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PROGRESS IN THE DEVELOPMENT OF QUANTITATIVE MARKET REQUIREMENTS MODELS FOR USE IN LONG-RANGE PRODUCT PLANNING

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USES OF MARKET DATA IN PRODUCT PLANNING

This paper describes a comprehensive quantitative market requirements model which was constructed primarily to aid in decisions regarding long-range product development programs. To get a clear picture of the application of such models it is helpful to distinguish between the types of market data required for long-range product planning decisions and for short-range product planning.

For purposes of definition we can think of these two types of planning decisions as analogous to the short-range and long-range concepts embodied in the classical economic theory of the firm. In the short run there are fixed and variable costs, but in the long run all costs are variable. Similarly, in the short run the basic product line and marketing policies of a firm are fixed to a considerable extent. Short-range product planning decisions are usually focused on improvements in existing products and relatively minor modifications in the line in order to better adapt the product to the market, or in order to meet competitive conditions. In the long run, however, the "total package" which is to be marketed is open to major revamping. Long-range product planning decisions are not limited by the current recognized market requirements, the current state of technology, or the current competitive situation--although they are definitely influenced by these factors.

Recognizing that generalization is dangerous and that there are many exceptions and variations, let us nevertheless attempt to characterize the two types of product planning decisions. Since

short-range product planning decisions are associated with relatively minor changes in the product line, the planning of products in the short-range is generally equipment oriented. Suggestions or proposals are usually made by marketing or engineering groups for new products or improvements which will meet specific recognized market requirement or which will exploit advances in technology. Frequently, the impelling motive is to improve the performance or price position of the products relative to specific products offered by competition. Product planning activities are primarily concerned with evaluating these proposals and with initiating action on them.

Long-range product planning activity, on the other hand, which is not limited to considerations of minor changes in the existing product line, generally must be more oriented toward basic market requirements with less reference to current products. Answers must be sought to such questions as: "What significant consumer or user requirements remain unfilled because the existing product line is basically not suited to meet those requirements?," and "What are the largest areas of market potential, outside the range of existing equipment and techniques?" or "What types of equipment should be developed to satisfy user requirements, and thus obtain a share of the indicated potential?." The principal tasks will be to identify and measure requirements (which at present will often be unrecognized by the potential customer), and to determine the appropriate functional equipment specifications in order to guide research and engineering development operations.

It is apparent that information for decision making will require different emphasis for short-range and long-range planning. In most situations there are not, of course, two such distinct classes of decisions, but rather there is a whole continuum from short-range to long-range, with corresponding information requirements. The information contained in the model to be described reflects the long-range product planning objectives for which the model was developed, as described below.

Development of the Market Requirements Model

The preparation of the market requirements model was carried out as a special project of the Product Forecasting Department of IBM's General Products Division. In the General Products Division, planning of new products is carried out by Systems Development groups which have the responsibility for new products in specific systems areas. The Products Forecasting Department prepares sales forecasts for all new and current products of the Division, and also provides information on market structure and market potential to the Systems Development groups for use in planning new systems and products

The work in constructing the market requirements model was done in connection with a project carried out by one of the systems development groups. The over-all purpose of this project was to explore the requirements of a group of industries which have a relatively low utilization of data processing equipment and might represent an area of opportunity for market expansion for IBM products. A specific objective was the development of functional specifications for new products which would satisfy the requirements of these industries. The project thus emphasized the uncovering of general market requirements and the resulting implications for new products rather than the evaluation of specific machines which had already been proposed for development. For this reason, and also because of the long lead time involved in developing and introducing new products in the data processing field, the total project was an aspect of the long-range product development activities of the Division. Consequently,

the market data required are illustrative of the types of information needed in long-range product planning. The work done by the Product Forecasting Department in the preparation of the market model was performed in close conjunction with the market planning operations of the systems development group which had responsibility for the over-all project.

During the course of the project it became evident that the approach being used to structure the market for the specific segment of the economy being explored would be applicable to other situations involving decisions on the development of new products As a result, the scope of the market analysis project was broadened to include general experimental work in developing models of market requirements and potential, and in developing techniques for utilizing this market data most effectively in the decision process.

