# Forecasting Considerations in Design of Management Information Systems

**By PAUL A. STRASSMANN**

A CLOSE EXAMINATION OF routine business decisions will reveal that many of them involve a forecast of events to come. The uncertainty about the outcome of events is, of course, built into our competitive economic system to assure maximum flexibility and rapid adjustment to consumer needs. Flexibility, however, costs money. It can be bought with a liberal inventory of ample supplies of finished, semifinished goods and raw materials. Flexibility can be bought also by a combination of policies that require excessive plant capacity, fluctuating employment levels, purchasing less than economic order quantities, use of overtime, heavy expense for expediting staffs or employment of fast but expensive means of transportation.

There is, fortunately, another and better way for a business to cope with the rapidly changing environment. A carefully designed information system will anticipate the consequences of various interactions in its organization and transmit them rapidly to every participant whose decisions affect expected overall costs.

## Segmentation of the Information Process

The flow of information in a typical organization with its own raw material, production and distribution facilities is characterized today by excessive segmentation and emphasis on historical reporting. This is illustrated by Exhibit 1.*

Customer needs are satisfied rapidly by daily shipments. Information about these needs then goes to the divisional production planning staff who impart to it the latest marketing thinking before passing along their reaction to warehouse conditions and recommendations to the plant production planning staff in the form of a production order. Upon receipt of the order, the plant people consider local conditions such as plant inventories of goods in process, inventories of supplies, short-term problems in labor efficiency, employment stabilization and production orders from other sources before placing an order with raw and packaging materials suppliers for delivery in time to make the desired production run and

* This is an idealized chart, characteristic of relationships in many consumer goods operations. Except as noted, all of the facts mentioned in this article are quoted for illustrative purposes only and do not represent existing operating statistics of any particular organization.

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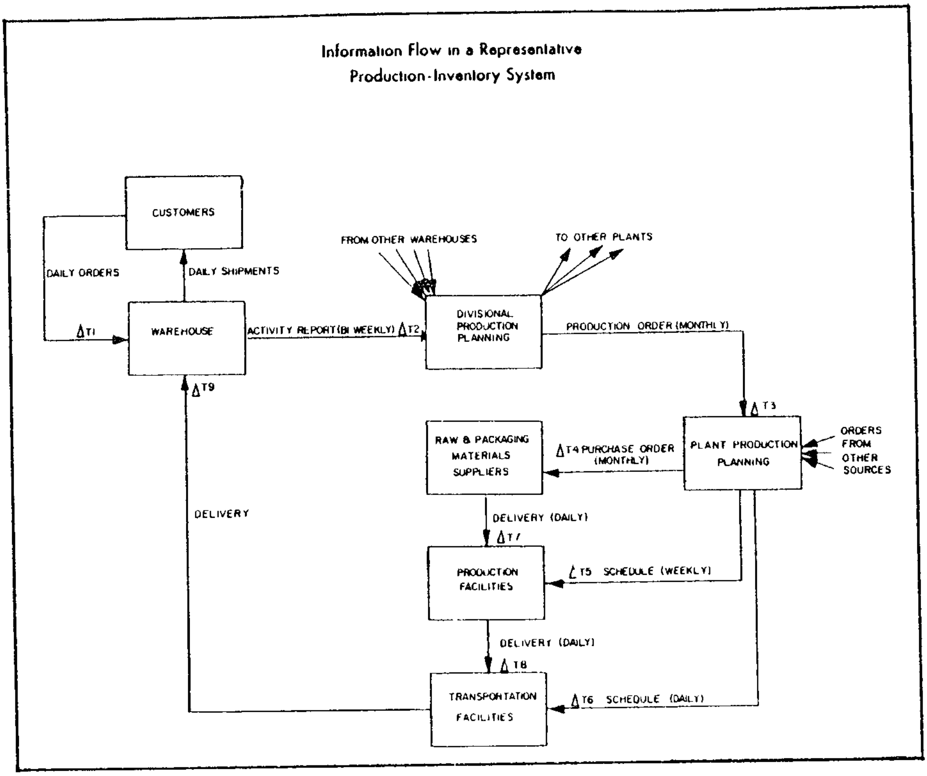


**EXHIBIT 1**

thereby replenish warehouse inventory.

It is this method of passing information that we call *segmentation* Commands about corrective actions needed are passed through a chain of specialists, each adding at his station to the original information certain additional elements which are necessary to reflect the marketing, production and distribution realities of the entire system This is very like an assembly method of production where the entire process must proceed in a strictly pre-determined sequence at a carefully pre-engineered speed

The facts received at any of the stations along the line are essentially records of past events Depending on: (1) the nature of the decision rules applied at each station of the information flow, (2) the magnitude of time-lags between each station and (3) the stability of the pace setting demand pattern at the customer level, one can determine the degree to which reliance on purely historical reporting will call for extreme variations in production rates [1]

When an organization examines the total cost of producing and distributing its products, it may find that marketing flexibility, which is becoming a necessity in our increasingly competitive environment, may indeed be purchased by market-oriented deployment of inventories, faster means

