017	0.017	0.017	0.017	0.016	0.015	0.016	—	—	—	—	—	—
b_{13}	−0.000	−0.000	−0.000	−0.000	−0.000	—	—	—	—	—	—	—	—	—
b_{14}	0.004	0.004	0.004	0.004	0.004	0.004	0.004	—	—	—	—	—	—	—
b_{15}	−0.020	−0.020	−0.020	−0.020	−0.020	−0.021	−0.020	−0.020	−0.021	−0.019	—	—	—	—

* Represents the minimum value of the estimate of residual standard deviation among 14 variations of regression equations.

Exhibit 7

The Set of Significant Independent Variables

No.	Name	Unit of Measurement	Estimated b Value	P(Sign)*
2	Product diversity	Subjective (6: low diversification, 1: high diversification)	−0.082	0.985
4	Competition	Subjective (6: intense competition, 1: no competition)	0.016	0.987
5	Level of technology	Subjective (6: stable technology, 1: changing technology)	0.124	0.999
6	Planner/nonplanner	Binomial (1: planner, 0: nonplanner)	0.298	0.984
9	Product/area orientation	Binomial (1: product-oriented, 0: area-oriented)	0.346	0.996
12	Foreign residency	Number of years	0.015	0.937
14	Number of subsidiaries	Number of overseas manufacturing subsidiaries	0.004	0.909
15	Growth rate	Annual growth rate during 1966～1975 in percent(%)	−0.020	0.970

* The probability that the true beta has the same sign as its estimate.

hypotheses were attempted. The analysis on each independent variable is presented below.

First, the direction of the parameter b_2 in Equation 2 indicated that as the facility planning project was concerned with diversified product lines, concerned managers were more inclined to use the computer model. Such inclination by the managers could have been affected by their relative frustration in dealing with highly diversified product lines which would put complex problems on their shoulders.

Second, the equation showed a significant correlation between the competition and the management response. More specifically, it suggested that as managers perceived higher levels of competition in their businesses, they responded more favorably to the computer application. Probably, managers confronting high levels of competition needed any device which could help them outperform their competitors.

Third, the stability of technology was considered to affect the management response favorably. At a stable level of technology coupled with a sophisticated manufacturing system, cost minimization would be seen as

one of the critical issues facing the managers. Therefore, the use of computer models which had been traditionally regarded as a scientific device to optimize the system might have been welcomed more warmly.

Fourth, the regression analysis confirmed the hypothesis on the planner/nonplanner identification. Planners were found to view the role of the computer model much more favorably than nonplanners. As discussed before, one of the prime responsibilities of a planner would be to provide frames of reference with which field managers could evaluate their specific projects. On the other hand, nonplanners might have been more likely to perceive the computer model as being naive because of many restrictive assumptions required.

Fifth, product-oriented managers showed more favorable attitudes than area-oriented managers toward the application of the model. Productoriented managers, by definition, were responsible for the worldwide coordination of their product lines, and therefore, were more attuned to the idea behind the computer model which was essentially to carry out such functions. Area-oriented managers, on the other hand, were responsible for regions. They might have been reluctant to employ a computer model with a scope more extensive than their responsibilities, but which overlooked many issues which were difficult to model, nevertheless too critical for the area-oriented managers to neglect.

Sixth, the length of foreign residency of a manager positively affected his response. Contrary to the hypothesis in this regard, the result of the questionnaire survey showed that managers with longer histories of living in foreign countries showed more favorable responses to the use of the computer model than those with less experience of that type. It was necessary, therefore, to reject the hypothesis regarding the foreign residency of managers. This could be attributable to faulty hypothesis and/or the sample error.

Seventh, the number of subsidiaries of a company positively affected the

response of its affiliated managers to the computer application. The result was consistent with the hypothesis, which suggested that the more foreign subsidiaries a corporation had, the more favorable the attitude of the affiliated managers toward the computer application would be. As managers had more foreign business operations, they would have needed better global coordination and control than before. This could have resulted in their favorable responses to the computer application.

Eighth and finally, the growth rate of a company negatively affected its management response. It was also consistent with the working hypothesis which suggested that managers from low-growth companies would show more favorable attitudes toward the computer application than those from high-growth companies. This result from the questionnaire survey might suggest that low growth of sales probably caused by the maturity of major product lines of the company, compelled the managers to consider more rationalized and systematic devices such as the computer model described in the questionnaire.

