Production and Operations Management

Principles and Techniques

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Preface

This is a book about Production and Operations Management. The production and operating functions within business are concerned with the conversion or transformation process. Such processes are technologically diverse and embrace the provision of both goods and services. This book is concerned with both of these aspects. Unlike the edition which it replaces (*The Techniques of Production Management*, R. Wild, 1971) and other books carrying a similar title, the book is *not* solely concerned with manufacture or production, i.e. goods production.

The book is concerned primarily with principles and techniques, and in particular the latter. It is intended as a teaching text but this does not, of course, mean that courses in production and operations management will necessarily be principles/techniques oriented. This is not a case-study book but could be used in teaching to complement case-study work. The nature, uses, and limitations of available techniques and principles must necessarily form a part of any comprehensive production and operations management course, but whether they constitute the foundation or the super-structure will depend upon the opinions of the lecturer and upon the objectives of the course. Whatever the approach, it is intended that this text should be used in conjunction with other teaching material.

The book is intended as an economic, straightforward text. Unnecessary words have been kept to a minimum, and 'padding' has been avoided. The result, I hope, provides maximum value for minimum effort, for both student and teacher. The book is structured in a semi 'life-cycle' form since it deals, in order, with the types of problem which would be encountered in establishing, designing, planning, running and maintaining a production and operating system.

This, in effect is the second edition of *The Techniques of Production Management* (R. Wild, 1971). In fact the original has been largely rewritten. Whilst attempting to retain a similar size I have tried to broaden the content considerably. Numerous new chapters are included and the whole structure of the book has been changed from that of the first edition. The first part of the book is completely new and in this I try to introduce some basic ideas and notions which hopefully will be of value to students in their own right, and also in interpreting and using the principles and techniques presented in later chapters. The book deals specifically with goods- and service-producing systems, unlike the first edition, which was concerned entirely with manufacture. I have attempted to provide a real and valuable treatment of the broad field of operations management and have attempted to avoid 'pretence'. I hope that the reader will find that the contents are

sensible, valuable, and relevant, irrespective of his particular focus, i.e. whether he is interested in manufacture, transport, service or whatever. The notions and ideas introduced in the first few chapters are not developed in detail but are provided as a framework on which to hang the relevant parts of the remainder of the book. Throughout I have updated references, although footnotes remain largely unchanged. Since these latter normally relate to the origins of ideas and techniques, i.e. original references, there is little point in seeking to update them. Several new questions are introduced at the ends of chapters. Numerous new ideas are introduced and some of the contents of the original book have been eliminated. In summary, I hope that the book will be found to deal realistically with the broad field of production and operations management, in sufficient depth and breadth for most purposes and with sufficient clarity.

Metric units are used throughout except in tables, figures and data reproduced from other sources, where the original units are retained, and where non-metric units are conventionally employed.

ACKNOWLEDGEMENTS

I am grateful to several companies and publishers for their permission to reproduce certain of the tables and figures in either original or modified forms. Chapter 21 is based partly on material from R. Wild *Operations Management – A Policy Framework*, Pergamon, Oxford, 1979. I am grateful also to the United Kingdom Universities of Bradford, Lancaster, Salford, London, Sussex and Warwick and to Cranfield Institute of Technology for the reproduction of examination questions (often in modified form). My thanks are due also to colleagues and friends, too numerous to mention, who have made useful comments on several chapters both in the original and revised forms; to typists and secretaries (paid and unpaid) who prepared the manuscript; to Fiona Stubbs, who managed the whole process; and to those who read and helped correct the manuscript.

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England
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Contents

PART 1

Operating Systems and Operations Management

1

The Nature and Significance of Operating Systems and Operations Management

We must, necessarily, begin by tackling one of the more controversial aspects of our subject. We must provide definitions. Since the structure of this book to *some* extent reflects a particular view of the nature of operating systems and operations management, that view must now be explained. Bookshop browsers are advised to scan this chapter before making their purchase decision. Those who have omitted this simple precaution are advised to reconsider their decision when they have read this chapter. All serious readers, including those who have no choice but to use this book, are requested to study this chapter before plunging into the remainder of the book.

Throughout this book we will, for brevity, use the terms 'Operations Management' and 'Operating Systems'. They will be defined below. The terms 'Production and Operations Management' (used in the title of this book) and 'Production and Operating Systems' are, for our purposes, synonymous.

THE NATURE OF OPERATING SYSTEMS[1]

Operating Systems

An operating system is a configuration of resources combined for the provision of goods or services.

Bus and taxi services, motels and dentists, tailors and mines, fire services and refuse removers, retail organizations, hospitals and builders are all operating systems. They all, in effect, convert inputs in order to provide outputs which are required by a customer. Physical inputs will normally predominate, hence: operating systems convert, using physical *resources*, to create outputs, the *function* of which is to satisfy customer wants, i.e. to provide some utility for the customer.

[1] The ideas introduced in this section are developed in detail in R. Wild, *Concepts for Operations Management*, Wiley, New York, 1977.

