Scientific Entrepreneurial Management: Bricolage, Bootstrapping, and the Quest for Efficiencies

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Frederick Taylor is well recognized for his principles of scientific management. Scientific management was designed with the intent of seeking greater efficiencies in the use of labor and the consequent production of material goods. More notably, scientific management was tested and promoted primarily in the context of established and larger businesses. We argue that Taylor's quest for efficiencies can apply in yet another context, that of entrepreneurial firms and small businesses. Bricolage and bootstrapping are presented as two resource management techniques used by entrepreneurs that closely resemble Taylorian efficiency perspectives. Taylor's relevance to the scientific management of entrepreneurship is discussed.

Since its publication a century ago, Taylor's classic treatise on the principles of scientific management (Taylor, 1911) has been instrumental in revolutionizing management thought. Taylor was primarily motivated by the need for greater national efficiency, and responded to President Roosevelt's call of the hour to conserve national resources as the first step on the road to reaching national efficiency. Taylor recognized that the greatest wastage of resources occurred in the area of human effort, as they were "less visible, less tangible, and are but vaguely appreciated" (Taylor, 1911, p.5). Towards this end, he systematically dedicated his efforts to improve, via scientific methods, the efficient and non-wasteful usage of human, material, time, technological, and capital resources.

Scientific management can therefore be viewed under the broader framework

of resource management techniques or approaches that are applicable to businesses. The management of resources is of critical importance because strategic management scholars have found that the mere possession of resources by itself is unlikely to lead to a long term competitive advantage or superior performance. Hence, strategic management (Teece et al., 1997) and resource based views (Barney, 1991) suggest that adequate resources are probably necessary but insufficient to ensure a firm's competitive advantage. Exploiting resources in unique and inimitable ways creates avenues for superior productivity. Creating value through resource combining and developing dynamic capability is essential for a sustainable competitive advantage (Teece et al., 1997; Eisenhardt & Martin, 2000). Dynamic capabilities allow firms to alter their resource base (Helfat, 1997) by extending, modifying or creating resources. The principal objective of scientific management was to ensure the maximum prosperity for both the employer and the employee. This maximum prosperity, according to Taylor, undeniably occurred when the individual reached the highest state of efficiency. As such, "maximum prosperity can exist only as a result of maximum productivity" (Taylor, 1911, p.12). In line with the logic of dynamic capabilities, Taylor emphasized the economical usage and combination of human and material resources to provide a higher level of productivity and performance. From this perspective, scientific management was an early precursor to the notion of dynamic capabilities and resource-based views of the firm.

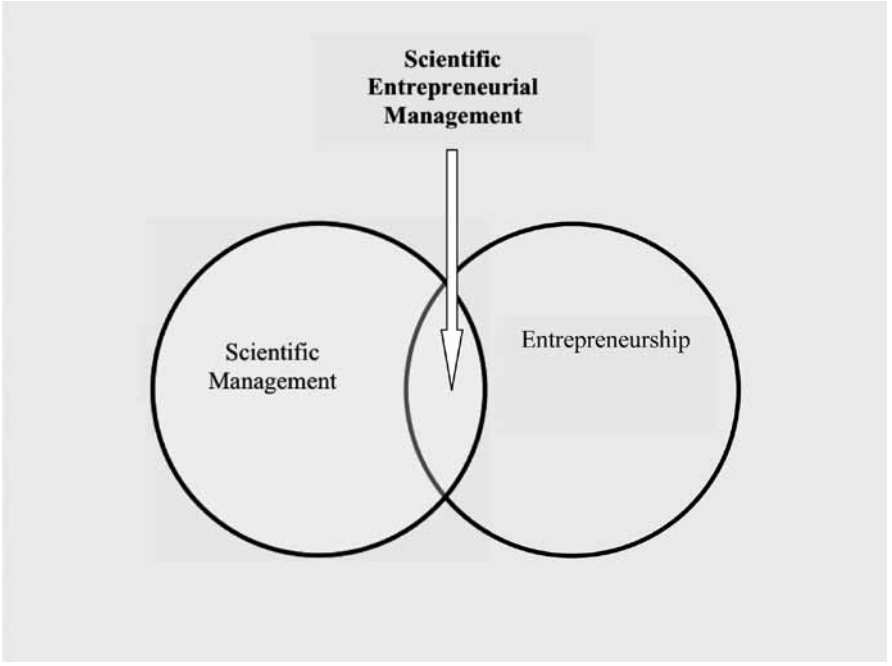
In this paper, we therefore view scientific management as a subset of the firm level resource management approaches that are available to businesses. No doubt, scientific management involves much more than resource management techniques or systematic experimentation. Therefore, it must be noted that we do not utilize all the principles of scientific management, but only some of them, as relevant to our objective. The rest of the paper (in which the primary objective is to showcase the relevance of Taylor's work to entrepreneurial practice) is organized as follows. First, we uncover the similarities in objectives between entrepreneurship and scientific management's mutual quest for efficiencies. Next, we present bricolage (i.e., improvisation) and bootstrapping (i.e., operating effectively without external/financial help) as particular examples of entrepreneurial behavior that reflect Taylor's principles of scientific management. Finally, we conclude with implications and the relevance of Taylor's work to enhance our understanding of entrepreneurship.