As thus modified, the market analysis operations of the project had four principal objectives:

1. To develop a quantitative picture of the total requirements and market potential for data processing equipment in the industries under consideration.
2. To provide specific information on market requirements which would help guide the market planners in the systems development group in determining the functional specifications of new products which might be proposed for the industries being studied.

3. To prepare estimates of market potential and sales forecasts for specific equipment that might be proposed to satisfy the indicated requirements.

4. To set up procedures for constructing models of market requirements for specific market areas, and to develop techniques for utilizing these models to prepare estimates of market potential for new proposed products. This involved setting up computer programs for relating the market model to the specifications of the proposed products.

Several organizations outside of IBM aided in the study. One of the co-authors, Mr. Frank Bacon of the Operations Research Department of the University of Michigan, and the Management Sciences Division of the public accounting firm of Touche, Ross, Bailey and Smart worked together in helping develop the analytical procedures, and in performing a major part of the analysis. The American Marketing Research Company of New York City also participated in the study.

The first phase of the project was an intensive case study program carried out by the market planning staff of the systems development group. The case studies enabled the planners to familiarize themselves with the data processing requirements and problems in the industries being investigated, and to obtain enough of a detailed quantitative understanding of the data processing requirements of individual firms to provide the basis for developing the conceptual basis for new machines and to develop functional specifications for

the machines. Analysis of the case studies also provided a basis for determining the information which would be included in the quantitative model which would be constructed to represent the entire market area.

The market area being studied related to certain industries, and consequently the primary organizational breakdown of the model was by industry. The definition of industries followed the standard industrial classification code, (SIC). The model was also set up in terms of significant functional areas related to data processing or use of information for management planning and control. In addition to certain unique functions related to the operations of the particular industries, a number of basic data processing functions common to many industries were included in the models. These basic functions were:

1. Order Processing and Billing
2. Accounts Receivable
3. Inventory Control
4. Accounts Payable
5. Payroll
6. Cost Accounting
7. Sales Analysis
8. General Accounting

In close cooperation with the market planning staff of the systems development group it was decided that the minimum information needed for determining market potential and for equipment design considerations would consist of the following items which were to be developed for each firm for each of the functional areas covered.

These items included the following:

1. Classification of current systems utilized to perform the function.
2. Classification of proposed system which should be used to perform function.
3. Measure of file requirements.
4. Measures of volume of data processing activity.
5. Displaceable clerical costs.
6. Current machine costs.
7. Additional values that could be obtained by changing to proposed system.

The composite of this information for a selected sample of establishments constituted a market structure model for data processing services by industry, and by function within each establishment.

The quantitative information used in the model was obtained through a personal interview survey using a prestructured questionnaire. A probability sample was selected of establishments stratified by industry and size class. The sample size varied within each industry depending on the number of firms in the population, and the degree of homogeneity present.

To classify the types of systems presently employed or which should be employed, a number of possible systems were formulated ranging from the most simple to the most sophisticated to be expected. A set of such systems categories were defined for each functional area. The number of classification codes needed to cover the number of variations in each functional area ranged from a minimum of four for Accounts Payable to a maximum of fourteen for Inventory Control.

The procedure followed was first to classify the present system. A system was defined as a set of procedures to accomplish a specific function, which might or might not involve the use of some type of business machine. Then, based on quantitative measures included in the questionaire, a decision was made as to whether a more sophisticated system in the range of possibilities was justified. The fact that a more sophisticated system was proposed, however, did not mean that the system was economically justified. The proposed system was meant to represent the most desirable type of system based on the judgment of experienced accounting systems designers.

The economic justification was assumed to depend on the clerical costs that would be directly displaced by the improved system and displaceable machine costs, or the amount of additional value that could be realized from the improved system.

Displaceable clerical cost was defined as a percentage of the present total clerical cost devoted to this function which could be substituted for by a new system. It does not imply that these costs are eliminated, since the new system may also involve a certain amount of clerical work time. The estimates of total clerical cost were based on information on the hours of clerical effort devoted to each functional area which was obtained from the survey questionnairs. Displaceable costs were calculated as a percentage of total clerical costs, the percentage applied depending upon the kind of system presently employed.

The machine cost for each function was computed as a percentage of the total rental value of any bookkeeping, punched card,

or computer equipment used. This percentage was based on the proportion of the total machine operation hours that was devoted to each function.

