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Editorial: IGLC 2011 Special Issue

John A. Rooke[1] & Alan Mossman[2]

In the editorial of the first issue of Lean Construction Journal (LCJ) in 2004, Tariq Abdelhamid and Alan Mossman described two approaches to construction: on the one hand, a historic approach, focused on the transformation of materials and managing by results; on the other, a newly developing, lean approach which focuses on managing by means, on spatial and temporal (flow) and the extension of customer capability (value). In the intervening seven years the differences between these two approaches have become clearer and the intellectual and practical divide between them more sharply defined, so that it seems reasonable to us to assert that they currently represent alternative paradigms for the industry. This special issue attempts to outline the essentials of this paradigmatic choice, its origins and significance and to offer some indicative examples of contributions to the new paradigm.

With its origins in the Japanese car industry (see e.g. Shingo 1988; Womak & Jones 1996; Liker 2004) *Lean Thinking* is a general philosophy and a set of principles that applies to most, if not all, areas of production. This has led some to suppose that *Lean Construction* (LC) is simply an attempt to transfer high volume manufacturing techniques to the construction industry. It is not. What we understand as Lean Construction has its roots in both manufacturing *and* construction: it is a synthesis, rather than a simple transposition. Following extensive observation of construction production, Ballard developed The Last Planner® System (LPS) for managing project-based production such as construction and further refines Lean thinking in a planning system capable of responding to the ever changing realities of rapid, uncertain and complex projects.

Chosen to illustrate both the depth and the breadth of the new paradigm, the eight papers in this special issue were all presented to the 2011 International Group for Lean Construction (IGLC) Conference in Lima, Peru. The conference - a primarily academic gathering - was hosted by Granya y Montero, the largest Construction company in Peru. This is important. Much of the groundbreaking research in *lean construction* is being led by practitioners in design, construction and other disciplines - many scholars are working with these leading practitioners - or playing catchup.

The collection opens with a ground-breaking paper from **Lauri Koskela** which also addresses a historic paradigm shift that is the reverse of that advocated by Abdelhamid

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and Mossman. Koskela's paper is an early report on work-in-progress, indeed the author was reluctant to publish it beyond the relatively intimate confines of IGLC. However, we felt that the message it contains is too important not to be widely published at an early stage and have persuaded him to allow us to republish it here.

He points to the effective abandonment of production theory in management studies in the 1960s, in the wake of two seminal reports, which effectively divided the subject area between engineering, economics and behavioural science (Pierson 1959; Gordon & Howell 1959). He argues that a nascent, production based classical management thus failed to develop, leading to half a century of stagnation, in which the three management disciplines grew increasingly remote from the real life problems wealth creation. As he tellingly observes, the importance of organization is not so much, as March and Simon (1958) would have it, that we spend so much of our lives in them, but rather that we do so in order to produce the wealth by which we live.

In the second paper, **Glenn Ballard & Lauri Koskela** address the work of Graham Winch, a leading critic of Lean Construction. Winch's sees LC as bureaucratic, appropriate only to high-volume manufacturing and exclusively site-focused *(an interesting contradiction)*. Ballard & Koskela point out that the concept of Just-in-Time (JIT) is a principle of response to customer requests, a move away from mass production thinking towards more flexible mass customization. As Ballard & Koskela note, they have already distanced themselves from the project of importing manufacturing techniques into construction, thus making construction more like manufacturing. As they reiterate: "successive waves of implementation would leave ever smaller remainders [...] for our part, we are interested in that remainder (102)". Armed with this understanding of LPS & LC, it is clear that Winch's conception of LC as exclusively site based is misconceived. The key insight behind the LPS is that "for non-standard products it is necessary to standardise at the meta-level of planning and control (102)." Indeed, LPS directly addresses the need for efficient information processing that Winch (2002) suggests is vital.

Communities that support paradigms are necessarily inward looking; problems, methods and findings are all dictated by the paradigm's limitations. Those of us in the Lean Construction community would certainly make this charge against those who still work within the historic paradigm: they cannot see beyond its boundaries to the new ideas that are on offer. In return, advocates of the historic paradigm make similar accusations; that IGLC is itself inward looking and self-referential and its leading thinkers do little to address the ideas of the wider construction community.

In the third paper **Christine Pasquire & Piers Connor** present a detailed statistical analysis of the papers referenced in IGLC conference theory sessions, showing both the eclectic nature of the group's sources and the coherence of its principal works. In the process they offer an effective rebuttal, demonstrating that, while a defined body of core literature does exist, this is not exclusively referred to. And they suggest that the rate of high impact innovations may be slowing down. One possible explanation for this is that while there is still work to be done in the elaboration and consolidation of theory and while further development of techniques is to be anticipated, the major challenges ahead may well be in the dissemination and implementation of ideas already largely formulated.

It is perhaps also significant in this regard that three of the remaining five papers we have chosen as best illustrating the new paradigm are primarily practitioner, rather than

academic reports. These five papers are substantial contributions to the development of the new paradigm, illuminating some key features of it and the breadth of the field.

The next two papers illustrate respectively the centrality of a theory of production and the importance of direct observation in industrial settings. These two principles constitute the dialectic of lean construction thinking: **Sven Bertelsen & Sten Bonke** demonstrate the truth of Lewin's observation that 'nothing is as practical as a good theory', in their application of TFV Theory ('Transformation Value Flow' - or as they would have it 'Value Process Operations') to the problem of construction company strategy, while **Mike Samudio, Thais Alves & David Chambers** demonstrate the importance of 'going and seeing' or '*genchi genbutsu*' (Liker 2004).

A relatively recent theoretical development (ca. 2001 - reported in Macomber & Howell 2003) was the introduction of the Language Action Perspective as a theoretical basis for Last Planner®. **Daniela Viana, Carlos Formoso & Eduardo Isatto** show how this perspective can facilitate a rich descriptive analysis of organization.

Value Stream Mapping (VSM) is another important analytic perspective. In a paper extending the interests of the lean construction community into a new area, **Tuuli Luoma & Seppo Junnila** show how VSM can be used to identify discontinuities in the flow of value creation in an asset management company. Among other things this paper underlines the importance of looking at and optimizing the whole process rather than just optimizing each piece.

Finally, addressing the need for dissemination and training, **Jorge Izquierdo, Mario Cerf & Santiago Gómez** report on a successful management training workshop. We feel that research on ways to disseminate and teach the new paradigm, to help people change the way they think - for that is why the new paradigm is such a challenge for scholars and practitioners alike - will become more significant as the experimental and anecdotal evidence in support of the new paradigm stacks up.

References

Abdelhamid, Tariq S & Alan Mossman (2004) Editors Note *Lean Construction Journal* 1(1) http://www.lean construction.org/lcj/V1_N1/LCJ_04_0000.pdf 24mar12

Gordon, R. A. & Howell J. E. (1959) *Higher Education for Business*, Columbia University Press, New York.

Liker, J. K. (2004) *The Toyota Way*, McGraw Hill, New York.

Macomber, H. & Howell, G (2003) *Linguistic action: contributing to the theory of lean construction*, in IGLC11, Blacksburg, Virginia. http://www.iglc.net/conferences/2003/Papers/

March, J.G. & Simon, H.A. (1958) *Organizations*, John Wiley & Sons.

Pierson, F.C. (1959) *The Education of American Businessmen*, John Wiley, New York.

Shingo, S. (1988) *Non-stock production: the Shingo system for continuous improvement*, Productivity Press, Cambridge, Mass.

Winch, G. (2010) *Managing Construction Projects: an information processing approach*, (Second Edition), Wiley-Blackwell, Chichester.

Womack, J. P. & Jones, D. T. (1996) *Lean Thinking: banish waste and create wealth in your corporation*, Simon & Schuster, New York.

Papers included

Koskela, Lauri (2011) Fifty Years of Irrelevance: the Wild Goose Chase of Management Science. *Lean Construction Journal IGLC Special Issue* 2011 pp 1-11
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Fifty years of irrelevance: The wild goose chase of management science

Lauri Koskela[1]

Abstract[2]

Purpose: to begin to understand the reasons for the spectacular failure of management research to create relevant results in the period 1960-2010.

Research Questions: How relevant is management science/management research? How was the 1959 change of direction in management science to social science justified and achieved? Which correctives have been proposed for management research? What can be said about the reasons for irrelevance of management research?

Research Method: Literature study

Findings: the ousting of production from management science in 1959 seems to have been a major contributing factor to irrelevance across managerial sub-disciplines. The two 1959 reports (by Pierson and Gordon & Howell) on the future of business education failed to give appropriate direction for management research; in spite of extensive (although somewhat myopic) discussion on irrelevance in the management scholar community from circa 1980 onwards, there has been little corrective action.

Limitations: this is a broad brush examination

Key words: Management science, irrelevance.

Introduction

Modern management science has existed since 1959 when two reports (Pierson 1959, Gordon & Howell 1959) on the future of business education were published in the US. At least since 1980, there has been a practically continuous, but somewhat fragmented discussion on the relevance of management research. Surprisingly, it seems that no synthesis has been made on this discussion that occurs in all major branches of the field. Although many different proposals have been made to rectify the situation, the mainstream of management research seems to be relatively untroubled and unaffected by this situation.

The paper aims at initial understanding of the reasons for this spectacular failure of management science to reach relevant results in the period of 1960-2010. This issue is important both for general management research and more specialized areas that draw

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from that, such as construction management, project management and operations management.

The paper is structured as follows. First, the situation of management science before 1959 is outlined. Then the suggestions in the 1959 reports are described. Next, the outcomes of implementing these suggestions are evaluated. Subsequently, reasons for the wide failure of management science to provide relevant knowledge are sought for. The paper ends with conclusions.

Management Science before 1959

In the beginning of the 20th century, management was essentially factory management. Only through the extension of productive activities and along with the enlarged firm sizes, general management as an activity emerged in the first decades of that century. Through its genesis, classical management science evolved as a technical discipline; it was intimately connected to production (design included) in three senses:

- The science of organization and (general) management was developed as an extension of production and industrial management (Wren 1994).
- The interest was to organizational engineering and design: prescriptive principles (for example, Fayol) and best practice descriptions
- Management was studied by engineers or managers of productive operations, by persons involved in the phenomena studied (Shenhav 1999). This is exemplified by Taylor and Fayol.

Surely, classical management science had its serious weaknesses. There was no solid methodology in use, and hardly any systematic empirical evidence. The disciplinary structure of organization and management studies was nascent, at best confused.

The 1959 reports

It is well known that the current understanding on management science and research has been strongly influenced by two reports from 1959, funded by the Carnegie Foundation and the Ford Foundation (Gordon & Howell 1959, Pierson 1959). In their suggestions, the reports blazed a trail for a social science understanding of management science. In making these suggestions, the reports distanced from and discredited the classical management and organization science that had evolved from the beginning of the 20th century.

What did the reports suggest?

In the prescription of these reports, management was to be approached through three root stems: behavioural science, economics and quantitative modelling. These stems already existed. The behavioural stem had been promoted by Simon, March and others. In economics, the neoclassical doctrine had just been consolidated and seemed to provide a firm foundation for understanding decision-making. Quantitative modelling was in good currency after the successes of operations research in the World War II and also through the prospect of using computers to facilitate modelling.

In addition, teaching and research was to be organized in so called functional fields, such as production, marketing, finance, human relations, etc. These were understood as application areas for the (general) management theories and methods.

All in all, in comparison to classical management science, the 1959 reports suggested a radically different direction:

- Management and organization science was seen as falling into social sciences.
- Research had to result in empirical generalizations about behaviour.
- Research was to be done by scientists external to the phenomena studied.

Implementation of the suggestions and its outcomes

The mainstream research work on management in business schools started to follow the guidelines presented in these reports. The behavioural stem gathered especially around Academy of Management Journal, whereas Management Science, which had been established in 1954, acted as the flagship for quantitative modelling. In contrast to the two other stems, the economics stem did not create any new scholarly area with a clear identity. Rather, topics of interest for management were studied in the framework of general economics, perhaps reflecting the view that issues pertaining to management and organization are inseparable ingredients of the economic doctrine.

Social Science Oriented Management Research

Assume that we have accounts from two exploration parties, each visiting an unmapped island, the location of which is not precisely known. Assume further, that these accounts are coherent, topic by topic. We are justified to think, first, that it is the same island that is being described, and secondly that the agreement of the two independent accounts adds to their trustworthiness. As oddly as it may sound, we have a somewhat similar situation regarding the mainstream management science. In two Harvard Business Reviews articles separated by 21 years (Behrman & Levin 1984, Bennis & O'Toole 2005), knowledgeable insiders of academic management science come up with a surprisingly similar diagnosis on management research in business schools; hardly anything has changed. Table 1 gives a self-explanatory overview on the similarities in these two papers.

These two articles are by no means outliers. One of the first overviews on critical views on relevance of management science was the paper by Thomas and Tymon (1982), which referred to several earlier criticisms from 1972 onwards. Also, the discussion on irrelevance is not only an American phenomenon; rather similar discussion has been carried out in the UK (Starkey & Madan 2001, Tranfeld 2002). Cogently, Tranfield found that there was a strong view that much management research was unreliable for use by both the academic community and particularly practising managers in providing a basis for justifying their decision-making and actions.

Quantitative Modelling

Operations research (OR) had its heyday in the 1960s and 1970s. However, in 1979, Ackoff bitterly attacked the developments in OR. The meetings and journals of the relevant professional societies, like classrooms, were filled with abstractions from an imagined reality. As a result OR came to be identified with the use of mathematical models and algorithms rather than the ability to formulate management problems, solve them and implement and maintain their solutions in turbulent environments. Ackoff's attacks initiated a fierce debate. Checkland (1983) commented some years later that in that debate the divorce of theory from practice is no longer taken as requiring proof; it is taken as a given. It has been presented that since the 1980s OR has been on the decline.

Table 1. Textual comparison of (Behrman & Levin 1984) and (Bennis & O'Toole 2005) regarding irrelevance of management research.

Topic	Behrman & Levin 1984	Bennis & O'Toole 2005
Sources of criticisms	The current criticisms of business schools (which come from the business press, corporate officers, the deans themselves, journalists, and other professional observers)[...]	These criticisms come not just from students, employers, and the media but also from deans of some of America's most prestigious business schools, [....]
Scientific approach as a root cause	The numbers orientation: By the early 1960s business school curricula showed a large increase in the number of quantitative courses such as management science and operations research on the one hand and behavioural science courses on the other hand.	During the past several decades, many leading B schools have quietly adopted an inappropriate - and ultimately self-defeating -model of academic excellence. Instead of measuring themselves in terms of the competence of their graduates, or by how well their faculties understand important drivers of business performance, they measure themselves almost solely by the rigor of their scientific research.
Incompatibility between problems and methods	Since real problems have an annoying habit of being difficult to solve, legions of the "new scholars and their undergraduate and graduate disciples promptly set about applying their new sciences to unreal problems, that is, to all those that would yield to these new models [...]	When applied to business-essentially a human activity in which judgments are made with messy, incomplete, and incoherent data-statistical and methodological wizardry can blind rather than illuminate.
Irrelevance of research done and published	In fairness, some research breakthroughs have been useful in managerial contexts, [...]. But, for the most part, given the thousands of faculty members doing it, the research in business administration during the past 20 years would fail any reasonable test of applicability or relevance to consequential management problems or policy issues concerning the role of business nationally or internationally.	To be fair, some of what is published in A-list journals is excellent, imaginative, and valuable. But much is not. A renowned CEO doubtless speaks for many when he labels academic publishing a "vast wasteland" from the point of view of business practitioners. In fact, relevance is often systematically expunged from these journals.
Professors are evaluated based on their publications	Any good and rising young professor had only to prove that he could communicate with those who *were* interested – his colleagues.	Another consequence of the scientific model is that professor's evaluations are influenced by the number of articles they publish in A-list business research journals.
Journals become solely academic	Most academic business journals have consequently become in-house (within discipline) organs rather than a means of communicating with those involved in management procedures and business leadership.	[...] the system creates pressure on scholars to publish articles on narrow subjects chiefly of interest to other academics, not practitioners.
Lack of relevance of journals; management must get help from elsewhere	The serious policy issues management faces tend not to be addressed in "academic" journals. Managers must get help from other quarters.	In fact, relevance is often systematically expunged from these journals. Practitioners who have to make real decisions, however, must meanwhile look elsewhere for guidance, notably to the business press and to the bestseller list-now home to fewer and fewer books by faculty members.

