

# APPROACHING CONSTRUCTION AS A LOGISTICAL, ECONOMICAL AND SOCIAL PROCESS

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## ABSTRACT

Industrialised construction can be understood as production of commodities through a flow of transformations. The commodities have a dual character, possessing both use-value and exchange value. This leads to the understanding of production as a physical/logistical process (producing use value) and an economical process (producing exchange value). However, the production process is always carried out by a group of people, by a social system. Understanding the social context under which the production process takes place is therefore crucial. If we do not understand “the social system of production”, our ability to understand and improve the production system will be limited. Improvements in the logistical process (the Last Planner System, Production System Design, etc) or in the economical processes (Value Chain Analysis, etc), will always have to be carried out within a specific social environment or system embedded in specific company cultures. In this paper we address the social infrastructure and the company culture of the construction processes as prerequisites for successful improvements in the logistical and economical processes in construction

## KEY WORDS:

flow of transformations, lean construction, physical logistics, social logistics, company culture, social infrastructure,

## INTRODUCTION

Since the early 1990s, Lean Construction has been one of the most promising theoretical approaches addressing specific problems of the dynamic production process in the

construction industry. Most notably by way of a thorough critique of the *transformational approach*, the dominant paradigm in production theory (Koskela 1992 and 2000) and by the introduction and practical use of the *Last Planner System of Production Control* (Ballard 2000). More

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generally, by drawing attention to the importance of stabilizing critical flows, reducing waste, improving plan reliability and by shifting the command structure of the project organizations from a top down system of push logistics, to a bottom up approach based on pull logistics. In essence, this throws a strong dose of cynical realism into the project management and the planning process itself, as the attention is shifted from an obsessive focus on production units and labour productivity, to the probably far more important problem of coordinating the interdependent work flows of craft- and subcontractor teams in the process productivity.

Though Lean Construction or elements of lean thinking and practice, certainly has made its way in a number of countries and construction companies since the early 1990s, still after more than 15 years, Lean Construction so far cannot be said to have revolutionized the construction industry. One obvious reason of course, being that an industry does not change overnight as a consequence of the development of new theories and practical tools, not the least in construction, often said to have a conservative bias. Another, and maybe not so obvious reason is, that the rather one-eyed preoccupation with construction logistics as problems of coordination of essentially use-value flows, has prevented the Lean Construction approach from analyzing the equally important problem of economic flows, and the accompanying social and cultural aspects of construction production.

Industrialised construction can be understood as production of commodities through a flow of transformations (Bølviken 2006). The

commodities (buildings, bridges, tunnels etc.) have a dual character, possessing both use-value and exchange value. This leads to the understanding of production as a physical/logistical process (producing use value) and an economical process (producing exchange value) i.e. production as a combined and interdependent work processes and value increasing processes carried out within a specific social environment or system embedded in specific company cultures. Production then can be conceptualized as interdependent and dynamic processes where an initial money capital, alternately appears in the form of productive capital and commodity capital, as *values-in-process*.

In the first section we question the understanding of Lean Construction as essentially a different way of managing construction physics. The second section outlines some important aspects of construction as an economic process. While the first section discusses critical flows of work, material, equipment and technical information as flows of *use-value processes*, the same processes are discussed as flows of economic values or values-in-process in the second section. In the third section we argue that social aspects of the production process and especially *company culture* can make a crucial difference as to failure or success and finally conclude, as to why and how Lean Construction probably could benefit from some of the suggestions made in this paper.

## CONSTRUCTION AS A PHYSICAL/LOGISTICAL SYSTEM

Concentrating on the use-value flows of the physical/logistical process, the construction process can be approached as the unfolding, successive moves or coordination of the *productive capital* employed in the specific form of materials and equipment.

### WORK- AND INFORMATION FLOWS: PRODUCTIVE CAPITAL CIRCUITS

Productive capital comes in different disguises, first as working teams and subcontractors, and second in the form of materials, equipment and technical information (drawings etc.) i.e., as specific labour and capital or the production technology characterizing the production process under consideration. The second part of this productive capital of course, being commodity capital from the suppliers' point of view, as this physical input to the construction process is the output from their production processes.