Additional value to be realized from the installation of an improved system was estimated exclusive of the savings in clerical and machine costs. These values were produced by savings or reduced costs resulting from such factors as reduction in bad debts, reduction in capital invested in inventory, or increases in production efficiency. To avoid obtaining values which would be out of line with realizable savings the computation of additional value was generally based on percentage reductions in tangible expense items.

For each function a measure of the size of the document or data files associated with the function was established. In the case of the order processing and billing function, for example, the pertinent files would be those containing information on each of the products produced by the firm and the files covering the account records for individual customers. Several measures of data processing activity were also specified for each function. These covered the important documents or operations associated with the particular function. The number of documents processed or operations performed in a specified time period would represent the data processing workloads and thus the total activity involved in performing the function. In the inventory control function, for example, pertinent measures of activity would include the number of order lines covering specific items shipped in a particular time period, the number of transfers

of completed goods to finished stock inventories in the time period, and the number of receiving reports for individual purchased items.

The market requirements model thus contained for each firm, and for each of the functional areas for each firm, the proposed systems, measures of file size, measures of volume of data processing activity, and estimates of displaceable clerical costs, displaceable machine costs and additional values.

How The Model Was Used

As pointed out earlier, market requirements models can contribute to product planning operations in several ways. They can, (1) aid in identifying opportunities for new products; (2) aid in developing functional specifications for the new products; and (3) aid in measuring and evaluating the potential markets for these new products.

In this project, the application of the model was primarily concerned with measuring the market potential for specific new products and thus aiding in the evaluation of alternative proposals. Concurrently with the development of the market model, the planning staff of the systems development group had been setting up specifications for a number of proposed machines. A large number of detailed case studies made by this group provided the basis for the development of a number of alternative machine designs. The size of the potential market for each machine was, however, an important factor in guiding further development efforts. It was also important to have a picture of the market potential in particular industries and in specific business functions.

The functional specifications of the proposed machines were organized in a form compatible with the organization of the model. This made it possible to relate the specifications of each machine to the requirements data contained in the model and thus obtain a quantitative measurement of the ability of each machine to economically satisfy the indicated market requirements. A special computer program

was prepared for use on the IBM 705 to perform the calculations of market potential. Data relating to the specifications of each proposed machine were stored in the computer. Input data on machine specifications included: (1) classification codes showing the systems categories which could be performed by each machine for each function, as previously defined; (2) the capacity of the machine to store information; (3) specific timing factors applicable to each system category for each document or operation which had been designated in the model to represent the work load requirements in particular functions. By applying these timing constants to the volume of documents processed or operations performed in a specific time period, it was possible to compute the total time that would be required for the machine to perform the data processing requirements of individual functions and groups of functions in the individual establishments included in the model.

The market requirements data for the firms in the model was then processed firm by firm against the specifications data for each proposed machine. The data processing requirements, costs and added values for each establishment in the model were related to the capabilities and costs of the particular equipment design under consideration. On the basis of these comparisons, the computer determined whether the establishment was included in the potential market for the product. The total of such firms as calculated by the computer program provided an estimate of the market potential for each machine. Since the program tested the economic utility of the proposed machine at different prices, the computer output showed the

market potential for each of the prices which had been stipulated. This provided, in effect, a price-demand curve for each proposed machine.

Limitations and Problems

A major problem in utilizing market requirements models to aid in long-range product planning is the difficulty and cost of constructing them. To be suitable for use in connection with product planning activities, a model must be constructed on a level of detail that even on a minimum basis may be more than is required for other types of less comprehensive market analysis. In addition, in order to have a valid representation of the market area, it may be necessary to include within the model data for a substantial number of individual establishments or firms. Furthermore, much of the information which is necessary to construct the model may be quite difficult to obtain. Extensive field surveys and case studies may be required, and these investigations may run into the problem of getting access to data which are held confidential by the intended respondents.

Another general limitation of the technique of utilizing over-all market requirements models, especially in view of their cost and the other complications, is that they do not provide answers to all the significant questions which arise in new product decisions. Although such models may provide some data on where and how competitive products are used in various industries, they do not provide a complete picture of the competitive situation. The quantitative market information in the models may not necessarily reflect the current or future attitudes of potential customers which may affect

their acceptance of new products. Furthermore, the models, particularly if they do not cover all the factors in the actual environment in which the proposed new products would be used, may not always directly measure the practical feasibility of applying the products in specific situations.

