IN PRODUCTION-DISTRIBUTION SYSTEMS

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The author presents Pillsbury's experience in developing a model for overall production-distribution systems to relate costs and trade off opportunities.

I will relate in some detail a major study in production-distribution systems which did, fortunately, end with several favorable impacts on The Pillsbury Company.

Presenting these ideas, I hope you will bear with me if I start by departing from a purely objective stance and describe a set of ideas that I have come to believe as a result of this study.

First, I believe that to be successful we must get major job enjoyment from work that shows a major impact rather than from the ironclad job of modeling.

Second, we must realize that the need for accurate, objective information far outweighs the need for sophisticated models.

Third, models can be a tool for getting a proper base of data and discipline established, but to do so we must not require long system turnaround. The time until the first useful result must be as short as possible. This allows for continuous recycling of needs and results over a long term.

The final prejudice is that we need a "champion of change" in the organization in order to implement the results and obtain benefits of our efforts. This individual must be able to follow each part of the study and be the prime mover in selling the implementation, preferably a position of some power.

Implied in the above prejudice is that the initiation process for a study, and the subsequent monitoring and prodding must be a top down process. This has disadvantages as well as advantages. One disadvantage is that the basic concepts top management believes are shaped by the perceptions of the department heads reporting to him. The real world, according to middle management, is more complex even than some of our models, whereas you and I realize that it is simpler than either one. Therefore, we must avoid solving problems that are more difficult than those that actually exist, or that over-reach the comprehension level of management. In order for a model to become an operational tool, the manager using it must be able to conceptualize all of the inter-relationships of the model and believe in the output of the model.

Second possible disadvantage regards problems that need a continued effort. You need a prime mover who will go along with you over the long pull, and not one who will abandon the analysis when he gets a new hot issue.

The advantages of the top down approach greatly outweigh these disadvantages and are well documented in other

discussions and studies. A great deal of work can be avoided on subjects that are essentially closed or "no sale" when the decision makers are included in the problem definition. Also, problems that inherently cannot have high impact on the Company can be avoided. The major advantage is impact. The implementation can be made on a much greater scale if the top down approach is utilized.

My story of this case begins in mid-1969. Pillsbury embarked on a full scale study of the Grocery Operations function. Pillsbury's Grocery Division produces some 40 major product lines, the major ones being flour, cake mix, pancake mix, instant potatoes, and Funny Face. These products are produced at four mix manufacturing plants and six flour mills which produce both Pillsbury's Best Family Flour and bulk ingredient flour. These products are all brought together and "mixed" at Grocery distribution centers located in ten locations throughout the United States. We do not distribute or mix products at the manufacturing center. Each one of our distribution centers is a free standing enterprise and is not included as part of one of our manufacturing locations.

The original charter of the product was brief - at no time had a full study been made of the economics of the total system of production and distribution. It was felt that it might be possible to reduce total costs of production and distribution by $1,000,000 per year. By the way, all of the costs related in this study you are about to see are not actual costs as they have been changed for this presentation, but the relationship between costs of the projects from a systems design and programming standpoint versus the economic results are in the correct ratio. The study was kicked off by the general manager, and two teams were designated: a team of line management to provide direction to the project, and a study team which was charged with the actual undertaking.

The first task formed by the decision or management team was to set priorities on the problems that were identified. Many problems had been identified, such as economic run sizes, value of high speed changeovers, the cost of promotional deals, month end order peaking, forecast accuracy, etc. But the major priorities set forth were:

1. Study the economics of the total production-distribution operation as identified by two main sub-issues:

   a. What run lengths in production cycles strike the best balance between inventory investment and changeover costs?

   b. What are the best levels of customer service?

2. What are the optimum number, size and location of warehouses to serve our market areas?

3. What is the importance of forecast accuracy on inventory carring costs, turnover, and customer service?

From these priorities, a plan of implementation and measurement was drawn up. These four problems, as stated before, were selected as the highest from a list of about 20. The study of these issues, along with a number of side issues which came up during the project, required two years of completion.

Since the primary tool for a study of production-distribution operations and the importance of forecast accuracies was a Monte Carlo simulation, the following, distribution simulation, product age model, production and distribution simulation development, revision and implementation of base stocks and contemporary distribution analysis represent the beginning of development of that Monte Carlo simulation. The fourth major priority, the study of warehousing, was initiated in the middle of 1970, and

completed by the end of 1971. Spin off studies were also initiated that related to month end sales analysis and the analysis of our customers' ordering patterns, the study of high speed changeovers and a summary of transportation data.

I would like to relate to you some of the reporting capabilities and the model capabilities as a result of this study.