We also introduce a new field that lies at the intersection of scientific management and entrepreneurship (Figure 1). Figure 1 visually depicts the two fields of entrepreneurship and scientific management. The overlapping domain that lies at the intersection of these two fields is the area that represents the new field of scientific entrepreneurial management. The identification of new fields that lie at the crossroads of two established research paths is not new. Prior scholars have used this approach to similarly introduce new fields such as international entrepreneurship (McDougal & Oviatt, 2000). The potential topics that may be included in this new field is provided and discussed later in Table 1.

The paper is, to our knowledge, the first in its attempt to link Taylor's contributions to entrepreneurial practice. Though entrepreneurship is a relatively new entrant in the field of management, and was, needless to say, nonexistent as a discipline during

Taylor's time, we find strong resonance and reflection of scientific management principles in the practice of entrepreneurship. As such, a century later, Taylor's work is still valuable and relevant to our understanding of business and management in a variety of contexts.

Figure 1: *Scientific Entrepreneurial Management lies at the intersection of Scientific Management and Entrepreneurship*



Quest for Efficiencies: Scientific Management and Entrepreneurship

In both scientific management and entrepreneurship, a major factor that drives success is the level of efficiency, or the efficient use of resources. Scientific management assists in the evaluation of internal and external factors so that efficient operations may be conducted within the organization. Hence, it allows businesses to earn a larger income from a given set of resources. This significant rise in income is made possible by resource conserving management and very efficient operational processes (Mohanty, 1993).

Taylor acknowledges that the restriction in output in the Midvale Steel Company was a result of inefficiencies that could easily have been corrected by scientific management of the work and workers (Wren, 1994). Both systematic and natural "soldiering" were identified as sources of inefficiencies in the worker that could be overcome by the application of differential pay rate systems for "first class" work (Taylor, 1903; Wagner-Tsukamoto, 2007).

Since the workers at Midvale commonly understood and believed in the "lump of labor" theory, they felt that working more quickly or doing more reduced the total work available, thus reducing their ability to find jobs for themselves or other fellow workers. By altering the wage system and appropriately structuring the incentives for highly efficient workers, Taylor was effective in creating a mental revolution on the part of both the worker and management (Locke, 1982; Wrege & Greenwood, 1991). This brought about a new mindset that propelled the way to greater economic prosperity for both the workers and management.

Taylor's quest for efficiencies did not stop at overcoming mental resistance, but went further to address the operational details in another well known experiment (i.e., the shoveling experiments). The goal of the shoveling experiments was to come up with the maximum/ideal weight that should be borne in a shovel. This optimal weight would allow a "first class man" to be most productive for the company. Though the optimal weight may cause tiredness, it would not lead to exhaustion of the worker. With systematic methods and observations of time and motion, scientific management came up with the most efficient, ergonomic, and economic set of activities that if performed in the proper sequence and timing, would potentially increase output several times over (Locke, 1982; Wagner-Tsukamoto, 2007). No doubt, such rigorous application of scientific principles to work activities was a significant departure from the prevalent "rule of thumb" or traditional approaches to management (Taylor, 1911; Locke, 1982; Schachter, 2010). The presentation of comparative evidence and data on both scientific and traditional approaches convincingly showed the superiority of the scientific approach (Drucker, 1976; Wren, 1994). Businesses that wanted to reap the benefits of greater productivity with the same or lesser resources, quickly adopted Taylor's principles, despite initial skepticism and opposition (Schachter, 2010). Thus, Taylor was successful in his quest for greater efficiencies in the workplace, and for introducing a scientific basis for the conduct of management.

Interestingly, Taylor's experimentation, observation, and application of the principles of scientific management seemed to occur primarily in one industrial context, i.e., large, established manufacturing plants such as the Midvale Steel Company and the Bethlehem Steel Company. Nevertheless, as pointed out by Taylor himself, scientific management was generalizable to other contexts as well (Taylor, 1911; Locke, 1982; Guillen, 1997). Smaller businesses and entrepreneurial firms can likewise benefit in equal measure and experience greater efficiencies by the efficient management of resources as espoused by the principles of scientific management.

In the entrepreneurial context, most new businesses and startups are small in size at the time of founding, and often face liabilities of size (Stinchcombe, 1965). In addition, liabilities of newness are another burden that these firms must endure during the initial stages (Stinchcombe, 1965). They are also usually constrained in the availability of resources, having less access to financial, technological, and human capital than established, and larger firms. The absence of slack resources puts these entrepreneurial businesses in an environment of constrained resources. The entrepreneur, in order to be successful, must ensure that productivity is not hampered by the lack of adequate resources. The quest for efficiencies therefore has a much more sharpened and focused edge in entrepreneurial businesses. Both labor and management are often located in

a single person, the entrepreneur owner, who tries to orchestrate firm performance single handedly, or with minimal help. Efficiency becomes the mantra that allows the entrepreneur to operate under constrained resources. By efficiently managing available resources (time, money, materials, labor) in unique and inimitable ways, entrepreneurs are able to deal with competitive pressures and grow into successful businesses. On the other hand, a large percentage of new startups fail because they are unable to operate with the desired efficiency and productivity levels of their competitors who may have the benefits of slack or richer resource environments (Aldrich & Auster, 1986; Carroll, 1993; Wu et al., 2008). The successful quest for continuous efficiencies therefore, may be said to characterize successful entrepreneurial businesses.

Table 1: *Linking Scientific Management and Entrepreneurship*

Conceptual Similarities	Examples in Scientific Management	Examples in Entrepreneurship
Developing a science for each element of each person's work	Optimal sequence of steps (Taylor, 1911*); Objective method for efficiency (Locke, 1982*); Mapping organizational efficiencies (Wagner-Tsukamoto, 2007*)	Efficiency and quality benchmarking in franchising (Kidwell & Nygaard, 2011); franchising as an entrepreneurial partnership to increase speed, scale, and scope of a workable system (Grewal et al., 2011; Buzza & Mozca, 2009); HR practices and role requirements directed toward increasing customer satisfaction (Voss, Frankwick, & Chakarborty, 2002*)
Workers are scientifically selected and trained	Right man for the right job (Taylor, 1903*; Lock 1982*); Tasks Identification and specification (Taylor, 1911*; Freeman, 1996*); Understanding human resource needs (Jones, 2000*)	Staffing for emerging and growing firms (Short et al., 2010); identifying potential candidates career potential with the firm (Lee & Vankataraman, 2006); Trade name membership to increase employee training (Litz & Stewart, 2000); someone is clearly responsible for all important processes (Sayles & Stewart, 1995*)
Cooperation between management and worker so that work is done in accordance with the developed science	Cooperation between managers and workers (Taylor, 1911*); Conflict resolution and overcoming opportunism (Wanger-Tsukamoto, 2007, 2008*)	Building social networks (Greve & Salaff, 2003); empowering employees through corporate entrepreneurship for organizational effectiveness (Sundbo, 1999)

* Specified link or mention to scientific management in article

Among other things, scientific management may be viewed as a systematic method that involves painstakingly developing a science for each element of an individual's task, then scientifically selecting and training workers for each position and roles, and finally, ensuring cooperation between management and workers so that the scientific processes are duly followed to accomplish each task. Table 1 links these three higher-order concepts of scientific management with similar concepts that are valued and sought after entrepreneurship. Here we provide examples from entrepreneurship research that involve the three scientific management processes for a) increasing effectiveness and efficiencies (Kidwell & Nygaard, 2011; Grenwal et al., 2011; Buzza & Mozca, 2009; Voss, Frankwick & Chakarborty, 2002); b) formalized procedures for hiring and training the right person (Short et al., 2009; Lee & Venkataraman, 2006; Litz & Stewart, 2002; Sayles & Stewart, 1995); and c) developing cooperative relationships between employees and the entrepreneur (Greve & Salaff, 2003; Sundbo, 1999). We provide these examples to support our vision of a new field of scientific entrepreneurial management, and to indicate the potential topics that may be included in the zone of

intersection between the two fields of entrepreneurship and scientific management previously depicted in Figure 1.

Given the similarities of objectives in both scientific and entrepreneurial management, it is surprising that extant scholarly research has failed to address this area of overlap. We close this gap in the literature by identifying two specific examples of entrepreneurial behavior that most closely embody the principles of scientific management. By taking this novel approach, we hope to stimulate a greater appreciation of the relevance and implications of Taylor's work to entrepreneurship.

Bricolage and Scientific Management

Levi-Strauss (1966) first introduced the idea of bricolage as a way of describing how humans relate to their environments. The idea of bricolage has been adapted and examined more extensively in management literature as a resource management process (Ciborra, 1996; Duymedjian & Ruling, 2010). The original notion of the concept developed by Levi-Strauss (1966) was to make do with whatever is available, and this description has been adopted by subsequent researchers (Duymedjian & Ruling, 2010). For example, bricolage has been discussed in relation to improvisation (Weick, 1993; Orlikowski, 1996; Ciborra, 1996; Moorman & Miner, 1998), sensemaking (Weick, 1993), entrepreneurship (Baker, Miner & Eesley, 2003; Baker & Nelson, 2005), technological systems (Ciborra, 1996; Orlikowski, 2000), and innovation (Garud & Karnoe, 2003).

The central concepts in bricolage include "making do," "improvisation," and "a refusal to be constrained by limitations" (Di Domenico, Haugh & Tracey, 2010). The centrality of bricolage to entrepreneurs can be seen from the fact that in addition to improvisational effects on some foundings, it permeates a wide range of entrepreneurial activity in the form of strategic, tactical, and network improvisation (Baker et al., 2003). Baker and Nelson (2005) suggested taking a constructivist approach to resource environments would be more beneficial to understanding entrepreneurial behavior, since bricoleurs refuse to enact limitations imposed by resource environments. That is, small entrepreneurial firms recognized and exploited opportunities from various inputs that were ignored or rejected by other firms.

For clarity, we adopt an integrated definition of the term bricolage as "making do by applying combinations of the resources at hand to new problems and opportunities (Baker & Nelson, 2005, p. 333). This definition is useful as it allows for further discussion of bricolage as an organizational process (Ciborra, 2002) for managing resources.

Environments change and organizations are not static (Ciborra, 1996), therefore organizations should be concerned with the timeliness with which they are able to react and recombine resources to meet those changes (Ciborra, 1996). In meeting those demands and reacting to environmental uncertainties organizations work within the constraints of a finite amount of resources (Duymedjian & Ruling, 2010). To overcome those constraints, organizations have several choices such as resource-seeking, refusing to act at all (Baker et al., 2003) or following a process of bricolage, making do or recombining resources in their inventory (Ciborra, 1996). The resource management process is characterized as having three components: resource inventory, resource bundling and resource leveraging (Simon & Hitt, 2003).

The process of bricolage is said to be a process where the actor has intimate knowledge (Ciborra, 1996) of their inventory "repertoire" (Levi-Strauss, 1966) and will assemble, often heterogeneous (Duymedjian & Ruling, 2010) resources. While the organization does have intimate knowledge of their resources and the identity of the platform (Ciborra, 1996) for which they operate, the assembly and recombination of resources is not a perfect process. It is a process of trial and error and often continual incremental adjustments to find the right fit for the problem at hand (Simon, 1997). Once the process of recombining resources addresses the problem, the process stops (Duymedjian & Ruling, 2010).

Baker et al. (2003) and Baker and Nelson (2005) identified the importance bricolage has for the entrepreneur's process of organization growth. For entrepreneurial organizations that are actively 'fiddling' (Ciborra, 1996) or recombining existing resources they are achieving several positive outcomes. First, the organization is involved in a learning process that will help it understand more about its own resources and how it can effectively compete in the environment (Fernandes, 2005). Second, they are finding new and possible beneficial responses to this innovative recombination of resources from the environment. This is a demarcation from the view that strategies and resource utilization occur primarily from an a priori idea (Duymedjian & Ruling, 2010). Network bricolage (Baker et al., 2003) occurs when organizations mobilize other actors in their existing networks to address the uncertainties they face in common. This idea of network bricolage is different than the entrepreneur's typical use of networking tactics to obtain resources. In contrast, they view network contacts as a primary 'on hand' resource to be utilized (Baker et al., 2003). Network bricolage is another area of resource management that entrepreneurial organizations seem to derive benefit from.

According to Weick (2001), successful bricolage in organizations requires the following conditions: intimate knowledge of resources, careful observation and listening, trusting one's ideas, and self-correcting structures with feedback. This fourfold description fits scientific management rather closely. Taylor's approach involved a thorough and deep understanding of the resources at hand, especially human resources. He stressed the importance of knowing what each worker was capable of, since effectiveness of the technique was dependent on finding the "right man for the right job." His selection of "Schmidt," a very tall, large and energetic man, was extremely critical for illustrative purposes. Had a less capable man been chosen, it would have been unlikely to get the results (increased productivity) that scientific management promised.

Taylor's scientific method involved careful observation of the men at Midvale Steel. One well-known experiment was the loading of pig iron ingots onto railroad carts. A systematic analysis of the time and motions required for each action was conducted, so as to come up with the optimal sequence of steps that were required to perform the task of loading pig iron ingots for transportation. The third aspect of bricolage, trusting oneself, is true of scientific management's emphasis on the philosophy of mental revolutions. Taylor cautions against mistaking "the mechanism of management for its essence, or underlying philosophy" (Taylor, 1911, p. 128). An essential component of Taylor's principles is the trust and belief that prosperity is ensured for both the worker

and management. Each worker was told very clearly what the expectations were for a "first class man." Further, if these expectations were met, they could trust management to pay them "first class wages." Management likewise could trust that workers understood and behaved as per this arrangement, and disputes were minimized. Both management and workers trusted that greater efficiency was in their best interest. Without this attitudinal buy-in to scientific management, companies would find it very difficult to ensure commitment or realize the success of heightened efficiencies.

The fourth aspect of bricolage, self-correcting structures with feedback, is also deeply evocative of scientific management. Once expectations for the differential pay rate system were set up and formalized, each worker received feedback on a daily basis regarding their performance the previous day. Color coded slips (white which indicated everything was okay, and yellow which indicated that they must do better or they would be shifted to another class of work) were placed in each worker's special pigeonhole. The ingenious use of colored slips ensured that the illiterate workers knew without reading, whether their work was above or below par, and allowed for self correcting behaviors as a result of their performance feedback.

Scientific management reflected a formalized and science-based system of management. Similarly, bricolage can also (but need not always) be considered as a formal system. Though bricolage may initially begin informally, over time it is likely to become routinized and explicitly encoded into behavioral and operational processes in a formal manner. Engaging the process of bricolage not only helps to build competitive advantages through the identification of new and creative outcomes, but it can also be a formalized process (Duymedjian & Ruling, 2010). The outcomes of bricolage can be transformed into a functional structure through codification of arrangements, effectively turning a process of trial and error into an organization routine (Ciborra, 1996; Duymedjian & Ruling, 2010). This formalization process is a way for organizations to exploit the value of the practical arrangement, and scientific management has much to contribute to the systematization of this process. Bricolage (like scientific management) is a useful management tool, that is both effective and beneficial (Duymedjian & Ruling, 2010).

Table 2 builds upon Weick's (2001) fourfold classification of bricolage to identify the conceptual similarities between scientific management and bricolage. In this table we have summarized the key research that showcases each of these four aspects in both scientific management and entrepreneurship. For example, we can see that scientific management is concerned with knowledge of firm specific resources in terms of human capital (Taylor, 1903; Locke, 1982; Jones, 2000). Similarly, knowledge of resources is central to bricolage in ensuring growth (Jarillo, 1989; Baron & Markman, 2003) and resource mobilization (DiMaggio, 1988; Battilana & Leca, 2009). Further scientific management is concerned with observation and efficiencies (Wagner-Tsukamoto, 2007) and in entrepreneurship as well, there is great focus on organizing activities and sequences (Delmar & Shane, 2004; Carter, Gartner & Reynolds, 1996). In terms of "trusting one's ideas," we observe that scientific management has focused on cooperation (Taylor, 1911) and conflict resolution (Wanger-Tsukamoto, 2007). Likewise, we find that entrepreneurship research considers cooperation (Aldrich, 2000; Wu et al., 2008) and self-confidence (Kollinger, Minniti & Schade, 2007) as important concepts. Finally,

both scientific management and entrepreneurship research identifies the need for examining feedback through goals (Locke, 1978) and entrepreneurial hindsight and exit (Cassar & Craig, 2009; Wennberg et al., 2010). The table also indicates research articles that identify or explicitly mention scientific management. We provide this summarized research table to show evidence from prior research that both bricolage and scientific management have conceptual links that could be further explored.

Table 2: *Linking Scientific Management and Bricolage*

Conceptual Similarities	Examples in Scientific Management	Examples of Bricolage in Entrepreneurship
Knowledge of Resources	Right man for the right job (Taylor, 1903*; Lock 1982*); Tasks Identification and specification (Taylor, 1911*; Freeman, 1996*); Understanding human resource needs (Jones, 2000*)	Entrepreneurial growth and external resources (Jarillo, 1989); Necessity of resources (DiMaggio, 1988); Need for resource mobilization (Battilana & Leca, 2009); Role of social capital and entrepreneurial success (Baron & Markman, 2003)
Careful Observation and Listening	Optimal sequence of steps (Taylor, 1911*); Objective method for efficiency (Locke, 1982*); Mapping organizational efficiencies (Wagner-Tsukamoto, 2007*)	Start-up behaviors (Gatewood, Shaver, & Gartner, 1995); Start-up event sequences (Carter, Gartner, & Reynolds, 1996); Organizing activities (Delmar & Shane, 2004)
Trusting One's Ideas	Cooperation between managers and workers (Taylor, 1911*); Conflict resolution and overcoming opportunism (Wanger-Tsukamoto, 2007*, 2008*)	Entrepreneurial Self-confidence (Koellinger, Minniti, & Schade, 2007); Building networks (Aldrich, 2000); Entrepreneurial trust (Welter & Smallbone, 2006);Cooperative networks (Wu, Wang, Chen, & Pan, 2008);
Self-Correcting Structures with Feedback	Goal setting behaviors and feedback (Lock, 1978; Locke, Shaw, Saari, & Latham, 1981; Locke, 1982)	Hindsight and nascent venture activity (Cassar & Craig, 2009); Entrepreneurial Discontinuance (Liao, Welsch, & Moutray, 2008); Drivers for Venture Exit (Wennberg, Wiklund, DeTienne, & Cardon, 2010)

* Specified link or mention to scientific management in article

Bootstrapping and Scientific Management

Consistent with both the resource-based view (Barney, 1991) and the resource dependence theory (Pfeffer & Salancik, 1978) entrepreneurs need to acquire, or have access to necessary resources within their firms to grow and survive (Ebben, 2009). However, small and entrepreneurial firms operate in resource constrained environments. For example, many startups experience significant difficulty in gaining access to necessary financial capital from formal avenues such as banks or venture capitalists (Winborg & Landstrom, 2001).

One way to effectively overcome resource constraints is through bootstrapping. Simply put, bootstrapping allows business operations to continue without the aid of external financial resources or aid. "Bootstrapping is entrepreneurship in its purest form. It's the transformation of human capital into financial capital, sweat equity into bankable equity" (Gendron, 1999, pp. 11-12). That's what we mean when we talk about "creating value" (Gendron, 1999, pp. 11-12). Bootstrapping includes the idea of "meeting the need for resources without relying on long-term external finance from debt holders or new owners" (Winborg & Landstrom, 2001). This strategy of bootstrapping can be separated into two forms; first, creating ways to acquire access to necessary financial capital through informal and alternative methods. The second is to minimize or eliminate the actual need for financing by securing resources at

minimal or no cost (Harrison, Mason & Girling, 2004). While bootstrapping is not explicitly associated with financial resources (as many different types of resources are needed), financial resources are often looked at as one of the most important because they enable the acquisition of those other needed resources (Bhide, 2000; Brush et al., 2006). This is one of the reasons that most research to-date has focused on financial bootstrapping strategies and their effects on the firm (Freear, Sohl & Wetzel, 1995; Winborg & Landstrom, 2001; Harrison et al., 2004; Carter & van Auken, 2005; Ebben & Johnson, 2006; Ebben, 2009).

The resource constraints faced by start-ups and small firms is in part due to the presence of information asymmetries and high transaction costs (Cassar, 2004). Information asymmetries have to do with the difficulty the entrepreneur has in articulating the potential of the company to formal investors (Winborg & Lanstrom, 2001) and lack of available public information (Carpenter & Petersen, 2002) which results in formal investing institutions considering it as a risky investment (Ebben & Johnson, 2006). These information asymmetries may be two-sided as financial institutions might have information regarding the industry as a whole that the individual entrepreneur does not have (Winborg & Landstrom, 2001). Transaction costs are often high because it can be costly for financial institutions to provide smaller sized loans or investments. Therefore, those increased costs are passed onto the entrepreneur (Ebben & Johnson, 2006). Bootstrapping in these cases then becomes the strategy of necessity and not of choice (Roberts, 2003; Cole et al., 2005).

Through empirical evidence researchers have identified four distinct classifications of bootstrapping that different strategies and methods fall under (Winborg & Landstrom, 2001); (1) customer-related, (2) delaying payments, (3) owner-related financing and resource, and (4) joint-utilization of resources with other firms. Customer-related methods include obtaining advanced payments, interest on overdue invoices, and not doing business with customers that make late payments. Delaying payments include negotiating longer terms with suppliers or possibly leasing equipment. Owner-related methods would include the owner providing the financial resources from savings, personal loans by the owner, personal credit cards or loans from family and friends. The joint-utilization of resources could involve the sharing of employees and/or assets with other firms.

Following Winborg and Landstrom's (2001) fourfold classification of bootstrapping, we find that both entrepreneurship and scientific management have significant conceptual similarities that can be identified from prior research. From a scientific management perspective we can locate specific formalized areas of management research relating to each of the four bootstrapping classifications. Some of these examples often directly discussed the use of scientific management (Drummond, 1995; Havs, 1994; Jeacle, 2004, Richardson, 1995) to formalize organizational processes in order to increase efficiency and effectiveness. Linking these concepts with entrepreneurial bootstrapping helps our understanding of how entrepreneurs often use formalized processes even when they are attempting to find innovative and creative means to survive and succeed. Thus, scientific management techniques are applicable and useful in the context of entrepreneurial bootstrapping. Research has also examined when and with what types of firms these different methods of bootstrapping are utilized. For example, both Freear

et al. (1995) and Harrison et al. (2004) found that software companies (in the U.S. and the U.K.) used bootstrapping techniques for both business and product development situations. The use of bootstrapping techniques throughout the life of the company was also examined by Ebben and Johnson (2006). Brush et al. (2006) found that female-run businesses used different bootstrapping methods based on the different life stages of the business, because different techniques were needed to meet varying demands as the companies grew. Ebben (2009) found that firms that were highly leveraged, had lower liquidity, and lower profitability were more likely to utilize one type of bootstrapping technique over another. The industry context and environment were found to affect the type of bootstrapping methods used and the investment decisions that were made by entrepreneurs (Van Auken, 2005; Ekanem, 2005).

Other studies have examined and identified different types of bootstrappers (Lahm, 2005). They include discouraged borrowers that have good credit and could potentially obtain financing through traditional formal methods, but think they will get rejected and therefore do not attempt it (Kon & Storey, 2003). Some entrepreneurs, having the desire for autonomy and privacy, do not do what is required to relinquish control or have some sort of oversight because of the financial obligations (Fried & Hisrch, 1995). Other entrepreneurs pride themselves on being self-sufficient and want to avoid any strings attached with borrowing, while other entrepreneurs look at the entrepreneurial process as a game and take pride in growing a business on their own (Lahm, 2005).

Table 3: *Linking Scientific Management and Bootstrapping*

Conceptual Similarities	Examples in Scientific Management	Examples of Bootstrapping in Entrepreneurship
Customer-Related	Improving customer management and relationships through controlling and improving processes (Snee, 2006); Formal processes of Total Quality Management (TQM) for customer management (Drummond, 1995*); stabilizing customer relationships through Quality Improvement methodologies (Hays, 1994*)	Obtaining advanced payments from customers (Winborg & Landstrom, 2001); including interest on overdue invoices (Ebben & Johnson, 2006); cease business relations with late payment customers (Harrison, Mason, & Girling, 2004)
Delaying Payments	Inventory valuation and management procedures (Jeacle, 2004*); Formalized process of supply chain management (Richardson, 1995*)	Lease equipment (Carter, Gartner, & Reynolds, 1996); Supply chain management (Madu, Kuei, Chow, Ndubisi, 2011); Inventory management (Carraher et al., 2006)
Owner-related Financing	Strategic financial planning and financial controls (Brinckmann, Salomo, & Gemuenden, 2011); Implementation of financial management systems (Coelho & Matias, 2010)	Financing through use of personal savings (Carter & Van Auken, 2005); Leveraging capital from family and friends (Au & Kwan (2009); Use of personal credit (Van Auken & Neeley, 2000)
Joint utilization of Resources with other Firms	Formalized interorganizational relationships (Todeva & Knoke, 2005); Identifying processes or steps to get the most out of collaborative arrangements (Hamel, Doz, Prahalad, 1989)	Knowledge and resource sharing (Vilamos, Halkos, & Tzeremes, 2009); Entrepreneurial teams and joint ventures (Lacobucci & Rosa, 2010)

* Specified link or mention to scientific management in article

Bootstrapping has been characterized as part of the creative problem solving process for the emergent nature of entrepreneurship and again is a necessity (Bhide, 1992). Luck or momentum also can play a role, where the business takes on a life of its own contributing to the success of the business (Lahm, 2005). Finally, bootstrapping is

often the speedier and more convenient way to gain access to large amounts of capital (e.g. through credit cards) (Cole et al., 2005). Entrepreneurs, through bootstrapping, can use their know-how, imagination and hard work as a substitute for external financial capital in an effort to grow and survive (Mamis, 1992).

There appear to be two view points of the actual effects that bootstrapping has on the performance of the firm (Ebben, 2009). First, some view bootstrapping as a negative and believe it should only be used a last resort (Binks & Ennew, 1996; Bruno, Leidecker & Harder 1987; Stancill, 1986). Resource dependency theory and resource-based views affirm that resources are necessary for competitive advantages, growth and survival. When firms utilize bootstrapping strategies, they lack access to financing, which puts an immediate constraint on survival, growth, and financial performance. This view has been empirically supported (Bechetti & Trovato, 2002; Bamford, Dean & McDougall, 2000; Cooper et al., 1994; Chandler & Hanks, 1994; Bruderl, Preisendorfer & Ziegler, 1992; Duchesneau & Gartner, 1990) and most recently by Ebben (2009) where firms were only engaging in bootstrapping out of necessity and not as a strategic decision, which often caused negative financial effects.

An opposing view states that bootstrapping may help firms succeed (Bhide, 1992; Timmons, 1999). One idea is that new entrepreneurs are inexperienced in investing financial capital and therefore increase costs without generating sufficient returns (Barker, 2000). Another benefit is that bootstrapping helps make firms more efficient as it teaches the entrepreneur how to identify and be concerned with how every dollar is spent while also ensuring nothing is being wasted (Timmons, 1999). Bootstrapping therefore has the effect of helping to make the firm lean (Timmons, 1999; Harrison et al., 2004). It is recommended that more research examine the effects of bootstrapping methods on performance and survival.

While the idea of bootstrapping has been discussed often from practical points of view (Gendron, 1999; Lahm, 2005; Lahm & Little, 2005), formal research examining the effects of bootstrapping on entrepreneurial behavior and firm success is lacking (Winborg & Landstrom, 2001; Harrison et al., 2004; Lahm & Little, 2005; Ebben & Johnson, 2006; Ebben, 2009; Lam, 2009). Even current entrepreneurial text books often only provide a few paragraphs on the idea of bootstrapping with more emphasis on traditional and formal methods of obtaining financing (Lahm & Little, 2005; Zimmerer, Scarborough & Wilson, 2008). Though not specifically discussed, the notion of bootstrapping is often implied in entrepreneurship (Lam, 2009), such as examining other sources of financing from family and friends to the business owner's savings and credit cards (Hamilton, 2001; Lam 2009). Another area that is problematic for the study of bootstrapping is that most studies are exploratory in nature and the conceptual framework and theoretical development is significantly lacking (Lam, 2009). From the above review of extant research, it is clear that "bootstrapping is a phenomenon which deserves more attention in future research" (Winborg & Lanstrom, 2001, p. 235). From a resource management perspective, bootstrapping can promote lean organizations and maximize internal efficiencies with limited resource sets, while simultaneously delivering desired levels of productivity. Scientific management can contribute to our understanding of bootstrapping by applying the same systematic observation and principles to bootstrapping behavior.

What is lacking in our understanding of the bootstrapping phenomenon can be addressed to a great extent by the methodology followed by Taylor. Table 3 indicates potential areas of overlap between bootstrapping and scientific management based on prior research. These potential areas have much unrealized promise that would need to be examined further in future research.

We therefore argue that entrepreneurial bootstrapping stands to benefit greatly from a fine tuned application of relevant scientific management principles. We call on future research to address this important application of Taylor's work to benefit entrepreneurs and small businesses. A systematic observation of entrepreneurial bootstrapping, coupled with scientific conclusions, the creation of formulas for maximum efficiency with minimal resources, etc. are all areas where scientific management can be of great relevance. Though entrepreneurship as a formal discipline did not exist during Taylor's time, the techniques of scientific management do bear surprising similarities to entrepreneurial behaviors such as bootstrapping. The motivations of both stem from the quest for higher efficiencies and higher prosperity. The promise of scientific management to bootstrapping is yet to be realized. Hopefully future research will be directed at this yet to be explored area. It is likely that with focused attention on the scientific management basis of bootstrapping, we may see a new area of scientific entrepreneurial management emerge and engage future scholarly interest and investigation.

Implications and Relevance of Taylor to Entrepreneurship

The emergence of scientific management occurred during a period of national crisis, with President Roosevelt calling for a stoppage of resource wastage and raising of national efficiencies. With the advent of scientific management, the industrial and manufacturing sectors of the economy saw unprecedented increases in productivity and consequent raises in national prosperity and wealth (Drucker, 1976; Locke, 1982; Simha & Lemak, 2010).

Entrepreneurship has been recognized to have made significant contributions to national wealth and prosperity (Schumpeter, 1950; Dubini, 1989; Quadrini, 1999). As such, governments seek to improve the level of entrepreneurship and new firm start-ups by providing a number of incentives. While much scholarly attention has been devoted to understanding entrepreneurship, its antecedents, causes, outcomes, and covariates, some areas demand more systematic inquiry. Among these are the unique entrepreneurial phenomena of bricolage and bootstrapping.

While most entrepreneurs instinctively, intuitively, or unconsciously adopt bricolage or bootstrapping as efficient ways to manage resource constraints, they are unable to articulate (beyond their particular resource environments) the principles that guide them through such decisions. Further, due to the successful use of bricolage and bootstrapping, these entrepreneurs continue to engage in these behaviors due to their beneficial effects on productivity, efficiency and profitability. Such knowledge remains embedded in the entrepreneur who discovers through constant "tinkering" what works best under specific situations.

Rarely is this knowledge externalized in a manner that can be easily adopted or

applied by other entrepreneurs. Rather each entrepreneur must begin the journey again, and discover through trial and error what resource management techniques work best. Hence, there is some "reinventing of the wheel" with each entrepreneurial journey that can easily be minimized. Perhaps this is the reason why the myth that entrepreneurs are born, or that entrepreneurship cannot be taught seems to perpetuate. Prior to the onset of scientific management, rules of thumb, or tradition guided most managerial practices. The replacement of scientific principles was revolutionary, and much credit is due to scholars like Taylor who contributed to the scientific basis of management.

With the application of the same scientific rigor, observation and study of entrepreneurial phenomena such as bricolage and bootstrapping, much would be gained in the form of rules, procedures, sequences, and activities that could potentially generalize to other entrepreneurial contexts. It is likely that such examinations could lead to Scientific Entrepreneurial Management, a new field that lies at the intersection of scientific management and entrepreneurship.

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