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DISCIPLINARY LINKS BETWEEN SCIENTIFIC
MANAGEMENT AND STRATEGY DEVELOPMENT

Bruce G. Cameron¹ and Julio A. Pertuze²

¹Engineering Systems Division
Massachusetts Institute of Technology
bcameron@alum.mit.edu

²Engineering Systems Division
Massachusetts Institute of Technology
pertuze@mit.edu

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Disciplinary Links Between Scientific Management and Strategy Development

Bruce G. Cameron, Julio A. Pertuze

Engineering Systems Division
Massachusetts Institute of Technology
77 Massachusetts Ave., Cambridge, MA, 02139
bcameron@alum.mit.edu, pertuze@mit.edu

Abstract

We investigate the incidence of links between the historical discipline of scientific management and the modern study of strategy development. Despite a century's separation, these two disciplines share noticeable commonality in their trajectories and their approach to management. We conducted a forward search of the impact of scientific management, finding influences on accounting, human resource management, and the creation of the modern MBA. We then conducted a backward search of the roots of strategy development, including a novel directed reference tree search by citation count. We find overlap between these two searches in organization theory, operations research, and industrial psychology. Further, we identify disciplinary oscillation between quantitative process studies and context-based ethnographic research in the study of management questions.

Introduction

Almost 100 years have passed since Frederick W. Taylor published his book “The principles of Scientific Management.” During these timeframe, his work has been acclaimed, criticized, interpreted and re-interpreted having vast influence in modern engineering systems. In particular, Scientific Management has influenced the emergence of management as a discipline (Wren, 2005), Organization Theory (March & Simon, 1958);(Scott & Davis, 2006), and Operations Research (Gass, 2005). This first part of this article will describe the historical context in which Scientific Management was born, the main proponents of its ideas, and impact it had on these different fields.

The second part of this article investigates the historical roots of strategy development, a contemporary methodology. Strategy development will be tracked from its origins in economics, management, and sociology from the 1940s through the 1990s, as represented by the work of Porter (1991) and Mintzberg (1990). Through the intersection of these two analyses, we will determine the extent of the influence of Scientific Management on the emergence of Strategy Development as a field.

The Historical Context of Scientific Management: The Progressive Era

Scientific Management emerged during the progressive era (1890-1920), a period in the US history characterized by social reforms to cope with some of the problems created by the industrial revolution. During that period, company owners were heavily involved in the management activities of their companies utilizing rudimentary management practices based on historical “rule of thumbs” (Taylor, 1911, p. 4). This underscores two problems, first, there was no formal training of these business leaders, and also there was no professional management class to help business owners to run their companies. From the labor perspective, workers often “soldiered,” that is, they intentionally worked slowly either because of fears of losing their jobs if industrial output increased, or as a consequence of defective management systems (Taylor, 1911, p. 4). In Europe, labor movements became strong, and industries were facing increasing labor strikes. This highlights yet another problem industries faced: antagonistic relationships between business owners and workers. As a result, the efficiency of industrial activity was low, a problem highlighted by President Roosevelt who called for increasing efficiency in US (Taylor, 1911, p. iii).

President Roosevelt’s call found response in the engineering community, which at the time had been dealing with the problem of increasing the efficiency in heavy industries. This National quest for increasing efficiency gave importance to engineers in American society, who started the Scientific Management movement (Shenhav, 1999, p. 71).

Frederick W. Taylor and the Emergence of the Scientific Management Movement

Frederick Taylor (1856–1915) was an American mechanical engineer often considered the father of scientific management. Taylor started experimenting on how to increase productivity while working at Midvale Steel Company in Philadelphia, where he ascended from common laborer to chief engineer (1878 -1884) (Wren, 2005, p. 122). Taylor then moved to the Bethlehem Steel company, where he further refined his methods and ideas. At the age of 37, became a management consultant and published a series of papers containing his work (Spender & Kijne, 1996, p. xiii). Of particular importance are “A Piece Rate System” (1895), “Shop Management” (1903), and “Principles of Scientific Management” (1911). This last book gained vast recognition in the US and was translated to several languages, spreading Taylor’s ideas around the globe (Spender & Kijne, 1996, p. xv).

While Taylor is considered the father of scientific management, he was not alone in this movement. For example, the term scientific management is actually attributed to Louis Brandeis, a pro-labor attorney who became a Supreme Court justice (Shenhav, 1999, p. 94). Other prominent proponents of scientific management were Henry Gantt, famous for the Gantt planning chart, and Frank and Lillian Gilbreth, who studied human motion to increase efficiency in the workplace (Gilbreth, 1911).

Scientific Management Principles

Scientific management consists of four basic principles (Taylor, 1911). First, the replacement of “rule of thumb” management practices by a scientific approach to analyzing management problems. This scientific approach is based on the application of systematized

experiments to solve production and management problems. This principle is perhaps one of the most important contributions of Taylor: the idea that managerial decision making can be done following a scientific approach (Locke, 1982).