Reporting Capabilities (Spin Offs of the Studies)

Orders - Number and Volume

- By zone and customer
- By price class
- By mode of shipment
- By customer and time of the month
- By bill of lading and major city area
- By bill of lading, warehouse, and major city area

Invoice History File

- Edited
- Lowest level of detail

Inventories

- Minimum inventory levels

Forecasting

- Comparison of forecast vs. actual

Modeling Capabilities

To analyze trade offs in the production distribution system

Find the least cost number, size and location of warehouses

Compare costs of alternative warehouse location plans

Determine the impact of factors of the distribution system on the age of products

Determine the run lengths which best balance inventory investment and changeover

I would now like to give you a little more detail of each of these models that were developed so that you can get a better understanding of their scope. It took us an extended period of time to develop the production-distribution simulation. One of the integral parts of that simulation program was developed as a separate model and integrated into the whole. This portion of the economic production quantities model.

Capabilities are to find the EPQ's for all products which give the best balance of changeover costs versus inventory carrying costs. The results were that the EPQ's were computed for all products except for flour and potatoes. The reason for not computing flour and potatoes is that potatoes are packed seasonally and basically as a continuous process run, and flour is packed by another division of Pillsbury and only purchased by the Grocery Division. A savings was identified by those changes that were made. Future: To run on demand as updates required for new products, changes in line capability, changes in volume, changes in line manning requirements, or to induce manpower leveling at the plants.

A satellite study was done at this time since Grocery Company was introducing a new ready-to-eat brownie fresh baked product into distribution. Since this product had a short shelf life we endeavored to develop a distribution system and simulate the age of the product at the retail level when the customer picked the product off the shelf.

Capabilities:

Measure the impact of deals, distribution systems, and inventory policies on the age of product at the time it is purchased by the consumer.

Results:

1. Used to estimate the age of RTE Brownie using a direct distribution system.

2. Estimated age profile of Great Danish and SIB in the contemporary system.

3. Verified the results of RTE estimates.

Future:

1. Estimate age of new product introductions which have short shelf life.

2. Simulate different policies for product reaching condemnation dates at our warehouses and trade warehouses.

The grand-daddy of the whole study from the standpoint of time and cost is the production-distribution simulation.

Capabilities were to simulate both production and distribution and evaluate the major potential cost trade-offs involved in both those processes. Two, was to predict the impact of internal and external changes on the system: a) increases in freight costs and transit times, and b) alternative inventory control policies; for example, plant warehousing versus field warehousing, and c) alternate customer service standards. Results: 1) Service, inventory, forecast error relationships were simulated. 2) The value of high speed changeovers at the plants were investigated, specifically for our Terre Haute facility. 3) Scheduling of our agglomerator. 4) Side benefits in software development for Pillsbury: a) virtual memory sub-routine which was developed and also used in other systems, one being R&D programs and two, being our Marketing Information System. b) General sequential follow update program was developed, which is also used in an Agri Products application. 5) It validated number of conditions and assumptions questioned at the time this study was initiated. Future: Is available for further analysis and potential savings identification.

At this point, I would like to point out that the system is tremendously complex, takes into consideration almost all of the variables which affect both production cycle and distribution function. In fact, it is so complex that it is impossible to "feed", meaning that the data gathering requirement does not allow it to become a model for use by management as a "what if" tool.

We used the production-distribution simulation to measure the impact of improved forecasting on our production-distribution cost system. Capabilities: Were to measure the dollar impact of improved forecast on inventories and service levels. Result: First, it pointed out the potential reduction of $700,000 in our working capital interest if the forecasting error could be cut in half. We are charged by our Corporate Office the prime rate on our working capital as if we were to borrow it from the bank. This $700,000 represented the interest on the working capital saved if we could reduce our forecasting error in half. Second, it generated a sensitivity to inventory levels and forecasting techniques. Our F'71 inventory was $1.7 million less than plan. Three, it provided the emphasis to restage the regional forecasting system and include SAMI data in that system. Four, it set the stage for a sophisticated inventory management system (base stock). Future: We plan to utilize the base stock system to better manage inventory levels and automate the inventory management system.

