Management Information

and

Control Systems

Second Edition
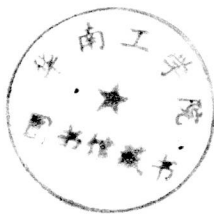
R. I. Tricker

The Corporate Policy Group
Nuffield College Oxford

and

Richard Boland

The University of Illinois

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Preface
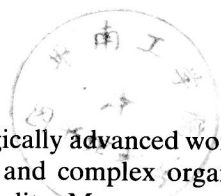
One of the major challenges facing the technologically advanced world is how society can function through vast, interrelated and complex organizations, without sacrificing human creativity and individuality. Management, whether in private or public sector, providing social services or profit orientated, is in a decisive position. Against a backcloth of psychedelic change the manager must create, plan and control his enterprise to achieve high goals.

In this situation effective management information and control systems are imperative, and those responsible for their design and operation need sound knowledge, rooted both in concepts and experience. Power underlies all attempts to control and managers must also appreciate the nature of power and the human implications of its use. Hence the reason for this book.

Origins

The work stems from material developed for a Masters level course at the University of Warwick when I held the Barclays Bank Chair in Management Information Systems. It was subsequently developed through work with senior executives when I held the Directorship of the Oxford Centre for Management Studies.

Structure

The conceptual weft and warp, which enables the fabric of a complex situation to be understood, can be expressed in many ways. Consequently there could be many alternative structures for this book. The one chosen starts with relevant theoretical concepts drawn from organizational, behavioural, quantitative and communication theories and from the concepts of management information. Subsequently theoretical ideas are exposed to operational issues—management of information and the development of information and control systems.

Purpose

The book is intended as a standard text for courses in management and can be used at undergraduate, masters and post-experience levels, in college, university or operating organizations. It also provides a source book for the experienced manager, consultant and systems expert, seeking more information.

Traditionally the development of management control systems could be considered a specialist function: today all managers are involved. Functional orientations need widening to meet organization wide demands for information. New bodies of knowledge are now available. Computers and modelling technology are only a small part of the answer. They must be matched by an ability to conceptualize, to understand what the organization is striving to achieve and how it uses information. The need is for managers capable of causing change, rather than merely reacting to it. Such managers must be able to think deeply about their organizations and perceive information needs. System developments must be set in the overall organizational context. There is as much need for new organization structure as computer assisted systems, to meet contemporary issues and opportunities.

The systems expert and the computer man, despite their technical skills, are sometimes insensitive to the human and organizational implications of their activities and to the problems caused by causing change. Thus the study of information and control systems is necessary for both manager, who must increasingly be in need of information, and the systems expert, who is increasingly involved in its supply. There is no simple, all pervasive, theory to explain management information and control—anymore than there are panaceas for changing men and organizations. To achieve high aims, organizations need managers able to control under increasing complexity, scale and change, who also have the perceptions to imagine new strategies, systems and structures. The overall purpose of this book is to contribute to that process.

R. I. TRICKER

Preface to the Second Edition

In the six years since the publication of the first edition the underlying technology of computers and communications has changed dramatically. The development of minis and micros, communication networks, important data based information services, and a galaxy of office automation opportunities have added new dimensions to the issues facing management. Moreover the organization of the data processing and information functions have evolved significantly. Such developments are reflected in the new edition. Significantly however the need for education and training in the field remain as urgent as ever.

The first edition was well received, particularly in the United States of America, and I consequently invited Dr. Richard Bolan of the University of Illinois to join with me in producing the second edition.

We have rewritten some of the cases and added others which reflect the current issues and opportunities in information systems. The briefings have been significantly developed, principally by Dr. Boland. We have repositioned some of the material to make a more coherent framework for courses, and also included material on performance measurement and transfer prices, as an appendix, for those who are not well versed in accounting.
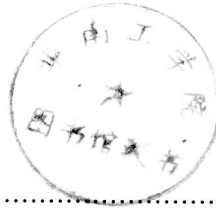
For teachers considering adopting this text for a course in information systems it should be noted that the Wallace case is available on film and video cassette; also that some of the longer cases such as 'ATCO' and 'The Visual Media Center' can profitably be used throughout the course as system design projects.

I have enjoyed greatly the collaboration with Dr. Boland. Furthermore, I should add a word of appreciation to his colleague Peter Chalos for his assistance in preparing 'The Visual Media Center' case and 'International Avionics (C)', and also to Arthur C. Joy for his help in preparing 'International Avionics (A) and (B)'.

Although the material has been developed and changed significantly to reflect the changes in the subject, the primary purpose remains—to provide essential material for courses in which both the theory and the management practice of information and control systems can be explored and understood.