The market requirements model which has been described had a number of important limitations. Although it was relatively detailed compared to other approaches which have been used to obtain an over-all picture of future markets, it presents a highly simplified picture in relationship to the actual complexity of data processing activities and requirements in the market area under study. It is believed, however, that the level of detail in the model is adequate for planning of long-range product programs. The limitations imposed by lack of detail on certain points apply mainly to the development of detailed product specifications, which is an important aspect of short-range product planning. Many decisions which must be made in connection with developing new products may require obtaining additional data by means of case studies or other field contacts made with the potential users.

Another important limitation of the model which was developed was the degree of accuracy of the estimates of displaceable clerical costs and added values in specific functions in individual firms. Although it is difficult to determine precisely the extent to which the present clerical costs in various paper-work operations could be substituted for by alternative methods, it was possible to set up reasonably accurate displacement percentages of clerical cost which

reflected the nature of the operations in each function. The percentages used were based on analysis of the clerical procedures used in various accounting and paper-work operations and of the breakdown of duties and allocation of time among specific tasks.

The estimation of the added values that could be derived by improving or extending present data processing operations in individual establishments was much more difficult and subject to error. The determination of these values involved considerable application of subjective judgment. Arbitrary factors were set up and were used to compute the amount of added values associated with improved systems. These factors were, however, applied to the specific cost data for various operational areas of the individual establishment which had been obtained through a detailed survey. Also, the factors were applied within fixed limits or ranges to reduce the possibility of substantial errors.

The estimates of displaceable clerical costs and added values, as calculated by those procedures, were believed to be sufficiently accurate for incorporation in the model and for valid application of the model in product planning decisions. Limited subsequent investigation toward validating the procedures used tends to support this contention. Nevertheless, it must be emphasized that the problem of estimating displaceable costs and added values is critical in any program for developing such models for industrial products, and requires intensive investigation and analysis.

Advantages of Market Requirements Models

The development and application of market requirements models can improve the effectiveness of long-range product planning operations and the supporting market research programs in a number of ways. Some of the most important advantages are:

1. They provide a systematic means for uncovering opportunities for new products. This especially applies to industrial products, but such models could be set up for some areas of consumer demand. A market requirements model which reveals unfilled customer requirements and shows up gaps in existing product lines can be an important tool in the search for new product ideas.
2. By measuring the potential markets for new products, these models indicate the relative attractiveness of proposed development programs and thus provide a basis for selecting the best products or projects for among various alternatives. The field sales organization and engineering groups usually originate a flow of ideas for new products and the evaluation of these ideas is a major function of new product planning activity. Market requirements models can also be used in screening these product ideas by indicating the size of the potential markets that they might tap.

3. By providing an over-all picture of a market area and the relative size of the markets open to various new product programs, the use of market models helps in laying out over-all product development programs which will maximize penetration into new markets They make it possible to set realistic priorities and to best allocate the manpower and financial resources of the firm among various development programs.
4. Comprehensive market requirements models make it possible to set up an integrated picture of the market areas associated with new product programs and thus help to reveal duplicating or overlapping programs.
5. Such models not only identify general market opportunities but also indicate the specific requirements that must be met to obtain these markets and thus help to guide the formulation of functional specifications for new products.
6. The development of market models is a means of increasing the effectiveness of the market analysis activities which are performed in connection with product planning. By providing a comprehensive and consistent frame-work, they make it possible to increase the efficiency of the collection and analysis of market data. Most market research

projects are done on a one-shot basis and much of the information which is obtained and processed is not retained in a form suitable for use in other projects even though the subject matter may be closely related. By getting maximum utilization of the available data, it is possible to eliminate much of the recurring and duplicating market research projects.

7. Market requirements models can also be useful in evaluating the effectiveness of new products which may be introduced by competitors. If information on the functional specifications and prices of competitive products is available, market potential can be quantitatively measured in the same manner that has been described for new product proposals originating within a firm.

In summary, we believe that market requirements models can be an important tool in long-range product planning Despite many problems which remain to be solved, we feel that considerable progress was made in the development of such models in the project which has been described.