[1] The work done by Professor J Forrester at MIT in the field of Industrial Dynamics provides the framework for conducting such analysis See J W Forrester "Industrial Dynamics," *Harvard Business Review*, July-August 1958 for a management introduction and J W Forrester, *Industrial Dynamics*, MIT Technology Press, Cambridge, Mass, 1962, for a more technical description

EXHIBIT 2

## Information Delay Analysis
(in weeks)

| Delay symbol | Explanation | Average duration | Range |
|---|---|---|---|
| $\Delta T_1$ | Orders placed for future delivery and not reflected in warehouse records [1] | 0.6 | 0.2 – 2.0 |
| $\Delta T_2$ | Delay for biweekly reporting | 1.0 | 0 – 2.0 |
| | Sensitivity of four-week moving average [2] | 1.0 | 0 – 2.0 |
| | Reporting lag – accounting reconciliation and transmission of data | 0.5 | 0.5 – 0.8 |
| $\Delta T_3$ | Reporting lag – administrative time and transmission of data | 0.2 | 0 – 0.5 |
| $\Delta T_4$ | Production scheduling administrative time | 0.4 | 0.4 – 0.6 |
| | Order placement with vendor | 0.2 | 0 – 0.2 |
| $\Delta T_5$ | Manpower assignment time due to union rules [3] | 1.0 [3] | 1.0 – 1.0 [3] |
| $\Delta T_6$ | Rail car availability planning [3] | 0.2 [3] | 0.2 – 0.6 [3] |
| $\Delta T_7$ | Supplier delivery lead time | 1.0 | 0.2 – 2.0 |
| $\Delta T_8$ | Variation in scheduled output | 0.2 | 0 – 0.6 |
| $\Delta T_9$ | Transit time | 0.8 | 0.5 – 1.2 |
| | | 5.9 | 1.8 –11.9 |

1. This delay can be introduced by strict adherence to accounting procedure. Since up to 15% of pending orders may be subject to several days delay, the rules frequently require only posting of orders with firm delivery dates. This shows how accounting practices may conflict with the need of the organization to get the best information available, even though it may be incomplete.

2. To make the re-ordering decision, a four-week moving average of past warehouse shipments is a fairly common practice.

3. Usually not additive to cumulative delays because path through $\Delta T_4$ and $\Delta T_7$ is the governing delay.

of transportation or more adaptable production methods. It is becoming more apparent that a thorough re-examination of the expenses associated with segmented communications and with actions based on historical records may uncover significant pay-off opportunities for many corporations concerned with the mounting costs of meeting high customer service standards.

## The Cost Penalty for Segmentation

The cost penalty for segmentation of the information process is best estimated by analyzing the delays in an existing system. Exhibit 2 shows how such an analysis may be tabulated for the production-inventory system in Exhibit 1. Possible findings:

*Cost of carrying inventory.* Since the requirements of customer service for consumer goods are exceedingly high (between 96-99% on-time delivery reliability), it can be stated as a first approximation, that for products in mass production, the minimum inventory requirement to support such a service will approach the manufacturer's maximum system reaction time. Hence, all elements which contribute to the maximum delay range and which result from the internal administrative process should be immediately earmarked for further investigation. Accordingly, this would classify delays $\Delta T_1$, $\Delta T_2$, $\Delta T_3$ and $\Delta T_4$ as prime candidates for analysis.

*Secondary suppliers' inventories.* Here one must learn whether the delivery lead times ($\Delta T_7$) of the secondary suppliers are supported by inventory levels or surplus capacity. The secondary suppliers must somehow meet the uncertainties of the prime manufacturer's fluctuating production levels. As a rule, if there are suppliers who devote a large share of their total capacity to a single major manufacturer, one must carry the analysis of the consequences of in-