R. I. TRICKER
Nuffield College
Oxford 1982

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CHAPTER 1

Information and Decision

BRIEFING: MANAGEMENT INFORMATION AND DECISION

Language, communication and society

Management is a process of responsible action that takes place in a larger social and cultural context. Individuals orient themselves towards the world at large and towards others by the norms of their culture (Stamper, 1973). Cultural norms for perception, cognition, evaluation and behaviour define appropriate managerial action. These norms are learned by an individual through participation in a language; through language the norms are reinforced or changed over time.

Norms of perception define accepted ways of categorizing and classifying aspects of the world; norms of cognition define accepted beliefs and knowledge about the world; norms of evaluation define frameworks for determining our interests and objectives; and norms of behaviour define standards for action and interaction. These norms allow us to share mutual expectations, see pattern and regularity in our social interactions, and give meaning to our world and our life in communication with others. In this sense, the social world in which management takes place is constructed through language and communication processes, as is management itself.

One can chart the evolution of species, individuals or societies as a series of stages of changing communication capability. Physical gestures, spoken words, myths and stories, written words, printing, telephones, radio and television transmissions, electronic data processing, computerized data banks and satelite transmissions are examples of man's increased capacity to generate, store, transmit and retrieve data. Each expansion of our information processing ability is associated with improved chances for survival. Since our language operates through these media, our ability to construct the social world through language and our ability to manage the world and the organizations in it is a function of our use of language and of our information processing ability. The perceptual, cognitive, evaluative and behavioural

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norms that shape our culture undergo dramatic shifts as our ability to categorize, summarize, identify patterns, test ideas and draw inferences change with each increase in our information processing ability.

The problem of being a manager changes in two ways as our ability to communicate changes. First, as enhanced language and communication processes shape a new culture, the manager confronts a different and shifting set of societal expectations with regard to issues such as authority, markets, hierarchy, dominion over nature, individual freedom and national and international rights. Second, since management itself operates through language, the ability to give directions and orders (denotative language), motivate and mobilize other individuals (affective language) and use mathematical models or quantitative analysis (formal language) also changes. Hence, changes in our information processing ability are associated with changes in our language and culture as well as changes in the aspects of society we attempt to manage, and our ability to manage them.

It is our position that managers should not uncritically mold themselves or their organization to existing information systems. Rather, managers have the responsibility to design information systems that meet humanly satisfying needs. One important need is to structure and allow for formal and informal communication that results in a learning process at both the individual and organizational levels of interaction. This age has been referred to as the information age. The challenge to management is to use the capacity for information processing that marks the information age to create a learning society.

To do this managers must be able to take a critical view of the information systems they encounter in their organizations and society. This means managers must view them as part of a larger language process that guides our way of perceiving, organizing, directing and controlling organizations as well as society at large. An important aspect of a critical perspective is to make design statements, or statements that indicate satisfaction or dissatisfaction with certain characteristics of an information system along with proposals for changes in the system. These design statements will, of course, be ultimately justified by value judgements. Thus, a critical view reflects on the value judgements implicit in existing designs and attempts to challenge them based on good reasons.

The study of management information systems is properly viewed as the study of how organizations use language and data processing to conduct daily operations, establish management control and plan for the future. These different levels of management decision are embedded in the organization's structure and standard operating procedures, administrative style and process, methods of performance evaluation and systems of rewards and punishments. The study of management information systems should include all these aspects of management decision in any judgement about computer applications.

The study of management information

For as long as men have been striving together to accomplish tasks, making

decisions about scarce resources in uncertain situations, management has been practised and information has been needed. The medieval baron handled information about his resources and the uncertainties facing him when deciding whether to send his men out to plough the fields. However, the managerial situation today has changed in a number of important ways:

1. Managers are increasingly remote from their resources. Less frequently are they in direct contact with the men, machines, materials and money that they manage. Other people, reporting systems and complex communication channels intervene.

2. Frequently managers operate in the context of large organizations, major markets, global operations. The scale has increased, whether the manager is in business, commerce, government or a social service such as health or education. One of the outstanding challenges to management in the remainder of this century is to extend the significance of the individual in the context of the effective, large enterprise.

3. Managers face greater complexity in many of their decisions. More factors have to be taken into account. Contrast the relatively simple world of the nineteenth century entrepreneur wanting to open a new factory, launch a new product or change his technology with his current counterpart. Today's executives must contemplate interactions with government, both nationally and internationally, unions, employers' associations, works councils, consumer groups, local interests, the stock exchange, predator take-over companies, the financial press, institutional shareholders and so on, as well as employees, customers, creditors and sources of finance. They must be sensitive to changes technologically, economically, sociologically and in the changing legislation. (Figure 1 illustrates the environment of the strategic decision maker. Every sector in the diagram is the source of massive potential information.)