In the transformational approach, this production technology is modelled within the theoretical framework of production functions, either as deterministic or stochastic frontier functions using company level cross section data or as production function models using sector level time-series data, and are essentially based on black-box reasoning. While this is a major problem as such, even when used to study company level data, the production processes in construction does not easily fit the standard concept of an underlying stable technical relationship between input and output. The proper output variable is a project completed, for example a building, while the organization of a project

from the design and planning stage to completion involves a number of firms and organizations, and can be done in a number of ways (Albriksen and Førsund 1991).

Lean Construction differs from pure Construction Management (CM) and BOOT-strategies in at least two important ways.<sup>1</sup> While these strategies can be said to represent defensive reactions to the productivity- and profitability problem in construction, by way of concentrating on everything else than the organization of project production, Lean Construction confronts the logistical problems directly. Second, Lean Construction differs from the others by opening up the black-box of the transformational approach, addressing and seeking solutions to the problems that seem to result in failure or success. However the theoretical and practical tools suggested by the Lean Construction approach to solve the problems of coordination will not be discussed at length here, as they by now is fairly well known. Instead, we will comment on the understanding of Lean Construction as a theory of "pure technical production".

Commenting on production theory at different levels of abstraction, Koskela (2000) mentions (i) conceptualization of production (with related universal laws and principles), (ii) taxonomies of production and (iii) design, control and improvement principles for different types of production. He emphasizes that in his study, the main focus is on the first level; "The focus is here on the pure production theory, even if, in particular, the problem of organizing is

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<sup>1</sup> BOOT is short for Build, Operate, Own and Transfer.

occasionally commented on” (Koskela 2000:28).

Production in general is an abstraction as production is always *social production* in a distinct context and point in time. It is difficult to imagine how production can be understood without organization. Pure production is an abstraction of course, but in this specific case, a *rational abstraction*, as the theoretical exposition, is a necessary step to an application of these general principles to the construction industry. Our critic is not about this, but the general understanding of Lean Construction as an approach restricted to “neutral” analyzes of pure technical production. In a reply to Green (1999), Gregory Howell and Glenn Ballard, has the following to say about this matter:

*“Green appears not to understand that production management is first about how things are made and not about how people are treated. He simply misses the fact that lean springs from a different way to manage the physics of production, in particular the effects of dependence and variation, and a different way to relate to customers than in mass or craft forms of production” (Howell & Ballard 1999:34).*

Though we certainly would not argue with the point that Lean Construction, among other things, is about managing the physics of production, in our view, production management also has a lot to do with how people is treated. For instance, in the transformational approach, the core model of the production function is said to conceptualize production units. This misses the point that production units have been part of production processes, at least as long as cooperation among groups of people

has been a prerequisite for producing necessities of life. The characteristic feature of modern capitalist production units however, is that they are also organizational, social, cultural and not the least financial units, producing commodities to be sold in dynamic markets. Theories of pure technical production are consequently of limited practical use, as the organizational, economic and social/cultural aspects of production units, increasingly are seen as some of the most important factors enabling and restricting how to manage, among other things, the physics of production.

It could be argued of course, that issues other than those related to pure production physics have theories of their own, which have to be interfaced with the theory of Lean Construction. However, in our view, this would render the Lean Construction approach a setback, even compared to traditional economic models of production. After all, in addition to accounting- and other connections that follow by definition, economic models of production includes not only connections of a production-technical kind, but connections related to behavioural, institutional and even demographic, biological and ecological aspects of production. The argument set forth in this paper is not that Lean Construction should copy the basic features of economic models of production and certainly not the transformational view, but rather that it should supplement the physical-technical understanding of production, by way of integrating economic flows and analyzes of the social infrastructure into the theory of production, i.e. to approach construction as a logistical, economical and social process.