The second principle is the scientific selection of the worker. As Taylor mentioned, “under systematic management, the best man raises to the top” (Taylor, 1911, p. iv), thus he advocated in favor of a differential piece-rate system for determining wages and incentives for workers. Under this system, each worker’s payment increased in proportion to the increase of output, and even more by considering the quality of the work (Taylor, 1895).

The third principle consists in the scientific education and training of workmen. Taylor utilized stop-watches and motion studies to determine how the working tasks should be accomplished. He made experiments to determine the amount of daily work a “first class man” could do, eliminating “soldiering” and setting standards to measure other workers performance.

Finally, the fourth principle is the friendly cooperation between managers and workers to ensure all work is done in accordance to scientific management principles. To achieve this principle, Taylor relied on functional foremen and a planning department which defined responsibilities and equal tasks among managers and workers.

Scientific Management First Steps

Taylor promoted scientific management as a pro-labor system since he believed that by increasing industrial efficiency, wages would rise, product costs would go down, resulting in better standards of living for the working class (LePore, 2009). Despite Taylor’s good intentions, scientific management was resisted by labor unions. Taylor even had to defend his ideas before the House of Representatives after the Watertown Arsenal strikes of 1911. This strike marked an inflection point in the influence of Taylor’s ideas (Spender & Kijne, 1996, p. 15). At the time of Taylor’s death in 1915, scientific management had diminished in influence thanks to the vigorous efforts of labor unions. However, as the winds of the First World War began to blow, scientific management was picked up again by industries seeking more efficient methods (Spender & Kijne, 1996, p. xiv). In particular, some authors argue Ford engineers standardized work routines following the rules of scientific management (Shenhav, 1999, p. 68), and that Gilbreth’s motion studies were adopted by Henry Ford for the automobile assembly line (Spender & Kijne, 1996, p. 86).

Scientific Management’s Influence on Management Theory

Taylor’s influence in modern engineering systems can be tracked in several ways. First, Taylor’s ideas heavily influenced management theory. From the academic perspective, since the early practitioners of management practices were “production engineers,” the first academic discussions of management practices can be found in engineering journals such as *American Machinist* (est. 1877) and *Engineering Magazine* (est. 1891). Figure 1 presents statistics on how management and organization systems articles permeated the engineering literature. From these journals, industrial management emerged as a field (Shenhav, 1999, p. 19).

Taylor's ideas also influenced two management subfields: accounting and human resource management. Taylor contributed theoretically to cost-accounting and to the application of accounting to manufacturing. He developed an accounting system while working at Simonds Rolling Machine Company and later propagated his findings as a consultant to DuPont and the Johnson Company, among others (Wren, 2005, p. 133). Taylor further perfected his system with the help of Harrington Emerson, creating a standard costing technique for railroad systems accounts. Finally, James O. McKinsey (1889-1937), founder of McKinsey and Co., perfected Taylor's accounting ideas by developing budget control techniques (Wren, 2005, p. 248).

The influence of scientific management into human resource management stems from Taylor's second and third principles, which are the scientific selection of the worker, their formal training, and a reward system that takes in consideration both output and quality of work (Taylor, 1911). The scientific selection of workers was an idea further developed by Hugo Münsterberg, the father of industrial psychology (Münsterberg, 1913). Other human resource management concepts such as managing by objectives (MBO), championed by Peter Drucker, can also be traced back to Taylor's differential piece-rate system (Waring, 1991, p. 78).