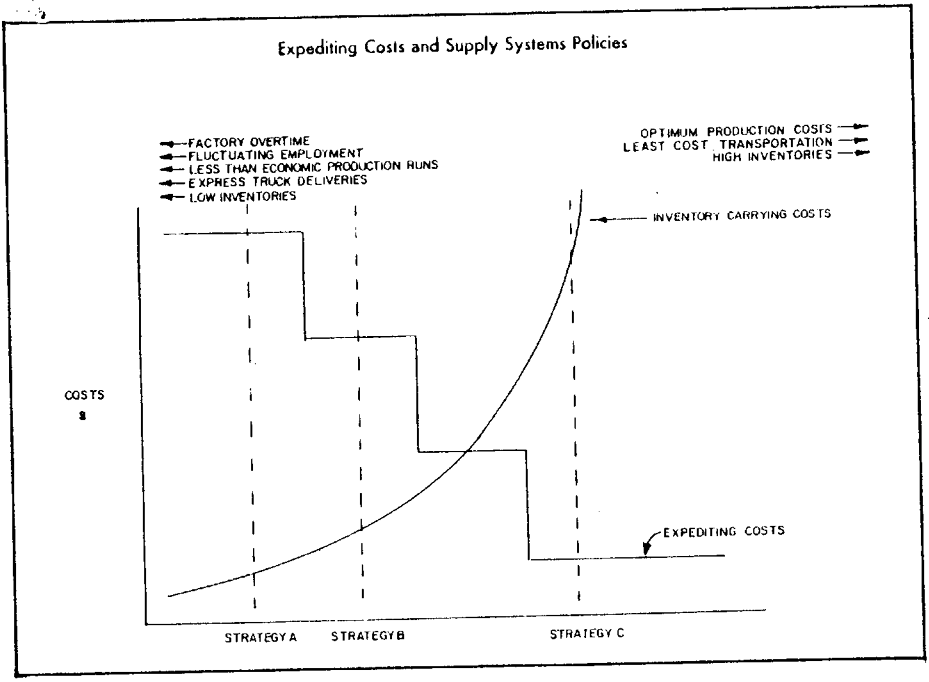


EXHIBIT 3

formation delays to the secondary level as well, inasmuch as costly practices may be prevailing here to satisfy the manufacturer's rapidly varying need for raw and packaging materials.

*Expediting costs* A clue that these may be substantial can be found in the spread between the minimum and maximum information delay as tabulated in Exhibit 2 A large difference between the average reaction delay and the minimum possible delay will invariably result in a shift to expediting as a method for maintaining customer service

A combination of cost expediting strategies for obtaining a desired level of customer service is shown in Exhibit 3 It seems that introduction of inventory controls reinforces the tendency toward Strategy A because expediting penalties are found in a variety of accounts reflecting operating costs whereas inventory levels are generally singled out as a special item on financial statements. For this reason claims of an inventory reduction are valid only if there is no offsetting increase in operating costs

## Uses of Forecasting

Delays in a segmented information system can be sharply reduced by re-orienting the flow of data. Such an alternative should be considered if it offers:

1 The possibility of a reduction in average and maximum delay in total reaction to customer requirements. (Cost savings at-

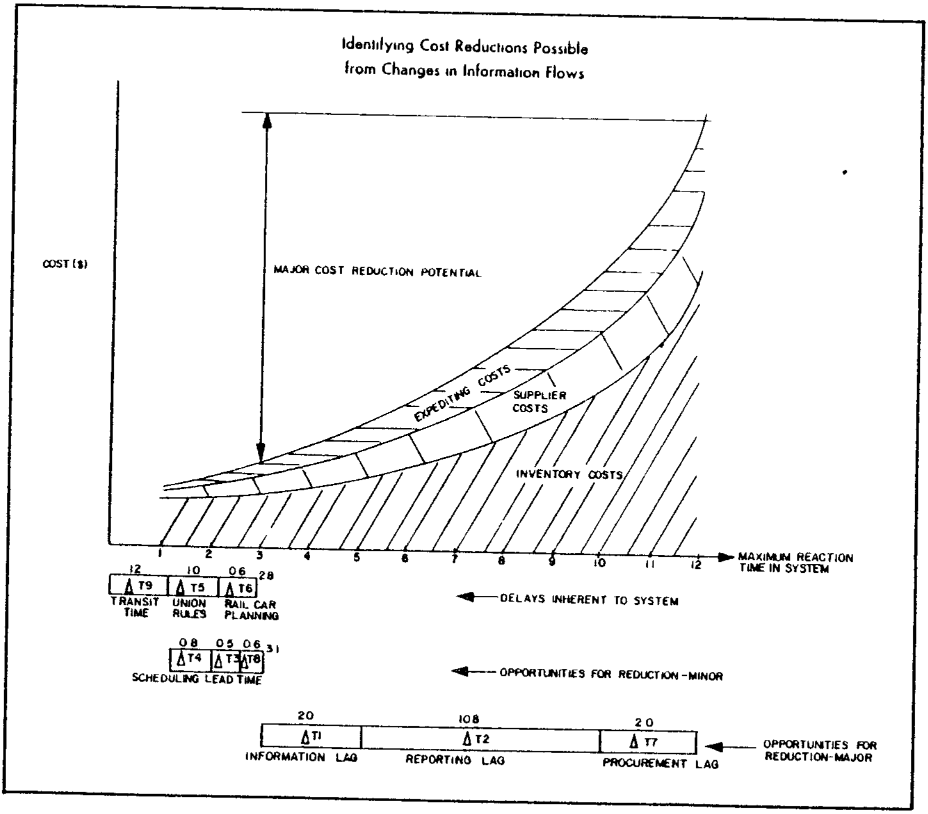


EXHIBIT 4

tainable through such a reduction can be identified by charts listing the varying delays and associated costs. For the system illustrated in Exhibit 1, we would draw a set of curves shown as Exhibit 4.)
2. An information handling capability that does not disrupt the necessary functions of the organization.
3. An information system which would be substantially less costly than potential savings identified.