## CONSTRUCTION AS AN ECONOMICAL SYSTEM

One important consequence of the physical-technical understanding of production is that the somewhat one-eyed focus on critical flows of work and information overshadows the equally important understanding of economic flows. Abstracting from the commercial or financial aspects of production, Lean Construction then appears as an approach based on purely *use-value reasoning*.

Reading the Lean Construction literature sometimes leaves the impression; that (i) construction projects always starts with the design process, (ii) the customer is the only privileged stakeholder in the construction process and (iii) the sole purpose of increased work flows and reduced waste is to produce a use-value for the customer. Opposed to this we argue that commercial business activity, whether in construction or not, always starts with financing, or more precisely, with how investments are to be financed.

## MONEY CAPITAL CIRCUITS OR VALUES-IN PROCESS

In modern capitalistic market economies, these values-in-processes includes the financing of both productive-, commodity- and money capital, either by debt, stocks or both as is most often the case. In addition, the supplements to capital equipment must be financed, which means that not only capital holdings, but even capital investments must be financed. Construction companies are profit-maximizing units, and as such have a fundamental priority of staying in business. The lean strategy of stabilizing variability and dependence in order to increase workflows and

reduce waste is obviously the right way to go, though we would question that the ultimate goal of the process can be reduced to providing a use-value according to customer specifications.

The construction process is not ended with the delivery of some use-value to the customer, but with a sale that (if the process was successful) returns the invested money capital to the company with a profit. The production of use-values however was never a motive for the process from the outset, as the initial investment in productive capital was motivated first by the profit to be collected as a result of the value increasing capacity of the production process to produce a commodity, not a use-value. The Lean Construction approach shows how variability and dependence create risk in the production process, but has little to say about the *economic risk* that follow from the possibility that the process will not be ended by the sale. Though certainly an important one, the reason for introducing lean construction principles is not to increase customer value, as reduction in costs and increased profits rather than increased value output is the main motive from the construction company's point of view.

There is, however, one question, which in the Lean Construction literature explicitly emphasizes the consequences of economic flows, namely the question of capital binding. In the Lean Construction literature, this question is often illustrated by *Little's law* (Koskela 2000), portraying the connection between *Work in progress*, *Cycle time* and *Throughput* as shown in the formula below.

$$TP = \frac{WIP}{CT}$$

Accelerating capital turnover as a productivity increasing device, of course is one of the drivers from the construction companies point of view, when deciding whether or not to introduce Lean Construction principles. New technology and new ways of organizing construction work processes, increases the turnover rate of capital by way of increased workflows and so labour productivity. This is an internal mechanism inside the companies, and these types of processes are also generated by external mechanisms, namely by the dynamics in financial markets.

The first mechanism of course, is that new technology and new working methods reduces the *work period* of operations (processing time) by increasing labour productivity in two different ways; by reduced *individual labour time* and by increased *labour intensity*. Reduced work periods, however, reduce the *turnover time* of capital (the time it takes for invested money capital to return as value increased capital) while at the same time, the *turnover rate* of capital (the number of annual capital turnovers) increases. The combined effect of reduced turnover time and increased turnover rate increases the part of the capital advanced to cover variable costs (materials, materiel and wages), because this part of the invested capital must be advanced at a frequent rate. Reduced turnover time influences the volume of necessary capital to be advanced in two different and opposite ways; while circulating capital advanced to cover variable costs increases as materials and wages have to be advanced at a frequent rate, the part of the capital invested to cover fixed costs (capital equipment etc.), is reduced.

The second mechanism indicates how access to equity (from the stock market) or debt (from banks and other financial institutions), influences the turnover time for the company's capital investments. First by the way the stock market and financial institutions, by financing horizontal and vertical mergers and acquisitions, contributes to increased centralisation and concentration (organic growth) of capital. Second because these activities tend to increase the average capital intensity of companies.