Resources in operating systems

Operations managers are principally concerned with the use of physical resources, hence we shall take a physical view of operating systems, and shall concentrate upon the physical resources utilized by the system, which for convenience will be categorized as follows:

Materials, i.e. those physical items consumed or converted by the system, e.g. raw materials, fuel, indirect materials, etc.
Machines, i.e. those physical items utilized by the system, e.g. plant, tools, vehicles, buildings, etc.
Labour, i.e. those persons who necessarily provide or contribute to the operation of the system, without whom neither machines nor materials are effectively used.

Function of operating systems

Given this definition a large range and variety of systems may be considered as operating systems. The examples above illustrate this variety. Some form of categorization of such systems would be of value, if only for descriptive purposes. One useful categorization is afforded by a consideration of system function.

The function of an operating system is a reflection of the purpose it serves for its customer, i.e. the *utility* of its output to the customer. Four principal functions can be identified, i.e.

1. *Manufacture*, in which the principal common characteristic is that something is physically created, i.e. the output consists of goods which differ physically, e.g. in form, content, etc., from those materials input to the system. Manufacture therefore requires some physical transformation, or a change in *form utility* of resources.
2. *Transport*, in which the principal common characteristic is that a customer, or something belonging to the customer, is moved from place to place, i.e. the location of someone or something is changed. The system utilizes its resources primarily to this end, and such resources will not normally be substantially physically changed. There is no major change in the form of resources, and the system provides primarily for a change in *place utility*.
3. *Supply*, in which the principal common characteristic is that the ownership or possession of goods is changed. Unlike manufacture, goods output from the system are physically the same as those input. There is no physical transformation and the system function is primarily one of change in *possession utility* of a resource.
4. *Service*, in which the principal common characteristic is the treatment or accommodation of something or someone. There is primarily a change in *state utility* of a resource. Unlike supply systems the state or condition of physical outputs will differ from inputs by virtue of having been treated in some way. (N.B. It should be noted that this definition is somewhat narrower than that normally implied by this term.)

Many organizations comprise systems with different functions. For example, an airline will depend upon operating systems whose purpose is transport, supply and service. A typical manufacturing organization will have internal transport and service

systems. In fact, excepting very small organizations, we are likely to be able to identify all four functions providing we consider sufficiently small parts of the total system. For this reason the description of a complex organization as a manufacturing system, or transport system, etc., provides only a very general indication of its *overall* or principal purpose. A more detailed description necessitates the consideration of parts, or sub-systems, of the whole. These four principal functions can together be used in describing all operating systems and their sub-systems. They provide a basic language for operations management and permit the development of a slightly more detailed definition of an operating system, i.e.

An operating system is a configuration of resources combined for the function of manufacture, transport, supply or service.

Each of these four basic functions is considered briefly, with examples, below.

Manufacture

This is perhaps the principal functional category of operating systems. Most texts on operations management focus implicitly upon manufacture, and, whilst we shall try to avoid undue bias, it is pertinent here to consider the nature of manufacture and in particular the types of manufacturing system which might be encountered.

Considering businesses or organizations as a whole, a tailor, coal mine and builder would be categorized as manufacturing systems since their *overall* purpose is that of creating goods. Manufacture is the *principal* purpose of motor vehicle firms such as Ford, and within such an organization most factories will be primarily involved in manufacture. Whether we consider large systems and therefore describe their function in overall terms, or whether we consider much smaller systems and therefore take account of more detail, will depend upon our purpose. However, whatever our level of description, in general it should be possible to identify different types of manufacturing system – such categorization again being of value mainly for description. We can divide manufacture in two, traditional ways.[2]

Firstly we can identify continuous, repetitive and intermittent manufacture. A *continuous* process will theoretically run for 24 hours per day, seven days per week and 52 weeks per year. Whilst this degree of continuity is often the objective, it is rarely achieved. Examples of this type of manufacture are steelmaking, petrochemicals, etc. A *repetitive* process is one in which the product (or products) is processed in lots, each item of production passing through the same sequence of operations, as, for example, in the assembly of motor vehicles. An *intermittent* process is one in which very small lots, or even single products, are made in response to separate customer orders.

The second and similar classification divides manufacturing processes into process or mass, batch and jobbing. *Process* manufacture involves the *continuous* production of a commodity in bulk, often by chemical rather than mechanical means. *Mass* production (or manufacture) is conceptually similar to process manufacture, except that discrete items such as motor cars and domestic appliances are usually involved. A single or a very small range of similar items is manufactured in very large numbers. *Batch* production occurs where the number of discrete items to be manufactured in a period is insufficient to enable mass production to be used. Similar items are, wherever possible, manufactured

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[2] Other categorizations are provided by, for example, H. Ingham, *Balancing Sales and Production*, Management Publications, London, 1971; J. L. Burbidge, *The Principles of Production Control*, Macdonald and Evans, London, 1968.

together in batches. Finally *jobbing* manufacture, although strictly consisting of the manufacture of different products in unit quantities, in practice corresponds to the *intermittent* process mentioned above.