It turns out that introduction of forecasting techniques throughout a segmented information system makes it possible to substantially reduce maximum information and reporting lags; simplify organizational and reporting relationships; and reduce overall administrative costs of providing proper information to all decision-makers in the system.

As can be seen from Exhibit 4, the physical time required for production of the hypothetical consumer item is relatively small as compared with the planning lead time. Under these conditions the ideal system solution is to devise the most accurate techniques practicably attainable to forecast customer sales.

Such forecasts should be translated instantaneously into actionable instructions to decision points within the supply system to gain the closest possible coordination of all stages in the interlinked sequence of events. If perfect accuracy and instantaneous communications could be realized, inventories at the raw, semifinished and finished levels would reach a minimum, expediting costs would be minor and purchasing agents would not have to call on suppliers to inquire about delayed deliveries.

Unfortunately, forecasting and communications are subject to very real limitations. The designer of future information systems will have to balance many conflicting elements before he can recommend to his management a method that would realize the maximum savings available.

Attainment of a new optimal design will be important because the properties of such information systems, not unlike the command and control systems that govern the deployment, logistics and ultimate use of modern weapons, will become an integral part of the overall performance characteristics of a manufacturer's product line. This means that a manufacturer possessing a well-designed technique for identifying the needs of customers will be able to ship, warehouse, market, service, manufacture and purchase his products at a lesser cost than a competitor whose overall strategy provides little room for information handling based on the best technologies available.

### The Costs of Forecasting

Forecasting is expensive. At General Foods for example, customers demand about 1000 product items a week at each of approximately 25 warehouse locations. To make a correct shipping decision from plants to the warehouses involves a minimum of 25,000 short-term sales forecasts or well over one million forecasts a year. Actually, short-term forecasts are not always adequate; for certain products customer demand for several weeks ahead must be continually re-appraised. Hence the yearly number of forecasts at General Foods can come to ten million or more.

The question of affordability is obviously important. Several mathematical models for demand forecasting costs are now available. The classical statistical correlation methods [2] are clearly priced out of further consideration for massive applications since unit costs range from $5 to $25 per forecast. The power of these techniques applies primarily at a high

[2] See "Forecasting by Generalized Regression Methods—Non Linear Estimation," Program M 2 A-3, IBM Applications Library, New York, N. Y.

level of aggregation such as in making consumption projections for a broad product line at national or regional levels, which results in tens or hundreds of forecasts per annum. Time series analysis,[3] particularly the type used by statisticians and economists for adjusting historical data about employment, industrial activity or sales volume, has costs comparable to the various correlation methods and, for this reason, is also not affordable.

It is only when we investigate a simple technique such as moving averages that costs are sufficiently lowered to cents per unit so that mass forecasting becomes practical. Even here, however, there are limitations,[4] hence, the technique of "exponential smoothing" recently has come to the forefront and is in extensive use.[5] Using a large-scale computer, General Foods now produces in excess of ten million customer demand forecasts per annum at a unit cost of less than one cent per forecast. It is interesting to note that both economies of scale and a steep learning curve[6] seem to apply, since our unit costs ran about 4.5¢ per forecast when our current information system became operational on a more limited scale two years ago.

## Organization of Forecasting

Who will do forecasting has always been a major organizational question. Should the production manager schedule output levels to satisfy sales forecasts made by the sales manager? What latitude is allowed to the production manager in "second-guessing" the probable outcome of a promotional campaign, particularly if it calls for heavy factory overtime and in the past has resulted in merchandise returned for re-work to the plant? Is it mandatory for a plant manager to firm up his production schedule before the purchasing agent orders supplies subject to high obsolescence?

Each question reveals conflicting objectives. Each underscores the fact that the efficient performance of one man depends in large part on the accuracy of the forecast received from another.

The organizational implications of such conflicts and dependencies become even more apparent when we observe elaborate procedures for transmitting forecasts from one level of decision-making to another. Each party in the information chain must protect himself with safeguards against error. But uncertainty is inherent in the business environment. Under rapidly changing conditions even good forecasts become obsolete while being communicated.

The complexity of the market itself also tends to promote inaccuracy. A nationally marketed product line is exposed at several thousand stock points to uncertainties of customer demand and to marketing activity initiated by its own or the competitors' sales forces. To describe the *status quo* of such a product line at any given time requires analysis of tens of thousands of facts. Usually this analysis is beyond the capability of staff specialists appointed to coordinate schedules, particularly if their interests are concerned with separate elements of the entire process such as production, traffic, distribution and procurement.

These, then, are the forces which underlie the need for reporting segmentation and information transmis-

[3] See Occasional Paper #57 by Julius Shiskin, National Bureau of Economic Research, 1957.

[4] See Chapter VII in R. G. Brown's *Smoothing, Forecasting and Prediction of Discrete Time Series*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1963.

[5] For instance, see IBM's manual on IMPACT, a standard program for the management of inventories in distribution industries.

