

Learning from the first Operations Management textbook

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Abstract

De Re Metallica by Georgius Agricola was published in 1556. It is arguably the first Operations Management textbook. In it the author describes the management and technologies of the mining and metallurgical industry of the period. Using the translation by Herbert and Lou Hoover, this paper reviews the book both to compare it with contemporary writing on Operations Management in process industries, and to draw lessons from its impact. Many areas which we see as contemporary, such as ethical and environmental issues, are explicitly addressed in the book although with a different view of their impact than today. The book describes how the operations should be organized and managed, the role of the foreman, and the education and training required. The characteristics of process industries as described by Agricola are compared to modern views. The most enduring lesson from this remarkable book is the importance of systematic capture and dissemination of knowledge in Operations Management.

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1. Introduction

A few years ago, I published a paper reviewing the history of Operations Management from Taylor to Toyota (Voss, 1995). Like many in the field, the work was based on the underlying assumption that Operations Management started with Frederick W. Taylor. However, as many have pointed out, it is possible to trace the field much further back. Wilson (1998) has plotted the history of JIT to about 1850; Schmenner (2001) and Lane (1934) have shown that the origins of mass production may have been in the Venice Arsenal which began production in 1104 and continued to 1797. It takes only a few seconds' reflection to realize that, as a topic of concern, Operations Management (whatever its name) must have been around much longer. It is

inconceivable that the pyramids were constructed without people who had substantial Operations Management skills. While history does not tell us whether the project was finished on time and to cost, the quality was clearly outstanding.

The development of any field is an accumulation of knowledge and learning passed on by many means including word of mouth, craft and skill training, and internal documentation. One sign of the growing maturity of a field is the development of textbooks. This work will review what is arguably the first modern Operations Management textbook, *De Re Metallica* by Georgius Agricola published in 1556 (Agricola, 1556; Hoover and Hoover, 1950). It is possible that this early writing in the West was matched if not preceded by that in both the Arab world and China, but this is outside the scope of this paper.

There are a number of important reasons why *De Re Metallica* is an interesting and relevant book to study. First, it brings together the earliest known set of

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systematic knowledge on the management of operations. Second, this textbook is also distinguished by being the first book of its kind to be based not just on the accumulated wisdom of previous writers, but also on sound empirical research. Finally, studies of the history of Operations Management have tended to trace it as a path from craft to mass production. This book focuses on process industries, and broadens our understanding of the history of the field. The paper will examine how Operations Management was viewed in the context of the mining and metals industry in the sixteenth century and relate this to the development of present day Operations Management. This analysis leads to speculation on what a medieval MBA curriculum might have looked like. Finally, conclusions are drawn about the evolution of the field.

2. Researching early operations

The principles of business history were set out by Professor Gras at Harvard in the 1920s and 1930s (Larson, 1950):

1. It is the study of process: it deals with operation, with doing, with a living stream of effort. It is concerned with a business unit, an industry or a whole system. The point of view is functional.
2. It proceeds from the standpoint of administration.
3. It is interested in the area of decisions and choices of alternatives in organizing and coordinating various functions in order to accomplish an end.

There are many sources of evidence for the early management of operations. The first is physical evidence of buildings such as pyramids, roads, bridges and other civil engineering works, manufactured goods from shoes to galleys, smelted metals from bronze to iron and implements such as axes and swords. From these it is possible to deduce much about how they were manufactured and distributed. For example, much has been learnt from studies of the stone-age axe and the wheel, and the lack of the wheel in the Americas. Scholars of technology management have a clear, well-documented history of their area going back to these technologies and their field is able to rely strongly on physical evidence. However, in Operations Management, physical evidence tells us little about how the operations were managed and we have to impute this from what can be observed. A good example is the pyramids in Egypt where there is no extant documentation on the management of their construction. Scholars have therefore used physical evidence to impute how

they were actually constructed and managed; Smith (1999), for example, has sought to reconstruct their project management.

The next source of evidence is documentation associated with particular artifacts, processes and centers of production. For example, Operations Management is associated with the initiation of writing, the earliest known examples being Egyptian and Sumerian inventory records more than 5000 years ago (Mattessisch, 2002). Much can be learned of the earliest history of Operations Management from contemporary written sources such as the extensive documentation over a very long period associated with the Venice Arsenal (Lane, 1934). Another early operation with substantial documentation was the Spanish Royal Tobacco Factory in the 18th century, better known for being the setting of the opera Carmen (Carmona et al., 1997). Studies of individual early factories such as these have revealed much about the management of operations in earlier times. The fact that mass production with standardized components was developed in Venice has been well documented. Studies have also revealed a continuous set of attempts at the Venice Arsenal to improve production methods, organization and management over many years—not all of them succeeding (Zan, 2003). This could be interpreted as the first documented attempts at Kaizen. Studies of the Royal Tobacco Factory have indicated that, by the 18th century, multi-process manufacturing strategies were being used as well as sophisticated management accounting.

Particularly interesting forms of documentation are textbooks: they tend to the generic, showing how things should be or have been done, not just how one person or one organization does things. Textbooks were written in Greek and Roman times, but tended to be associated with farming, law, morals and religion. The predominance of crafts and guilds in manufacture may account for the lack of early Operations Management texts. The nature and details of a craft were generally closely guarded: putting it in writing risked loss of these secrets.

De Re Metallica is a textbook on mining and metallurgy. That such a text should appear could be due to the advent of printing in the 16th century which had a major impact on the economics of book publishing. Further, mining and smelting were process industries and may not have had the same set of closely guarded secrets that were associated with crafts. Finally, it may have been due to the political and religious context of the time and to the author himself. The book has been described a transitional genre between the Hellenic encyclopaedia and the “Book of Secrets”, a handbook

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