4. In addition to the greater complexity facing the manager, the rate of change has tended to increase in recent years. True, men throughout the ages have faced increasing change. The implications for present management, however, lie in the bludgeoning effects of continuous change throughout their environment, their available resources and their organizations. Whereas in the past managers could look on change as the problem they overcame to return to the stable *status quo*, a primary task of management today is causing change and managing it as an inevitable, continuous process.

In this managerial world of increasing remoteness, scale, complexity and change, information becomes the key to management effectiveness. Not surprisingly the study of management information has blossomed. Until very recently information, though obviously vital, was not considered overtly. It was not a subject for study in the earlier, classical works on management. Like
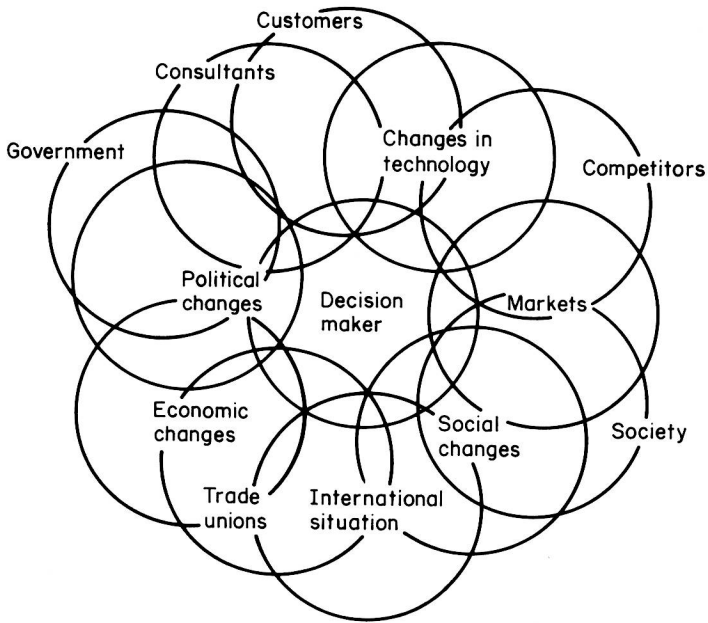
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Figure 1

sunlight for the Victorian naturalists it was recognized as vital, but either it was available or it was not. Today the manager faces a confusion of potential sources of information. He has to determine what information he needs. This is a new and crucial management function. In earlier centuries the scholar alone had to decide what information he needed. The rest of society could respond intuitively to the information that was available. Subsequently the scientist faced this task. Now it is a fundamental part of management. It is also a very difficult process.

Ideas about information

Information is a multifaceted and sometimes ambiguous concept. Essentially, information deals with the transmission of knowledge and the process of learning. Information is that which informs or changes the knowledge of an individual. This is the root of the ambiguity with information—it does not reside on a piece of paper or in a spoken word but only as the written or spoken material 'informs' an individual. This, of course, is a function of the specific person, their history and experience, the immediate context including its non-verbal connotations, and so on. Information is then a very personal and idiosyncratic phenomenon.

A popular way of representing the process of information transmission is the communication model:
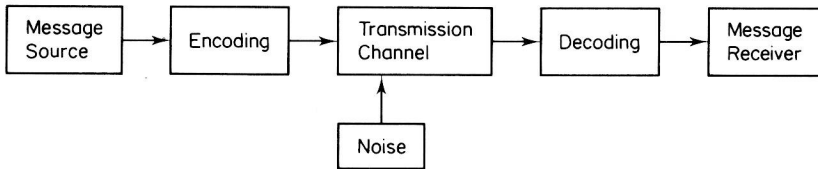
At one level we can speak of the message itself. The message has been selected from a set of possible messages and we can therefore think of the probability of the particular message having been sent and the amount of uncertainty reduced by knowing which message was sent. This is the basis of statistical decision theory and information analysis (Demski, 1980).

At another level, we can speak of the transmission of messages. This focuses our attention on the adequacy of a coding scheme to capture the nuances and distinctions intended by the message. It also focuses attention on the capacity of the transmission channel to convey the message without distortion even in the face of noise and disruption. In general, the redundancy in a communication channel is the amount by which the coding scheme and the channel capacity exceeds the minimum necessary to transmit a given set of messages under ideal conditions.

At a third level of analysis, we can speak of the meaning gained by the receiver of the message. At this level we must be concerned not only with the message but with the context in which it is exchanged. In addition to the importance of context, human communication contains several levels of messages simultaneously. In a conversation we are not only saying things to another person about some object or event, we are also saying something about how we perceive them and how we believe they are perceiving us.