[6] See Winfred B. Hirschmann, "Profit from the Learning Curve," *Harvard Business Review*, January-February 1964.

sion delays so costly to an enterprise

It appears that the most efficient way to organize the forecasting function is to strip it of its narrowly departmental character, so far as this is possible, and to make it an equally accessible service function The concept is illustrated in Exhibit 5 which describes a computer-oriented information system based on detailed customer demand forecasts, it services the needs of the representative production-inventory organization described in Exhibit 1 The corresponding information delays, listed as Exhibit 6, show a marked improvement

From an organizational standpoint, however, the most interesting change can be observed in the positioning of the divisional (or corporate) planning group with respect to the information flow Instead of passing all data through the centralized group for occasional modification as warranted, the information system now passes all forecasts without delay directly to decentralized production points

In this process, facts from the local warehouses as well as instructions describing the marketing plans are within a few hours transformed by a computer into production forecasts and shipment dispatches In other words we have dispensed with delayed communications in two segments ($\Delta T_3$) and substituted for it rapid information transfer from several points of origin simultaneously

The same process is repeated in providing production forecasts to suppliers Rather than waiting for clearance through the plant organization ($\Delta T_1$), the information system simultaneously provides the plants' production forecasts in terms of raw and packaging materials usage to individual major suppliers after making allowances for all goods in transit as well as for all safety stocks required at the user plants.

Information Flow in a Forecasting-Oriented Production-Inventory System

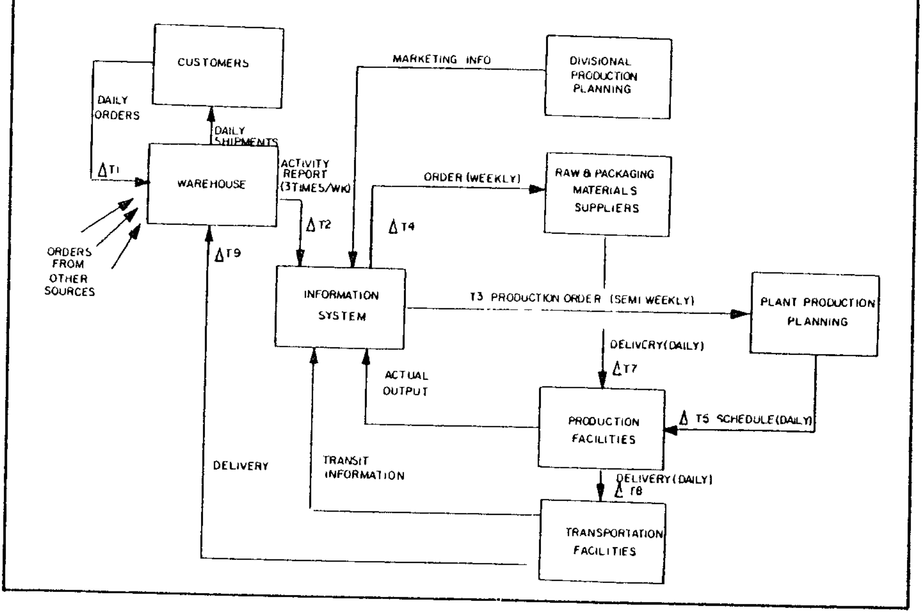


EXHIBIT 5

The major advantage of the integrated management information system over a more conventional method of operation is that it permits the investment of all forecasting know-how at a single location for ready distribution to everyone. Hence more money can be spent in perfecting the single source of forecasts as contrasted with diluted efforts resulting when two or more organizational units attempt to develop partial approaches to the problem of anticipating each other's needs. Consolidated forecasting can also materially aid in eliminating a certain amount of organizational friction because it carries within itself the guarantee that everyone will base plans and action on identical assumptions about the future.

When information delays shown in Exhibit 2 are compared with those in Exhibit 6, it becomes evident that the most significant improvement through information system design based on forecasting can be found less in the decreased average reaction time (a reduction from 5.9 weeks to 2.4 weeks) than in the markedly improved precision with which a well-designed information system operates. For a consumer-oriented enterprise, the maximum reaction time to a change in the competitive environment will most likely be a significant yardstick for measurement of good performance. For this reason the change in this characteristic (as illustrated by a decrease from a maximum delay of 11.9 weeks to 3.7) is particularly worthy of attention, because the reflexes of an organization with maximum delays close to the average delays can be predicted with greater accuracy.