Economics

In 1985, Kuttner wrote an article in the Atlantic Monthly that strongly criticized the discipline of economics:

> *...departments of economics are graduating a generation of idiots savants, brilliant at esoteric mathematics yet innocent of actual economic life.*

However, wider discussion on irrelevance of economics was ignited only a decade later, in 1996, again on a forum external to economics, the magazine New Yorker Cassidy's (1996) article had a simple message:

> *...that a good deal of modern economic theory, even the kind that wins Nobel Prizes, simply doesn't matter much." The article succeeded in stimulating debate both among economists and laymen.*

The kernel of the criticism is aptly summarized by Blaug (1997):

> *Modern economics is sick. Economics has increasingly become an intellectual game played for its own sake and not for its practical consequences for understanding the economic world. Economists have converted the subject into a sort of social mathematics in which analytical rigour is everything and practical relevance is nothing.*

The economic crash in 2008 added further weight to such calls for a renewal (Hodgson 2009).

Production/Operations Management

It is of course of special interest how production management coped with the re-orientation of management science away from production in 1959. The starting points were indeed not good. Buffa (1980), who wrote one of the first post 1959 text books on production management comments[3]:

> *Being left with what we knew about production systems at that time was to be left with a nearly empty basket of techniques: time and motion study, plant layout, Gantt's production control boards, the simple EOQ model, and simplistic descriptions of how production systems worked.*

In this situation, the majority of production management scholars turned to quantitative methods. However, the problem of fragmentation plagued the field (Buffa 1980):

> *...looking at research in the field before and after the MS/OR revolution, it appears that we have learned a great deal about inventories, scheduling, aggregate planning, quality control, capacity planning, and so on, in the sense of models of those isolated subsystems. We have not learned very much about the relationship between these subsystems; we view the field as a collection of seemingly unrelated subsystems rather than as whole systems (there are exceptions).*

Later, Portougal and Robb (2000) commented that scheduling research undertaken for more than 40 years has done little to improve production planning practice. Thus, not

[3] We can argue that Buffa (and his colleagues) failed to see many conceptual and methodical gains existing, for example the quality methodologies and their underlying concepts.

even this field seems to have avoided the problem of irrelevance. Perhaps with some understatement, Slack & al. (2004) state:

> *.. despite the apparently overwhelming practical focus of academic OM, it also appears to have a history that demonstrates anxiety about how "helpful" to operations practice it is really being [...]*

Discussion on outcomes of implementation

In connection to the 50 year anniversary of the business education reports of 1959, they have been commented in a largely positive tone (Anon. 2009), although pinpointing that Gordon & Howell (1959) called for better research, and that in this regard, there is still much room for improvement. In other words, there is a slight problem of implementation of the 1959 recommendations.

It is argued here that such an assessment is misinformed: the poverty of current management research has been directly caused by the very recommendations of the two reports. All the three stems of management science have miserably failed; the functional fields, spearheaded by production/operations management, do not seem to have fared any better.

Indeed, with the benefit of 50 years hindsight, it can now be convincingly argued that the direction proposed in 1959, and closely followed by the management scholar community, has been utterly wrong. It has led to a massive, discipline wide idling of management science.

Another striking feature is the helplessness and inertia of the scholarly community in rectifying the situation, as illustrated through the above mentioned two almost identical diagnoses, separated by 21 years. This has not been a period of the Kuhnian normal science, focusing on remaining pieces of the puzzle and waiting to be replaced by a new paradigm when exhausted. Rather, would this be more aptly characterized as cargo cult science (Feynman 1974), where just the external forms of research are followed, without reaching to the essence of the phenomena in focus?

These observations and judgements raise many serious and difficult questions. We briefly consider two questions arising. First: how was the social science turn of management science in 1959 justified and achieved? Second: which correctives have been proposed for management research, up to now?

Social science turn in management science as a paradigm shift

The reports of 1959 achieved a social science turn in management and organization theory, which up to that point had been largely been developed as a technical field oriented around production. How did this social science turn happen?

Cutting the connection of management science to production

In practice, the suggestions in the 1959 reports meant that the connection of management to production, which earlier had been the conceptual starting point, was to be cut off. This was realized by reconceptualising organizations around decision-making, and around the interplay between individual and organization. These ideas did not emerge in an intellectual vacuum. Rather, a sense of general hostility to the production centric paradigm was clearly visible. Gordon and Howell (1959), two economists, repeatedly make negative comments on all things related to production – by way of example:

> *Production management courses are often repository of some of the most inappropriate and intellectually stultifying materials to be found in the business curriculum. Not only do many faculty members have little respect for such courses, but students in a number of schools complained.*

It is not difficult to find the probable inspiration to this attitude. Production had been purged out of economics somewhat earlier (Koskela 2011), with comparable attitudes and arguments. One of the leading proponents of this purge, Robbins (1935), wrote about the old paradigm in economics:

> *It should not be necessary at this stage to dwell upon the inappropriateness of the various technical elements which almost inevitably intrude into a system arranged on this principle. We have all felt, with Professor Schumpeter, a sense almost of shame at the incredible banalities of much of the so-called theory of production…*

A parallel trend existed in organizational science. In his seminal book on administrative behaviour (first edition in 1947), Simon (1976) states:

> *In the post-industrial society, the central problem is not how to organize to produce efficiently (although this will always remain an important consideration), but how to organize to make decisions – that is, to process information.*

In March' and Simon's (1958) book "Organizations", the contempt of the technical understanding went even further: the importance of organizations is derived from the fact that people spend so much time in them - rather than from the production purpose, which is not even mentioned.

Rejecting production as an independent scholarly field

Moreover, production as an independent scholarly field was to be rejected; rather production was to be seen as a functional field, best approached through the underlying disciplines. Say Gordon & Howell (1959):

> *In the world of business, the so called functional fields (e.g., marketing and production) provide the major problem areas, short of general management, for the exercise of decision-making and tool-using abilities.*

Pierson (1959) writes:

> *If the functional business subjects are cut off from their underlying disciplines, as often tends to be the case, they are likely to become pedestrian and narrow, but if they are studied as integral parts of broader fields, they can become both challenging and meaningful. [...] Thus, the study of production should keep particularly close ties with mathematics, engineering and the sciences;...*

More specifically, the division of work should be as follows (Pierson 1959):

> *Putting the components together, we may generalize the complete decision process in production problems as follows: (1) the development of physically feasible alternatives, (2) identification of the more economical of these alternatives, (3) final choice of one alternative based on the human aspect involved. The first step is essentially engineering (applied physical sciences);*

> *the second step is essentially applied micro-economic theory; the third step is an application of the behavioural sciences, usually through judgement.*

Thus, the consideration of production was divided among engineering, economics and behavioural sciences, and no space was left for any independent production theory or discipline.

Positive knowledge

Research leading to "positive" knowledge (generalization on behaviour) as well as methods and tools for decision making was encouraged. Instead, research oriented towards "principles" of classical management science, that is prescriptive knowledge, was discouraged. Similarly, practice-oriented R&D was implicitly discouraged.

Fate of the old paradigm

All in all, practically all major characteristics of the old management paradigm were thus discredited, and it soon fell into oblivion. Only a few defenders of classical management science, such as Koontz (1980), tried to mobilize for a counterattack, but it came to nothing.

Correctives suggested

During the long period of discussion on the relevance problem, of course a large variety of correctives (as well as defences) have been presented. However, a surprisingly high number of such correctives go counter-current, towards the things rejected in 1959.

Connecting organization theory back to production

Since 1959, production has been almost a taboo in organization science – it has simply not been discussed. In alignment with this, organizational theory has avoided the phenomena of work or materiality, both issues belonging to production. However leading organizational theorists are ready to criticize this situation. In a paper titled "Taking work back in", Barley & Kunda (2001) argue:

> *…we argue that organization theory's effort to make sense of post-bureaucratic organizing is hampered by a dearth of detailed studies of work. We review the history of organization theory to show that in the past, studies of work provided an empirical foundation for theories of bureaucracy, and explain how such research became marginalized or ignored.*

Orlikowski (2007) writes:

> *Over the years, the field of organization studies has generated important and valuable insights into the cultural, institutional, and situated aspects of organizing. However, I want to argue that these insights are limited in large part because the field has traditionally overlooked the ways in which organizing is bound up with the material forms and spaces through which humans act and interact.*

It can be argued that these calls provide strong circumstantial evidence for the neglect of production and the need to rectify the situation. Regarding Barley's and Kunda's call, of course it has to be noted that work does not exhaust the phenomenon of production. Work is about what people do to objects of work. Production is also about

what happens to objects of work in production and about what happens to the cause of production: customer voice. Regarding Orlikowski's call, these "material forms and spaces through which humans act and interact" are often, if not mostly, embodied in the respective production system.

Reviving production as a discipline and theory

One of the original promoters of the social science turn of management science, Simon, soon came to other thoughts. In (Simon 1969), he wrote:

> *Natural science is knowledge about natural objects and phenomena. We ask whether there cannot also be "artificial science" - knowledge about artificial objects and phenomena.*

Simon continued by explaining that a science of the artificial will be closely akin to a science of engineering: it is concerned how things ought to be, in order to attain goals, and to function. He remarkably presented business as one example of professional fields where this science applies.

Another approach to revive production as a theoretical field is that of the author (Koskela 2000). He argued that there are three mostly implicit theories on production in use: transformation, flow and value generation theory of production. In this presentation, for the first time, it is possible to pinpoint probable causes for this lack of explicit scholarly treatment of theories of production: the 1959 reports which denied production as an independent topic for theorizing.

Alternative ways to knowledge

Already in 1978, Susman and Evered suggested action research as a suitable type of research in organizational science. Somewhat later, often influenced by Simon's arguments for the science of the artifial, calls for constructive or design science research in accounting (Kasanen & Lukka 1993), information systems (March & Smith 1995, Hevner & al. 2004) and management research in general (van Aken 2004, Boland & Colloby (2004) were presented. The common feature in these calls was that the end result of research is seen to be a new artefact or technological rules on how a certain goal can be achieved. Thus, the goal is not to describe the world but to change it. Of course, these technological rules are near the "principles" of classical management science, poured scorn on by Simon (1976).

Another related corrective is "type 2 research", essentially co-production of knowledge (Starkey & Madan 2001). The central idea is close collaboration between the researcher and the manager, whose essential role is to pinpoint relevant problems.

Conceptual research is one more corrective forwarded. In another remarkable turnaround (besides Simon), March (Reed & al. 2000) belittles the sacred topics of the 1959 reports, and stresses the importance of conceptual gains:

> *The key role of the university is not in trying to identify factors affecting organizational performance, or in trying to develop managerial technology. It is raising fundamental issues, and advancing knowledge about fundamental processes affecting management.*

Conclusion

There has been a wide interest in correctives that factually equate to the production centric features of pre 1959 approach to management, which were pushed aside in the social science turn.

Conclusions

There are three major conclusions from this broad brush examination. First, the 1959 reports on business education have failed, throughout, to give appropriate direction for management research; the outcomes have not passed the test of relevance. Second, in spite of extensive (although somewhat myopic) discussion on irrelevance in the management scholar community from circa 1980 onwards, not much movement towards rectifying the situation can be seen. Thirdly, judging by the way the social science turn in management science happened, and at the correctives suggested, it is plausible that the ousting of production from management science in 1959 has been one major contributing factor to irrelevance across managerial sub-disciplines.

Management is important as a phenomenon and management science is an important scholarly field, which has a considerable influence on more specific managerial fields, like construction management and project management. Unfortunately, the self-complacent acceptance of irrelevance that currently radiates from management as a scholarly field is a dangerous disease. The situation seems to invite urgent volunteer efforts from all directions to find a cure.

References

Ackoff, Russell L. 1979. The Future of Operational Research is Past. The Journal of the Operational Research Society, Vol. 30, No. 2, pp. 93-104.

Anon. 2009. The Gordon-Howell report of 1959: The more things change…; A seminal critique of American business education, five decades on. Economist, June 4.

Barley, Stephen R. & Kunda, Gideon. 2001. Bringing Work Back In. Organization Science, Vol. 12, No. 1, pp. 76-95.

Behrman, J.N. & Levin, R.I.. 1984. Are Business Schools Doing their Job? Harvard Business Review, Jan.

Bennis, W. G. & O'Toole, J. 2005. How Business Schools Lost Their Way. Harvard Business Review, May.

Blaug, Mark. 1997. Ugly Currents in Modern Economics. Policy Options, September, pp. 3-8.

Boland, J. Richard Jr. and Collopy, Fred (eds.). 2004. Managing as Designing. Stanford University Press.

Buffa, Elwood. 1980. Research in Operations Management. Journal of Operations Management, Vol. 1, Iss. 1, pp 1-7.

Cassidy, John. 1996. The Decline of Economics. The New Yorker, December 2, pp. 50 - 60.

Checkland, Peter. 1983. O.R. and the Systems Movement: Mappings and Conflicts The Journal of the Operational Research Society, Vol. 34, No. 8, Systems in O.R. First International IFORS and O.R.S. Meeting. Discussion Conference at Henley, U.K. 9-11 May 1983 (Aug., 1983), pp. 661-675.

Feynman, Richard P. 1974. Cargo Cult Science. Engineering and Science, June, pp. 10 – 13.

Gordon, Robert A. and Howell James E. 1959. Higher Education for Business. Columbia University Press, New York.

Hevner, A.R., March, S.T., Park, J., Ram, S. 2004. Design Science in Information Systems Research. MIS Quarterly, Vol. 28, No. 1.
Hodgson, Geoffrey M. 2009. The great crash of 2008 and the reform of economics Cambridge Journal of Economics, Vol. 33, pp. 1205–1221.
Kasanen, E,. Lukka, K. & Siitonen A. 1993. The Constructive Approach in Management Accounting Research. Journal of Management Accounting Research, No. 5, pp. 243-264.
Koontz Harold. 1980. The Management Theory Jungle Revisited. The Academy of Management Review, Vol. 5, No. 2, pp. 175-187.
Koskela, L. 2000. An exploration towards a production theory and its application to construction. VTT Publications 408.
Koskela, L. 2011. On the theory of production in economics and production management. In: Modern Construction Economics: New Developments in Theory, ed. by de Valence, G.
Kuttner, Robert. 1985. The Poverty of Economics. The Atlantic Monthly, February, pp. 74-84.
March, J.G. & Simon, H.A. 1958. Organizations. John Wiley & Sons.
March, S.T. & Smith, G.F. 1995. Design and natural science research on information technology. Decision Support Systems Vol. 15, Nr. 4, pp. 251 – 266.
Orlikowski, Wanda J. 2007. Sociomaterial Practices: Exploring Technology at Work. Organization Studies 28(9): 1435–1448.
Pierson, F.C. 1959. The Education of American Businessmen, John Wiley, New York.
Portougal, Victor and Robb, David J. 2000. Production Scheduling Theory: Just Where Is It Applicable? Interfaces Vol. 30, No. 6, pp. 64-76.
Reed, John, March, James and Sigismund Huff, Anne. 2000. Citigroup's John Reed and Stanford's James March on Management Research and Practice. The Academy of Management Executive, Vol. 14, No. 1, pp. 52-64.
Robbins, Lionel. 1935. An Essay on the Nature and Significance of Economic Science. 2nd ed. Macmillan, London.
Shenhav, Yehouda. 1999. Manufacturing Rationality: The Engineering Foundations of the Managerial Revolution. Oxford University Press.
Simon, Herbert A. 1969. The sciences of the artificial. The M.I.T. Press, Cambridge (MA).
Simon, Herbert A. 1976. Administrative Behavior, 3rd ed. The Free Press.
Slack, Nigel, Lewis, Michael and Bates, Hilary. 2004. The two worlds of operations management research and practice: Can they meet, should they meet? International Journal of Operations & Production Management, Vol. 24 No. 4.
Starkey, K. & Madan, P. 2001. Bridging the relevance gap: aligning stakeholders in the future of management research. British Journal of Management, Vol. 12, Spec. Iss., S3 – S26.
Susman, Gerald I.& Evered, Roger D. 1978. An Assessment of the Scientific Merits of Action Research. Administrative Science Quarterly, Vol. 23, No. 4, pp. 582-603.
Thomas, Kenneth W. and Tymon, Walter G., Jr. 1982. Necessary Properties of Relevant Research: Lessons from Recent Criticisms of the Organizational Sciences. The Academy of Management Review, Vol. 7, No. 3 (Jul., 1982), pp. 345-352.
Tranfield, D 2002. Formulating the Nature of Management Research. European Management Journal Vol. 20, No. 4, pp. 378–382.
van Aken, J.E. 2004. Management research based on the paradigm of the design sciences: The quest for field-tested and grounded technological rules. Journal of Management Studies, Vol. 41, Nr. 2, pp. 219 – 246.
Wren, Daniel A. 1994. The Evolution of Management Thought. Fourth Edition. John Wiley & Sons, New York.