Each of these three or four (depending on which classification is adopted) types of manufacture is characteristic of several different industries, but nevertheless no industry consists exclusively of any one type of manufacture. Increasing demand for products presently manufactured by means of a jobbing-type arrangement may enable a form of *batch* production to be introduced; and, similarly, increased demand for products presently manufactured in batches may indicate the desirability of mass production. It is, however, quite unrealistic to consider these types of manufacture in a strict or absolute sense since they are only parts of a production continuum, whose ends do not, except in theory, exist.

Transport

The principal function of transport systems is that of changing the location of someone or something. A taxi or bus service, ambulance service, furniture remover or refuse removal system can be categorized as a transport system. Within manufacturing organizations, transport systems may be employed for moving work-in-progress between manufacturing departments, removing waste materials, etc.

Supply

Supply systems have the principal function of changing the ownership or possession of item(s) which are otherwise physically unchanged. At an organization level, a retail shop, warehouse, petrol station and broker may be seen to have the principal function of supply. Within organizations, supply systems may be evident as internal stores, etc.

Service

A dentist, fire service, launderette, hospital ward and motel may be considered to have the principal function of service, i.e. the function of treating or accommodating something or someone. Within organizations a similar function may be performed by systems such as welfare departments, rest rooms, etc. No such categorization can be watertight. Inevitably there will be overlap and such an approach is of value only for descriptive purposes. Such descriptions indicate something about the purpose of and reason for systems, but of necessity we must develop a somewhat different approach if we are to explore the nature of operating systems from an operations management viewpoint.

Structure of operating systems

Categorization by function identifies the scope of operations systems but tells us little about their nature. The nature of the operations manager's job will to some extent depend upon the nature of the system he is managing. His role is partly influenced by the characteristics of the system. Not only what he must do, but the way in which it can be done, is influenced by the nature of the system. To explore the nature of operating systems we will examine their structure or 'shape'.

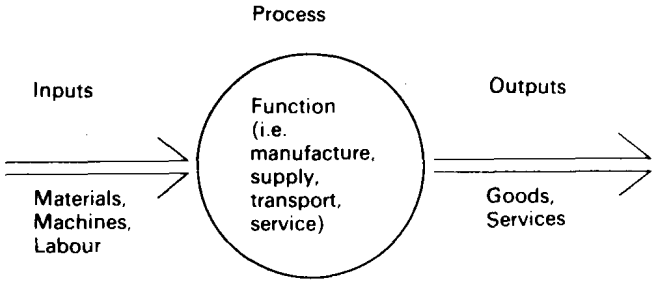

Figure 1–1. *A simple system model*

Using simple systems terminology[3] all operating systems may be seen to comprise 'inputs', 'processes' and 'outputs' in the manner of Figure 1–1. This simple system structure can represent any operating system and at any level of detail, e.g., an organization as a whole, or some part of it. As a descriptive device it is limited, hence we must examine system structure in slightly more detail. The terminology of Figure 1–2 will be used for this purpose. With this simple approach we can identify four simple structures for *manufacturing* systems, i.e.

(a) '*Make from stock to stock, to customer*', i.e. all input resources are stocked and the customer is served from a stock of finished goods.
(b) '*Make from source, to stock to customer*', i.e. no input resource stocks are held, but goods are produced to stock.
(c) '*Make from stock direct to customer*', i.e. all input resources are stocked but goods are made only against and *on* receipt of customers' orders.
(d) '*Make from source direct to customer*', i.e. no input resource stocks are held and all goods are made only against and on receipt of customers' orders.

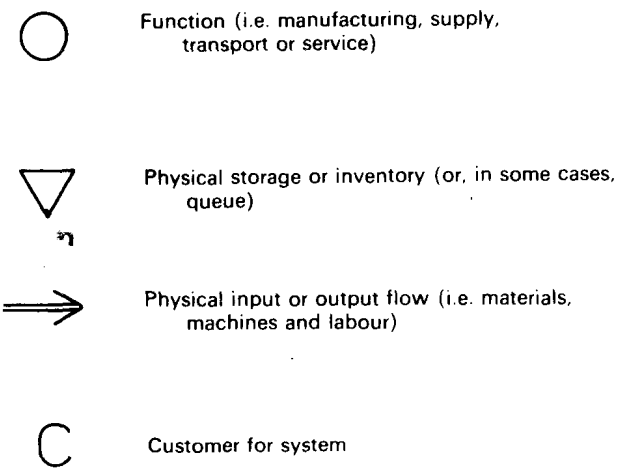

Figure 1–2. *System notation*

Each structure shows how a system will provide for future output. Structure (d), for example, indicates that, in order to provide the next output for a customer, resources must first be acquired, whereas in (c) the next customer order will be satisfied through the use of already existing resources.

[3] For a detailed discussion on the use of systems concepts in the study of management, see D. I. Cleland and W. R. King, *Management: A Systems Approach*, McGraw-Hill, New York, 1972, and the readings given at the end of this chapter.