It can also be said that a production and distribution organization not possessing such a high degree of predictability invariably invites the creation of expediting staffs. They must necessarily receive a variety of information and, in turn, forecast how and when a specially handled item should be produced and delivered. Hence, from the standpoint of overall information system design, communication to and from expediters very rapidly complicates data handling. Such complexity may actually aggravate the

**Information Delay Analysis**
(in weeks)

| Delay symbol | Explanation | Average duration | Range |
|---|---|---|---|
| $\Delta$ $T_1$ | Orders placed for future delivery reflected in system | 0 | 0 |
| $\Delta$ $T_2$ | Delay of reporting cycle | 0.2 | 0 – 0.4 |
| | Reporting lag | 0.1 | 0 – 0.1 |
| $\Delta$ $T_3$ | Reporting lag – transmission of data | 0 | 0 |
| $\Delta$ $T_4$ | Production scheduling administrative time | 0.4 | 0.4 – 0.6 |
| | Order placement with vendor | 0 | 0 – 0 |
| $\Delta$ $T_5$ | Manpower assignment time – union rules | 0.6 | 0.4 – 0.6 |
| $\Delta$ $T_6$ | Rail-car availability planning | 0.2 | 0.2 – 0.6 |
| $\Delta$ $T_7$ | Supplier delivery lead time | 0 | 0 |
| $\Delta$ $T_8$ | Variation in scheduled output | 0.1 | 0 – 0.2 |
| $\Delta$ $T_9$ | Transit time | 0.8 | 0.5 – 1.2 |
| | | 2.4 | 1.5 – 3.7 |

**EXHIBIT 6**

condition which it has set out to cure, particularly if it involves the creation of coordinating staff groups through which certain priorities must be cleared. The expediting group may indeed shorten the minimum reaction time of a complex production process. On the other hand, only a thorough information system analysis with particular emphasis on the effects of such an expediting body on overall predictability would reveal whether the expediters themselves do not actually create the need for additional coordinating personnel.

When starting work on business forecasting it is necessary to define carefully the desirable level of aggregation at which the forecasts will have to be made as well as the cost consequences of such forecasts if they prove to be inaccurate:

*Level of aggregation.* It is well known among commercial fisherman that if you are after big fish a net with small mesh is burdensome. On the other hand, herring cannot be caught with nets that have tool-large openings. Since the role of forecasting in management information system can be likened to fishing in a sea of expected facts, it is important to design the forecasting "net" to fit its operational use and to make forecasts at an appropriate level of detail.

When designing an integrated information system, all the needs must be taken into account. The principal advantage of the system lies precisely in its capability to fully and consistently satisfy all informational needs. For this reason, subject to limitations of cost and availability of data, forecasting should take place at the lowest possible level of detail within the shortest forecasting cycle available. Consolidated (product line, divisional, corporate, etc.) forecasting should then be built up by synthesis of the detailed projections or by synthesis of detail data to serve as input into higher level forecasting models.

When adopting this approach, the information system designer will have to overcome strong pressures from management who may not be readily convinced of the need for extensive detail and who may be concerned about the increased margin of forecasting error at the lower levels of aggregation. The temptation to appear a good prophet may influence a system designer to take the easy route and produce longer term, consolidated forecasts which are invariably more accurate because they contain a variety of data which has already built in compensating influences arising from averaging of basic data.

### How to Communicate about Forecasts

The presentation technique and format of forecasting information places appreciable demands on the ingenuity of an information system designer. The personnel costs associated with the administration of the system will bear some relationship to the effectiveness with which the results obtained through the system are communicated and displayed.

A sales forecast in the hands of a production scheduler at a plant is not by itself particularly meaningful. The scheduler addresses himself chiefly to questions that are narrowly focused around the functions of his job: *when* to produce, and *how much*. To answer these questions, the sales forecast must be adjusted to reflect inventories, goods in process and goods in transit. Further allowances must be made for transit lead time, safety stock levels desired, economic production quantities, provision for seasonal inventory build-ups and for pending marketing promotions. This involves extensive computations to transform a sales forecast into a simple computer output which will allow the scheduler to scan the system's recommendations in terms that are meaningful to his frame of reference such as the latest allowable calendar dates when the production may begin without jeopardizing the desired levels of customer service[7]

Insofar as presentation of computer output is concerned, misdirected emphasis is mainly due to one of the two typical biases: (1) the accountant's bias and (2) the operations researcher's bias.

*The accountant's bias* An analyst with heavy accounting systems background invariably designs the reporting format by resortng to full printout of all detailed data, in columnar format With all facts thus displayed heavy reliance is placed on the user's judgment to arrive at decisions Such reporting may be adequate and provide the basis for making a planning decision, but as the frequency of reporting increases and approaches real-time decision making, the "full facts tabulation" method becomes too burdensome and the recipients of reports reach their human limit for absorbing the contents of computer-generated reports

*The operations researcher's bias.* An information system designer with a mathematician's point of view is inclined to produce reports which focus on the limitations of the mathematical model used in the various computations This approach to the presentation of results has important uses particularly if the scheduling decisions are infrequent or if they involve major commitment of resources The "business model" oriented outputs have also important uses in analyzing broad policy alternatives in plant scheduling However, the typical production scheduler is task oriented, pressed for time. He will gladly delegate the analysis to staff specialists In the fast world of everyday decisions, the finer points of forecasting models are of little interest to the user. If the tendency to display mathematical back-up information is carried to an extreme it will slow down appreciably the acceptance by line personnel of computer-oriented management information systems