For the warehouse location system we actually went outside the Company in order to get the basic system. We obtained the system from McGill University, Montreal, and adapted it to handle the Pillsbury system. Its capabilities were to find a

least cost warehouse for a given set of volumes and cost information. It utilized transportation cost, inventory carrying cost and warehousing expenses to get a least cost system of distribution centers. The results were that: 1) The model was updated to directly simulate our total distribution network for the first time. 2) Data representing the current system was gathered. 3) F'72 volumes and cost runs were made assuming transit time restrictions and no transit time restrictions. Our current system "fits" the optimum very closely. No major changes were foreseen. Refined study on Huntington savings we felt was necessary since Huntington Distribution Center is a public facility and most of our volume moves out of there at consolidated freight rates instead of the absolute freight rates that we used in the model. Future: We had planned to test the five year horizon under different "what if" alternatives in F'72. Again, we were going to study transit versus no transit application system, contemporary distribution versus conventional distribution, current flour pricing versus actual transportation costs and plant warehousing versus field warehousing. This study was actually never done as, again, the complexities of data gathering were very great and it seemed that our current warehouse location analysis system was producing the correct results, since our current system fit the optimum very closely.

Month end surge system was designed to measure customer orders within the time dimensions to show the pattern of outbound orders as they related to days of the month. The results were that we quantified the month end order peaking, individual customers were identified as problem accounts due to their order pattern, and we have been able to affect some changes in their order pattern by speaking with the sales force and dealing with that issue. A realistic evaluation and attitude toward the problem after the quantification from a standpoint of extra cost was attained. No monetary incentives were offered to alter the ordering pattern due to small out-of-pocket expense incurred. Future: We have run the system on demand to update ourselves on those problem accounts which still exist.

Trade data analysis proved to be the most profitable analysis we did in the entire two and one-half year period. Capabilities we developed were to analyze customer order buying profile by price class, order size, shipment load, geographic location, and many other methods. Results: 1) Development of an easily accessible data source which could be used in any particular analysis, be it now or into the future on customer ordering patterns. 2) Runs showing the order profile by account by dominant price class for support of a new pricing structure were developed. A $575,000 annual savings objective was set if this plan was implemented. 3) Invoice summaries by customer within region were used by the sales force as an aid in approaching customers affected by our pricing structure change program. 4) Runs were available which summarized contemporary products through refrigerated or irregular out carriers to obtain tariff commitments. Future: We planned and have utilized the existing systems where they were needed, and we planned to design new recaps to support future analysis projects using this data base which became a very important "find" in the total two and one-half year project. This system was not a modeling system per se; basically, each program was developed independently and summarized data to answer a particular question.

The last system I will discuss is a transportation summary system which recaps Grocery shipments monthly by shipping point and cumulative from the shipping point to a destination city. This system also used the data base that was developed in the trade data analysis studies. The results of this system were that: 1) It pointed out a truck cost savings in the Buffalo-Rochester-Syracuse

area by using a contract carrier in lieu of a common carrier. 2) It uncovered a rail cost savings by diverting some of Buffalo Warehouse business to our Fort Wayne Distribution Center. 3) Study is underway to shift more business to Fort Wayne from Buffalo to achieve greater savings. 4) Identified cost penalty to Grocery for the manner in which they purchased flour from our Agri Products Division at the Buffalo Mill. Adjustments were made in the F'73 contract to equalize the situation, and it layed the groundwork for a backorder policy change to a 50 case minimum. Future: We have used this system to develop more accurate national average rates used in annual planning, more accurate regional average rates to be utilized and updated in the regional P&L system, allow transportation to pursue consolidation programs on a greater scale, and provide the Grocery Products Company with accurate volume information by bill of lading classification for use in transportation analysis. The system is utilized on a daily basis for decision making in transportation questions.

Now I would like to give you an idea of how these overall systems have paid off in terms of cost reductions or service improvements or even in the realm of improved information. This chart is actually my attempt to show the payoff in three dimensions. The bottom of the graph shows the dollar payoff in terms of thousands of dollars. The left graph shows the information returned in three basic categories, little, some or great deal. And the circles with the numbers inside opposite the systems I have previously described show the development cost of each of these systems. As you can see, production-distribution model gave us little information, little payoff and cost us an estimated $60,000. The man who did most of the systems design and programming work on this system calls it his "white elephant" since it is so complex and so cumbersome it cannot be used as a dynamic decisionmaking tool. The transportation summary and customer data systems, you can see, have a tremendous dollar payoff and together gave us a great information payoff while their cost development was very minimal. I should point out, though, that without the development of the production-distribution model, the warehouse location model and the other systems, many of these spinoff studies would not have been accomplished. The data gathering required for those systems pointed us to the other areas.

So, while our production-distribution model per se did not give us the particular $1,000,000 payoff we were looking for out of distribution and production changes, it did allow us to get that payoff from spinoff studies that were done during its analysis. We are estimating hard savings in a ratio to cost of about 4 to 1, and potential savings in the neighborhood of about 10 to 1 to cost.