

# Operations management in the information economy: Information products, processes, and chains

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Available online 21 December 2006

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## Abstract

The process of economic evolution from agriculture to manufacturing to services is nearing its end in the U.S. and other developed economies. Another major evolution along a different dimension is now underway: it is from a material-based economy to an information-based economy. In the past, the product–service dichotomy has proved useful as an organizing principle for the study of operations management. Today, however, a material–information categorization of products and services appears to be equally important and useful. The information sector now comprises the major share of the U.S. private economy and includes many of the largest industrial sectors and firms. We discuss the implications of this evolution for research and teaching in operations management (OM).

The basic questions addressed here are: In what ways are information products, services, processes and chains similar to, or different from, those in the material world? To what extent is it possible to manage operations in information industries using the existing operations management concepts and techniques? The conclusions are mixed. To a great extent, traditional concepts are indeed applicable and useful. However, there are significant differences. For example, quantification and measurement pose a fundamental problem in the study of information industries. As a result, there are difficulties in analyzing some of the most basic OM issues related to productivity, cost, value, and transformation. Nevertheless, the process-centric methods of operations management can be quite effective in analyzing firms and industries that produce information goods and services. An understanding of process economics and information chains is also central to the analysis of competition given the impact of new technologies on processes, firms, information chains and information industries. We conclude that while there is much in the information sector that can be addressed with our current toolkit, some very interesting and challenging issues still remain open for research. From the perspective of management education too, operations management in the information economy is an area of growing importance, with some easy wins and some significant challenges.

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*Keywords:* Information economy; Information products; Information processes; Information chains; Information intensive services

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## 1. Introduction

As long as there has been organized commercial activity of any kind, there have always been “operations” to be managed. But the modern academic field of operations management (OM) can trace its roots to the scientific management and work-study techniques of

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Taylor (1911) and Gilbreth (1911, 1912), the lot-sizing models of Harris (1913) and Camp (1922), and the shop floor models of Gantt (1916). In the service sector, the queuing analyses developed in telephony by Erlang (1909) and Palm (1957) have proved to be seminal in modeling many service contexts. Of course, the fundamental concept of a production function has been used in the field of Economics for many years, starting with agriculture and the production of simple goods. An early discussion of the special characteristics of the production function in service industries can be found in Fuchs (1968).

Casual observation suggests that there has been a bias towards the manufacturing sector in teaching and research in OM in the past (Roth and Menor, 2003). But there is now an awareness of the large role of services in the economy, research on services is growing, and service operations management appears in most management curricula. Heineke and Davis (2007) and Chase and Apte (2007) describe this in their articles in this Special Issue. Today it could be fairly said that the shift to services for developed economies is far advanced without room left to go much further. It is time to address another significant shift in the economy—that towards the information sector. The motivation for this paper is that the information sector has already become the dominant part of the economy in the U.S., and this shift is ongoing and inexorable. Furthermore, it does not work to cast study of the information sector in terms of information technology, computer science or information systems, any more than manufacturing management could be cast in terms of mechanical engineering, reaction kinetics or parts machining. Like any industry sector, there are management questions related to operations, technology management, marketing, strategy, and human resources that need to be examined, although they may look a bit different, and may have to be sliced differently from the traditional functional divisions. Certainly, the traditional topics addressed in OM are very much in evidence in the information sector as well. We would include among these topics, the analysis of processes and process economics, the framing of decisions about stocks, flows and capacities, the management of productivity, quality, time, variety and cost, the design of products and services, the configuration of the systems and networks by which products and services are produced and delivered, the management of these production and distribution systems, the management and application of new technologies, and the analysis of resource and capability based competition. The size and growth of the information sector suggest that it

behooves us to study the special features of this sector, and to develop new research and educational perspectives.

### *1.1. Information economy*

There are many definitions of data, information and knowledge. One operational definition of data is everything that can be sensed by humans (primarily heard and seen) and everything that can be converted into a symbolic (and therefore digital) representation. Information has been described as that subset of data, which is relevant, accurate, timely, and concise. It has the characteristic that it depends on the receiver as well as the sender. And, as a practical matter, information is usually generated by the processing of data by machines and/or humans.

That we live today in an information economy is an assertion with which few people would disagree. We can define the information economy in many different ways and at several different levels of resolution. With respect to the latter, we could first look at the major sectors in the economy at the level of industries. A more detailed view might look at companies. A finer view would look at jobs. A still finer view would go to the level of operations or tasks. All these views provide somewhat different perspectives on the subject. In fact, it is useful to look at the information economy at different levels of resolution so as to serve different purposes.

There exist two well-known early studies that have tried to define and measure the so-called information economy. In his pioneering work, Machlup (1962) studied what he called the “knowledge industry”. He identified the components of the knowledge industry and measured its contribution to gross national product (GNP). According to Machlup, 29% of the US GNP in 1958 was generated by the knowledge industry. Subsequently, using an approach that is quite distinct from the one used by Machlup, Porat (Porat and Rubin, 1977) measured the size and structure of the US information economy in 1967. Porat strictly followed the national income accounting framework. Machlup, on the other hand, had included a number of economic activities that were not part of the national income accounts.

The approach followed by Porat is not perfect. Companies get lumped into sectors as though they do only one thing. Nevertheless, one of the major advantages of this approach is that the definitions are (reasonably) clear, data is available for many countries, and the results are reproducible and repeatable. Porat

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