Ideally, the presentation technique built into a management information system based on computers should reflect both the accountant's bias toward elaborate tabulation of facts and the operations researcher's concern about limitations of mathematical models. An information system should be capable of generating a large variety of each type of these reports but only upon request rather than as a matter of reporting routine

A corollary concept to this striving for economy in reporting is the idea that each organizational level should have the capability to assess the information system in terms of its particular functions The relevant time span of decisions and the appropriate level of detail answering the question *when* and *how much* are different when asked by a transportation dispatcher or by a purchasing agent

The practical business world, in short, calls for a highly diversified capability to generate a variety of reports about the consequences of business forecasts Inasmuch as the precise organizational relationships and skill levels of all recipients of forecasting information cannot be pre-planned during system design, the computer system should be constructed to allow easy modification of the scope and format of all information produced for management uses

## Forecasting by Opinion

Mathematical and statistical forecasting techniques are of little use when dealing with customer demand patterns that are unique or timed without relationship to prior historical experience In point is the product

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[7] For an example of such a calendarized index see the author's article "A Plant Warehouse System Using Variable Lead Times & Reorder Times," *Management Technology*, August 1962, published by the Institute of Management Sciences, Pleasantville, N Y

movement resulting from trade promotions, customer premium offers, concentrated advertising campaigns or new product introductions The demand pattern for such practices is characterized by its deliberate starting date, pre-planned duration and overall demand level somehow related to the intensity or effectiveness of the promotional activity.

Exhibit 7 illustrates the sales pattern for a product possessing certain probabilistic properties that seemingly lends itself to statistical forecasting techniques and the sales curve for a heavily promoted item. We can still chose to apply forecasting methods such as exponential smoothing to the latter demand pattern, with the consequence that relatively large forecasting errors will develop. However, if forecasting errors are expensive, as they frequently are for reasons discussed earlier, the designer of a management information system may have no choice but to find a way for incorporating the intelligence about the pending promotional activity into the overall flow of data

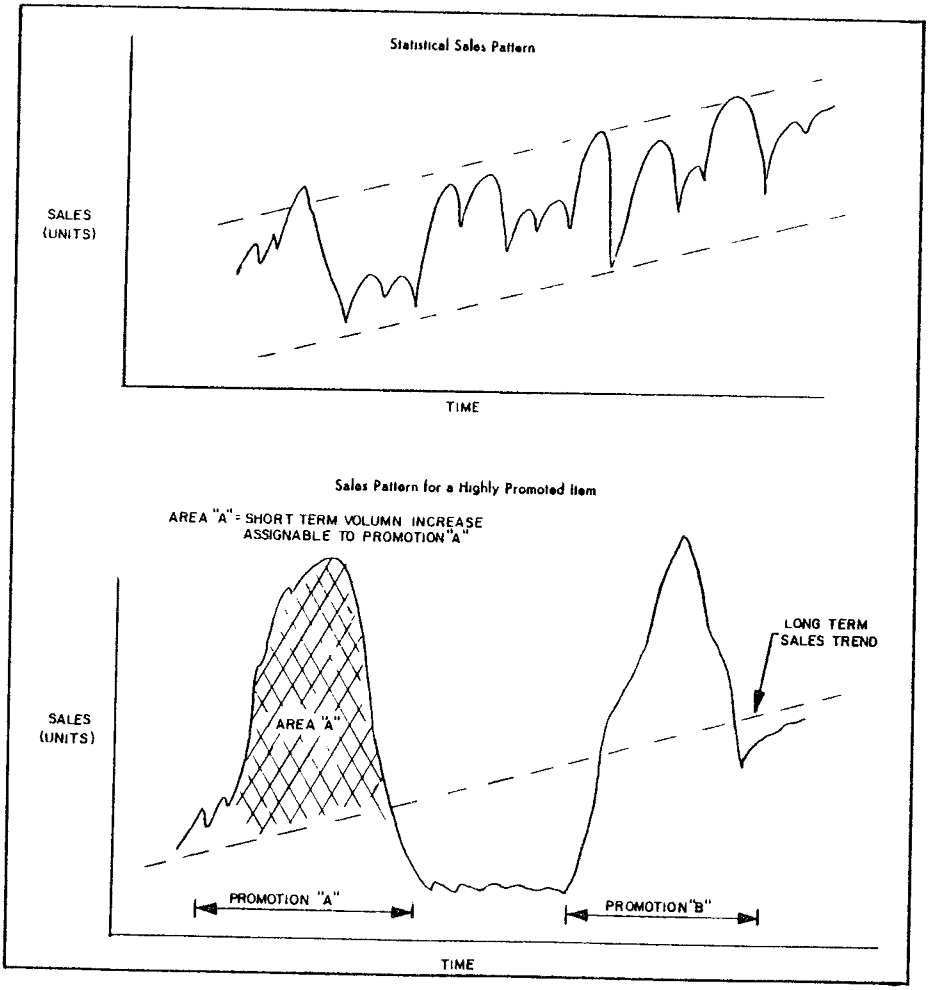


EXHIBIT 7

The starting date, location, scope, type and duration of a particular promotional activity is usually known to the sales force because considerable planning must precede the successful launching of a campaign. Capturing the information in a definitive form and at an authoritative source will be in itself a major accomplishment, even though this data often represents only estimates rather than facts. For example, the effective duration of a promotion will be only an expression of opinion by the sales force rather than a statistically determinable forecast.

