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Integrated Information Systems - Shadow or Substance?

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The 'total information system' serving every possible need of all the departments of a company is a goal eagerly pursued by many businesses. Are they moving too fast and too optimistically? The authors say they are —

INTEGRATED INFORMATION SYSTEMS— SHADOW OR SUBSTANCE?

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RECENTLY there has arisen a cult of high priests devoted to the mission of propagating the concept of completely integrated information systems. With their arsenal of newly furbished equipment they have gone forth proliferating phrases such as "unified information systems" and "total integrated systems."

If one were to take these prophets seriously, he would soon find himself entangled inextricably in endless controversies and pointless debates. Since it is a fact that such a concept is popular and seemingly desirable, its proponents have acquired ardent followers who have been quick to echo the credits of integrated systems without a knowledge of their limitations. It is the purpose of this article to examine the idea of a total integrated system and problems encountered in pursuing such a goal.

During the past two decades the computer certainly has been heralded as *the* vehicle for the Second Industrial Revolution. Linked almost inexorably to this is the idea that advances in computer and information technology necessarily lead to an all-embracing, all-purpose system best suited for managing industrial corporations. In some quarters there is still the misconception that the primary objective of a computer system is managing information rather than providing information for management. In the former instance (and, incidentally, many of today's systems are still designed with this objective in mind) the information system is concerned with the rapid collection, processing, and display of data which often have little to do with decision making. In the latter instance, information not only is collected but also is restructured to reduce the uncertainty inherent in decision making.

It is not too difficult to see why the notion of a total system received so much attention . . . and so much abuse. The notion of integrated information systems no

doubt had its origins in integrated data processing systems. Since raw data gathered from separate information centers could be used for more than one decision making function, many felt that further technological advancements would lead to totally integrated systems. Efforts have been made in many companies to design a total data base and then to use that base to generate the necessary information. To be sure, there has been some integration of data in many organizations, but, for the most part, this has been true only for those systems utilizing the same *kinds* of related data. This similarity of inputs is one of the requirements of an integrated system; if compatibility of data does not exist, the system is not integrated. But before information systems can be integrated, the models which accept, process, and analyze such information must first be integrated; only then can one even commence to discuss integrated systems.

The fact that compatibility may not exist in all the subsystems does not negate the entire concept of integration but rather coerces one to define initially the boundaries of the system. Thus, one does not have an integrated system in the true sense of the word, i.e., "to form into a whole," but rather a limited integrated system; the system simply is not a total (or holistic) one. Thus, it may be said then that the degree of integration is somewhat dependent upon the design of the system.

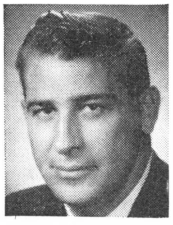
In the initial stages of designing a management information system, the designers typically ask managers what information is required for their decisions. Such a question implies that the managers can identify the important variables involved in the process, assuming at the same time that the availability of this information will lead to better decisions.

There is much weighty evidence to the contrary. There is also evidence that many managers cannot reduce the decision making process to quantifiable expressions. This may not be an unwillingness on the part of the managers to cooperate, but rather a genuine inability to comply, since in order to identify the information that one needs, one must first have a model of how he makes decisions. Until a model of this process exists one cannot specify the information required, and, too often, mathematical concepts cannot capture the expressions of human values which often dictate decisions. Thus, neither simply the abundance of information nor mathematical expressions generally reflect human decisons. The lack of useful models in general obviously limits the integration of them in attempting to develop information systems.

For the most part, the interactions of the major functions of the organization have not been duly noted in the design stage of information systems. Typically what occurs is that the organization is wrenched apart and divided into its principal functions and subfunctions. This is what has accounted for the superabundance of systems—production information systems, marketing information systems, and so on. To further compound the situation the above functions are further splintered into inventory systems, scheduling systems, market research systems, forecasting systems, and a host of others specialized for each duly important function. When one attempts to integrate these many systems, all designed for varying and specific purposes, each possibly using a different mode of information, the result is inevitable. The multiplicity of subsystems which may use separate data bases suggests that different kinds of information are required, and while some information centers may be created for external reporting, others will surely be utilized for operating decisions, and still others for planning or forecasting purposes. There is nothing inherently incorrect in developing subsystems independently of each other as long as they retain their capability for interfacing.