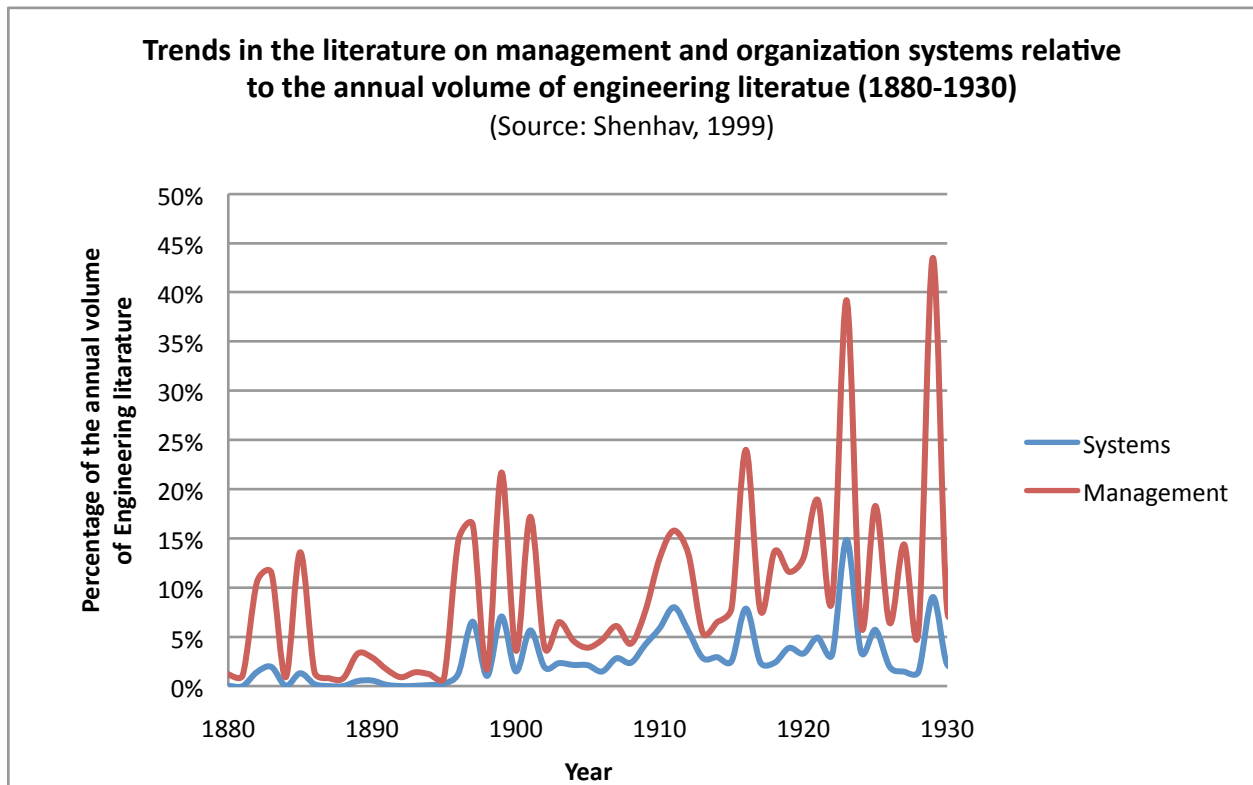


Figure 1: Evolution of management and organization systems literature relative to the annual volume of engineering literature

While this paper is mainly concerned with the academic legacy of scientific management, Taylorism also influenced both the teaching and practice of management. Indeed, as mentioned earlier, Taylor refined his methods while working at the Bethlehem Steel Company, at the time led by Joseph Wharton (Spender & Kijne, 1996, p. 13). Wharton, convinced by Taylor that management

was a science, founded the first business school in Philadelphia in 1881. Another business school influenced by Taylor's ideas was Harvard. After visiting Taylor in Philadelphia, Edwin Gay, a Harvard economics professor, decided to found Harvard's Business School to pursue a "scientific method underlying in the art of business" (LePore, 2009). Taylor became a frequent lecturer at Harvard where he influenced the future managers and business owners of his country. Taylor's ideas continue to be an object of study, as evidenced by their pervasive presence across management, human resource management, organizational behavior, industrial organization, and college psychology textbooks (Payne, Youngcourt, & Watrous, 2006).

Professional societies also played a role in diffusing Taylor's ideas. Of particular interest is the American Society of Mechanical Engineers (ASME) where Taylor first presented his papers. In addition, Taylor, Gantt, and Gilbreth, among others formed a society to advance the ideas of scientific management. The society—renamed Taylor Society after the author's death—gathered executives from the most prominent US corporations at the time, such as General Electric, DuPont and AT&T (Harber, 1964, p. 163). This society which continues to exist today played an important role in spreading Taylor's both inside the US and overseas.

Scientific Management and the Birth of Organizational Behavior

Taylor's influence on the development of organizational behavior was important albeit indirect. Indeed, organizational behavior as a discipline emerged from criticism of the Taylorist approach to human resources. Taylor posited that workmen are only motivated by their personal ambition, which translates into high wages (Taylor, 1911, p. 1). This idea was challenged in the 1930s, after the Hawthorne experiments revealed that worker motivations transcended the economic realm. Between 1924 and 1927, the Western Electric Company conducted a series of experiments to understand what factors in the workplace could affect the "morale and productive efficiency of shopworkers" (Roethlisberger & Dickson, 1939). The experiments took place at the relay assembly line in the Hawthorne Works facility, outside Chicago. A particular experiment tried to determine whether increasing the illumination levels in the shopfloor, productivity would increase. The researchers increased the illumination and observed an increase in productivity. Then they proceeded to decrease the illumination hypothesizing that would reduce productivity; however, productivity went up again. Unable to explain these findings, Western Electric managers contacted Harvard University who send a multidisciplinary group of anthropologists, sociologists and psychologists, led by clinical psychiatrist Elton Mayo to study the phenomenon. This group found that the workers at the relay assembly line increased their productivity because they were observed by a supervisor during the experiment. This phenomenon, known as the Hawthorne effect, marks the beginning of the human relations school of thought and organizational behavior as a field of study (Wren, 2005, p. 279).

After the Hawthorne experiments, organizational researchers discovered that humans are motivated by many other factors than money. Douglas McGregor nicely elicits this distinction in his Theory X and Theory Y description of human motivations (1960). While Theory X would consider that workers are motivated mainly by money (in reference to Taylor), Theory Y acknowledges that men are motivated by the desire of self-fulfillment (McGregor, 2006, p. 51).

Scientific Management impact on Operations Research

Scientific management and operations research share the same basic goal, which is the search for efficiency through scientific analysis. Therefore, Taylor, as well as Gilbreth, and Gantt, among other promoters of Scientific Management can be considered precursors of operations research (Gass, 2005, p. 19). Some of their techniques, for example the Gantt chart, are still being used for project management. Operations research as a field; however, emerged formally in 1936 when the British Air Ministry founded the Bawdsey Manor Research Station in Suffolk to study the development of the radar (Gass, 2005, p. 45). In 1937, the scientists working at the research were known as “the operational research section,” which later became the name given to all military work involving mathematical methods for resolving management problems (Waring, 1991, p. 21). While Operations Research evolved as an independent field of study, it continued to embody some of Taylor’s principles such as the scientific quest for efficiency and the need for planning departments (Operations Research departments) to guide these efforts.

Scientific Management’s Impact Overseas

As the work of Taylor gained notoriety, it was translated to several languages and started to influence industries outside the US. In 1924, Japanese Rear Admiral Takuo Godo compared the productivity of Japanese workers at the Osaka Efficiency Exhibition. He mentioned that while the British steel worker was 5.3 times more productive than the Japanese worker, the American steel worker was even 7 times more productive (Nakagawa, 1996, p. 163). Again, it was the quest for increasing efficiency what motivated Japanese industrialists to adopt some of Taylor’s ideas. In 1913, Toshiro Ikeda published the influential book *The Secret of Saving Lost Motion*, which drew on Taylor and Gilbreth’s motion studies. That same year, Yukinori Hoshino translated Taylor’s *Principles of Scientific Management* to Japanese. In 1925, the Institute of Industrial Efficiency in Tokyo opened its doors, becoming the first overseas branch of the Taylor Society (Nakagawa, 1996, p. 168). Japanese firms quickly adapted scientific management to their idiosyncrasy.

Taiichi Ohno, the inventor of the Toyota production system, mentioned that all the concepts implemented by Toyota (i.e. Just-in-time production, Kanban system, supplier relations, flexible job structuring, quality control circles, and harmonious industrial relations) were embodied in Taylor’s work (Nakagawa, 1996, p. 164). New forms of scientific management such as statistical quality control promoted by Deming and Juran emerged in Japan in the 1970s.

Historical Roots of Strategy Development

The concept of strategy is ubiquitous in modern business practice. It is the ultimate responsibility of leaders everywhere, from CEOs to Presidents. Strategy has become the broad moniker for the analysis and process leading to success – indeed, in the hallmark of American ambition, business schools, it is the capstone discipline. Despite this broad appeal, the actual foundations of strategy development remain poorly understood. This is partially due to the inherent difficulty of living up to the burden of a process which addresses all great problems, and partially due to the significant uncertainties involved. In this section, we will define the current

state of strategy development, and we will excavate its history, with a view to understanding the genesis of this modern faith.

Given the decentralized nature of modern strategy development in academia and practice, we begin with on a pair of modern thinkers to solidify our thinking: Michael Porter and Henry Mintzberg.



Figure 2 Michael Porter (left) Professor of Strategy at the Harvard Business School, and Henry Mintzberg (right), Professor of Management Studies at McGill University

Michael Porter created the modern goal of strategy development – achieving sustainable competitive advantage. His 1979 paper *How Competitive Forces Shape Strategy* (Porter, 1979) launched a framework for investigating potential strategies, commonly referred to as Porter’s Five Forces. Porter also posited the existence of common strategies across industries – namely differentiation and cost leadership (Porter, 1980). He is a Professor at the Harvard Business School, and a founder of the fourth largest management consultancy, the Monitor Group.

Henry Mintzberg is a champion of the idea of emergence of strategy, and key challenger of Porter’s views. His best known work, *The Rise and Fall of Strategic Planning* (Mintzberg, 1994), enumerates a number of fallacies of the strategic planning process, and reframes many tasks of strategic planning as ‘roles’, to specifically recognize the collaborative and multifaceted nature of strategy. He is a Professor of Management Studies at McGill University, and a founder of a small firm, Coaching Ourselves.

The dichotomy between these two thinkers illustrates the breadth that strategy touches. As an operating definition of modern strategy, we will use the process of identifying sustainable positions within an industry, capturing value at those strong positions, and aligning the firm to realize these goals. With broad definitions, it is helpful to define by exclusion – strategy development is not logistics, organizational behavior, marketing, management by objectives, leadership, microeconomics, mergers and acquisitions, or game theory, although many of these will be noted as contributors to strategy.

Literature Tree for Strategy Development

Given the wide-ranging nature of the strategy discussion, we sought a method for evaluating strategy’s evolution with rigor. We built a literature tree beginning with a seminal paper of Porter’s, and we use this as a guide to the historical roots of the discipline. We focus tightly on academic

which subsequently gained popularity is scored for its all-time citations. Google Scholar includes citations in books and (modern) conference proceedings, the former of which we feel is a mitigation of our omission of books as sources, and the later of which is a small effect for a tree whose newest entry is in 1991. By the way of anecdotal evidence, work in the 1940s and 1950s in Economics was more likely to reference books than later work, at roughly the 1/3 level (1/3 of references from this era were books). As an extreme example, Stigler's 1951 *The Division of Labor is Limited by the Extent of the Market* contains 2/13 references to journals, 8/13 references to books, and 3 references to government reports.

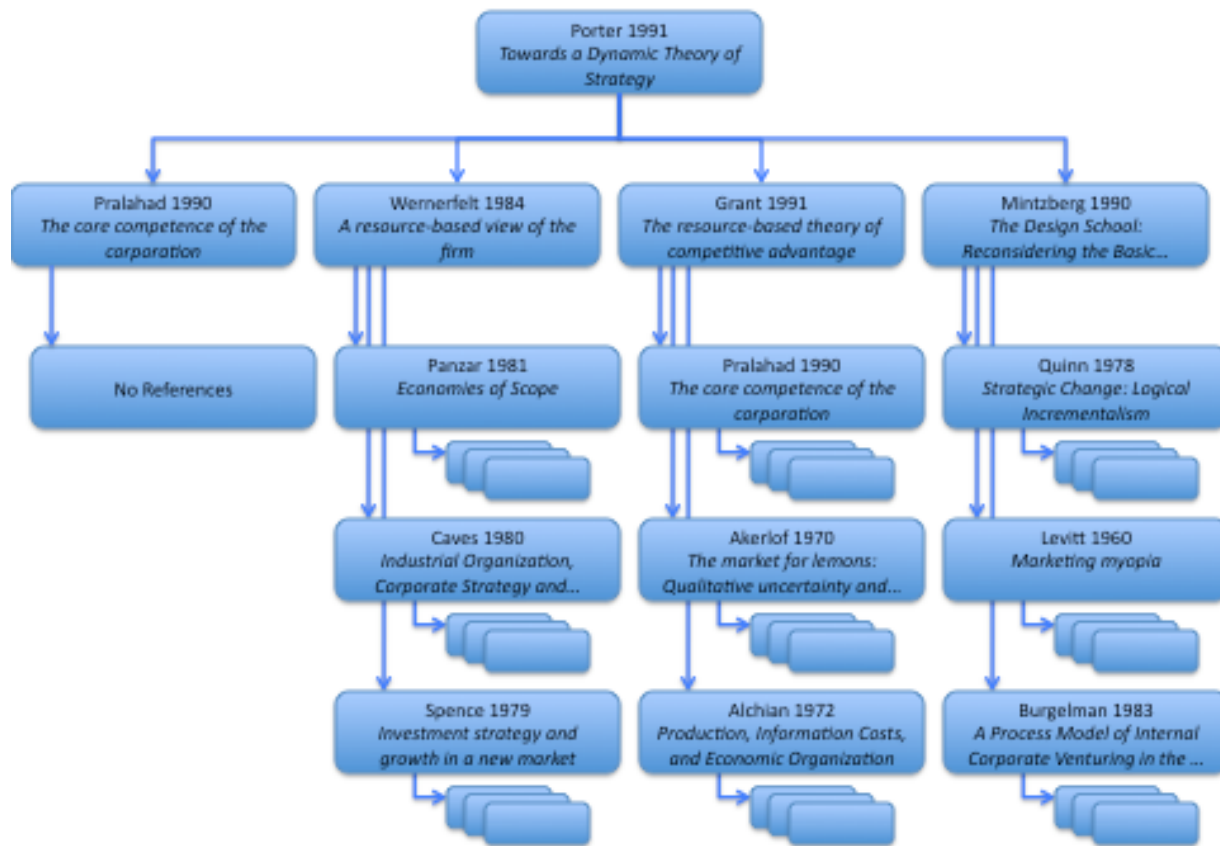


Figure 4 A representation of the constructed literature tree, showing 14 of 300 papers

The four level tree includes exactly 300 unique papers, the earliest of which dates to 1891. This historical reach ensures that we enable historical overlap with Scientific Management. Clearly this depth of analysis does not span the discipline. However, we do see some reassuring indications of coverage – 7 papers appear at least twice in the list, under different branches. A frequency distribution of the time incidence of papers in the tree is shown below.

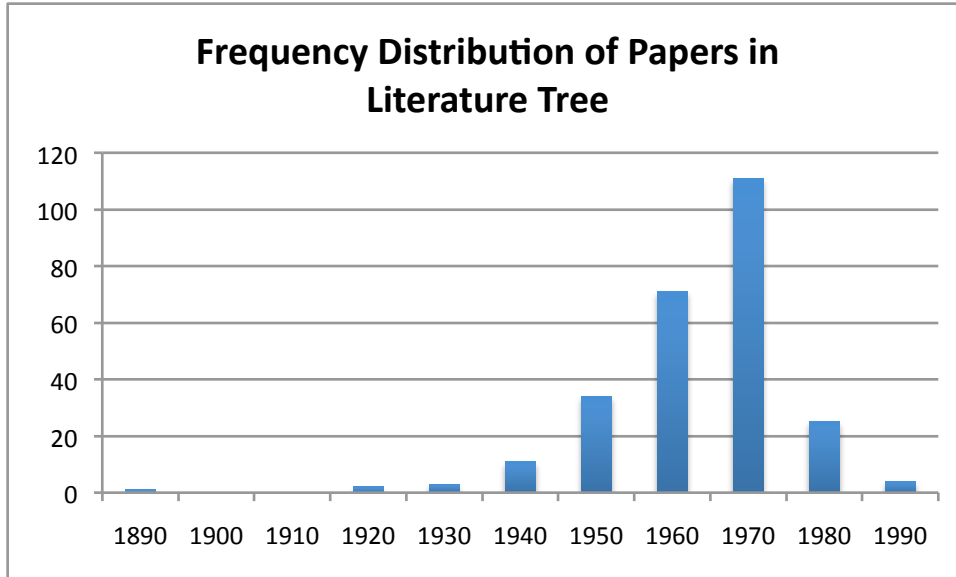


Figure 5 A frequency distribution of the time of incidence of the papers included in the literature tree

The vast majority of papers included fall into either Economics or Management, which are difficult to separate in terms of journal titles historically. Therefore, we discuss them at length, but we do not include them in the figure below. The figure below shows that the most significant contributors to strategy development outside management and economics are sociology, political economy, and psychology.

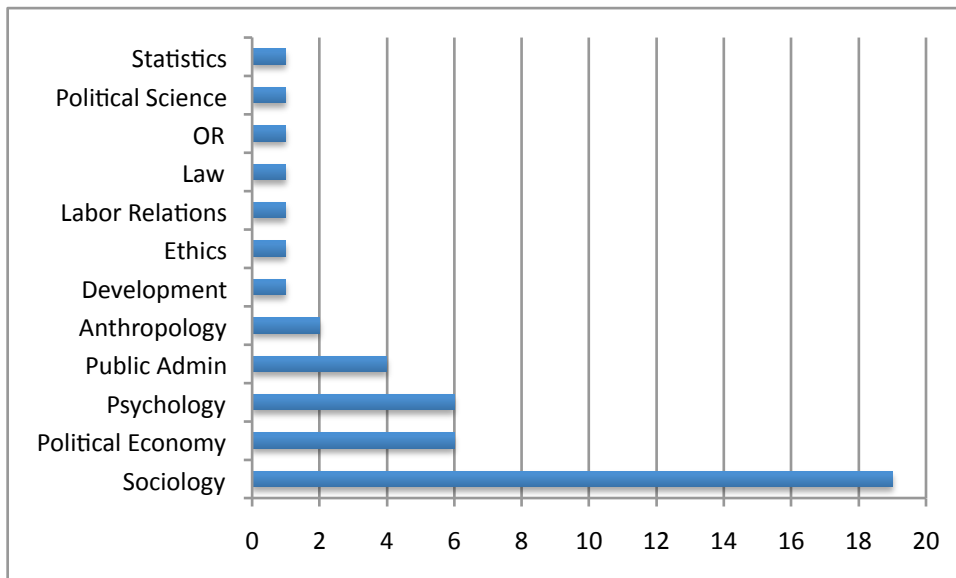


Figure 6 The incidence of non-economic and non-management papers in the literature tree

In the following pages, we will explore how the branches of the tree to determine which fields originate from which branches, what currents of thinking flowed through these contributory

disciplines, and how they contributed to the formation of strategy. We begin with the contribution of economics, most of which accumulate within the Porter branch. This is followed a focus on sociology and management, found largely within the Mintzberg branch. Subsequently, we highlight additional tributaries for their diversity of origin.

Historical Roots of Strategy in Economics

Within economics, Porter (1981) cites industrial organization / industrial economics (Learned, 1969) as an influence on industry analysis, specifically in the development of consistency tests between one's strategy and the industry characteristics. Porter (1981) credits Ansoff (1964) with translating this work into a process-based view of strategy formulation. This link is identified in the tree via:

Porter (1991) -> Mintzberg (1990) -> Ansoff (1964)

Ansoff is arguably one of the earliest proponents of the modern process view of strategy, including the idea of planning by scenarios (Middleton, 2003).

Still within economics, Porter cites the resource-based view of the firm as a contributor to strategy (Barney, 1991; Grant, 1991; Wernerfelt, 1984). This field of economics and management has attempted to quantify the assets the firm possesses which yield competitive advantage. Early work in economics, namely Stigler's *Information in the Labor Market* and Coase's *The Nature of the Firm* can be seen to represent the predecessors to this theory, via:

Porter (1991) -> Grant (1991) -> Akerlof (1970) -> Stigler (1962)

Porter (1991) -> Wernerfelt (1984) -> Caves (1980) -> Alchian (1972) -> Coase (1937)

This work in economics led to a management branch of this theory, best known as Core Competence (Prahalad, 1990).

Porter's framing of forces influencing the firm did much to unite the previous work in economics, and make it accessible to managers conceiving strategy. Industrial economics informed how the firm should analyze its industry context, and the resource-based view of the firm informed which industries the firm should compete in, and much earlier work on barriers to entry informed how the firm should protect its competitive position. This work on barriers to entry was nascent in other the thinking of other management thinkers at the time (Dixit, 1979) when Porter proposed his Five Forces, but it was clearly grounded in work on economic analysis from the previous two decades, such as Wenders (1971) *Excess Capacity as a Barrier to Entry* and Williamson (1963) *Selling Capacity as a Barrier to Entry*.