The total short-term incremental volume increase (see Area A in Exhibit 7) that is assignable to a particular type of promotion is much harder to forecast. Certain types of activity such as X cents "off-label" sales are reasonably well estimated by experienced sales executives. Other activities, such as the introduction of new or improved products are seldom well estimated even by seasoned judgment reinforced by marketing research.

When considered as an intra-organizational communications problem, the important factor may not at all be the degree of accuracy of the incremental volume estimate assignable to the marketing promotion but the information handling problems. They can contribute even more significantly to the maximum reaction delay of an organization than forecasting errors.

At General Foods a technique has been devised for injecting the salesmen's estimates of short-term effects of promotional activities into the overall flow of data. Several hundred such judgments are contained within the information system at any time.

As input to the system, coded entries are received containing pertinent geographic and production information and anticipated changes in the long-term sales trend. The new information is then matched against a detailed historical file containing the week to week sales rate of all prior promotions of a similar type in the same sales district.[8]

A computer program now performs a series of computations which make an allowance for dissimilar lengths of promotional campaigns in the past and the present, relative intensity indexes of promotional efforts in the past and the present, etc. The result is a series of weighted factors representing a mix of historical facts tempered by current judgment which are, in turn, entered into exponential smoothing mathematical equations expressing the long-term sales trend for the promoted item. The short-term "promotional" factors, so to speak, override the long-term pattern and produce detailed weekly shipment schedule estimates for the entire promotional period.

The exponential smoothing techniques can be further utilized for the improvement of the entire forecasting process after the promotional period has passed. A series of computer routines has been provided that analyze the actual shape of the short-term promotional activity and compare it to the one which was originally forecast. The computer program is equipped with the facility to reflect the relative weight of each completed promotion on all the historical records of prior promotional activity. Thus, the latest experience can be brought to bear its effect on new forecasts under controlled conditions.

It is too early to make broad generalizations about the relevance of judgmental estimates as an important input into management information systems. The resistance to using this approach stems from well-founded arguments that a computer system is only as good as its input. Hence, the

[8] For further detail see the author's paper "Managerial Problems in Designing and Organizing a Computer System for Inventory Control," Proceedings of the Food Industries Symposium, IBM Corporation, Endicott, N. Y., 1963.

orthodox approach to systems design calls for meticulous verification of all incoming data that should, so far as possible, tie in with records maintained as an integral part of conducting the business: Executive judgment is, therefore, excluded from a reporting system.

It cannot be denied that such conservatism is well founded if the system design is concerned primarily with the recording of the past or with reactions to presently incoming information be it customer orders, shipping advices, airline reservations or stock market purchases. If, however, the role of management information systems in planning and coordination of future events is to grow, an executive's judgment somehow will have to be tapped and translated into coded form so that full implications of his views will be available for rapid dissemination throughout the information system. It seems that one of the important areas for tempering extrapolated facts with judgment lies precisely in the field of forecasting where complex interactions between a firm and its environment may be best expressed by attaching quantitative value expressions to the executive's feeling of optimism or pessimism.

The alternative to this approach remains in the continued reliance on communicating the intensity of the executive's feelings through a number of informational channels and reporting levels. Wherever the relative efficiency speed and undeniable flexibility of such communications serve adequately the needs of an organization, a more formal approach is not necessary. However, if the environment changes rapidly and results in a need for continuous reassessment of short-term forecasts, which in turn is attended by costly practices, then the incorporation of judgmental forecasts may provide a marked improvement in serving the communicating needs of the enterprise.

## Conclusion and Summary

When designing a management information system, the role of forecasting in it must be carefully assessed. The ability to forecast short-term customer demand and then rapidly distribute this information throughout the organization so as to obtain an optimal reaction to a change in a firm's competitive environment is seen as one of the primary objectives in the uses of forecasting. To attain such an objective, forecasting must be done at a sufficiently low level of detail and forecast results should be communicated to all personnel in a format oriented toward the decisions which must be made.

Forecasting of customer demand for a product is the principal unknown factor in business planning. Therefore, a concerted effort toward unified forecasting should be made. The cost effects of forecasts, modified by passage through several organizational levels, can be identified through an analysis of the average and maximum informational delays traced by the flow of paperwork.

It is further suggested that complete reliance on a variety of mathematical forecasting techniques will not adequately meet the needs of business organizations engaged in vigorous promotional activities. Executive judgment must be a significant design concept of the information system.

Better forecasting within integrated management information systems may, in the future, be assigned an important cost reduction mission and serve as one means by which increasing demands for better service and changed products are met. The increased production and distribution costs associated with unpredictable customer demand patterns can in large part be offset by improved handling of information.