5. IMPLICATION FOR MANAGEMENT

There are two groups of managers who are directly responsive to the practical use of the concepts and findings from this thesis: one includes sellers of scientific technologies for decision making and planning; and the other includes users of scientific technologies.

Suggestions to Sellers of Scientific Technologies

This study identified various causes which were likely to affect the attitude of managers toward the use of scientific technologies in their planning processes. Therefore, a typical seller of scientific technologies such as computer software packages can increase the degree of the effectiveness of his salesmanship by comprehensively studying and screening the backgrounds of a customer in terms of his individual characteristics, his organization,

and the nature of his committed projects. In an interview with a manager of a large U.S. corporation which sells and provides computer software services to domestic and international businesses, the skills required by salesmen of computer systems were succinctly described: "When you meet a potential customer, the first thing you have to do is to catch his personality and political power in the organization. To promote your product is a distant second."

Suggestions to Users (Managers) of Scientific Technologies

This article has examined the attitudes of managers in multinational companies toward an application of the computer model to their international facility planning processes. The testing of the hypotheses asserted that the application of the computer model to strategic planning was affected not only by the corporate perspective of a manager, but also by the perspective of his affiliated suborganization and/or his personal non-job-related values.

An implication of this is a new role for a practitioner in strategic planning, namely, as a *manager* of the process instead of a *maker* of the decision. The objective to the manger of the process is to provide and stimulate an environment in which strategic planning can be processed in an orderly manner with minimum of friction. As a means to successfully achieve this objective, the manager of the process can consider the following suggestions.

At the most general level, managers should recognize that a planning process involves a number of management groups with often diverging perspectives. Therefore, it is imperative for the managers to evaluate carefully the nature of the project and assign it to the suborganizations and personnel which have the proper perspective to comprehend the implications of the project.

In more operational terms, the decision to apply scientific approaches to the planning process should not be made for economic reasons alone. Once adopted, such approaches become part of an organic process, and thereby

changing the working relations of the personnel, the organization, and the planning system. Therefore, managers as potential users of the scientific approaches should be aware of political, organizational, and personal inclinations of participants in the planning process, and find ways to avoid potential conflicts among the participants who might perceive the new approaches as disrupting the currently maintained equilibrium among the constituents of the whole system. One way to avoid such conflicts or at least to reduce them as much as possible would be to provide personnel with an orientation which will introduce potential benefits of the scientific approaches as well as their limitations. At the same time, it has to be made clear to each person involved in the planning process that the differences in perspectives among the participants are not only inevitable but also desirable, and that such differences should be mutually respected.

Nevertheless, some potential users might consider the orientation of personnel as a naive approach. For those, reorientation of the organization supportive to the use of scientific technologies can be considered a viable alternative. The research suggested as the change of an area-oriented organization to a product-oriented organization will provide an excellent environment for the use of such technologies. However, this change often requires a substantial restructuring effort over a period of time. If managers foresee potential obstacles to the change of organizational orientation, they can consider personnel change. By assigning the responsibility of instituting and implementing technologies to managers responsive to them, the likelihood of the use of such technologies will be greatly enhanced.

Politically concerned managers can also use these technologies as a means to change the power structure of the present organization. By adopting a centralized planning mechanism, managers can increase power at headquarters and justify the need for coordination and control at the top. By the same token, the de-emphasis of such technologies can provide managers with a motive for developing regional business plans based on area-specific

information and knowledge.

Managers should also consider the likely impact of other competitors' adopting scientific technologies upon their competitiveness within the industry. Especially in a low-margin business with diversified products, intense competition, and stable technology levels, managers should be concerned about the spread of the computer model usage in the industry because any change in the performance and profitability of competitors would be a critical concern to the managers.

Appendix

Listing of 222 Multinational Corporations in U.S.

ACF Industries
AMF
Abbot Laboratories
Addressograph Miltigraph
Air Products & Chemicals
Allegheny Ludlum Ind.
Allied Chemical
Allis-Chalmers
Aluminum Co. of America
American Can
American Cyanamid
American Home Products
American Standard
Anaconda
Anderson, Clayton
Archer Daniels Midland
Armco Steel
Armstrong Cork
Ashland Oil
Atlantic Richfield
Avon Products
Babcock & Wilcox
Baster Laboratories
Beatrice Foods
Becton, Dickinson
Bemis
Bendix
Black & Decker Mfg.
Blue Bell
Borden
Borg-Warner
Bristol-Myers
Brunswick
Budd
Burlington Industries
Burroughs
Cabot
Campbell Soup
Barborundum
Carnation
Carrier
Caterpillar Tractor
Celanese
Central Soya
Champion International
Champion Spark Plug
Chemetron
Chesebrough-Pond's

