

Engineering Management: The Evolution, Conceptual Model, and Social Responsibility of an Emerging Discipline

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ABSTRACT

This article continues the conversation about the formation, history, and evolution of the EM concept. It contributes to the description and advancement of engineering management (EM) as an emerging discipline, by providing a new conceptual model that depicts a framework for distinguishing a generalist-engineering manager from a discipline-specific one, such as a systems engineering manager. It discusses the challenging social responsibilities facing engineering managers and their roles. It also examines the EM body of knowledge including the engineering design management, and the need for effective engineering managers who can anticipate technical challenges and work with various stakeholders to create a better future in technical organizations.

KEYWORDS

Definitions of Engineering Management, Engineering Management Body of Knowledge, Engineering Management Education, Engineering Design Management, Engineering Management

INTRODUCTION

The seeds of any new concept are watered through their openness to relevant innovative approaches that contribute to its effective application. The engineering-management discipline has evolved through the integration of engineering and management approaches. However, to distinguish itself from existing disciplines, the engineering-management field must clearly define its purpose, scope, and roles, and make them available to various stakeholders. For instance, engineering managers must channel the impact of their activities within acceptable boundaries that do not create conflicts with existing disciplines.

This article examines the concept of engineering management. It begins with the formation of the engineering-management discipline, and a brief review of common engineering-management definitions and their analysis. Next, the paper discusses the social-responsibility aspects of engineering management during the course of the product's life cycle, from product introduction, growth, and maturity, to its decline phase.

The article also describes the engineering-management body of knowledge. It ends with the history and evolution of the engineering-management discipline, with more focus on engineering-management education, and the new and challenging social responsibilities of engineering managers as professionals in an emerging discipline (Sarchet, 1981). In the first section, the author reviews the two core disciplines contributing to engineering management: Traditional discipline-specific engineering and general management.

DOI: 10.4018/IJORIS.2018100103

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GENERAL MANAGEMENT

Anyone who participates in activities within or across organizations is either managing or being managed. Therefore, management is everybody's concern. Management originated with the construction of the Egyptian pyramids, beginning about 2639 BCE (George, 1972). While technicians were responsible for determining the characteristics and compatibility of materials, other people involved were planning, organizing, and controlling work activities. Management is about overseeing and coordinating other people's work in a cost-effective manner, to achieve organizational goals (Robbins & Coulter, 2014).

The work of the Egyptian pyramid planners is similar to the current form of management practices in organizations. Another very complex project that required careful planning and effective organization was the 13,000-mile Great Wall of China, designed and constructed between 220 and 206 BCE. The wall was built to protect the empire against external threats from enemies. The project employed more than 100,000 workers and lasted for at least 20 years.

Although no one published a study on the role of management until Adam Smith wrote *The Wealth of the Nations* in 1776 (Robbins & Coulter, 2014), management existed in various forms long before it was formally defined. The pillars for management as a discipline were established in 1911, when Frederick Taylor published *The Principles of Scientific Management*. Henry Fayol introduced management practices to the discipline in his 1930 book *Industrial and General Administration*, in which he defined management functions such as planning, organizing, commanding, coordinating, and controlling. These functions are still relevant to today's management principles. Max Weber then introduced management roles (impersonal, decisional, and informational), which added relevance to the practice.

According to Robbins & Coulter (2014), four approaches to management emerged during the course of formal management's development as a discipline:

1. The classical approach is one of scientific management, as promoted by Frederick Taylor, and the general administrative management championed by Henry Ford and Max Weber.
2. The behavioral approach, whose early advocates were Mary Parker Follett, Robert Owen, Hugo Munsterberg, and Chester Bernard, has one branch called organizational behavior.
3. The contemporary approach emphasizes systems and contingency.
4. The quantitative approach focuses on mathematical modeling and the statistical solution to management problem solving.

THE CONCEPTUAL MODEL OF ENGINEERING MANAGEMENT

The engineering-management field has its roots in discipline-specific traditional engineering, such as mechanical, electrical, civil, or nuclear engineering, and general management (Kotnour & Farr, 2005). In other words, engineering management is derived from the integration of the general management and engineering disciplines. Although fields such as systems engineering are thought to be technical disciplines, much of the work involves managing engineering activities that support product development (Eggstaff, 2013). In *Handbook of Systems Engineering and Management*, Sage and Rouse (2011) also describe systems engineering as a management discipline.

Engineering managers are the bridge between general management and engineering (Kotnour & Farr, 2005). Figure 1 illustrates the two contributing core elements of the engineering-management discipline and its branches, namely general management and traditional discipline-specific engineering (e.g., mechanical, electrical, biomedical, nuclear, or chemical engineering).

Generalist engineering management is charged with managing two or more discipline-specific engineering endeavors. For instance, a generalist engineering manager could be responsible for managing a project that relates mechanical- and electrical-engineering aspects. Some projects could

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