In discussing a problem where each system was designed by the systems group residing within the individual organizations, Clinton Williams of Chrysler Corporation recently stated:

> Each organization took a parochial view of their own requirements without regard to the impact of these systems on the total business. This is not a unique example. I could cite many others. This problem was eventually resolved by a central staff with total corporate planning responsibility. Such a staff is necessary to build an M.I.S. in a big company. Some companies have at-



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> tempted to solve this problem by centralizing systems design. This satisfies the requirement of looking at the corporate view but creates a more serious problem; that of not being responsive to the needs of the individual organizations. Central planning combined with decentralized systems design offers the best combination for big business organizations.[1]

Even the task of delineating an MIS for a large organization is a formidable one, much less integrating it. Says Williams:

> The job of defining an information system for a large company is an enormous undertaking. We have 160 computers installed in our company, world-wide, supporting such diverse products as cars, trucks, boats, air conditioners, chemicals, tanks and missiles, and subsidiary companies engaged in commercial credit, land development, and car leasing. The thought of putting this into an overall M.I.S. scheme staggers the imagination.[2]

A common area of disagreement is what does and what does not constitute an integrated system. It would not be difficult to point out obvious dissimilarities from authors and practitioners alike. Some would define an integrated system as including both on line and real time considerations (OLRT). In William Crowley's view, if a system is integrated, it will:

> 1. Supply historical data and analysis of that data.
> 2. Supply "on line" data, that is, factual material picked right out of the system as fast as it is generated.
> 3. Supply data in "real time," fast enough so that management can exercise necessary management control instantly.[3]

Others appraise the merits of real time information systems as producers of instant and relevant information. Pattillo states:

> On line real time information systems are upon us. The benefits to be derived focus mainly around the "instant information" aspect. At any time we are able to query the computer and receive up-to-date information on any desired phase of the business. The information system may be limited or *total*. It may deal with financial information only, or the system may include data on all functions of the business. . . .[4]

If integrated systems were to embrace the elements suggestive of a more sophisticated computer system, the task would be no more formidable since an on line real time system of itself does not imply an integrated system. Many firms with real time capability do not thereby claim to have an integrated system. Indeed, most of the applications of real time systems were born of critical but very specialized problems.

Some authorities rather than demanding the presence of a real time requirement for an integrated system even question the legitimacy of the entire concept. In a provocative article, Dearden, after relegating the functions of management to six categories, concludes that real time is of value only for controlling certain logistic systems.[5] While Dearden has been accused of fabricating a straw man (and to some extent this is certainly true), nevertheless, he does address himself to some penetrating questions for the systems man. The salient point he rightly makes is that the concept of an integrated system does not depend upon the use of real time hardware for producing instantaneous information. He unmistakably scores the point that many organizations do not need real time systems and at the present time cannot justify extensive use of them; moreover, the attempt to achieve an integrated system does not cut down on the problems at all. Williams also makes the same point:

> Our major batch systems have daily update. This gives us a lot of flexibility for producing needed information with high response timing. Not very many information requirements have been established that require higher response than this.[6]

One of the more formidable ob-

[1] Clinton C. Williams, "Practical Problems of M.I.S. in a Business Environment," paper presented at the First Annual Meeting of the American Institute for Decision Sciences. New Orleans, La., Oct. 30-31, 1969, pp. 3-4.
[2] *op. cit.* p. 4.
[3] William J. Crowley, "Can We Integrate Systems Without Integrating Management?" *Journal of Data Processing*, August, 1966, reprinted in *The Computer Sampler*, McGraw-Hill Book Company, New York, 1968, p. 272.
[4] James W. Pattillo, "A Study in Instant Information," *Management Accounting*, May, 1969, p. 17. (Emphasis by the authors.)
[5] John Dearden, "The Myth of Real-Time Management Information," *Harvard Business Review*, May-June, 1966. Also see John Dearden and F. Warren McFarland, *Management Information Systems*, Richard D. Irwin, Inc., Homewood, Ill., 1966.
[6] Williams, *op. cit.*, p. 5.

stacles to an integrated management system is the unproductiveness of insight into the nonrepetitive decision making process of the data generated by systems reports. Since some hold that information is imperfect whenever it is unavailable, or too costly, or unproductive of knowledge, the reason why many systems do not generate insightful information may be that much of the information actually utilized in the decision making process is information *external* to the firm. In many cases this external information dictates decisions irrespective of internal conditions. Robert Anthony succinctly states this:

> It is because of the varied and unpredictable nature of data required for strategic planning that an attempt to design an all-purpose internal information system is probably hopeless. For the same reason, the dream of some computer specialists of a gigantic bank, from which planners can obtain all the information they wish by pressing some buttons, is probably no more than a dream.[7]

It is noteworthy that typically the higher the decision making in the organization, the more judgmental the factors involved. Decisions made at the levels of middle management and above are more in response to external pressures upon the firm than to indigenous factors. Those systems which purport to employ a central data base, for the most part, do so for decisions made either at the lower management level or those which are repetitive.