Rounding out the economic contribution to strategy per Porter are game theory (Von Neumann & Morganstern, 1953) for framing competitive interaction, and oligopoly theory for filling the gap left by economist between pure competition and monopoly (Sherer, 1970). While game theory's contribution to strategy is still a on-going, March's (1958) early work on bounded rationality formed early ties between the economic modeling and managerial literature.

Historical Roots of Strategy in Management and Sociology

Porter's analytic and process-based view of strategy contrasts strongly with a long thread of management thinkers who believe strategy is emergent. To these ends, sociology and management case studies are commonly utilized to understand how strategies came to be, and what the human forces that influence strategy development.

Peter Drucker is one of the original management thinkers on strategy, with a distinct focus on people. From a background in international law and politics, his early career transitioned to management during a two year study of GM in 1943 (Drucker, 1946). This study was similar to an ethnography, and approached organizational decision-making as a social process, rather than as a linear progression. His work revealed decision-making to be a non-trivial process worthy of scientific study, and also began the influx of sociological techniques into management. Among many contributions, his "management by objectives" has clear lines to the future interaction of strategic planning. His later work is captured in the literature tree via

Mintzberg (1990) -> Quinn (1978) -> Mintzberg (1976) -> Drucker (1971)

Drucker's work contributed to the early formation of organizational behavior, which would become the home the social sciences in management, which in turn came to influence how thinker like Mintzberg conceived of strategy as embodied by the organization. This work of organizational behavior can be seen as a trace through the literature tree, from Thompson (1958) *Organizational goals and environment: goal-setting as an interaction process* to Hall (1967) *Organizational size, complexity, and formalization* culminating at Child (1978) *Organizational structure, environment, and performance: The role of strategic choice*.

It is largely organizational behavior which received the influx from sociology. In fact, it appears that there was a cross-fertilization, whereby many sociology of management papers were published in sociology journals. For example, MacAulay's (1963) *Non-Contractual Relations in Business: A Preliminary Study* was published in the American Sociological Review. While the contributions to theory from sociology are many, some examples are the Problem of Authority (Drucker's original interest), Contingency Theory (there is no best way to make decisions in an organization), and Organizational Ecology (framing of competition as natural selection).

Historical Roots of Strategy in Ecology and Psychology

Organizational ecology leads nicely into the influence of the sciences into strategy. Ecology was inspirational to strategy both through economics and sociology. While the question of why some firms succeed is not a new question, it's framing with respect to the environment (read: industry analysis) was novel. Richard Nelson's (1982) book *An Evolutionary Theory of Economic Change* had impacts on strategy both via economics, and on sociology through his earlier work *The Simple Economics of Basic Scientific Research* (Nelson, 1959) on framing technical innovation as a key variable in the firm's environment – the latter is captured in the literature tree.

The psychology of decision-making comprises the second major contribution of science to strategy. Studies highlighted in the literature tree range from controlled experiments – Shapiro's

(1960) *A contribution to a history of the placebo effect* – to surveys aimed at validating theoretical models of the decision-making process, such as Stagner's (1969) *Corporate decision making: An empirical study*. While some avenues have contributed significantly to the literature (such as employee motivation – see House (1967)), psychology's basic science focus has made it difficult to establish clear principles among the complexity of operational strategy decisions. As such the influence of psychology has not traditionally impact strategy directly, but percolated through sociology and organizational behavior- for example, Porter (1991) notes that cognitive psychology holds promise for business, but he cites an HBR paper rather than the psychology literature.

Analysis and Conclusions: What Impact Did Scientific Management Have on Strategy?

Having now investigated both the forward impacts of scientific management and the historical roots of strategy development, we are now in a position to determine the extent to which they overlap. As seen in the figure below, scientific management was clearly a predecessor or contributor to a number of fields which in turn influenced strategy development. Among these links, the influence of Taylor to the development of organizational behavior can be seen as clear link forward to work conducted on assessing organizational goal setting and alignment for strategic purposes.

Another thread linking Taylor's work with Porter's ideas can be found through Operations Research. Porter described there are two ways to achieve strategic advantage: differentiation or cost leadership (Porter, 1980). As mentioned earlier, Taylor's ideas permeated Japanese manufacturing and these companies, in the quest for increasing efficiency, achieved cost leadership against their US counterparts. Some authors have argued that the ideas of Deming and Juran on quality management were directly influenced by Taylor (Wren, 2005, p. 463).