Criticizing the concept of flow used by Womack and Jones (1996), Koskela finds it "*confusing to call work-in progress value*" (Koskela 2000:101), which is understandable when work-in progress is understood as a use-value flow. However, when analyzed as values-in process, this is not confusing at all, as use-value flows are values-in process precisely because they represents values *in the course of realization*, meaning that these values are anticipated but not yet socially realized values. This is exactly why such processes are often *ante validated* by banks, as an a priori acknowledgement of the social validity of privately engaged labour, and *pre validated* by the same banks, when the assignment of a loan is done.

We do not mean to say of course, that the Lean Construction approach is not aware of the fact that construction projects also has an economic dimension.<sup>2</sup> Neither would we argue with the understanding most prominent in Lean Construction that producing a product that satisfies the customer's

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<sup>2</sup> Sacks and Harel (2006a), Sacks and Harel (2006b) and Bertelsen and Sacks (2007) among others are notably examples to the contrary

needs in the best possible way is an important goal. The point we want to make is that analyzes of economic flows or *values-in-process*, should be integrated in the Lean Construction approach in the same way as analysis of work flows and flows of information already are. In the Lean Construction approach it seem to us, that these kinds of processes are for the most part taken for granted as by-products of improvements in the use-value flows, or left to some possible ex post social validation in markets. Bertelsen (2003) suggests separating the physical /logistical and the economical management of construction. Our argument leads us to the opposite conclusion. We argue that because the product of the construction process is a commodity, with a dual character of use and exchange value, the management of the construction process must cope with both the physical/logistical and the economical dimensions of the process in an integrated way.

#### CONSTRUCTION AS A SOCIAL SYSTEM

A *social system* can be described as a network of social relations with more or less clear demarcation against other parts of social life. Social systems therefore are characterized by and grouped according to their permanence, inner coherence, common beliefs, common focus and mutual problem perceptions. According to this, a construction company can be seen as a social system, but so could also a construction project. With the project level in mind, the *social relations* in such a network, consists of more or less stable cooperative units founded on interdependence and expectations. The *social structure* of

projects, or the horizontal and vertical order of positions into larger and smaller units (division of work and hierarchical ordering of authority relations), is constituted by *roles* defined by *constituent norms* which describe which tasks are to be carried out and which actions are legitimate, and *strategic norms* that is, how to behave to fulfil the roles.

In a strategic business environment like a construction project, purposive actors clearly should not be expected to let their behaviour be directed by social norms alone, though specific *industry norms*, telling people how to behave in different situations, usually backed up by sanctions, of course have a major impact on the behaviour of different groups in the construction process and their level of cooperation.

#### THE LOGIC OF SOCIAL LOGISTICS

Generally speaking it would always be a good working hypothesis to assume that the participants in a construction project are *purposive actors*, primarily following the interests of their own and not those of others. This of course does not necessarily presuppose sole egoistic motivation. Project managers, working teams and subcontractors, should be perceived as purposive actors with specific *interests* and varying degrees of *control* with *events* and *resources* in the construction projects. When the coordination problem of *construction physics*, created by the high variability and dependence in the construction industry, is approached as a *social system*, it could be interpreted as an *interaction structure* characterized by the following interdependencies; (i) the outcome of each depends on the choice of all, (ii) the outcome of each is dependent on the outcome of all and

(iii) the choice (i.e. action) of each depends on the choices of all.

The first follow from general causality, as when the wage to be earned in a piece rate scheme, depends not only on the effort of individual members of the team, but also on the work effort of others. The second can be interpreted as the result of a zero-sum-game, as when the total project budget is given, additional and accepted bills from subcontractors necessarily reduce the profit to the main contractor.<sup>3</sup> The last illustrates the *conditional character of cooperation* in construction. When the productivity problem in construction is formulated this way, the physical logistical problem of *coordination* as treated in Lean Construction is paralleled by an equally important social logistical problem of cooperation and *collective action*.<sup>4</sup>