Daniel, in his oft-quoted article, "Management Information Crises,"[8] states that a dynamic management information system requires information of three types: environmental information, competitive information, and internal information. Even if management were able to successfully integrate the internal information, it would be impractical for a firm to attempt to synthesize a system with input data based upon continually changing political, economic, and environmental factors as well as data relating to the past, present, and probably future activities of direct and indirect competition. Anthony makes the same point when he writes:

> Strategic planning relies heavily on *external information,* that is, on data collected more from outside the company, such as market analyses, estimates of costs and other factors involved in building a plant in a new locality, technological developments and so on. . . . Strategic planning and management control activities tend to conflict with one another in some respects.[9]

Recent studies show an increasing awareness of the importance of this external information. Aguilar in his recent book, *Scanning the Business Environment,* examined the kinds, sources, and modes of external information that executives use for strategic decision making.[10] He found that for large companies 51 per cent of the information utilized for strategic decisions came from sources external to the organization, while 49 per cent of the information came from internal sources.[11] Keegan examined the sources and the manner in which executives at headquarters level learn about the significant opportunities and threats to their companies.[12] He found that documents were the source of only 27 per cent of the important external information received by executives. He also states:

> The bulk (60%) of these documents are publications and information service reports from *outside* the company. Letters and reports from inside sources account for the remaining 40%.[13]

Those enamored with the integrated systems concept are often unaware of the heavy financial commitment required. Many managers have been sold on the notion that with a totally integrated system they would be able to query the computer and receive answers to virtually any question they desire. Even if such a system were possible, and it is not, this would require a monumental data base and a special computer access language. Such a course of action could hardly be justified in regard to the time-cost expenditure relative to the benefits received. Several years of developmental time is

[7] Robert N. Anthony, *Planning and Control Systems: A Framework for Analysis,* Graduate School of Business Administration, Harvard University, Cambridge, Mass., 1965, p. 45.

[8] D. Roman Daniel, "Management Information Crises," *Harvard Business Review,* September-October, 1961, p. 55.

[9] Robert N. Anthony, "Framework for Analysis," *Management Services,* March-April, 1964, p. 21.

[10] Francis J. Aguilar, *Scanning the Business Environment,* Macmillan Company, New York, 1967.

[11] *Ibid.,* p. 80.

[12] Warren J. Keegan, "Acquisition of Global Business Information," *Columbia Journal of World Business,* March-April, 1968, pp. 35-41. See also Warren J. Keegan, "The Scanning of International Business Environment: A Study of the Information Acquisition Process," unpublished Ph.D. dissertation, Graduate School of Business Administration, Harvard University, June, 1967.

[13] *Ibid.,* p. 37.

common just with modular systems, let alone a system purporting to include all relevant data.

Characteristically, the cost of an installation and its payoff will dictate the degree of integration that is feasible, and in many instances the computer may be cost-justified for only one or two functional areas. For these firms, then, the optimal degree of integration has been achieved at that particular point in time. On the other hand, the attempt to tie together the entire information flow would be economically unwise. The great effort expended, regardless of the hardware sophistication, would be enormously disproportionate to the benefits produced.

This splintering-up approach to information systems is one which often has been derided as ignoring future requirements of the firm. On the contrary, it can be said that management seldom fully ignores future benefits but rather that it discounts the value of these benefits and hence seems to rely upon the more verifiable short-run values.[14] The number of firms that have attempted complete integration of information (often with the computer manufacturer's warranties and vows of assistance) only to experience absolute failure is not insignificant. These firms, understandably, do not draw the wide attention to their misadventures they deserve.

It is suggested that the acquisition and operation of an integrated management information system be viewed in the same light as the purchase and operation of an additional amount of capital equipment. Both actions can and often do involve large amounts of financial resources. If the purchase of capital must be verified as cost-effective, an information system should also contribute its share to profit. Obviously, the verification of benefits from any integrated management information system is difficult, but certainly it is not impossible. Systematic analysis of the almost unlimited volume of output will not only expand the initial list of probable benefits but will help to ensure that the system is earning its keep.