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A response to critics of lean construction

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Abstract

Purpose: To reply to criticisms of lean construction made by Graham Winch in the 2nd edition of his *Managing Construction Projects*.
Method: Reasoned argumentation from published statements.
Findings: Winch's criticisms of lean construction are based on misunderstandings.
Limitations: Other papers will continue the debate regarding the appropriate conceptualization of projects in relation to production, including the question whether organization design is part of production system design.
Implications: Regarding the mainstream construction management community, we respectfully propose that it should get rid of certain temporal myopia. Two central concepts of lean construction are production, as a starting point for managing and organizing, and waste, as a focus of improvement. Winch denies the role of production in management and fails to recognize the importance of waste: it is not in the index of his book, although lean production and lean construction is discussed. This is fully aligned to other current literature in management, which – through silence - denies the role of production and waste. However, these concepts were present in the management literature preceding the two influential books on business education in 1959 (Gordon & Howell 1959, Pierson 1959). Lean construction represents a continuation of the discussion in the first half of the 20th century, which seems to have become opportune again as a result of the massive criticism on the lack of relevance of management science since the 1980's.
Value for Practitioners: To invert a well-known saying: 'There is nothing so impractical as a poor theory.'
Keywords: Construction management, lean construction, theory

Introduction

This paper continues a discussion with Graham Winch that has taken place primarily in print, beginning with an exchange in the Building Research & Information Forum in 2006, in which Winch's views on construction management and lean construction, expressed in the 1st edition of his *Managing Construction Projects*, were criticized (Koskela & Ballard,

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2006). Winch replied to those criticisms in that same Forum exchange (Winch, 2006), and has made additional criticisms of lean construction in the 2nd edition of his text.

There are more critics of lean construction, but Graham Winch is widely, and properly, recognized as a leading thinker in the field of construction management. In this discussion, we understand ourselves to be in conversation with a number of scholars in the field, and engage in the conversation in hopes of providing more clarity regarding the lean construction movement.

The next section of the paper presents the discussion to date; claims and counterclaims. A critique of Winch's comments in the 2nd edition follows, leading to a concluding section in which we propose implications of the issues in dispute and suggest what the lean construction community can do to initiate fruitful interaction with the mainstream academic community.

Brief History of the Discussion

The discussion with Graham Winch has spanned over eight years, from the publication of his major work on construction project management in 2002 (Winch, 2002) to the 2nd edition of that text in 2010. The previous contributions to this conversation have been:

A. Winch, G. M. (2002), Managing Construction Projects: an Information Processing Approach, Blackwell, Oxford.
B. Koskela, L., Ballard, G., and Howell, G. (2004), "Project management reconceived from a production perspective", Proceedings of the CIB World Congress, Toronto, Canada.
C. Koskela, L. and Ballard, G. (2006), "Should project management be based on theories of economics or production?," Building Research & Information Forum, 34(2), 154-163.
D. Winch, G. M. (2006), "Towards a theory of construction as production by projects", Building Research & Information Forum, 34(2), 164-174.
E. Winch, G. M. (2010), Managing Construction Projects: an Information Processing Approach, 2nd edition, Wiley-Blackwell, Chichester.

The primary contributions have been made in Winch's two editions and in the BRI Forum exchange in 2006. At the risk of concealing the richness of the argument, it seems fair to say that the conversation, although amicable and constructive by intent, has thus far not brought the parties closer together in their thinking. We hope to achieve a remedy, if not in this paper, in the future discussions it enables and provokes.

The initial critique, expressed in C above, was summarized in Table 1, contrasting Winch's approach, termed economics-based, and the lean approach, termed production-based.

Table 1: Comparison of the foundational issues of the economics- and production-based approaches to project management (p. 161, Koskela & Ballard, 2006)

	Economics based	Production based
Fundamental assumptions on the nature of projects	Organisations integrate through transactions	Production systems
Conceptualisation of the project	Information-processing system	Transformation, flow value
Intrinsic goal	Uncertainty reduction (i.e. elimination of lack of information)	Getting the facility produced, eliminating waste, increasing value
Nature of management	Creating the (contractual and organisational) structure	Designing, operating and improving the production system

Winch responded to each of these criticisms as follows (Winch, 2006):

- Koskela and Ballard have misconstrued the nature of transaction cost economics. The make or buy decision is central, and both production costs and transaction costs are taken into account in making those decisions.
- The job of the project manager is to coordinate production, which involves processing information rather than materials. (Winch refers us to an earlier book, which is said to explain how information and materials processing are integrated (Winch, 1994)).
- "…a construction project is essentially a proposition about a unique future state, and…uncertainty in decision-making is inherent to the process of achieving that future state." (p. 168)
- In defense of his tectonic approach to management, Winch again refers back to his 1994 book in arguing that "…information processing in organizations cannot be directly managed, but is managed through changes in organizational structure in terms of both internal and inter-organizational arrangements." And further on the same page: "From the tectonic perspective, project management is essentially about the coordination of discrete materials transformation processes, not the management of the materials transformations that take place within those processes." (p. 168)

Winch also takes the opportunity to direct two criticisms at Lean Construction; "…two surprising omissions from the LPDS (Lean Project Delivery System) toolbox"; namely:

- lack of attention to new forms of organization to provide the context for the LPDS, and
- lack of attention paid to Goldratt's theory of constraints and critical chain[3].

[3] For the record, a special issue on relational contracting was published in the Lean Construction Journal (www.leanconstructionjournal.org) in 2005 and Goldratt's critical chain was discussed in relation to the Last Planner® System in (Ballard and Howell, 2003). The latter topic was also addressed in (Koskela, Stratton & Koskenvesa 2010).

Criticism of lean construction in Winch's 2nd edition

In the 2nd edition of his *Managing Construction Projects,* Winch repeats his response to previous criticisms of his own work by the authors of this paper, and adds new criticisms of Lean Construction, among them the following:

- Lean construction is a form of bureaucracy, as opposed to the professionalism Winch advocates.
- Lean construction has its roots in high-volume lean manufacturing and is thus constrained to "high volume construction", rather than one-off projects.

These closely connected criticisms reveal a fundamental misunderstanding of lean in both manufacturing and construction. We could note the many publications and presentations that contradict this conceptualization, and we will do that, but the question still remains why those have been ignored. In the Conclusions, we analyze this misunderstanding for its root causes and make some proposals for its correction.

According to Winch, the principal features of lean production are the following (pp. 471-2):

- "The production flow is paramount – the flow of components through a factory, or the flow of passengers through an airport, should be maximized and the old concept of batch and queue to maximize capital utilization is outmoded.
- The production process should be pulled by customer demand rather than be pushed by production scheduling which requires flexibility in production processes.
- Suppliers should be tiered in proactively managed and partnered supply chains.
- The elimination of in-process and finished inventory by the focus on flow and pull-scheduling leads to reduced working capital requirements for production.
- Continuous improvement of the production process takes place through team-oriented activities such as total quality management.
- The challenges in improving performance are largely organizational and do not depend on high levels of technology in the production process."

We agree that these are among the underlying principles of lean production. However, when Winch characterizes Lean Construction as follows (p. 475), we cannot see how he is deriving these characterizations from the "principal features of lean production" above:

- Winch sees Lean Construction appropriate for slow, simple and certain projects, as distinct from those that are complex, uncertain and quick; interestingly, the exact opposite of the way Lean Construction advocates understand the matter. "Where needs are predictable and can be standardized, bureaucracy remains the most effective way to meet them." "Where needs are more complex or dynamic, professionalism defined as the ability to configure established expertise to solve novel problems is more appropriate."
- Winch sees lean construction as imitating manufacturing's product development in separating designing and making: "(Lean production) is, essentially, about what happens in the factory or on the construction site."
- Winch sees lean construction as limited to the production of standard products: "The crucial question in assessing the potential for the application of the lean

approach to construction is the extent to which the one-off nature of the construction process can be changed." "Lean concepts as a whole are unlikely to be applicable to refurbishment projects, let alone repair and maintenance,…" and he dismisses the applicability of lean construction to most if not all new construction because of the limited ability to standardize product designs.

Rebuttal

Briefly stated, we see Lean Construction the more needed for more dynamic projects, integration of designing and making as the hallmark of the lean approach to production, and the applicability of lean concepts and methods, far from being limited to standardized products, rather enabling and promoting innovation and value generation.

Our characterization is inconsistent with Winch's criticisms; namely, 1) 'Lean construction is a form of bureaucracy, as opposed to the professionalism Winch advocates, and 2) Lean construction has its roots in high-volume lean manufacturing and is thus constrained to "high volume construction", rather than one-off projects. We shall try to understand and rebut Winch's claims, and also to support our own characterizations of lean construction.

Categorization of TPS as bureaucratic is presumably based on its formalization and standardization, but this ignores the differentiation between coercive and enabling bureaucracies introduced by Adler in his 1996 paper, in which he cites Toyota as exemplary in its use of standardization as a platform for learning. It also ignores the findings of research by the National Center for Manufacturing Sciences (2000) that found Toyota's product development system alone to value learning rather than compliance, and found Toyota's product development performance much superior to competitors from a variety of industries (see the mentioned research report and also the two popular books, 2003 and 2008, by Michael N. Kennedy).

Winch's assessment of lean production seems to have been formed in 1994 when he claimed in *Managing Production* (Winch, 1994) that lean production was limited to high volume manufacturing, based on the argument that JIT (Just-in-Time) was essential to lean production and that JIT was possible only in high volume manufacturing. In our view, this reflects a misunderstanding of JIT, the essence of which is to do work in response to customer request. Winch appears to assume that some specific quantitative criterion is implicit in the concept, but no such criterion is possible for 'just-in-time'. The objective is to strive continuously to reduce the time work is performed prior to the use of that work output by the immediate customer process; done in order to reduce the waste of overproduction (Ohno, 1998). The ideal is to achieve zero lead time. The extent to which the ideal can be approximated will vary with the nature of the work being performed. What's more, JIT has been demonstrated to work in construction, in the delivery of components to sites (Arbulu & Ballard, 2003) and of information to design offices (Ballard, 2002).

A second issue is **the implicit assumption that if lean production has a certain characteristic, that also applies to lean construction**. The Lean Construction community has not tried to simply imitate lean in repetitive manufacturing, but to abstract up to fundamental principles, then move them to new domains, and adapt them and the corresponding methods as needed for the new domains.

Part of the gap in understanding may be a consequence of the tendency, at least until recently, for lean construction to be understood in the U.K. as turning construction into (repetitive) manufacturing; a barely hidden subtext in the Egan Report (Construction Task Force, 1998). In contrast, the International Group for Lean Construction and the Lean Construction Institute have embraced the differences between construction and repetitive manufacturing and have sought since 1993 to adapt lean principles and methods to a new domain. To take but one example[4], consider the following statement from the abstract to Ballard and Howell's "What Kind of Production is Construction?":

"Applicability of lean principles to construction might seem to require that construction's differentiating characteristics be softened or explained away. This is the strategy employed by those who advocate making construction more like the manufacturing from which lean thinking originated. Following that line of thought, successive waves of implementation would leave ever smaller remainders that are not yet reduced to manufacturing, and consequently not yet capable of being made lean. This approach offers tremendous opportunity for reducing the time and cost of constructed facilities. However, for our part, we are interested in that remainder, in understanding its peculiar characteristics, and in learning how to make it lean. Our interest is founded on the belief that construction is a fundamentally different kind of production; i.e., that there is an irreducible remainder. We also suspect that learning how to make construction lean will help show the way to the manufacturing of the future. Manufacturing is becoming more like construction. Far from being the most backward, in our view, construction can be among the leading edge industries in lean thinking. Adopting a single-minded strategy of transforming construction into manufacturing would be precisely the wrong thing to do." (Ballard & Howell, 1998)

Construction is one type of project production system. Projects may be dedicated to the production of standard products, products that have previously been designed, but are usually the type of production system appropriate for non-standard products, which require the integration of designing and constructing. As such, projects present unique challenges to the application of lean principles and methods. Many, though not all, of the studies done in applying lean to construction have tried to meet those challenges.

Does lean construction only apply to site production? Consider the closing paragraph from (Ballard & Howell, 1998) - cited above:

"What is dynamic construction and what challenges and opportunities does it pose for lean thinking? While product and process design can be standardized for standard products, for non-standard products it is necessary to standardize at the meta-level of planning and control[5]. In other words, it is necessary to develop standard procedures for planning and managing the design and installation of unique facilities. The engineer/constructor firms of the industrial sector have gone the farthest in this direction. The building sector in the U.S. has only just begun to map its production (design, procure, install) processes. The industrial sector's lead seems based on their control of the entire process, as opposed to the extreme fragmentation in the building sector. This is now changing as building sector specialists band together to pursue design-build opportunities. This social unity is a prerequisite for process mapping and streamlining that can maximize customer value and minimize waste."

[4] Other examples of the treatment of these issues are provided in (Koskela 2000, Vrijhoef & Koskela 2000).

[5] The "meta-level of planning and control" refers to the Last Planner® system.

Designs, whether 'completely' unique or only slight modifications from templates, are produced using many of the same processes; e.g. making calculations, producing drawings, evaluating design alternatives. Consequently, standardization of component processes or even component parts need not imply standardization of constructed assets. Further, even in Toyota's repetitive manufacturing, not everything is standardized, and not everything that is standardized is standardized at the same level of detail (Ohno, 1998; Liker & Meier, 2007).

This issue is linked with Winch's view that lean construction is basically a set of tools. He applauds Last Planner®[6] on several occasions, but does not seem to recognize that the 'tool' is intimately linked with the lean philosophy. The entire lean community is indebted to Jeffrey Liker for his books that reveal the intimate connection between the lean ideal, lean principles, and lean methods and tools (Liker, 2004 and Liker & Maier, 2005).

What evidence exists to support our claim that **lean construction applies to, and in fact substantially improves the performance of, 'one-off' projects**? Winch makes no reference to lean construction's work on other aspects of project management than site management. One notable area of LC contribution has been to target costing, to which Winch (2010) makes reference on six different pages (161, 241, 263, 264, 268 and 480), but never mentions any lean construction publication on the topic. Indeed, on p. 264, he cites Nicolini (2000) in support of his claim that target costing is not viable in the current state of the (construction) industry, despite the fact that the first successful application of target costing in construction was reported in 2004 (Ballard & Reiser, 2004), and a stream of successful projects have been reported in subsequent publications; e.g., (Ballard, 2006) and (Ballard, 2008). Experimentation has so far been done in the institutional sector (healthcare and education), with projects ranging from relatively simple medical office buildings to highly complex acute care hospitals. Two anomalistic outcomes have proved to be predictable; namely, 1) the expected cost has fallen as the design has become more detailed, and 2) costs at completion are 15-20% below market. These outcomes are, we believe, the result of aligning commercial interests of the participants, integrating organizationally, including the client as a permanent and active member of the project team, revealing to the team what the client is able and willing to pay to acquire the constructed asset, setting targets for the facility to be delivered and for client conditions of satisfaction regarding cost and time, steering design toward these targets proactively and aggressively, and using lean management methods such as Last Planner® and set based design[7]. Increasingly, also building information modeling is being used in these efforts[8].

The inspiration for lean construction should naturally be from lean product development, which has the same scope. Repetitive manufacturing begins when product development ends. The construction project is a product development process, though not necessarily of a product the design of which will be copied multiple times. Remarkably Winch ignores the Toyota Product Development System (Clark & Fujimoto 1991, Ward et al. 1995, Fujimoto 1999, Sobek et al. 1998, Sobek et al. 1999), not to mention the Toyota Way (Liker, 2003), each a reconceptualization of Toyota's achievement and contribution,

[6] The Lean Construction Institute holds a trademark.

[7] See (Ward, et al., 1995) and (Sobek, et al., 1999) for set-based design in Toyota; and (Parrish, et al., 2007) for application of the concept in construction.

[8] The intimate connection between lean and building information modelling has been analyzed in (Sacks et al. 2010).

moving from a focus on making to the integration of designing and making and finally to a philosophy of organizational management in which the organization's purpose is to generate value to customers and to society through its products and services.

Conclusions

We have critically countered the following claims made by Winch:

- Lean construction is a form of bureaucracy, as opposed to the professionalism Winch advocates.
- Lean construction has its roots in high-volume lean manufacturing and is thus constrained to "high volume construction", rather than one-off projects.
- Lean construction is limited to site construction, and separates designing and making.
- Lean construction is applicable only to slow, simple and certain projects.
- Lean construction is limited to the production of standard products.

We contend that there are two underlying complexes of reasons for the difficulties Winch has encountered when trying to make sense of lean: one related to IGLC, another related to the received view in management.

The International Group for Lean Construction was formed in 1993, as a forum for discussing the theory and practice of lean construction. From the first workshop, attended by a dozen people, it has grown to a medium sized conference, held annually. Except for a few of the first conferences, a rigorous refereeing process has been in place. The conferences are characterized by knowledgeable discussion on the papers presented. Indeed, IGLC conferences have evolved to be the main outlet of scholarly work on lean construction for many researchers in the field. This feature seems to have gone unnoticed by mainstream construction management researchers who have expected main results to be published in Journals. In addition, the lack of overview presentations on lean construction has added to the problem. In view of these factors, it is suggested that the IGLC members make the nature of their work as conference centred clearer, but also strengthen their presence in mainstream Journals.

Regarding the mainstream construction management community, we respectfully propose that it should get rid of certain temporal myopia. Two central concepts of lean construction are production, as a starting point for managing and organizing, and waste, as a focus of improvement. Winch denies the role of production in management and fails to recognize the importance of waste: it is not in the index of his book, although lean production and lean construction is discussed. This is fully aligned to other current literature in management, which – through silence - denies the role of production and waste. However, these concepts were present in the management literature preceding the two influential books on business education in 1959 (Gordon & Howell 1959, Pierson 1959), which achieved a social science turn in management science. Lean construction represents a continuation of the discussion in the first half of the 20th century, which seems to have become opportune again as a result of the massive criticism, since the 1980's, on the lack of relevance of management science.

References

Adler, Paul S. (1996), "Two Types of Bureaucracy: Enabling and Coercive", *Administrative Science Quarterly*, March 1996, 21/1, 61-89.

Arbulu, Roberto and Glenn Ballard (2004). "Lean Supply Systems in Construction". *Proceedings of the 12th annual conference of the International Group for Lean Construction,* Elsinor, Denmark, August, 2004.

Ballard, Glenn (2002). "Managing work flow on design projects: a case study." *Engineering, Construction and Architectural Management,* 9/3, June 2002, pp 284-291.

Ballard, Glenn (2008). "The Lean Project Delivery System: An Update". *Lean Construction Journal*, 2008. Available at leanconstructionjournal.org.

Ballard, Glenn (2006). "Rethinking Project Definition in terms of Target Costing". *Proceedings of the 14th annual conference of the International Group for Lean Construction*, Santiago, Chile, July 25-27, 2006, pp. 77-89.

Ballard, G. and G. Howell (1998) "What Kind of Production is Construction?", *Proceedings*, 6th annual conference of the International Group for Lean Construction, Guaruja, Brazil

Ballard, G. and Howell, G. (2003), "An Update on Last Planner", Proceedings of the 11th annual conference of the International Group for Lean Construction, Blacksburg, Virginia

Ballard, Glenn and Paul Reiser (2004). "The St. Olaf College Fieldhouse Project: A Case Study in Designing to Target Cost". *Proceedings of the 12th annual conference of the International Group for Lean Construction,* Elsinore, Denmark, August, 2004.

Clark, Kim B. and Takahiro Fujimoto (1991). *Product Development Performance*. Harvard Business School Press, Cambridge, MA. 409 p.

Construction Task Force (1998) *Rethinking Construction,* London, Department of the Environment, Transport and the Regions

Fujimoto, Takahiro (1999). *The evolution of a manufacturing system at Toyota*. Oxford University Press, Oxford, U.K. 380 p.

Gordon, Robert Aaron and James Edwin Howell (1959) *Higher Education for Business*, Columbia University Press, New York, NY

Kennedy, Michael N. (2003). *Product Development for the Lean Enterprise*. The Oaklea Press, Richmond, Virginia. 254 p.

Kennedy, Michael N., Kent Harmon, and Ed Minnock (2008). *Ready, Set, Dominate: Implement Toyota's Set-Based Learning for Developing Products and Nobody Can Catch You*. The Oaklea Press, Richmond, Virginia. 296 p.

Koskela, L. (2000) *An Exploration towards a Production Theory and its Application to Construction,* Technical Research Centre of Finland, Espoo

Koskela, L. and Ballard, G. (2006), "Should project management be based on theories of economics or production?", *Building Research & Information Forum*, 34(2), 154-163.

Koskela, L.J., Stratton, R. and Koskenvesa, A. (2010), "Last planner and critical chain in construction management: comparative analysis" , in: *Proceedings* of the 18th Annual Conference of the International Group for Lean Construction, 14-16 July 2010, Haifa, Israel.

Liker, Jeffrey K. (2004). *The Toyota Way*. McGraw-Hill, New York, NY. 330 p.

Liker, Jeffrey K. and David Meier (2006) *The Toyota Way Fieldbook,* McGraw-Hill, New York, NY

National Center for Manufacturing Sciences (2000). *Product Development Process-Methodology and Performance Measures,* research report available at http:// www. ncms. org/ express/projects

Nicolini, D., C. Tomkins, R. Holti, A. Oldman, and M. Smalley (2000) "Can Target Costing be Applied in the Construction Industry – Evidence from Two Case Studies", *British Journal of Management,* 11, 303-24

Ohno, Taiichi (1998), *Toyota Production System: Beyond Large-Scale Production,* Productivity Press, Portland, Oregon

Parrish, Kristen, John-Michael Wong, Iris D. Tommelein, and Bozidar Stojadinovic (2007), "Exploration of Set-Based Design of Reinforced Concrete Structures", *Proceedings of the 15th annual conference of the International Group for Lean Construction,* Michigan State University, East Lansing, July 2007, 213-222.

Pierson, F.C. (1959) *The Education of American Businessmen,* John Wiley, New York, NY

Sacks, Rafael, Lauri Koskela, Dave Bhargav and Robert Owen (2010) "Interaction of Lean and Building Information Modeling in Construction", *J. Constr. Engrg. and Mgmt.* 136, 968

Sobek, Durward K. II, Jeffrey K. Liker and Allen C. Ward (1998). "Another Look at How Toyota Integrates Product Development". *Harvard Business Review,* July-August, 1998.

Sobek, Durward K. II, Allen C. Ward, and Jeffrey K. Liker (1999), "Toyota's Principles of Set-based Concurrent Engineering", *Sloan Management Review,* Winter 1995, 67-83.

Vrijhoef, Ruben and Lauri Koskela (2000), "The four roles of supply chain management in construction", *European Journal of Purchasing & Supply Management*, Volume 6, Issues 3-4, December 2000, pp. 169-178.

Ward, Allen, Jeffrey K. Liker, John J. Cristiano, and Durward K. Sobek II (1995), "The 2nd Toyota Paradox: how delaying decisions can make better cars faster", *Sloan Management Review,* Spring 1995, 43-91.

Winch, G.M. (1994) *Managing Production: Engineering Change and Stability,* Oxford University Press, Oxford.

Winch, G.M. (2002) *Managing Construction Projects: an Information Processing Approach,* Blackwell Science, Oxford, U.K.

Winch, G. M. (2006), "Towards a theory of construction as production by projects", *Building Research & Information Forum*, 34(2), 164-174.

Winch, G.M. (2010) *Managing Construction Projects: an Information Processing Approach, 2nd edition,* Wiley-Blackwell, Chichester, U.K.

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Where does the Theory Informing the International Group for Lean Construction Come From?

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Abstract

Research Question: is lean construction theory, as represented in International Group for Lean Construction (IGLC) theory papers, based on other IGLC papers or do they draw from a wider literature?

Research Hypothesis: the IGLC knowledgebase is inward looking and theory is being developed largely internally

Purpose: to clarify the basis for a debate about fears that lean construction theory is being developed largely internally, without drawing sufficiently on new ideas or recent thinking from the wider academic and industrial community.

Research Method: counting references used to generate lean construction theory within IGLC conference papers

Findings: The analysis identifies the leaders in the development of Lean construction theory and confirms that their work is referred to outside the IGLC community. The level of referencing from sources published outside the IGLC conferences is high; the quality of sources used and a lack of new thinking generated gave cause for concern. Design is generally under-represented in theory papers.

Limitations: The research only looks at IGLC papers and makes no attempt to define any aspect of lean construction theory. It was simply a counting exercise to show the flow of references and theory sources.

Implications: There is room for the IGLC community to improve its theoretical base.

Value for scholars: guidance on seeking a wider basis for theory papers and engaging with academic journals

Keywords: IGLC, development, theory, papers, conferences, references, citations.

Paper type: main

Introduction

Over the last 20 years, the idea of Lean Construction has been developed across the world by a small number of academics working both together and separately. The aim is to formulate a firm base for Lean Construction theory and to translate this theory into

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usable and manageable systems for practical application in the construction and building industry. Considerable progress has been made over the years and world-wide co-operation is well established in the form of the International Group for Lean Construction (IGLC) and a number of industry-facing Lean Construction bodies such as the Lean Construction Institute (LCI) and its affiliates.

In spite of the progress made, the development of Lean Construction theory has been largely unstructured – that is to say, it has not been directed by any underlying strategy or pre-prepared road map. This paper presents a review of past conference papers presented on the IGLC website (IGLC 2010) and suggests that it has developed in gradual and sometimes variable steps, drawing from a wide range of manufacturing process improvement studies, project planning ideas, specialised workplace studies and management improvement theory.

In the last few years, the Lean Construction community has been criticised for a lack of theoretical foundation or clear idea of what was driving it. Indeed, there were some fears expressed that the theory was being developed largely internally, without drawing in enough new ideas or recent thinking from the wider academic and industrial community. Thus the principal purpose of this work was to test the hypothesis that the majority of IGLC conference papers supporting Lean Construction theory today are largely based on internally developed IGLC literature and reference sources. This paper attempts to test this hypothesis by providing a review of the references cited by IGLC papers and to show, as far as possible, which theories and ideas have driven the development. The work also shows those references originating from journals and conferences and those authors who have the highest number of citations.

Methodology

The population of references cited by the conference papers was sampled to create a manageable number. The sample included all papers to up to and including 1998 but from subsequent years only the theory theme papers were included. It is recognised that Lean construction theory is developing in all IGLC research themes but the Theory theme is the most likely to concern fundamental theoretical development. The exception to this was the year 2000 where papers were not themed. All papers from this year were originally included but this skewed the statistics by a factor of four. As a result a subjective selection of papers was made to represent the theory theme. In any case, the sample papers cited 2,970 references by 1,873 authors.

Following the sample selection, the second stage of data collection comprised entering the data into a Microsoft Excel spread sheet in such a way that identified the IGLC paper and conference year in which each reference was included, plus the year and place each reference was published, its title and its author/s. The reference titles were entered in such a way that made it possible to search the titles and count the occurrence of significant words.

Care was taken to ensure the date entry and subsequent search instructions were precise enough to prevent miscounting as a result; for example, where the word sought also formed part of a longer word e.g. “allen” and “challenge”. A checksum of the data input showed an error rate of 0.01 in the range of 2,970 references. This was considered acceptable given the number of data entries.

The Results

The statistical results of the work are set out in Table 1. In terms of scale, the number conference papers included in the sample was 162 and the total number of references cited by them was 2970. The annualised average of references cited was 19.7 per paper, of which 11.59% were IGLC papers. The data includes references cited more than once.

Table 1: References Cited in Selected IGLC Conference Papers 1993-2010

Year	No. of IGLC Papers Assessed	Total Citations	IGLC Papers Cited	External Citations	Average citations per Paper	Av. IGLC citations
1993	5	63	0	63	12.6	0.0%
1994	14	130	0	130	9.3	0.0%
1995	16	171	7	164	10.7	4.1%
1996	16	221	15	206	13.8	6.8%
1997	15	114	15	99	7.6	13.2%
1998	4	50	2	48	12.5	4.0%
1999	8	125	7	118	15.6	5.6%
2000	8	164	17	147	20.5	10.4%
2001	6	113	12	101	18.8	10.6%
2002	4	89	8	81	22.3	9.0%
2003	7	184	29	155	26.3	15.8%
2004	9	252	24	228	28.0	9.5%
2005	11	279	42	237	25.4	15.1%
2006	5	145	20	125	29.0	13.8%
2007	7	194	51	143	27.7	26.3%
2008	9	222	48	174	24.7	21.6%
2009	9	185	36	149	20.6	19.5%
2010	9	269	63	206	29.9	23.4%
Total	**162**	**2970**	**396**	**2574**		
Yearly Avg		**171.0**	**13.3%**		**19.7**	**11.59%**

The number of IGLC conference papers cited in subsequent IGLC papers was plotted against the external references cited and shown in Fig. 2

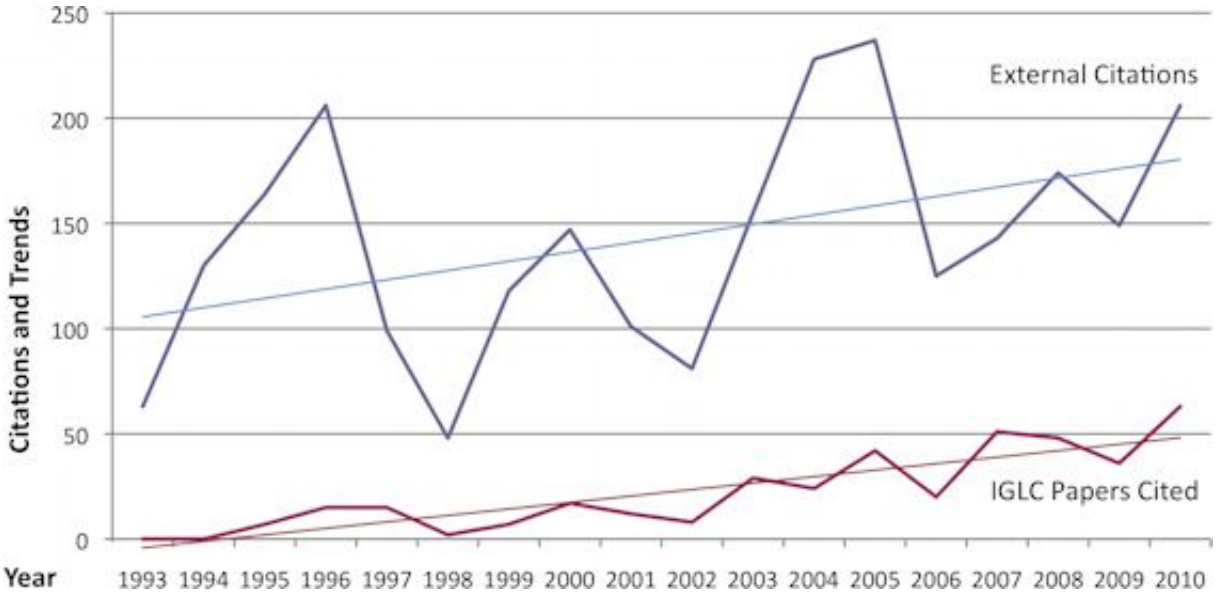

Figure 2: Number of external and internal references per year

The trend lines included in Fig. 2 show a general rise in the number of references per paper. They also show that the percentage difference between external references and IGLC references has remained reasonably constant. This demonstrates that the original hypothesis is false in assuming that the greater proportion of theory is supported by internal referencing. The average annual proportion of external references is 88.41% over the 18 years reviewed.

Cited Authors

The total number of named authors cited in the sample papers was 1873. The total number of authors of IGLC papers cited was 145 or 7.7% of the total. However, these authors are named in an average of 23.53% of cited references (Fig. 3 below).

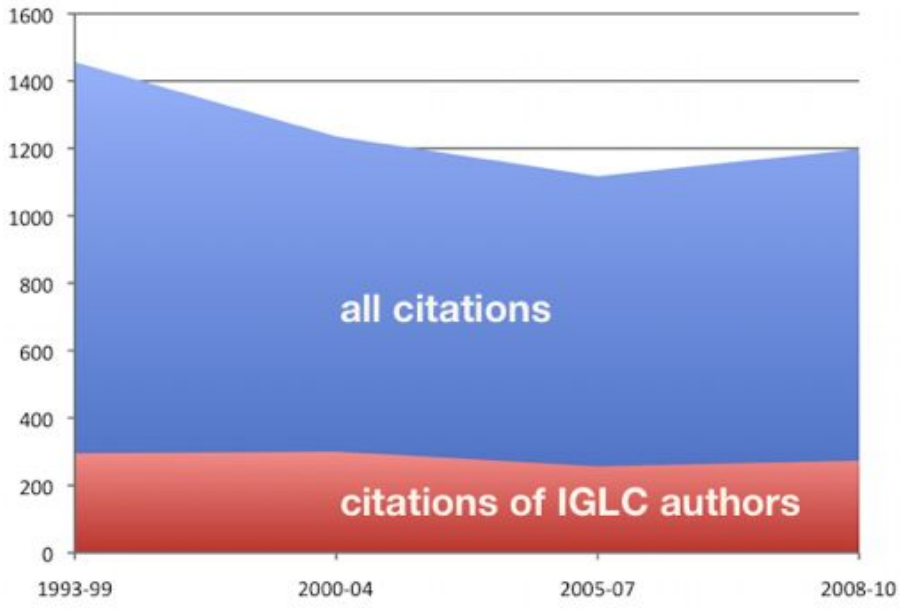

Figure 3: IGLC authors cited against the total of all authors

The data was also sorted to show the names of authors most cited in the sample papers (Figure 4).

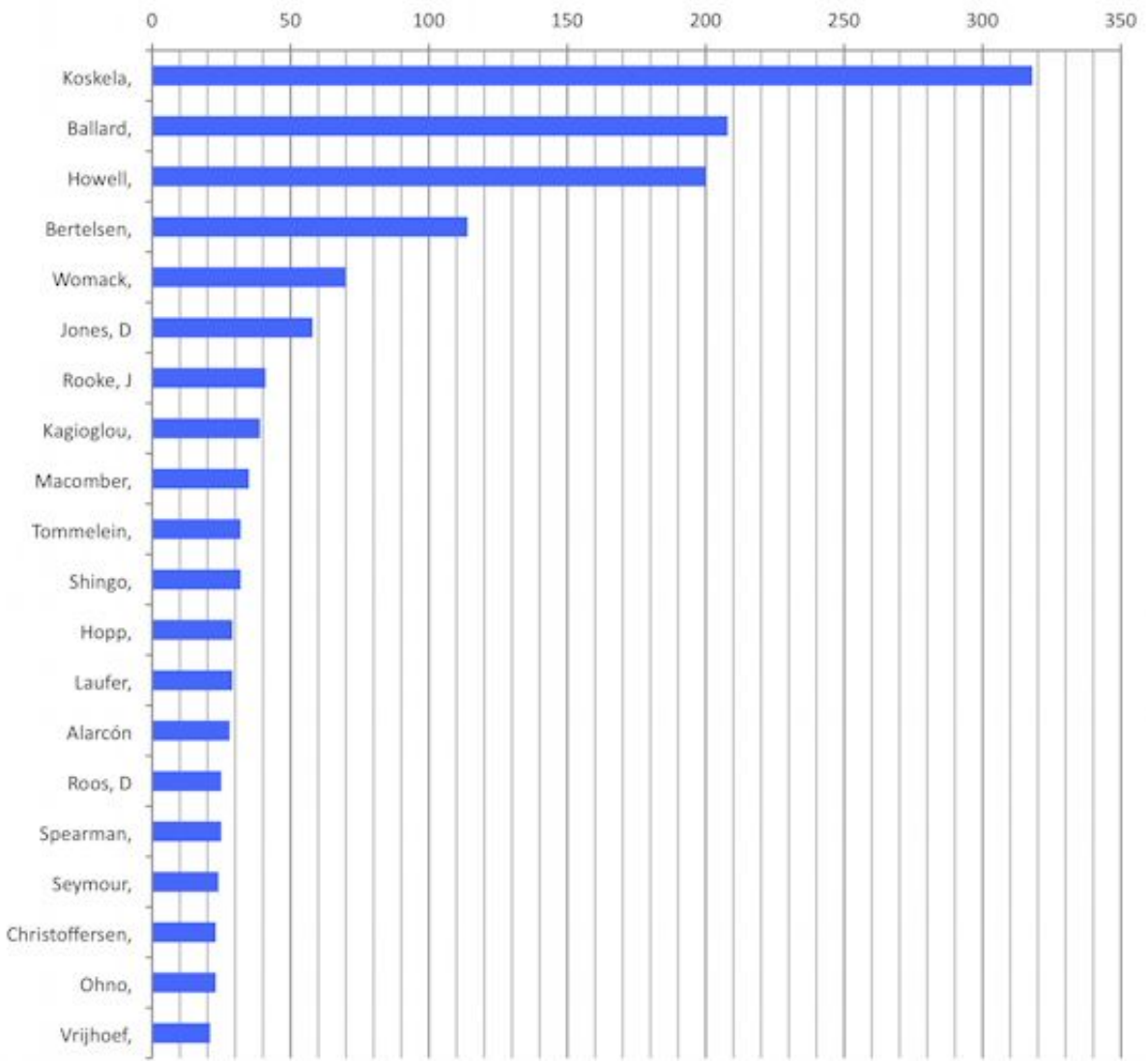

Figure 4: Bar chart showing the top twenty most cited authors in all references listed in the surveyed papers.

Then, the authors of IGLC papers sampled were sorted and listed showing the top conference contributors. These are shown in Figure 5 below.

It is not surprising to note that the names of the most cited authors are similar in both lists. It is also worthy of note that the top five authors listed in Figure 4 represent 49% of the citations in the total of 1,873 individual authors. Thus 2.5% of the authors are referenced in almost half the total of 2,970 papers cited.

It should be noted that authors like Tommelein who, for example, has published only three of the sampled papers is actually quite highly cited in the sampled papers. Whilst some like Seymour for example, move the other way

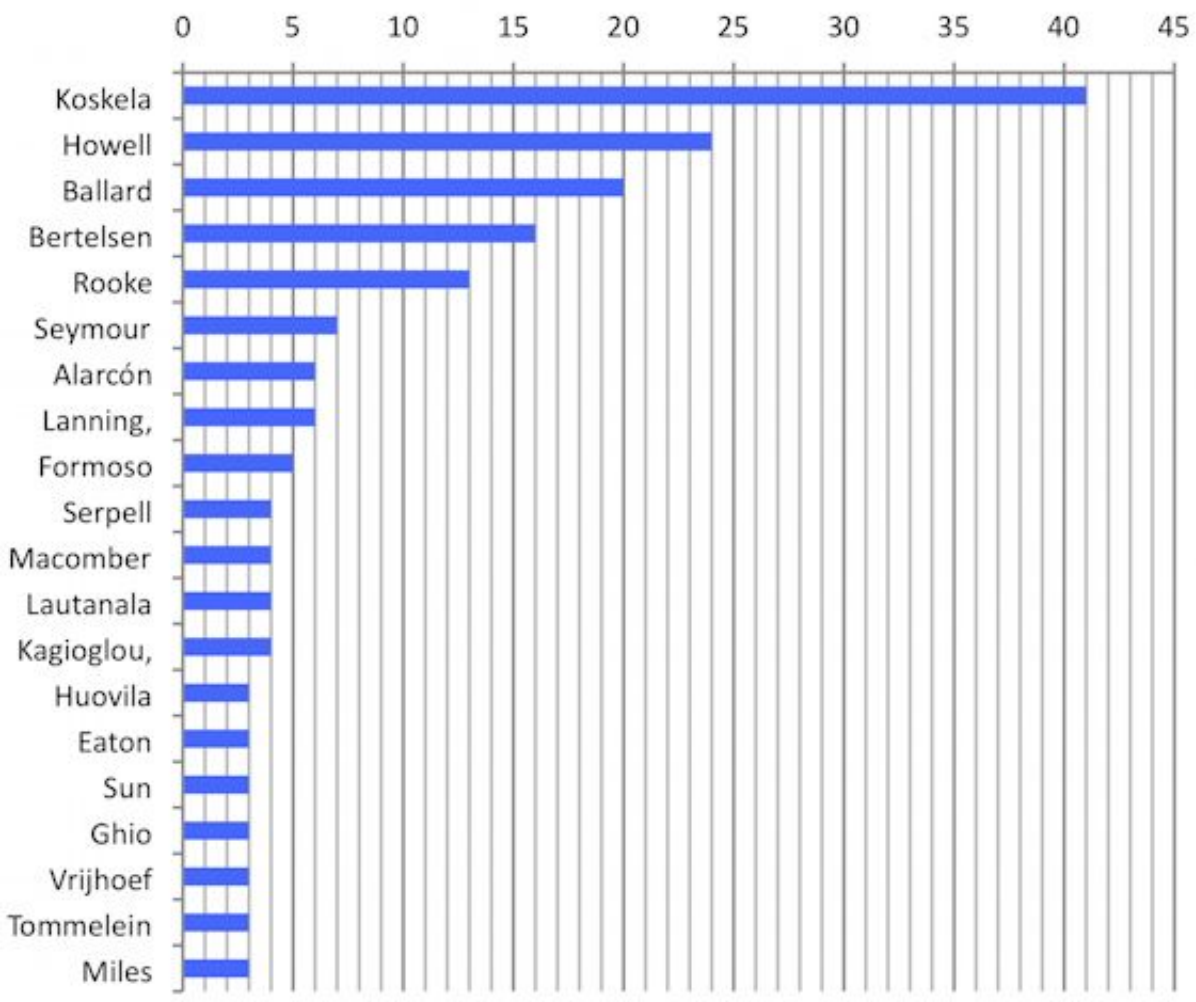

Figure 5: Bar chart showing the authors of the sample conference papers.

Conferences and Journals

Peer reviewed journals are considered the most authoritative source of good quality research information. Therefore in order to provide an assessment of the quality of the theory informing the IGLC, the data was further explored to identify the number of references that were published in journals. There is evidence that not all references listed had supplied details of the exact source but the data was checked for known journal publications so that a reasonable level of accuracy was obtained. Nevertheless, there is clear evidence that journal sources are, in general, very low. Of a total of 2,970 sources, only 339 or 13.17% were recognised peer-reviewed journals. Most the remainder was conference papers, trade magazines, books, company reports and industry papers.

It is the authors' view that the apparently low number of journal papers informing the IGLC is a concern and needs to be addressed.

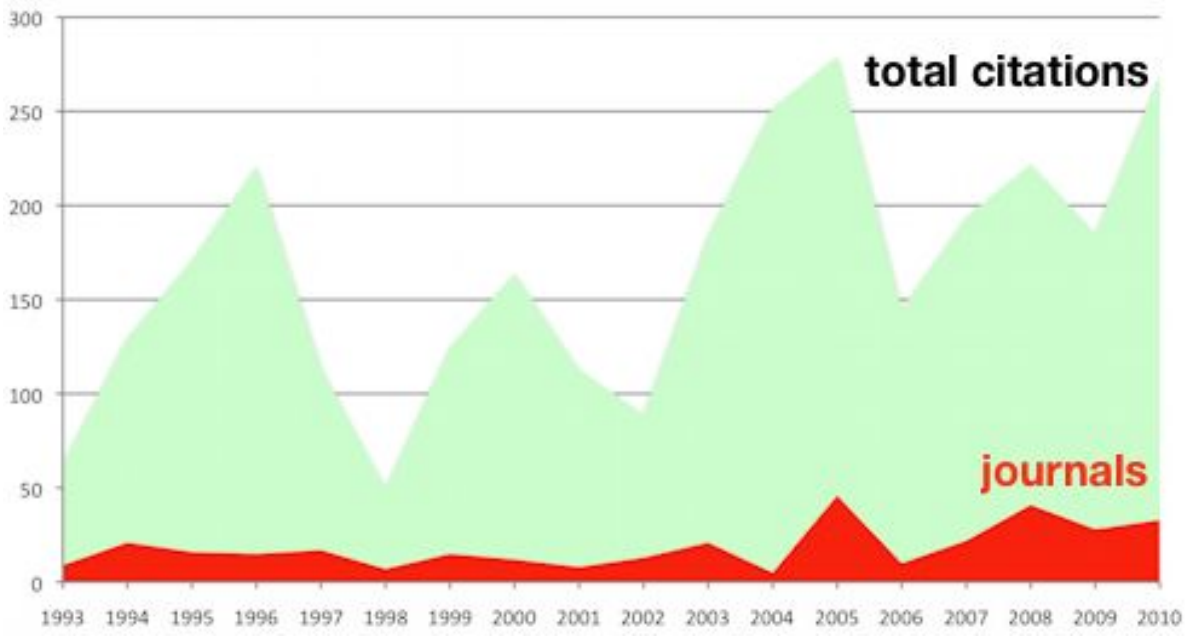

Figure 6: Chart showing the total number of citations to those citing journals.

Most Cited Sources

In order to obtain a view of the major sources of theory for the IGLC, the titles of documents cited in the sampled papers were sorted by the number of citations recorded for each. Of these, a total of 57% were cited once, 7% were cited twice and 36% cited more than twice.

Table 3: Most Cited References in the Sampled IGLC Conference Papers 1993-2010

Rank	Source Title	Pub'n Year	Type of pub'n	IGLC citations
1	Koskela, L. (1992) "Application of the New Production Philosophy to Construction', Technical Report No 72, Centre for Integrated Facility Engineering, Stanford University, California.	1992	Report (book)	55
2	Koskela, L. (2000). "An Exploration towards a Production Theory and its Application to Construction." VTT Publication, Technical Research Centre of Finland, Espoo.	2000	PhD	41
3=	Womack, J, and Jones, D. (1996) Lean Thinking: Banish waste and create wealth in your corporation. Simon & Schuster, New York.	1996	Book	32
3=	Womack, J. P., Jones, D. T. & Roos, D. (1990) The Machine That Changed the World, Simon & Schuster, New York.	1990	Book	32
5	Ballard, G. & Howell, G. (1998) "Shielding Production: Essential Step in Production Control', Journal of Construction Engineering and Management, 124(1):11-17.	1997	Journal	26
6	Shingo, S. (1988). Non-Stock Production: The Shingo System for Continuous Improvement. New York: Productivity Press.	1988	Book	18
7=	Ballard, G. (2000): "The Last Planner System of Production Control", School of Civil Engineering, Faculty of Engineering, The University of Birmingham	2000	PhD	17

Rank	Source Title	Pub'n Year	Type of pub'n	IGLC citations
7=	Ohno, T. (1988). Toyota Production System: Beyond Large-scale Production, Productivity Press, Portland, OR.	1987	Book	17
9	Ballard, G. (1999). "Improving Work Flow Reliability." In: IGLC-7, Berkeley, CA, USA, 275-286.	1999	IGLC Conf	16
10	Bertelsen, S. and L. Koskela, 2002 Managing the Three Aspects of Production. 10th Annual International Group for Lean Construction Conference – IGLC. Gramado, Brazil	2002	IGLC Conf	13
11=	Ballard, G. & Howell, G. (1994). Implementing Lean Construction: Stabilizing Work Flow. Conference on Lean Construction, IGLC Santiago, Chile.	1994	IGLC Conf	12
11=	Hopp, W. and Spearman, M. (1996) "Factory Physics: Foundations of Manufacturing Management". Irwin/McGraw-Hill, Boston. 668 p.	1996	Book	12
13=	Koskela, L. (1999). "Management of production in construction: a theoretical view." 7th International Group for Lean Construction Conference, Berkeley - USA, p. 241-252.	1999	IGLC Conf	11
13=	Tavistock Institute (1966). Interdependence and Uncertainty. Tavistock Publications, London, U.K.	1966	Report	11
15	Howell, G.A. (1999). "What is Lean Construction – 1999." IGLC-7, Berkeley, CA.	1999	IGLC Conf	10
16	Howell, G., Laufer A. & Ballard G. (1993). Interaction Between Subcycles: One Key to Improved Methods, ASCE Journal of Construction Engineering and Management, Vol. 119 No. 4.	1993	Journal	8
17	Koskela L. and Howell G. (2002) The underlying theory of project management is obsolete. Proceedings of the PMI Research Conference, pp. 293-302.	2002	Other Conf	8
18	Spear, S & Bowen, H (1999) Decoding the DNA of the Toyota production system, Harvard Business Rweiew, 1 September 1999.	1999	Journal	7
19	Howell, G. & Ballard, G. (1994). Lean Production Theory: Moving Beyond 'Can-Do'. Conference on Lean Construction, IGLC Santiago, Chile.	1994	IGLC Conf	7
20	Latham, M., (1994): Constructing the Team – Final Report of the Government / Industry Review of Procurement and Contractual Arrangements in the UK Construction Industry HMSO, London, 1994	1994	Report	7
21	Koskela (2004), Making-Do - The Eighth Category of Waste, Proceedings of the 12th International Group for Lean Construction Conference, Denmark, 2004.	2004	IGLC Conf	7

In this table, the top five references cited are generally regarded as seminal works informing the industry. Of the remaining 15 sources, 7 are internal IGLC conferences – almost 50% - and this fact alone appears here to be supporting the hypothesis that much of the theory behind the IGLC is internally driven. This is further supported in that, of the 20 sources, 70% are from regular IGLC authors.

It may be noted that this table shows that the most recent paper cited is six years old and most are over 10 years old. It may be considered significant that no new ideas are being introduced regularly into the thinking behind more recent papers.

To see whether the top five sources from Table 3 (above) were informing a wider audience than the IGLC, a Google Scholar search (2011) was done. This represents a quick

snapshot of a more global position for citations compared with those for the internal IGLC paper sampled.

Table 4: Most Cited IGLC Authored Papers compared with Google Scholar citations

Rank	Source Title	Pub'n Year	IGLC Citations	Google citations
1	Koskela, L. (1992) "Application of the New Production Philosophy to Construction', Technical Report No 72, Centre for Integrated Facility Engineering, Stanford University, California.	1992	55	485
2	Koskela, L. (2000). "An Exploration towards a Production Theory and its Application to Construction." VTT Publication, Technical Research Centre of Finland, Espoo.	2000	41	328
3	Ballard, G. (2000): "The Last Planner System of Production Control", School of Civil Engineering, Faculty of Engineering, The University of Birmingham	2000	17	303
4	Ballard, G. & Howell, G. (1998) "Shielding Production: Essential Step in Production Control', Journal of Construction Engineering and Management, 124(1):11-17.	1997	26	234
5	Ballard, G. (1999). "Improving Work Flow Reliability." In: IGLC-7, Berkeley, CA, USA, 275-286.	1999	16	65

The Google Scholar search indicated that papers 1 – 4 in Table 4 are heavily cited, even when considering they will be commonly cited in the total population of IGLC papers it is clear that these papers are informing wider audience. This is less clear for paper 5, as a further 49 citations included in IGLC not included in the sample would not be an unreasonable figure given the number of papers presented since 1999

Conclusions

The results generated by the research carried out for this paper raise a number of issues. It could be said to be reassuring that the original hypothesis for this paper, i.e. that the IGLC knowledgebase is inward looking and that the theory was being developed largely internally, has been disproved, statistically at least, by the analysis. In this respect it is of note that 57% of authors cited are only ever cited once.

This, while comforting to some extent, may be masking a lack of progressive development. A very small number of authors quoted regularly are dominating the citations. As shown earlier, 2.5% of the total of authors occurs in almost half of the total citations. Also the youngest of the top 20 citations is six years old and most are over ten years old. This would confirm the fear that the IGLC is not drawing in enough new ideas or recent thinking from the wider academic and industrial community

So the principal conclusion from this work is that the health of the discipline is open to question and the original hypothesis is neither confirmed nor denied. Although the statistical analysis shows that only 21% of references cited in the sampled papers are by authors who are IGLC members and the actual number of citations of IGLC-based papers is only 13.3% of the total citations, 14 of the top 20 citations (70%) are internally generated.

The work shows that, only 13.41% of citations are journals. There are more references to books, conference papers, reports and trade magazines, which would suggest

less rigorous source data. However, the top eight most cited publications are journals, technical reports and seminal books, not conference papers, indicating the core reference material to be potentially more reliable.

The comparison based on the Google Scholar survey undertaken suggests a wider international use of the top cited IGLC sources. The IGLC references surveyed for this work represent an average of approximately 13% of their international citations generated by Google Scholar (2011). Even allowing for citation within the remaining IGLC body of papers a significant external citation presence can be seen.

The authors appreciate that a view might also be taken that the lack of internal citing might suggest a lack of robust theory being developed within IGLC. But the level of international citing of core of IGLC theory papers suggests there is evidence of a theoretical base developing. An opportunity presents itself for some guided strategy from within IGLC itself to build upon this established base. One method for this might be for IGLC authors to publish more in academic journals and other significant research outputs. Closer links between the IGLC and journal publishers might be helpful here as it seems the majority of IGLC work is not finding its way into the wider academic arena, at least not in any way that can be seen from the IGLC proceedings.

It has not been possible to assess how many citations are self-citations but it is not unreasonable to conclude that the level of self-citing might be similar across all papers so the order of most cited publications will remain the same even if the numbers may be suspect.

The authors consider that whilst the theory development does include a design aspect, as demonstrated by the inclusion of Emmitt and Christofferson in the top 20 authors, the theory associated with production dominates the most cited papers. It is also surprising to note that the Latham report is more widely referred to than the Egan report, even though the latter expressly mentions Lean construction.

The authors observed that some notable contributors seem to be under-represented, e.g. Tommelein, Formoso and Alarcon. This is probably due to the study being concentrated on theory papers, whereas these writers offer contributions in other sectors of the Lean construction arena.

Acknowledgements

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Internet Sources

IGLC (2010), http://www.iglc.net/conferences/
Google Scholar (2011), http://scholar.google.co.uk/ accessed 1st April 2011.

Bertelsen, Sven & Sten Bonke (2011) Transformation-Flow-Value as a strategic tool in Project Production
Lean Construction Journal IGLC Special Issue 2011 pp 33-40 www.leanconstructionjournal.org

Transformation-Flow-Value as a strategic tool in Project Production

Sven Bertelsen[1], Sten Bonke[2]

Abstract

The paper investigates the use of the Transformation-Flow-Value theory as a strategic tool in the development of the project production firm. When producing products such as ships, focus on value more than on cost may be the best approach, but in service industries such as construction, focus on flow may often be a far better approach than just looking at the costs.

The paper presents a simple, general financial model to support this argument and not least to assist the reader in conducting similar analyses in his own company.

Research Question/Hypothesis:
Purpose:
Research Design/Method:
Findings:
Limitations:
Implications:
Value for practitioners:
Keywords: Transformation-Flow-Value, Strategy, Business approach, Financial model
Paper type:

Introduction

Bertelsen and Koskela (2002) proposed the use of the Transformation-Flow-Value theory (the TFV theory (Koskela, 2000)) as an approach to the management of the three aspects of production in construction. Since then this approach has more and more been adapted throughout the industry, albeit in full in very few projects.

Recently the first author has once again taken the idea of using the TFV theory in practice and studied its application to the strategic planning of the development of a specific project producing company, and the principles recommended are partly 'converted' to a business novel about a construction project (Bertelsen 2009). This novel

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also introduces the concept of Construction Physics (Bertelsen et al, 2007) in practise[3]. It is these ideas that are presented in this paper.

The paper introduces a simple model for the strategic analyses, a model that can be established with adequate accuracy in any company within hours. It proceeds by discussing the strategy development process, and compares it to common practice as observed by the authors. It concludes by asking some key questions to the management of either contracting companies or project managers. Both parties may learn from this.

The paper is an industry paper and does as such not present research but merely knowledge new to part of the industry. Most of the ideas have been known, understood and used for years in the manufacturing industry, but are apparently not studied in the construction industry context and in similar project production industries. Construction Physics (Bertelsen et al, 2007) is still new to most practitioners as well.

To spice the paper a number of cases from the first author's lifelong experience in project production are mentioned briefly as footnotes, since most of these are not documented scientifically.

Transformation-Flow-Value revisited

The seminal explanation of the nature of the production in construction is the Transformation-Flow-Value (TFV) theory (Koskela, 2000). Besides Last Planner (Ballard, 2000) Koskela's dissertation is probably the work most often quoted within the lean construction body of knowledge. The TFV theory explains beautifully the nature of construction and opens up the readers understanding of the three different perspectives.

However, while fine in a historic perspective, TFV may not be the best approach when dealing with project production in practice, as done in this paper and in Bertelsen and Koskela (2002). The theory as such is not challenged seriously, but is – inspired by Shingo (1988) and the first author's own experience – changed in its wording to: Value-Flow-Operation as discussed in the following.

Value

Value is put first, as value is the objective of any production. Value for somebody but value for whom and what is the value? These are obvious questions that should be asked at the outset of any project or production. Understanding and defining value must be the first step, recognizing however that different value perceptions manifest themselves in the construction design process, and that focussed facilitation might then be appropriate (Thyssen, 2010).

Flow

While Shingo (1988) uses the term Process, Koskela chooses the term Flow, which is more descriptive in a scientific understanding, and indeed more useful in project production. Understanding and improving the Flow, the flow within the value chain, should be the next step in forming a strategy, as it is the process that generates the throughput

[3] Construction Physics is inspired by Hopp and Spearman's Factory Physics (2000) but differs in two important aspects: Firstly it recognizes the complex nature of the construction process and thus its unpredictability and secondly it considers all the flows feeding the construction process and not only the flow of work as is usually the case or the flow of work and crew as done by Goldratt (1997). Construction Physics is thereby a firmer basis for a general logistic approach to the project management (Bertelsen, 2009)

and therefore the desired value. It is here bottlenecks and their influence on the throughput Goldratt (1984) comes into the picture as a source for inspiration, turning the view at the critical flow (Bertelsen et al, 2007). Jacob et al (2010) introduce by a business novel the concept of *Velocity* – speed with a direction – and this idea is very useful in practice as well. Speed is of little value if not improving the over all value stream.

Operations

Operations are the third and last issue in understanding the project process. And it should indeed be the last step: 'Do the right things before doing things right' as Shingo advocates (Shingo, 1988). Jacob et al (2010) describe a possible chaotic outcome of improving the operations efficiency by lean methods, if the flow and its bottlenecks are not managed diligently.

And by this the scene has been set for a new approach to the strategy development.

A general Financial Model

In this section a general financial model is introduced. It is a model that one should expect to find and see used throughout the project production industry, but which the first author in his fifty years of practice – not least within the construction industry – has seldom met or seen used in strategic planning.

The Model

The model is based upon a simple break down of the cost of production in the project producing company, and the model investigates the bottom line impact of a certain change of each of the three parameters: Value, Process and Operations respectively.

In doing this, the model takes an overall view in stead of just looking at the project. The reason is that most of the benefit from improved velocity may not show up in project accounting, but in the company's total account only, because the benefit stems from higher throughput in the form of more projects completed with the same resources.

Thereby the old 'wisdom' that increasing earnings in project production must take place by increasing profit on each project is challenged.

Basis

Figure 1 shows a frozen picture of the model.

	Imp.	Profit	# Units	Unit price	Total	Base Case: Total cost	Fixed 40%	Wages 20%	Variable 40%	Total	Total profit		Incr.	Ratio
Base case		5%	10	100	1,000	950	380	190	380	950	50	5%		
						Value								
Impact of change %							50%	50%	50%					
Value increase	10%		10	110	1,100		399	200	399	998	103	9%	205%	2.1
						Process								
Impact of change %							0%	50%	100%					
Flow increase	10%		11	100	1,100		380	200	418	998	103	9%	205%	2.1
						Operations								
Impact of change %							80%	10%	0%					
Cost reduction	10%		10	100	1,000		350	188	380	918	82	8%	165%	1.6

Figure 1: The Financial Model (numbers in black framed boxes may be changed by the user as part of the process.)

The model is divided into four main segments each with its own objective. The upper segment establishes the basis while the next three analyses the effect of improving either the Value generated or the Process (flow) efficiency, or reducing the cost of operations, the three parameters usually available for management actions in order to improve the business.

Basis

Looking at the basis for the example company – the upper segment – one sees in the left hand box that this company produces 10 units with a sales price of 100 each making the total turnover 1.000 with a profit of 5%.[4]

The 5% profit on the turnover gives a production cost of 95 per unit or 950 in total as shown in the middle box.

The production costs are divided between 40% fixed (Permanent facilities and equipment, management, staff etc), 20% cost and wages varying to a certain degree with the production throughput, and 40% directly variable (Materials etc).

Besides the profit (which is much lower) similar figures are often found in the Danish construction industry.

Value

In the Value segment a 10% value increase is investigated. The increased value is yielding a 10% higher sales price or 110 per unit or 1.100 in total. However, the value is not obtained for free. It is in this case assumed that it will demand an increase of all three cost elements of 50% of the value increase or 5% of the total say by more staff, better sales service and higher material quality as shown in the middle box.

The effect of this value improvement is shown in the right hand box and it is a profit of 9% instead of the 5% in base case or a profit improvement by a factor 2.1 because of the increased volume.

[4] Usually the profit is calculated as turnover minus cost divided by the turnover but for easier discussion of the impact of different profit margins it is here made an input, making the costs a calculated number. The true profit is therefore 5.26% in this case.

One may speculate whether this is possible within construction in general, where procurement as a rule is based upon lowest price, but when possible is an interesting albeit difficult route to pursue.

Process

The third segment investigates the effect of improving the Process – or rather the flow – and thereby the throughput with application of the lean principles in mind. Again a 10% improvement is looked at, but here the fixed costs stay more or less at the same level, the wages increase with 50% of the process improvement (in Denmark because of the use of piece rates yielding higher salaries with improved productivity), while the cost of materials obviously grows with 100% of the throughput increase.

Again the effect – as seen in the right hand box – is a remarkable growth in profit, here the same as in the value case.

However, while the ten percent value improvement may be hard to obtain, and probably often impossible in ordinary construction, a ten percent flow improvement is what lean construction offers as a minimum. Setting out one should rather aim for twenty percent within the first year in our opinion.[5]

Operations

The bottom segment considers the usual approach: Cutting costs. Again 10% is used as the outset, but as most managers may know, it is never possible to cut all costs. Here it is assumed that the fixed cost may be reduced by 80% of the 10% at the outset or 8%, wages by 10% or only 1% and materials not reduced at all.

Even though there is an effect – a profit improvement by a factor 1.6 – this may come in a very expensive way. Cost cutting often focuses on reduction of middle management as they are seen as a cost in the bookkeeping, while accountants are seldom reduced in the process. However, even though a reduction of middle management may be possible if Last Planner™ is diligently introduced it should never be the objective in its own right. Middle management is the key to the efficient logistics that should support the Last Planner process through the Look ahead planning.

Using the model

Establish the model

The figures for the model should be easily available from the accounting. If it is not possible in general, then make an analysis of a handful of projects, or use the sample figures as an outset for a discussion with the key staff, and adjust as required. The key question may be the sensitiveness in relation to the tested improvement initiatives, but again: Start with rough figures and refine as needed.

Working with the Model

In developing a strategy, each of the three parameters should be considered individually: Where may we improve and how much? What will the impact be as calculated by the model using our own figures?

[5] A 20% improvement in this case will render a 13% percent profit or a profit improvement by a factor 3.1.

Value

The starting point should be Value.

However, this aspect of the company strategy is most often forgotten in construction, even though quite often the value may be increased through a very small effort in terms of cost of production. Being on budget and schedule are value parameters, which may be reached through diligent focus on the process which anyway is the primary key to improving the financial result, and awareness of the client's value parameters in general, and not least in the specific case should be part of the strategy.[6] There are often simple actions at hand.[7]

Maybe this is just a matter of the client's satisfaction, but it will motivate him to come back, saving marketing costs in the long run.

However, with the exception of design and build contracts, added value is often hard to get paid for directly in traditional construction.[8]

Process

The Process should come next. Remember Shingo: *Do the right things before doing things right*. (Shingo, 1988)

While Shingo states the approach, it is Eliyahu Goldratt (1984) that shows the means. His message is to identify the bottleneck, ease it and subordinate the rest of the production to the bottleneck. In the transient world of construction the last part may be difficult to do while the first part: Identify and ease the bottleneck is highly important. Again, this is often quite simple and may be done with little or almost zero costs and it generates an enormous effect on productivity and thus on earnings for all parties involved.[9] [10] [11]

Understanding and managing the process – the flow – is of paramount importance, and the new position: Process Manager as proposed by Bertelsen and Koskela (2002) is therefore seen more and more often in lean project management at least in Denmark.

Operations

Last the organisation and its costs of operations should be considered.

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6 At the third LCI congress in Berkeley 2001 a US general contractor presented a concept aimed at remodeling office facilities for major corporations within banking, insurance, it etc. They put great focus on schedule making it possible to undertake the projects during weekends only, causing no shut down of the daily operations at all.

7 If the client by a mistake has bought 5.000 packages of green copying paper, it will be of value requiring all reports, minutes etc in this project be printed on green paper provided by the client. This will by the way make it easier to identify the papers in the mess on most desks throughout the organization.

8 The case is quite different in Shipbuilding, where an new and more efficient design may get much higher prices even though the construction and materials costs are nearly the same.

9 Building Logistics was a Danish experiment carried out in the early 1990'ies where the flow of materials was considered the critical one and consequently put under a systematic control with methods quite similar to Last Planner. The outcome was an up till twenty percent increase in productivity. (Bertelsen and Nielsen, 1997).

10 At a domestic building project in Copenhagen the crane was found to be a bottleneck in the flow of materials. A simple booking system solved the problem and assured reliability in the flow of materials.

11 At a shipyard workers access to the ship in the dock was by narrow gangways for up to eight floors. A person elevator as known from construction sites placed on the outside of the boat solved the problem.

However, most often this is the first issue on the agenda: How do we cut our costs? The construction industry is most often totally cost fixated. One reason may be the tendering and contracting system, which tempts to reduce overhead costs and overload the total production system as discussed by Bertelsen and Sacks (2007) causing huge delays in all the streams feeding the process and thus hampering the flow by generating new bottlenecks.

Another often seen action is to cut the costs of middle management, as it on the books is seen as an expenditure. But knowing Last Planner and understanding the importance of the Look Ahead Planning as control of the logistics, saving middle management increases failures in the supply system feeding the process and thereby causes waiting, make do, and delays. (Koskela 2004)

Unfortunately the accounting department often plays a too big role in the strategy making within the project production industry.[12]

Discussion

The paper is highly based on the first author's experiences from his work in the project production industry and it may thus be biased. However, the ideas presented and the model introduced have been implemented in practice, albeit not as much as may be desired. Project production has a cowboy nature: Get out there and fight the Indians no matter how they look, instead of reflecting on the issues to be managed.

Gemba – observe and reflect – is a Toyota term very useful in the strategy process. To observe and reflect is often a fine way to get along. Forget the third of the working time at the construction site that generates value (Nielsen and Kristensen, 2001) and focus on the non value producing work and ask: *Why?* Not once, but five times as done by Toyota.

Conclusion

The paper presents a simple theory based approach to establishing a strategy for the management of project producing companies such as found in construction, shipbuilding, IT, entertainment and probably in many more places. Project production is becoming increasingly more important, as mass production more and more becomes robotised. A deeper understanding of the nature of the project production and its management is therefore needed.

Improving business must quite often come from improving velocity and thereby throughput, a challenge for project managers always asking for more time. In doing this company managers may understand the velocity concept and convince their project managers that faster project completion is the real route to profit.

[12] When the first author introduced Last Planner to a group of top executives in a major industrial company, the response by the CFO was: If the crew leaders take over the planning, we can save 50 foremen. And it was very hard to convince him, that resources made free should be used on improving their highly unreliable flow, not least from outside vendors.

References

Ballard, G. (2000): *The Last Planner System of Production Control,* School of Civil Engineering, Faculcy of Engineering, The University of Birmingham

Bertelsen, S. (2009): *Semiramis – en beretning om Louise og Construction Physics.* Sven Bertelsen aps

Bertelsen, S. and Koskela, L. (2002), *Managing the three aspects of production in construction*. IGLC-10, Gramado, Brazil

Bertelsen, Sven; Koskela, Lauri; Heinrich, Guilherme and Rooke, John (2007): *Construction Physics*. IGLC 15, Lansing, Michigan

Bertelsen, S and Nielsen, J (1997), *Just-In-Time Logistics in the Supply of Building Materials*. 1st International Conference on Construction Industry Development, Singapore.

Bertelsen, S and Sacks, R (2007): *Towards a New Understanding of the Construction Industry and the Nature of its Production*. IGLC 15, Lansing, Michigan

Goldratt, Eliyahu M. (1984), The Goal, Gower Publishing

Goldratt, Eliyahu M. (1997), Critical Chain, North River Press

Hopp, Wallace J. and Spearman, Mark L. (2000): *Factory Physics*, McGraw-Hill International Editions, second edition.

Jacob, Dee; Bergland, Suzan and Cox, Jeff (2010): *Velocity, Combining Lea, Six Sigma, and the Theory of Constraints to Achieve Breakthrough Performance*. Free Press, New York

Koskela, Lauri (2000): *An exploration towards a production theory and its application to construction*, VVT Technical Research Centre of Finland

Koskela, Lauri (2004): *Making Do – The Eighth Category of Waste*. IGLC 12, Elsinore, Denmark

Shingo, Shigeo (1988): *Non-stock Production*, Productivity Press, Cambridge

Thyssen, Mikael H. (2010): *Facilitating Value Creation and Delivery in Construction.* PhD Thesis, DTU Management, Technical University of Denmark.

Samudio, M.; Alves, T.C.L.; Chambers, D. (2011)
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Employing the principle of "going and seeing" to construction

Mike Samudio[1], Thais da C.L. Alves[2] and David Chambers[3]

Abstract

Purpose: the paper describes the team's journey from learning about the main production problems to going and seeing in the field how to improve operations and plan reliability in a large laboratory replacement project in San Diego, CA.

Research Method: analyzing root causes the team realized the two categories that reduced reliability were over-committing and revising the plan. Tools employed to track the data included value stream maps and employee feedback to inform project planning. The counter measures employed improved performance in these categories, which improved reliability of meeting scheduled commitments. However, unexpectedly cycle times for concrete wall pours increased. Then, the team employed the principle of "going and seeing" to gather information to make informed decisions. The production line was observed for several hours a day, performance was measured, and barriers to flow were documented.

Findings: The result of "going and seeing" brought the team closer to managing the project as a production line. The data collected provided insight to the contributing factors to production cycle times including wait time, inventory, and rework. This provided the necessary balance to complement the implementation of Last Planner on this hard bid federal project.

Limitations: data were collected from a single project.

Implications: Real time data collected directly from field observations and feedback from workers was used to make adjustments every week.

Value for practitioners: examples from a project that used the principle of going and seeing to continuously improve production and increase the reliability of weekly work plans.

Keywords: Go and see, Gemba, Last Planner System™, value stream map, laboratory building

Paper type: Case Study

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Introduction

The paper describes a general contractor team's journey from learning about the main production problems to going and seeing in the field how to improve operations and plan reliability on a large laboratory replacement project in San Diego, CA. The result of "going and seeing" brought the team closer to managing the project as a production line. Just as Ohno walked the shop floor and discovered new ways to eliminate waste, the team now walks the field to find the waste and seek improvements. The data collected from "going and seeing" provided valuable insight to the contributing factors to production cycle times including, wait time, inventory, and rework. Without this study the team would not know where to improve.

The paper is organized into three main parts: a literature review on going and seeing and continuous improvement; the description of the case and the methods used to investigate production; and conclusions.

Going and Seeing and continuous improvement

An integral part of the Toyota Production System (TPS) is the practice of going and seeing how the work happens at the shop floor level or in the field where operations are carried out (Ohno 1988). Ohno and Shingo constantly referred to instances when they were observing production or sent others to observe operations where they happened. The simple act of observing production tasks as they happen grants multiple insights that data collection and complex analysis cannot show. Shingo (1988) often dives into details when explaining how he and his teams went about studying a product or process and proposing new ways of doing tasks, all without losing sight of the production process as a whole.

Paying attention to minimal details and analysing (scientifically) how they impacted production were practices used by Frederick Taylor, Frank and Lillian Gilbreth, and Henry Ford. However, TPS engineers became famous for putting that into practice and making their organization extremely successful.

Gemba is the Japanese word for "actual place" (LEI 2008, p.25. The practice of going and seeing work practices on the shop floor gave origin to the term "*Gemba* walks" to represent the walks managers do to see production tasks where they happen. Managers who are familiar with Lean concepts often call their team members to go to the Gemba and see work practices for themselves.

The term going and seeing is recognized in the Lean Production literature as *Genchi Genbutsu*, which relates to the action of verifying data at the source through personal observation (LEI 2008). It is common to see in value stream maps (VSMs), the "go and see" symbol, illustrated by a pair of glasses, indicating that data has to be confirmed in the field through direct observation. VSMs are maps that show the sequence of tasks in a value stream using symbols that have been standardized and popularized by the Lean Enterprise Institute, based on the work developed at Toyota. VSMs depict data related to each activity (value-added, non-value added and supporting), while simultaneously illustrating the flows of material and information to deliver a product or service to the client (Rother and Shook 2003).

Using Plan-Do-Check-Act (PDCA) to improve production

Going and seeing is one step toward the improvement of production processes. Other steps are related to how people organize and make sense of the data they collect, and how they implement and verify how the suggested changes affect production. Along these lines, the simple method illustrated by the PDCA cycle (Deming/Shewhart Cycle) provides a structured way to improve production through a series of structured observations, test, and documentations.

The Last Planner System of Production Control™ (LPS™) is an example of a system that uses the basic tenets of the PDCA cycle and the going and seeing principle to shield construction operations against uncertainty. The LPS™ relies on information provided by those close to production (the last planners) to define weekly work packages based on information coming directly from the field. Ideally last planners select (pull) work packages from a pool of tasks screened for constraints in a previous phase, i.e., the make ready process during the lookahead plan preparation (Ballard and Howell 1998). However, in reality production pressures bring some tension to the planning process when it comes to defining weekly work packages. There are times when managers choose to push tasks, which have not been completely screened through the make ready process, to the weekly work plan due to the need keep production moving. An example is discussed later in this paper.

After the end of each planning cycle, the completion of work packages is tracked and causes for non-completion are recorded; actions to prevent recurrence of problems are defined. The planning and control cycle continues as the plan for the following week addresses the shortcomings of the previous week and defines new work packages (Ballard and Howell 1998).

The LPS™ follows the logic outlined by the PDCA cycle in that they promote continuous improvement cycles of planning, implementing, checking the solutions implemented, and acting to correct deviations (Figure 1). Another way to look at the PDCA cycle is to use the words employed by Toyota to represent a similar cycle namely plan, try, reflect, and standardize (LEI 2008). Defining the last step as "standardize" means that uniform ground rules are set based on the way operations are currently executed. The use of a standard allows results to be compared and deviations from plans to be quickly detected. Standardization also allows small continuous improvement activities (*kaizen*) to depart from a common ground (standard) which is used as a step to the next level (Figure 1).

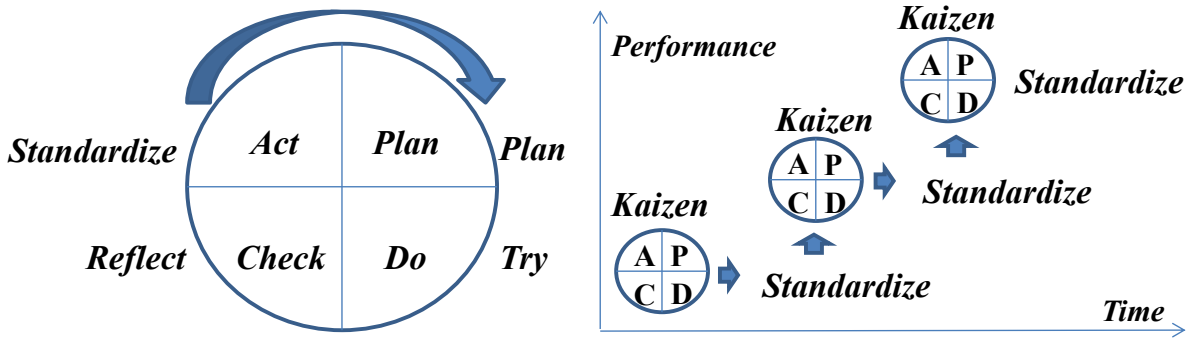


Figure 1 – PDCA cycle, standardization and kaizen (after LEI 2008)

The project and the work methods

This section describes the project that provided the examples discussed and the work methods employed to carry out the studies presented in this paper.

The new $60 million facility will provide oceanic research to assist in the management and maintenance of the marine ecosystems in the Pacific Ocean. The total constructed area will be 287,000 square feet, which includes new parking, offices and laboratory areas. The project will include an extensive aquaria area, necropsy lab, biology labs, chemistry labs, Class 100 clean room and a new 1-million-liter seawater ocean technology development tank which will expand researchers' ability to develop and apply advanced technologies for surveys of fisheries resources and their associated ecosystems. The project is funded by the American Recovery and Reinvestment Act and is seeking LEED Gold certification through numerous sustainable features, including a 250KW rooftop photovoltaic system, vegetative roofs for storm water management, recycled and regionally sourced building materials, and natural ventilation systems. Although the procurement of the project included a best-value component that considered qualifications, the contract structure is a firm-fixed price based solely upon project solicitation instructions, plans and specifications.