A frequent mistake is to deal with the message itself as information. The message should properly be considered as mere data. Only when data has been interpreted by an individual is information present, and the information is to be found in the meaning of the data to the individual. Yet this proves to be an overly restrictive use of the term information, because the meaning of a datum to an individual is a part of a private, subjective world of experience that we cannot enter. Therefore, we will refer to information as data which are selectively assembled and structured in such a way that we believe they will prove informative to their recipient and that we can adequately anticipate the meaning that will be gained. To do this we must carefully specify the recipient of the data, the context, and the use that will be made of them. In a management setting this emphasizes that any discussion of information presupposes a decision maker who will interpret and use it in a decision making situation.

It also emphasizes that any discussion of information presupposes a culture with norms of perception, cognition, evaluation and behaviour within which data are meaningful and informative. Our study of management information and control systems will therefore emphasize the importance of first
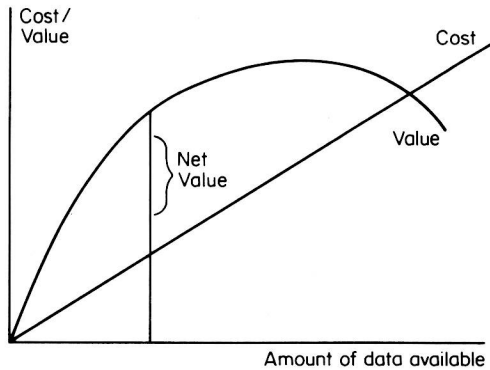
Figure 2

understanding the cultural context of organizations and society in order to make design statements about information systems.

Data has a cost, information a value.

The cumulative costs of providing data increase with the volume provided, but the value of information does not. (See Figure 2.) Intuitively one might seek to keep the cost of data at an acceptable minimum. The relationship one should have in mind, however, is that between the cost of data and its value to the decision maker who uses them. Initially information value tends to increase dramatically as each new bit of data removes considerable uncertainty. Thereafter the incremental value reduces, until mere reinforcement or even surfeit occurs. It is the maximization of net value, not the minimization of cost, that is significant, and this is a function of the use by decision makers of the data, as well as the cost of its provision.

There are a number of insights available into the use of information—semantics and syntactics are concerned with the meaning and arrangement of words, statistics is concerned with numerical assessment and mathematical decision theory is concerned with people's expectations of the likelihood of uncertain future events and the utility they attach to any outcome. Both social and clinical psychology involve studies of people's ability to think, process data and perceive. But the decision process is not well understood. In considering management information the broader perspective of language is necessary; anything less is concerned with management data, not management information. This behavioural concept of information emphasizes the value in the use of data. It highlights the need to study the use of information in the context of decisions.

Levels of decision

Decision making is an iterative process involving the recognition of the opportunity or the problem, obtaining data, understanding the information

content, seeking alternatives, evaluating them, making choices and implementation. Although it is useful to conceptualize stages in the decision process, very few decisions are taken in this logical sequence. There is frequent feedback to earlier stages; decisions nest together, the thinking on one opening up other issues. Much of the process, being mental activity that defies logical analysis, is referred to as 'creative thinking', 'intuitive feelings', and 'entrepreneurial flair'·

Also, decisions are apparently of quite different orders of magnitude. Contrast the decisions to switch on a light, work overtime next weekend or close down a factory. To study management information and control some conceptual framework is necessary.

A common approach is hierarchical, recognizing levels of decision, from operating decisions concerned with short term operational matters (such as switching on the light) to managerial or tactical decisions concerned with how to utilize resources (such as the overtime decision) and strategic decisions concerned with the major opportunities and threats facing the enterprise (such as the plant closure).

The features of operating decisions include short time horizons, repetition, little uncertainty, indeed the relative unimportance of each activity except as part of the whole concern's operation. Managerial decisions, referred to by Anthony (1965) as management control, are more concerned with how to employ resources to achieve corporate objectives, within the prevailing corporate strategies. The focus of attention is within the company, but the time horizon has extended beyond that necessary for hour by hour operations. Such decisions tend to reoccur but are not highly repetitive. There is more uncertainty; more factors need to be considered. Strategic decisions, on the other hand, are concerned with longer term aspects. Decisions about a take-over bid, change in the capital structure, a new product line, introducing a new basic technology, relocation, have strategic dimensions. The issue can raise questions about the purpose of the enterprise. Time horizons are long, uncertainty great, more is at risk and, most significantly, the focus of attention has broadened—information is generated outside the enterprise itself.

The distinguishing attributes of decisions at various levels are summarized in Table 1. Authorities differ in the terminology and precise identification of levels, but the hierarchical framework is universal. Clearly, although decision makers at each level need information, the information process varies considerably between levels. The concept of levels is of importance in the study of management information, management control systems and their organizational implications.

Some fallacies of management information

Having looked at some conceptual aspects of management information and decision, some of the conventional wisdom is open to challenge. Consider the following six fallacies: