A LOOK AT THE UNDERLYING CAUSES OF SUCCESSFUL PRODUCTION SYSTEMS

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ABSTRACT

Despite advances in project management methodologies, system design in project production is still a developing topic. It is a common, challengeful issue for firms in different industries because proper strategy-structure alignment is crucial to business performance. The challenge comes from the fact that a myriad of factors can affect the workings of a production system, many of which are unobvious to outsiders. Consequently, the contents of production strategies are often described superficially, neglecting some of the underlying causes of successful production systems.

In contrast, this paper argues that best-in-class production systems can only be well understood if their tangible and intangible attributes are captured alongside with contextual factors. This paper aims to show that true best practices and production competences arise from a number of coherent strategic choices that help shape the production system. In addition, it points to the importance of perceiving the implicit leadership assumptions and theoretical foundations because of their role in creating coherence between design and operation decisions. Finally, a theoretical hierarchy of these tangible and intangible attributes is proposed. This extended view on the content of production strategy becomes primordial to understanding the challenge of designing well adjusted lean production systems for construction projects.

KEYWORDS

Production strategy, production system design, best practice.

THE CONTENT OF PRODUCTION STRATEGY

Companies have only partial control over the emergence of production systems and even the aspects supposedly under control are often misunderstood and misused. For a start, Acur et al. (2003) mention that there is still no common definition of production strategy. In industrial management literature, researchers agree that it involves the identification of competitive criteria that should be prioritized, based on a balance between business strategy and internal competences (e.g., Voss 1995, Acur et al. 2003). They also agree that the term encompasses a number of key decision areas such as vertical or horizontal integration, workforce, capacity, technology, facilities and organization. It is generally accepted that there needs to be a relationship between these two aspects in order to achieve high levels of performance. The competitive criteria should guide strategic choices in production strategy, which in turn need to be aligned with one another and with other functional strategies so as to make the whole organization capable of supporting the business strategy (e.g., Wheelright 1984). Despite the two above mentioned aspects and the notion that the

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key decisions have a direct effect on production system design, there is still much to be uncovered and agreed upon by academics in the field.

Knowing that both conjunctural needs and internal characteristics influence the key decisions does not explain how top competitors rationalize when shaping their organizations internally. Indeed, little is known about the methods they use to make the specific content decisions that create production systems. However, at least in the case of top competitors, there must be principles or assumptions aligning decision-making and thereby providing the first step towards organizational efficacy. This is corroborated by the idea that, due to the existence of contextual factors that vary from firm to firm, the focus of production system design should not be on the tools of best-in-class production models. Instead, the focus should be on their underlying principles. In the following topics, arguments are presented to propose that a production strategy, especially one that is supported by best practices, can only be fairly understood if its content is seen as composed of competitive criteria, structural and infrastructural strategic choices, underlying assumptions, and theoretical foundations. The discussion in this paper is supported by a literature review on strategy implementation and by the author's personal experiences with the topic.

THE CONTENT COMPRISING KEY COMPETITIVE CRITERIA

The fulfillment of key competitive criteria is the aspect of production strategy that is most easily perceived by clients. There are different nomenclatures for competitive criteria in literature: competitive objectives, competitive priorities, competitive factors, performance goals and performance criteria (e.g., Hayes and Wheelwright 1984, Gerwin 1987). Regardless of the nomenclature, there are several commonly used criteria: cost; quality; flexibility; delivery; and innovativeness. Each criterion has variables belonging to different dimensions. Just to mention a few, innovativeness can be measured in terms of frequency or degree while delivery can be in terms of reliability or speed. It is important to capture the variables clients value the most and to share with them the same perception on their level of importance.

The notion of which competitive criteria should be prioritized is particularly important for any organization to decide how to compete. In each market in which the firm operates it should identify those criteria that win orders against competition. Only then it can structure itself properly to support the processes that are critical for achieving the important competitive criteria (e.g., Voss 1995). The same logic applies to project production, since projects are developed for various reasons. Mission parameters established by the client organization must guide the making of a suitable temporary production system, which is structured under the existing contingency factors.

In the case of project production, the common definition of a project as a temporary organization established with the predetermined purpose of developing a unique product under budget and schedule constraints gives an initial idea of the strong relationship between time and competitive success. In fact, Steyn (2002) has discussed this relationship and provided reasons for identifying project duration as the major criterion of projects in general. According to the author, if the focus is on the product life cycle, then it often makes sense to reduce project duration in order to reduce the time between development and commercialization. Market share could be lost if a project is delayed. Moreover, project costs often escalate as a result of extended duration. Another issue is that extended project duration leads to scope changes because stakeholder needs could be expected to change over time. Such changes can either cause more project delay or require the project organization to develop expensive flexible production capabilities.

The discussion above clarifies that the most common competitive criteria are affected in one way or the other by time-based competitiveness. Consequently, reduced project times are important to many aspects of competition other than just delivery speed. It should be kept in mind that projects are used by organizations to achieve different internal and external objectives, like business process improvement and product customization. Therefore, in most cases, project duration will either be an order winning competitive criterion or at least a qualifying criterion (e.g., Hill 1993).

Viewing time as a major criterion in project production whatsoever highlights the importance of using it as a competitive weapon. As a matter of fact, many firms use time not to compete with shorter lead times but to improve performance in other competitive criteria. From what has been discussed here, the same can be implied to project-based organizations, where the projects' performance goals and the firms' own competitive criteria may confound. Such organizations should identify the criteria that are directly supported by time improvement initiatives and welcome best practice programs aimed at reducing value added activity times, eliminating non value-added activities and improving activity coordination.

THE CONTENT COMPRISING PRODUCTION BEST PRACTICES AND COMPETENCES

Companies must have certain competences in order to be able to compete in specific market sectors. But if a company is doing particularly well and building a reputation, then it is likely that performance is being supported by one or more best practices. A method that delivers superior results is the aspect of production strategy that is most visible to competitors in an industry. Thus, sometimes such a method can become a benchmark for other companies.

However, the notion of what is best will depend on the context. Like other aspects of functional strategies, some best practices are applicable only in specific contexts and therefore may not be relevant for all companies. In fact, some production practices may be of interest and even appropriate only to companies belonging in the same strategic group, which are those following a similar strategic orientation and sharing the same geographic area. Thus, different strategic groups emphasize the implementation of different bundles of production practices, resulting in different operational performance (e.g., Christiansen et al. 2003).

Furthermore, it is important to maintain realistic expectations when implementing a best practice. If best practice programs are implemented alone, some companies may not obtain satisfactory results. As discussed by Voss (1995), best practices usually come in small isolated pieces and require some systemic adjustments to be effective. Hence, a best practice will not by itself guarantee improved performance. Regardless of what many consultants like to say, a best practice is not a method that can be easily taught or transplanted from one industrial environment to another. Similar to production competences, which are defined as variable attributes, production best practices may only occur or bring the best results under certain circumstances. The reason lies in the fact that true "best" practices are derived from a combination of contextual factors and organizational adjustments. Hence, it should be understood that "best practice" must be what the best performing companies do within a market sector (e.g., Laugen et al. 2005), but knowing that there is much more than meets the eye.

The failure to consider the role of underlying organizational adjustments often leads to disappointment. A well known example in the construction industry is the implementation of quality management systems, which appears to be negatively affected by both labour turnover and sucontracting strategies in construction projects. Therefore, when implementing a successful production practice in a new context, efforts could be made to identify and match some of the strategic choices that have made it so effective in its original environment, but even that may not be enough. In a dynamic environment like the construction sector, it is difficult to understand the implications of individual or combined construction strategies on project performance. The reason for this is that there are many other internal and external factors that are not fully understood or replicable. This helps to comprehend why some practices fail to provide the alleged positive results. In fact, Alarcón et al. (2005) perceived organizational elements to be amongst the main barriers to a more complete implementation of the Last Planner System and other lean construction practices.

The discussion herein serves as a reminder to the construction sector of the need to critically perceive the numerous contextual factors that may hinder an organization from satisfactorily applying certain practices or developing competences. This includes being aware of the underlying strategic choices that affect the emergence and behavior of production systems.

THE CONTENT COMPRISING STRUCTURAL AND INFRASTRUCTURAL DECISIONS

Strategic choices in production strategy are attributes more usually observed by researchers and consultants because they constitute an inner dimension of firm competitiveness. According to Wheelright (1984), the key decision areas in production strategy can be split into two sets of strategic choices. One set relates to structural decisions, such as resource capacity, facilities, equipment, and technologies to be used. In manufacturing, these decisions create the physical part of the production system design and are usually seen as onerous, long-term and difficult to reverse. The other set relates to infrastructural decisions, like relationship with suppliers, managerial philosophy, production planning and control, workforce management, quality control and so on. These are less obvious decisions and are behind the creation of intangible competences and capabilities that cannot be copied by the competition. The two categories are the most commonly accepted in industrial management literature.

In the context of construction, attention is mostly given to the set of structural decisions relating to facilities, resource capacity, and equipment. The other set has been usually taken for granted or has been mainly limited to misaligned initiatives at the level of operations. As a consequence, the development of project production systems has been very much restricted to the construction phase. Moreover, it is a subject that has been mostly approached from a project management perspective and not really from an organizational one. This is quite clear in construction management literature, where the concept of work structuring has been confoundingly used to refer to production system design.

It is not hard to understand why decision-making has focused on facilities, resource capacity, and equipment. The concern with these structural aspects of the production system has a direct relation to construction peculiarities. Not only there is the influence of site production, but also of the product's one of a kind design, location and specificities. Thus, when designing project production systems many mission parameters may be inaccessible a priori or poorly defined, making the initial decisions to be very broad (e.g., Levchuk et al. 2001, Schramm et al. 2006). Once the mission scenario unfolds, decisions become more detailed and the actual specifications and values of the parameters may require adaptations in the structural aspects of the production system in order to achieve the desired performance. Furthermore, Levchuk et al. (2001) mentions that throughout the course of the mission, various factors (operational resource failures, regulation changes, bad weather, etc.) can trigger unexpected alterations in either mission environment or in organizational constraints. The bottomline is that construction peculiarities and uncertainties can cause deviations in performance and force some decisions to be made at the last minute possible. Consequently, unlike in manufacturing, the production system design in construction cannot be an isolated activity but an ongoing one (e.g., Schramm et al. 2006). This explains the importance of the approach from a project management perspective, though it should not be the only one.

In reality, the structural aspects focused by project management are only a part of the production system. There are other aspects of production system design in construction that stay more or less constant over a longer period of time, like the set of infrastructural decisions concerning the relationship with suppliers, production planning and control, and workforce management. These comprise the strategic choices and production practices organizations use to attain higher performance. Because infrastructural decisions may involve top executives and stretch well beyond project boundaries, one can only speculate that these might be some of the reasons to why they have been frequently neglected by traditional construction management.

However, attention should be given to infrastructural decisions in order to take advantage from the benefits of a formalized production strategy. More than just the definition and sharing of important competitive criteria, the formalization of production strategy is also about carefully choosing and making explicit the policies, strategies and practices applied. Whether it is done in a written or explicitly expressed manner, the formalization of production strategy establishes guidelines to actions taken at all levels. Thus, a formalized production strategy enhances the translation of competitive criteria into action programs (e.g., Acur et al. 2003). It also reduces improvisation in production sytem design and operation. The ultimate consequence is that companies tend to have a more decentralized structure because goals and methods are less uncertain.

In addition, infrastructural decisions not only have a topdown effect over other infrastructural decisions, like “best practice” implementation, but also over structural decisions concerning resource capacity, facilities, equipment, and technologies. The hierarchy between the two sets of key decisions reinforces the importance of paying more attention to infrastructural decisions when developing project production systems. The need to expand the focus from structural decisions to one that also encompasses infrastructural aspects comes from the fact that nowadays sistemic performance is more constrained by organizational policies than by production resources.

In spite of that, infrastructural decisions seem to be the least understood aspects of production systems. When analysing the content of production strategy, Harris (1997) reported the existence of interactions between strategic, tactical and operational factors and argued that consistent decisions at all three levels would give returns over and above the benefits obtained from particular levels of any one factor. Although the alignment of fundaments and subsequent decisions is made somewhat easier with formalized strategies, academics still have difficulty in capturing all the strategic choices and even the underlying rationale used by decision-makers when structuring organizations to support business strategies. Practitioners offer little help, since few put effort into analysing and understanding why they do what they do. Not only there is little information on the infrastructural strategic choices made to support the practices, the reasons to why they have been chosen and how they align are usually not explicit. The poor understanding conceals the importance of strategic choices. And this is true in both manufacturing and construction literature. The only certainty, however, is that the strategic choices in production strategy and the production practices effectively implemented or developed internally by top competitors are in some way aligned with one another and with the companies' business strategies.

THE CONTENT COMPRISING LEADERSHIP ASSUMPTIONS

Perhaps the most critical barrier to enhancing performance in project production is not an outside factor, but rather an internal one. To begin with, when two people experience the same event, their mental images of that event will not be identical (e.g., Gillard and Johansen 2004). Thus, each of us lives in a world built upon numerous assumptions, some of which come from theory while others result from everyday experience. These encompass a body of hypothesis, beliefs and principles used to explain phenomena. As mentioned by Werther Jr. (2003), our lives are built upon a foundation of assumptions that are seldom questioned. In fact, they tend to be reinforced whenever events occur in ways that corroborate their validity. Together, these assumptions form each individual's assumptive world.

Underlying all strategic choices are the explicit or tacit assumptions held by leaders (e.g., Werther Jr. 2003). Thus, before dealing with stakeholder resistance, leaders need to be aware of their own assumptions and how those assumptions shape their actions. This is a challenging thing because an individual usually has different levels of conscience regarding each of his/her own personal characteristics. Therefore, sometimes it is easier to identify assumptions that influence decisions by asking the people who directly work with the individual. For this reason, co-workers and direct subordinates are the most capable in pointing out the leaders'assumptions.

Ideally, the use of a multi-perspective approach to capture different "worldviews" would be very appropriate for decision-making. It would lead to finding accommodations and taking effective action to remedy the situation. Unfortunately, everyday adaptive decision-making cannot be done on the same basis because it often has to be done in real-time. In situations with high time pressure or increased ambiguities, individuals use intuitive decision making rather than structured approaches. This helps to understand why sometimes conflicts occur between the design and operation of a production system. It is not unusual for a production system to be designed following a set of conceptualizations, but operated according to different assumptions. This problematic situation is also common when structuring and managing other organizational functions and is partially responsible for systemic inefficiencies.

Nevertheless, organizations find different ways to deal with this matter. Current benchmark companies such as Toyota have built an exceptional workforce by striving to maintain people's jobs, at every level. Continuity among personnel and their ever blending assumptions have been some of Toyota's secrets to creating a sense of unity, to improving work, and, most important of all, to making employees at all levels embody through time the same values and vision that founded the world famous production system. The same strategy is applied to outsourced operations. The common goal or vision of what an ideal production system would be is believed to inspire and drive further improvements to the existing production system, from the highest to lowest levels of the organization.

This aspect of Toyota's production strategy is well in accordance with Mintzberg's (2003) study on authority flows, which concluded that the decreasing formality in the division of work increases the importance of coordination through the shared values and beliefs in a given group. Morgan and Hunt (1994) acknowledge the shared values as extensions of the common beliefs people have about the behaviours, goals and policies that are important or not important. The authors add that shared values are prerequisites to trust and commitment. Thus, as organizational structures become flat and characterized by decentralization and delegation of responsibility, the procedural patterns tend to be substituted for behavioural patterns. This shows the importance for modern organizations to formalize not only the production strategy but also what they expect from employees in terms of profile and behavioural patterns. Such information provides useful guidelines to various business processes.

THE CONTENT COMPRISING THEORETICAL FOUNDATIONS

In traditional project production and management, in spite of individual "worldviews", perhaps the most widely diffused is the assumption where a project can be broken down into parts that can be improved separately or managed independently towards the established goals (e.g., Ottosson and Björk 2004). It is believed that the parts can then be subsequently reassembled in a logical sequence to form the original totality. As a consequence, conventional construction management practices have focused on variances from project objectives for quality, cost and schedules. The prevailing managerial mentality has been to allocate responsibility to internal and external work parties, which are then controlled against schedule and budget commitments. That is, in many aspects more attention is given to the process output than to the process itself and its interconnections. Koskela (2000) calls this theoretical foundation the transformation model.

The transformation model seems to be the "mother" of many wrong assumptions in large-scale product developments. One example is the assumption that work can be benevolently driven from above. The project manager breaks the mission into smaller objectives, which are then passed on to the work teams. Because of this, it is quite common for the manager to wrongly assume that it is up him to make decisions at all times instead of getting decisions made. Consequently, construction projects can either have managers get overwhelmed with micromanaging many aspects of production or organizational charts showing many authority relationships in the chain of command. Furthermore, the low level of confidence shown by project participants towards workflow reliability, project plans and allocated work capacity is reflected by the protection they individually seek through the application of time buffers. Thus, uncertainty brought upon subcontractors from the use of transformation model concepts turns them into sources of uncertainty internal to the project organization.

This discussion highlights the need to defy traditional paradigms and to change assumptions if the objective is the development of a best-in-class production system. A firm that understands the assumptions in which the industry is built upon is the one that might establish a strategy that changes them. Indeed, underlying all structural and infrastructural decisions of a top competitor are different assumptions that may have evolved without supporting evidence, even though their origins may lie in one solid, explicit theoretical foundation. A conceptual framework based on the practices of a top competitor is no different, since it is the end result of a paradigm shift supported by one or more theoretical models.

In fact, when proposed alone, a conceptual framework presents a limited prescriptive character. The same goes for simple statements like principles, policies, and rules. They all leave out many underlying assumptions that are either influencing or being generated from them. Thus, it is important to be aware that the description of a set of strategic choices or the proposition of a conceptual framework does not entirely cover the paradigm shift that fosters the development of "best practices". Although conceptualizations based on production best practices contribute to creating a more ample theoretical basis to cover situations encountered in project based production systems, it should be accepted that they will not capture all assumptions held by decision makers. Even so, efforts to better understand the content of a top competitor's production strategy must try to capture as much as possible details like contextual factors, theoretical foundations and underlying assumptions.

FINAL COMMENTS ON THE EMERGENCE OF PRODUCTION SYSTEMS

As discussed throughout this paper, there are many internal and external factors influencing the emergence and evolution of production systems, some of which lie beyond managerial control. Therefore, it is important to recognize that an understanding of the competitive criteria, best practices, structural and infrastructural decisions, managerial assumptions and theoretical foundations can provide only a partial perspective on the workings of a best-in-class production system. Thus, it is most unlikely that such a system can be fully replicated in a different context. Nevertheless, proper theoretical foundations can provide a good starting point for the development of adequate solutions under different contextual factors (Figure 1).

In the context of construction projects, construction peculiarities cause the physical part of the production system to be redesigned for every new project and even many times during the construction phase. This has led the concept of production system design to be misinterpreted by many academics and practitioners. The great concern with the match between resources and tasks to accomplish the project schedule has made production system design an issue mostly approached from a project management perspective and not really from an organizational one. Consequently, the development of project production systems has been very much restricted and deviated to structural decisions, such as resource capacity, facilities, and equipment. On the other hand, the aspects of production system design that stay more or less constant over a longer period of time, like the set of infrastructural decisions concerning the relationship with suppliers, production planning and control, and workforce management, have been frequently neglected by traditional construction management literature. The reason lies in the fact that these are less obvious aspects that may stretch well beyond project boundaries and involve decision-making from top executives. However, infrastructural decisions have a top-down effect over structural decisions and, therefore, over "best practice" implementation. The notion of a hierarchy between the two sets of key decisions shows the importance of paying more attention to infrastructural aspects when developing project production systems.

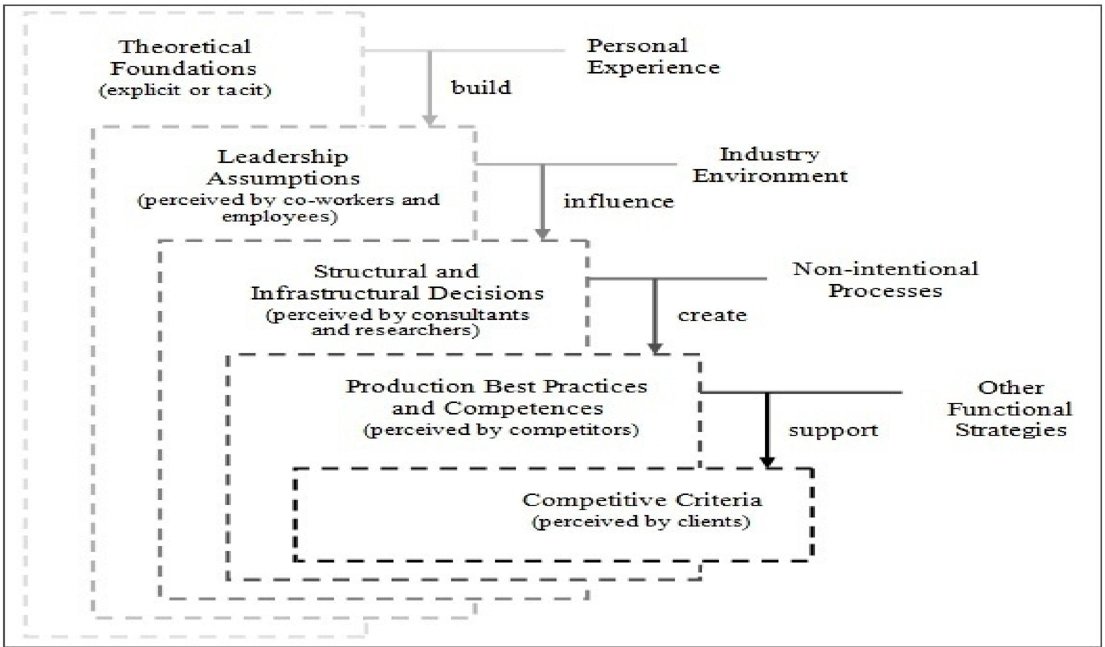

Figure 1: A Conceptual Model Showing that Proper Theoretical Foundations are the First Step towards the Development of a Successful Project Production System.

The true "best practices" in each context mainly emerge from infrastructural decisions and other related "soft" factors. These strongly contribute to originating the intangible competences that cannot be copied by the competition and that really make a difference in a successful production system. Hence, besides the competitive criteria and structural strategic choices, the content of a successful production strategy can only be fairly understood if the infrastructural decisions, underlying assumptions, and theoretical foundations are also explored. This understanding is needed because there exists somewhat of a hierarchy between them. Taken together, these factors influence the shape and operation of production systems.

REFERENCES

Acur, N.; Gertsen, F.; Sun, H.; and Frick, J. (2003). "The formalization of manufacturing strategy and its influence on the relationship between competitive objectives, improvement goals and action plans." *International Journal of Operations and Production Management*, 23 (10), 1114-1141.

Alarcón, L.F.; Diethelm, S.; Rojo, O.; and Calderon, R. (2005). "Assessing the impacts of implementing lean construction." *The 13th annual conference of the International Group for Lean Construction*, Sidney, Australia.

Christiansen, T.; Berry, W.L.; Bruun, P.; and Ward, P. (2003). "A mapping of competitive priorities, manufacturing practices, and operational performance in groups of Danish manufacturing companies." *International Journal of Operations & Production Management* 23 (10), 1163-1183.

Gerwin, D. (1987). "An agenda for research on the flexibility of manufacturing processes." *International Journal of Operations and Production Management*, Vol. 7 No. 1, pp. 38-49.

Gillard, S. and J. Johansen (2004). "Project management communication: a systems approach." *Journal of Information Science* 30(1): 23-29.

Harris, C.R. (1997). "Modelling the impact of design, tactical and operational factors on manufacturing system performance." *International Journal of Production Research* 35(2): 479-499.

Hayes, R.H. and Wheelwright, S.C. (1984). *Restoring our competitive edge*, Collier Macmillan, New York, NY.

Hill, T.J. (1993). *Manufacturing strategy.* Macmillan, Basingstoke.

Koskela, L. (2000). "An exploration towards a production theory and its application to construction." Espoo, Tech. Research Centre of Finland. *Doctoral Thesis*: 296.

Laugen, B.T.; Acur, N.; Boer, H.; and Frick, J. (2005). "Best manufacturing practices: what do best-performing companies do?" *International Journal of Operations and Production Management* 25 (2), 131-150.

Levchuk, G.M.; Meirina, C.; Levchuk, Y.N.; Pattipati, K.R.; and Kleinman, D.L. (2001). "Design and analysis of robust and adaptive organizations." *The 6th International Command and Control Research and Technology Symposium*, Annapolis, MD.

Mintzberg, H. (2003). "Criando organizações eficazes: estruturas em cinco configurações." São Paulo: Atlas.

Morgan, R.M. and Hunt, S.D. (1994). "The commitment-trust theory of relationship marketing." *Journal of Marketing*, July, 20 - 38.

Ottosson, S.S. and Björk, E. (2004). "Research on dynamic systems - some considerations." *Technovation* 24(11): 863-869.

Schramm, F.K.; Rodrigues, A.A. and Formoso, C. T. (2006). "The role of production system design in the management of complex projects."*The 14th Annual Conference of the International Group for Lean Construction,* Santiago: Catholic University of Chile, School of Engineering.

Steyn, H. (2002). "Project management application of the theory of constraints beyond critical chain scheduling." *International Journal of Project Management* 20: 75-80.

Voss, C.A. (1995). "Alternative paradigms for manufacturing strategy." *International Journal of Operations and Production Management* 15 (4), 5-16.

Werther, W.B. (2003). "Strategic Change and Leader-Follower Alignment." *Organizational Dynamics* 32(1): 32-45.

Wheelwright, S. (1984). "Manufacturing strategy: defining the missing link." *Strategic Management Journal*, v. 5.