Chrisler
Cincinnati Milacron
Cities Service
Clark Equipment
Coca-Cola
Colgate-Palmolive
Combustion Engineering
Container Corp. of America
Continental Can
Continental Oil
Corning Glass Works
Crane
Crown Cork & Steel
Cutler-Hammer
Dana
Dart Industries
Deere
Del Monte
Digital Equipment
Dow Chemical
Dresser Industries
Du Pont
Eastman Kodak
Eaton
Eltra
Emerson Electric
Emhart
Ex-Cell-O
Exxon
FMC
Federal-Mogul
Ferro
Firestone Tire & Rubber
Ford Motor
Fruehauf
General Cable
General Dynamics
Generel Electric
General Foods
General Mills
General Motors
General Refractories
General Signal
General Tire & Rubber
Genesco
Gillette
Goodrich (B.F.)
Goodyear Tire & Rubber
Gould
Grace (W.R.)
Gulf Oil
Harsco
Heinz (H.J.)
Hercules
Hewlett-Packard
Hobart
Honeywell
Hoover
Hygrade Food Products
Indian Head
Ingersoll-Rand
IBM
International Harvester
International Paper
ITT
Johns-Manville
Johnson & Johnson
Joy Manufacturing
Kaiser Industries
Kellogg
Kidde (Walter)
Kimberly-Clark
Koehring
Koppers
Lier Siegler
Libbey-Ownes-Ford

Libby, McNeill & Libby
Lilly (Eli)
Litton Industries
Lockheed Aircraft
Lubrizol
Martin Marietta
Mattel
McGraw-Hill
Mead
Merck
Miles Laboratories
MMM
Mobil Oil
Monsanto
Motorola
NCR
NL Industries
Nabisco
National Distillers & Chem.
Norton
Olin
Owens-Corning Fiberglass
Ownes-Illinois
PPG Industries
Parker-Hannifin
Pennwalt
PepsiCo
Pet
Pfizer
Phelps Dodge
Philip Morris
Phillips Petroleum
Pilsbury
Procter & Gamble
Purex
Quaker Oats
RCA
Ralston Purina
Raytheon
Revlon
Rexnord
Reynolds (R.J. Industries)
Reynolds Metals
Richardson-Merrell
Riviana Foods
Robertson (H.H.)
Rockwell International
Rohm & Haas
SCM
St. Regis Paper
Schering-plough
Scott Paper
Scovill Manufacturing
Seagram & Sons
Searle (G.D.)
Signal Company
Simmons
Singer
Smith (A.O.)
SmithKline
Sperry Rand
Square D
Staley Manufacturing
Standard Brands
Standard Oil of California
Standard Oil (Ind.)
Sundstrand
Stanley Works
Stauffer Chemical
Sterling Drug
Stevens (J.P.)
Studebaker-Worthington
Sunbeam
Sybron
TRW
Tenneco

Texaco	Upjohn
Texas Instruments	VF
Textron	Warnaco
Time Inc.	Warner-Lambert
Timken	Westinghouse Electric
Trans Union	Weyerhaeuser
Union Carbide	Wheelabrator-Frye
Uniroyal	Whittaker
United Brands	Witco Chemical
United Merchants & Mfrs.	Wrigley (Wm.) Jr.
Universal Leaf Tobacco	Zenith Radio

BIBLIOGRAPHY

(1) Anthony, Robert N., *Planning and Control Systems: A Framework for Analysis*, Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1965.

(2) Bower, Joseph L., *Managing the Resource Allocation Process*, Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1970.

(3) Cho, Dong Sung, *International Facility Planning: Regarding the Application of Scientific Approaches*, Unpublished Doctoral Dissertation, Harvard Business School, 1977.

(4) Pomper, Claude L., *International Facilities Planning: An Integrated Approach*, Unpublished Doctoral Dissertation, Harvard Business School, 1974.

(5) Simon, Herbert A., *Administrative Behavior*, New York: The Macmillan Company, 1957.

(6) Stobaugh, Robert B., *The Product Life Cycle, U.S. Exports, and International Investment*, Unpublished Doctoral Dissertation, Harvard Business School, 1968.

(7) Vernon, Raymond, "Memorandom," Unpublished Note to the Faculty of the Harvard Business School, December 17, 1969.