Interestingly there is a fourth type of social interdependence not covered by game theory, namely that; (iv) the *preferences* of each depends on the actions of all. Game theory is about

strategic interaction among rational, utility maximizing actors, and takes preferences as given. When the construction game is modelled as a repeated game, the possibility of conditional cooperation increases, and so the possibility that the numbers of cooperative participants in a project will reach a *critical mass*, that is, a sufficient number of participants to render the cooperative behaviour a self enforcing strategy. Collective action problems where it is better for all if all cooperates, yet better for each to defect, could then be turned into a game with a preference structure similar to those in an *Assurance Game* (Sen 1967) where all would prefer cooperation to non-cooperation, but only if all or at least a substantial numbers of other participants cooperates. Critical mass then, is contingent upon the right level of information and trust.

As shown by Sacks and Harel (2006), the Last Planner and the use of PPC make the degree of plan reliability transparent to project participants (i.e. subcontractors). Simultaneously they increase the participants control over work assignments, assuming that plan reliability actually is improved, thereby creating a social infrastructure with more information and higher levels of trust. However this is an outcome resulting from social interaction characterized by social interdependencies similar to the first three interdependencies as referred to above. To paraphrase the language of Ballard (2000); the Last Planner System make probable what *Can* and *Should* be done, the company culture then, acting as a motivational mechanism between *Can* and what actually *Will* be done, by way of

<sup>3</sup> This interdependence of outcomes can also arise if the outcome to be maximized is a weighted average of payoffs, as when the material or psychic welfare of others affects my own psychic welfare (Elster 2007).

<sup>4</sup> The limited space of this paper, prevent a more detailed presentation of the theoretical framework and the arguments related to the concept of social logistics. However Andersen (2008a forthcoming) uses simple binary n-person game theory models to illustrate the difference between physical- and social logistics, when the productivity problem is interpreted as a combined problem of coordination and cooperation/collective action, within a theoretical framework where construction processes are modelled as N-person repeated games.

turning the construction game into a process of strategic interaction where probably beliefs, but possibly also the preferences of each are dependent on the actual behaviour of others i.e.; a social infrastructure conducive to *organizational learning*.<sup>5</sup>

**THE IMPACT OF COMPANY CULTURE:  
DOES SUCH A THING AS A BEST  
PRACTICE REALLY EXIST?**

Culture can be defined as the attitudes, values and norms within a group. The culture is a framework for communication and action, for the interpretation of meaning and purpose. Although surprisingly often overlooked, actions that in a physical or concrete meaning are identical will be understood and reacted upon in different ways in different cultures. In other words, identical actions in different cultures can be expected to give different results. This means that the interpretation or effect of for example The Last Planner System (or any other logistical or economical approach) will differ in from national or company cultures to others. *Best practice* has been a common approach in many improvement strategies, but has often been hard to materialise in the construction industry. The argument below gives an important answer as to why it has often been so, and raises the fundamental question: *Does such a thing as a best practice really exist?* We argue that what is the “best practice” can very well vary from situation to situation, and from culture to culture.

<sup>5</sup> In the language of causality; The Last Planner System could be seen as a necessary, but not a sufficient condition for stable work flows and plan reliability, company culture being the motivational missing link.

There are two important implications of this: (i) the focus can no longer be on the action or practice alone, but must also be on the culture, environment or social system in which the action or practice is to take place, and (ii) the focus will to a far less degree have to be on *implementation* or *demonstration* of the assumed “best practice”. Instead we will have to focus on *learning*, i.e. which actions to take in the present circumstances.<sup>6</sup>

Discussing and understanding *why* activities were or were not carried out as planned is an important part of the learning process in the Last Planner System. But there is more than one answer only to the question “Why?” The differentiation between direct and root causes is often used. Tilly (2006) introduces another categorisation of answers to the question “Why?” He divides the reasons people give into four types: Conventions, stories, codes and technical accounts. What type of reason people gives is not a consequence of what has happened (in a technical sense), but of how people experience and interpret what has happened. Reasons are always given in a cultural or social context. If we approach construction purely as a logistical process and exclude the economical or social perspective, we will neither be able to understand the

<sup>6</sup> An important point commented on by Marx already in 1845, in his third thesis on the static materialism of Feuerbach: “*The materialistic doctrine, that people are the product of their circumstances and education, and that changed people therefore are the product of different circumstances and changed education, forget that the circumstances actually are changed by people, and that the educator himself must be educated*” (Marx 1973:40).

reasons people give, nor why they are given.