The literature is replete with articles dealing with resistance to change, psychology for the systems analyst, and the like. And yet, in spite of this overabundance of advice, engineering acceptance of change is a major factor in the reception given information systems. While this is especially true for advanced installations, which necessarily employ operations research personnel for model building and simulation, the same problems exist for initial installations. It could be expected that firms "learn" to deal with these "human" problems before advanced applications, but this is not the case. Churchman, in regard to why recommendations by O.R. personnel are not accepted by management, notes:

> These reflections imply that the missing ingredient in the process of implementation is the understanding of the manager. Any research team that fails to study the manager and his personality may well fail to bring about a recommended change.[15]

There is much evidence to support the fact that many information systems now in existence remain on the shelf unused. Chambers states concerning a producton information system:

> We developed a very sophisticated model for the finishing operations at that plant (finishing is a semicontinuous operation there). The model takes into account not only the speed of the production lines, inventories at various stages, order quantities, and labor smoothing, but also how the kilns are loaded. There are about six or seven control variables, and the model very closely approximates reality. It has optimizing features, where possible, and involves some simulation. However, the plant is not using it because they don't understand what is in the model and how it works. We have found that unless we get people to understand what we have done, and unless we develop the model or system slowly, it isn't going to be used.[16]

He makes the point that if a system is developed sequentially and the managers are allowed to absorb it on a piecemeal basis, then there is a higher probability of success. This is especially true where the decision making function is highly complex. It is also common knowledge that when change is understood, resistance to it is less formidable.

[14] A firm in the farm implement industry just announced "that they were abandoning their efforts to integrate their international operations because of both problems encountered in the endeavor and the tremendous high cost relative to benefits expected."

[15] C. West Churchman, "Managerial Acceptance of Scientific Recommendations," *California Management Review*, Fall, 1964, p. 35.

[16] John C. Chambers, "Total Versus Modular Information Systems: Empirical Experience in Finance and Personnel," *Management Information Systems for the 1970's*, Robert D. Smith (ed.), Center for Business and Economic Research, Kent State University, Kent, Ohio, 1970, pp. 52-53.

The quest for a total integrated system is sheer folly as well as misleading. The quantum jump from modular subsystems to one "holistic" system is neither financially nor technically feasible at this time.

At a recent symposium on simulation it was stated in regard to a sophisticated corporate model:

> . . . We would like to cite this evidence, but we cannot. The reason that we can't is that we do not have a data bank of interactive estimates, because no analyst is currently using this system. This is despite the fact that the model has been in a finished form for almost nine months, and has been introduced to approximately one hundred security analysts and four different organizations, including the Security Analysts of ———————— Bank. Obviously, something has gone very wrong: a large amount of money has been spent to develop a product which is sitting on the shelf unused.
>
> The model was not, however, "human engineered" by someone familiar with the thought processes of a non-computer-oriented user. . . . Furthermore, the user was provided with very little assistance as to how he was to derive the imputs to this model: how is an analyst to be expected to make probabilistic forecasts, when this represents to him an entirely new mode of thought?[17]

Traditional managers, who have had neither the exposure nor the training to adequately cope with computer technology, are overwhelmed by this new vehicle, which they rightly or wrongly perceive as a threat to their decision making prerogatives. Even when training has narrowed the gap slightly, it has by no means bridged the chasm. Besides, many of the training programs are of little benefit to the participants since they are one-shot operations which do not provide in-depth knowledge of the system. It is not enough simply to know what information to ask for and how to read computer printouts. If a manager is to evaluate a system, he must know some of the inner workings of the system.[18]

A major division exists both in theory and practice concerning integrated management information systems. The authors suggest that this is so because of a failure to describe precisely not only the scope of the system itself but also the types of decisions toward which the system must be designed. At the one extreme is the all-embracing integrated system with inputs of objective data based upon continually changing political, economic, and environmental factors, as well as data relating to past, present, and probably future activities of the firm and its competitors. At the other extreme lies a system with a capability to provide an analysis of only segmented internal data. The degree of systems sophistication even at this end will be difficult to achieve since true integration will require the formidable meshing of many modular subsystems. Notwithstanding the often-cited examples of several major firms that have had some measure of success with integrated logistic systems, progress has been modest.

In any event, the quest for a total integrated system is sheer folly as well as misleading. The quantum jump from modular subsystems to one "holistic" system is neither financially nor technically feasible at this time. It is hoped that the steady flow of literature on "total" systems will be slowed and the hypnotic attraction will dissipate as the slow integration of modular subsystems proceeds in industry. As this occurs, the concept of integrated systems will become a substantive one instead of mere shadows.

[17] Wayne H. Wagner *et al.*, "Telecommunications Earnings Estimation Model (TEEM): An Evaluation," paper presented at Symposium on Corporate Simulation Models, Seattle, Wash., March 23-25, 1970.

[18] This point is succinctly made in Russell L. Ackoff's article, "Management Misinformation System," *Management Science*, December, 1967.