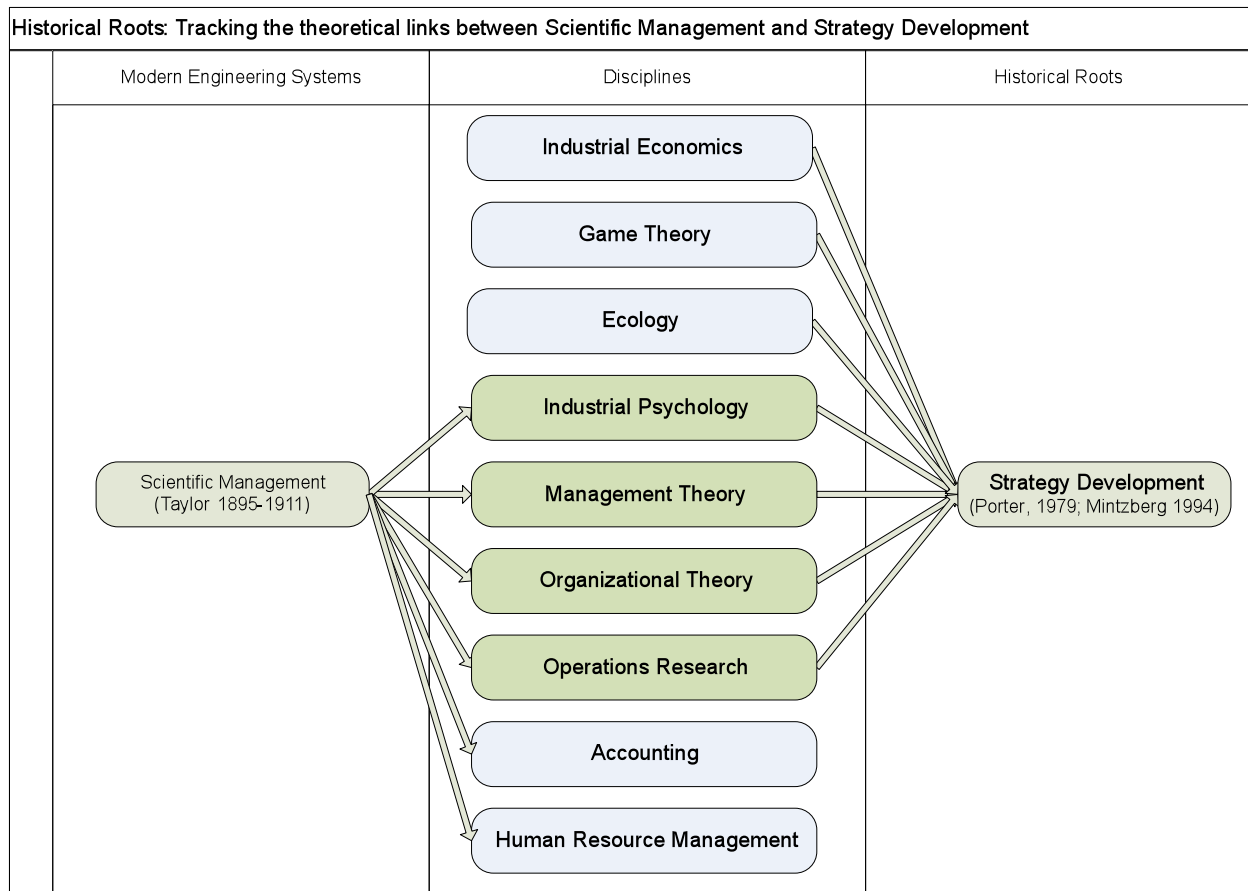


Figure 7 A representation of the overlap between scientific management and strategy

While we do note that there is overlap, the connections are at best indirect and tenuous. In part, this is due to the separation in time between these two disciplines – Taylor’s first writing dates from 1895, and strategy only began to emerge as a separate academic discipline from management and economics in the 1970s and 1980s. Further, there is a clear difference in the mode of representation for theory and methodology between these two times – Taylor’s era lacked the clear traceability of academic journals we now enjoy.

That said, in large part, the indirect nature of this link is a reflection of the nature of methodological evolution. With a broad brushstroke, it can be argued that management and strategy have oscillated between art and science, experience and method, determinism and emergence. This debate is still alive today among Porter and Mintzberg, to some extent. Taylor’s early attempt to reduce management heuristics to science based methods was the first in a series of waves in modern times. When a limited test succeeds, inventors and theorists seek to generalize that knowledge to a broader field. Therefore, while discrete manufacturing processes can be well characterized by time, materials, and labor, more complex processes such as group behavior cannot be so simply characterized. A given attempt at creating a descriptive or prescriptive representation is not necessarily passed to its successor theory. Subsequent attempts react to previous failures and successes – in some cases, like in manufacturing, they find strong applications, such as assembly

lines. In other cases, they seek the opposite end of the spectrum, as did Peter Drucker in using ethnographic and sociological techniques to describe GM.

It can be seen that both of these disciplines evolved non-linearly, lying in wait until enabling contributions in other fields or techniques became ready. Scientific management was first dependent on the data gathering and processing techniques developed in its wake, and secondly on computational and mathematical resources, in order to progress forward as Operations Research. Likewise, strategy development existed as a more qualitative process until sufficient economic research could put together in order to characterize broad heuristics of competition. This evolution of disciplines by fits and starts contrasts with a linear model of knowledge progression, but we believe that this representation enables a greater understanding of the underlying true dynamics.

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