**GOOD PRACTICES FOR MANAGING PEOPLE**

Zelevnik (1977) discusses the differences between managers and leaders, and thereby introduces a distinction between management and leadership. A manager “emphasizes rationality and control”, he is “directed towards goals, resources, organization structures, or people, a manager is a problem solver” (Zelevnik 1977:2). A leader on the other hand is focused on “visualizing purposes” (Zelevnik 1977:2) and on “what the events and decisions mean to participants” (Zelevnik 1977:5). Heading the logistical or economical processes of construction can to a large degree be described as management, while heading the social process is more a question of leadership. Expanding the skills of personnel heading construction projects from project management to project leadership, is therefore essential if we want to create project environments where the participants can build trust and establish common goals for the project.

According to Porter (1985) there are five fundamental competitive forces that determine the ability of firms in an industry to earn above-normal returns: “The entry of new competitors, the threat of substitutes, the bargaining power of buyers, the bargaining power of suppliers, and the rivalry among existing competitors” (Porter 1985:4). Pfeffer (1994) questions Porters analyses and points out that the five American companies that have provided the greatest return to stockholders from 1972 to 1992 are all within industries “characterized by massive competition and horrendous losses, widespread bankruptcy, virtually no barriers to entry, little unique or proprietary technology, and many substitute products or services” (Pfeffer 1994:4). Pfeffer examines Porters competitive forces and finds they are becoming less and less important, and further concludes “what remains as a crucial, differentiating factor is the organization, its employees, and how they work” (Pfeffer 1994:14). He then identifies sixteen good practices for managing people as shown below (Pfeffer 1994:30-59):

<i>Practices related to production</i>	<i>Practices related to economic behaviour</i>	<i>Practices related to social aspects of production</i>
<ul style="list-style-type: none"> <li>• Teams and job redesign</li> <li>• Cross-utilization and cross-training</li> <li>• Selectivity in recruiting</li> <li>• Training and skill development</li> </ul>	<ul style="list-style-type: none"> <li>• High wages</li> <li>• Incentive pay</li> <li>• Employee ownership</li> <li>• Wage compression</li> <li>• Measurement of the practices</li> <li>• Employment security</li> <li>• Long term perspective</li> </ul>	<ul style="list-style-type: none"> <li>• Overarching philosophy</li> <li>• Information sharing</li> <li>• Participation and empowerment</li> <li>• Symbolic egalitarianism</li> <li>• Promotion from within</li> </ul>

Figure 1: Management principles according to Pfeffer

No company uses all of these practices, but a substantial number of successful

companies have a company culture where they incorporate many of these

practices. The Toyota Production System has been extensively studied, described and copied, but academics and others have not been able to agree on what the Toyota System is “really about”. Descriptions of the system tend to be either technical or “religious”, and most companies implementing the system have not been able to copy Toyotas success. This can be seen as an example of one of the main points in this paper: Toyotas logistical concept is working as an integral part of the company culture, and will not necessarily work the same way in other cultures.

## CONCLUSIONS

If we want to understand and improve the design, engineering and production processes of the construction industry,

we have to combine the logistical, economical and social perspective of the construction process. This leads to the understanding of production as a physical/logistical process (producing use value) and an economical process (producing exchange value) that is, production as combined and interdependent work processes and value increasing processes. Improvements in the logistical processes or in the economical process will always have to be carried out within a specific social environment or system, embedded in a specific culture. Properties of the social system of construction can therefore be seen as prerequisites for successful improvements in the logistical or economical processes in construction.

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