Work Method – Going and seeing

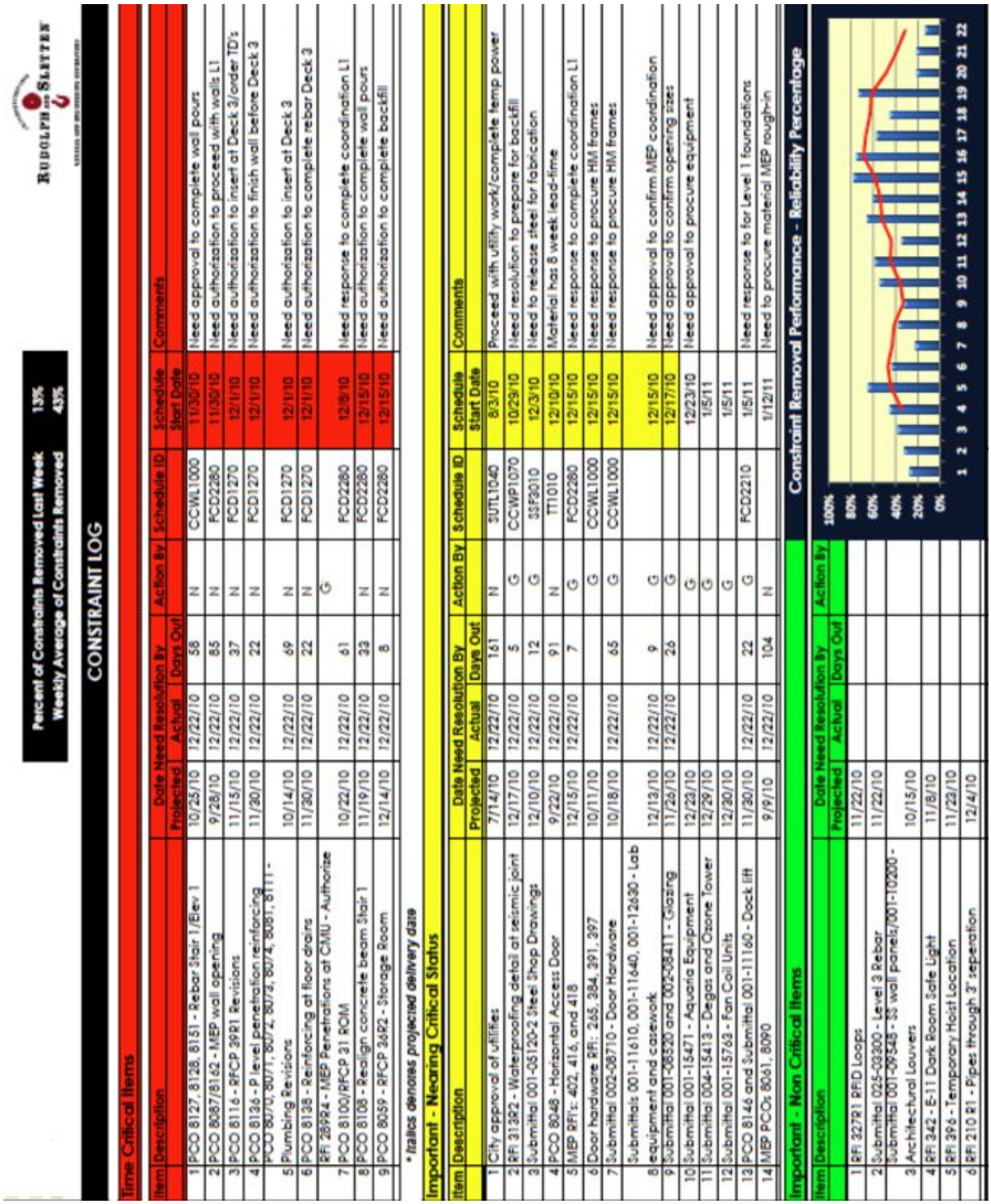
The use of LPS™ was employed from the start of the project and was familiar to a good percentage of the project team management staff. However, LPS™ was a new process to the self-performed concrete personnel assigned to the project. Early on in the process two major factors were contributing to reducing reliability of the weekly work plans: over-committing and design changes. In order to address these factors the team employed two countermeasures to help address the causes of these problems, i.e., pre-planning meetings and constraint analysis.

To address the over-committing, early on the team initiated a weekly concrete production pre-planning meeting to discuss activities for the week related to self-performed concrete. The intent of this meeting was to thoroughly analyze the plan for self-performed work and confirm the commitments that would be shared in the weekly subcontractor foremen planning meeting. This effort helped to increase reliability and affirm realistic commitments for the week. Collected data (Figure 3 discussed later) suggest that this meeting helped to reduce the incidence of over-committing as a problem that contributed to unreliable plans.

It was anticipated from the outset of the project that a contributing factor to reducing plan reliability would be the impact of design and constructability issues. Being a traditional design-bid-build project, there was no cross-functional team during the development of the design documents. As a result, a thorough constraint analysis effort was developed and employed as an integral part of the agenda during the Owner Architect Contractor (OAC) coordination meeting. A constraint log was used to document the items that needed attention and make them visible to all involved (Figure 2).

Essentially, the constraint log functioned as a work plan for the Owner and the Design team outlining issues that required resolution in order to meet the scheduled dates. The constraint log was updated weekly and summarized a variety of constraint types in a concise one-page report. Moreover, the list was prioritized by importance and employed

visual categorization to improve communication. Since this report was a "work plan" for the Design team and Owner, reliability was measured to track performance.



RUDOLPH and SLETTEN

Percent of Constraints Removed Last Week 13%
Weekly Average of Constraints Removed 43%

CONSTRAINT LOG

Time Critical Items

Item	Description	Date Need Resolution By: Projected	Actual	Days Out	Action By	Schedule ID	Schedule: Start Date	Comments
1	PCO 8127, 8128, 8151 - Rebar Stair 1/Elev 1	10/25/10	12/22/10	58	N	CCWL1000	11/30/10	Need approval to complete wall pours
2	PCO 8087/8162 - MEP wall opening	9/28/10	12/22/10	85	N	FCD2280	11/30/10	Need authorization to proceed with walls L1
3	PCO 8116 - RFCP 3981 Revisions	11/15/10	12/22/10	37	N	FCD1270	12/1/10	Need authorization to insert at Deck 3/order TD's
4	PCO 8136 - Plevel penetration reinforcing	11/30/10	12/22/10	22	N	FCD1270	12/1/10	Need authorization to finish wall before Deck 3
5	PCO 8070, 8071, 8072, 8073, 8074, 8081, 8111 - Plumbing Revisions	10/14/10	12/22/10	69	N	FCD1270	12/1/10	Need authorization to insert at Deck 3
6	PCO 8138 - Reinforcing at floor drains	11/30/10	12/22/10	22	N	FCD1270	12/1/10	Need authorization to complete rebar Deck 3
7	RFI 28984 - MEP Penetrations at CMU - Authorize PCO 8100/RFCP 31 ROM	10/22/10	12/22/10	61	G	FCD2280	12/8/10	Need response to complete coordination L1
8	PCO 8108 - Redsign concrete beam Stair 1	11/19/10	12/22/10	33	N	FCD2280	12/15/10	Need authorization to complete wall pours
9	PCO 8059 - RFCP 3682 - Storage Room	12/14/10	12/22/10	8	N	FCD2280	12/15/10	Need authorization to complete backfill

* *Italics denotes projected delivery date*

Important - Nearing Critical Status

Item	Description	Date Need Resolution By: Projected	Actual	Days Out	Action By	Schedule ID	Schedule: Start Date	Comments
1	City approval of utilities	7/14/10	12/22/10	161	N	SUTL1040	8/3/10	Proceed with utility work/complete temp power
2	RFI 31382 - Waterproofing detail at seismic joint	12/17/10	12/22/10	5	G	CCWP1070	10/29/10	Need resolution to prepare for backfill
3	Submittal 001-05120-2 Steel Shop Drawings	12/10/10	12/22/10	12	G	SSF3010	12/3/10	Need to release steel for fabrication
4	PCO 8048 - Horizontal Access Door	9/22/10	12/22/10	91	N	TT1010	12/10/10	Material has 8 week lead-time
5	MEP RFI's: 402, 416, and 418	12/15/10	12/22/10	7	G	FCD2280	12/15/10	Need response to complete coordination L1
6	Door hardware RFI: 265, 284, 391, 397	10/11/10			G	CCWL1000	12/15/10	Need response to procure HM frames
7	Submittal 002-08710 - Door Hardware	10/18/10	12/22/10	65	G	CCWL1000	12/15/10	Need response to procure HM frames
8	Submittals 001-11610, 001-11640, 001-12630 - Lab equipment and casework	12/13/10	12/22/10	9	G		12/15/10	Need approval to confirm MEP coordination
9	Submittal 001-08520 and 002-08411 - Glazing	11/26/10	12/22/10	26	G		12/17/10	Need approval to confirm opening sizes
10	Submittal 001-15471 - Aquaria Equipment	12/23/10			G		12/23/10	Need approval to procure equipment
11	Submittal 004-15413 - Degas and Ozone Tower	12/29/10			G		1/5/11	
12	Submittal 001-15763 - Fan Coil Units	12/30/10			G		1/5/11	
13	PCO 8146 and Submittal 001-11160 - Dock lift	11/30/10	12/22/10	22	G	FCD2210	1/5/11	Need response to for Level 1 foundations
14	MEP PCOs 8061, 8090	9/9/10	12/22/10	104	N		1/12/11	Need to procure material MEP rough-in

Important - Non Critical Items

Item	Description	Date Need Resolution By: Projected	Actual	Days Out	Action By
1	RFI 32781 RFD Loops	11/22/10			
2	Submittal 025-03300 - Level 3 Rebar	11/22/10			
3	Submittal 001-09545 - 33 wall panels/001-10200 - Architectural Louvers	10/15/10			
4	RFI 342 - E-11 Dark Room Safe Light	11/8/10			
5	RFI 398 - Temporary Hoist Location	11/23/10			
6	RFI 210 R1 - Pipes through 3" seperation	12/4/10			

Constraint Removal Performance - Reliability Percentage

Figure 2 – Constraint log indicating tasks assigned to the Architect and the Owner

Over a 16-week period the effectiveness of these countermeasures was demonstrated in downward trends in these two contributing factors and others related to miscommunication and misinformation (Figure 3a).

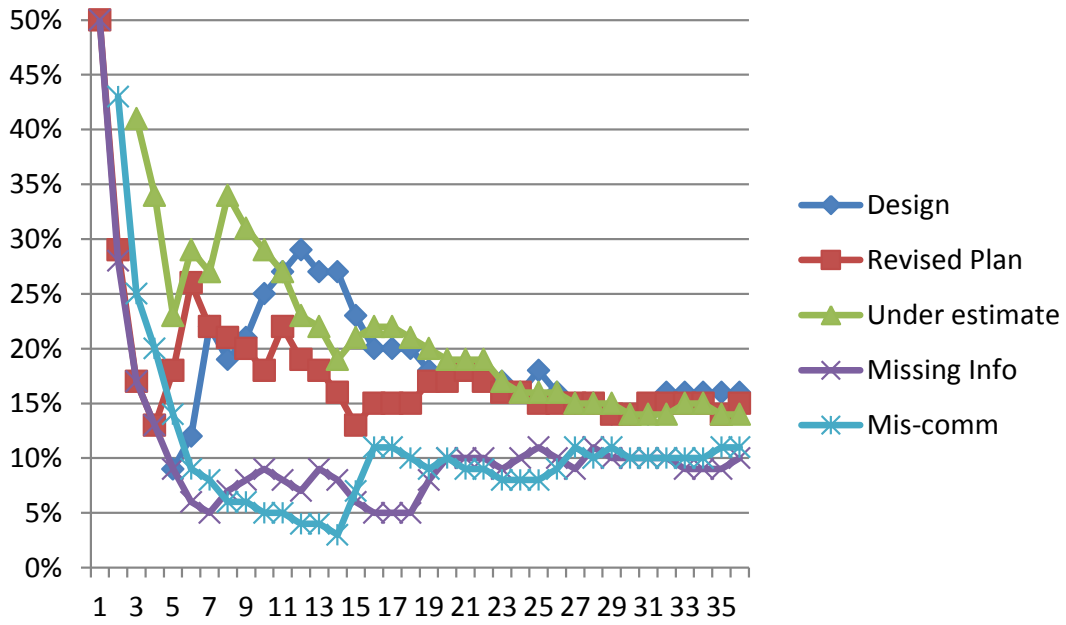


Figure 3a – Root cause history tracking: Causes showing a downward trend

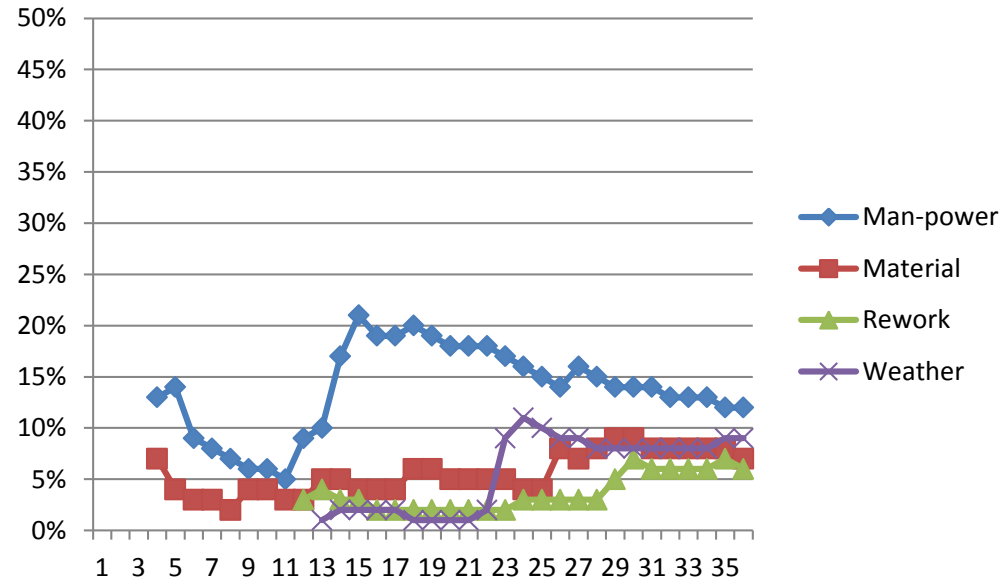


Figure 3b – Root cause history tracking: Other causes including manpower

Although improvement in planning reduced overcommitting, a counter trend reduced reliability: lack of manpower to meet planned commitments (Figure 3b). Initially, the manpower constraints were solely associated with the rebar subcontractor not meeting committed schedule dates. However, after getting down to the root cause that contributed to this situation it was determined that this was caused by concrete work not being completed as planned. Thus, the conclusion was that the self-performed concrete crew was not adequately staffed to meet production demand. Tracking the causes of problems allowed the team to observe how the changes implemented impacted production and how other problems surfaced and had to be addressed.

The process just described is along the lines of what Goldratt and Cox (1992) illustrate in the Theory of Constraints. Once a constraint (in this case a problem) has been identified and actions are taken to address it, a different constraint will surface elsewhere

in the system and limit its ability to reach the goal. Accordingly, the team decided to investigate in more detail the new problem, which was related to field conditions and not to external causes (e.g., designer and owner tasks). A discussion of the team's efforts to address field related issues is presented in the following item.

Examples of going and seeing

This section describes different instances in which the principle of going and seeing was used to actively manage production by the project's team.

Value stream mapping – Concrete activity

The hesitancy to increase manpower levels was based upon the fact that original projections were being exceeded. This observation from the data being collected initiated the development of a new process and opportunity to integrate Lean principles to the construction practice: the team employed the practice of "*genchi genbutsu*" or going and seeing for themselves. Concurrently, the team also discussed the need to track concrete production at a greater level of detail. The concern over meeting production units and the contributing cause of lack of manpower created the "burning platform" that initiated the process to collect data for assessment. A collaborative meeting amongst the team generated the idea of value stream mapping the concrete activity ("go and see" production and record the results) (Figure 4).

The results of production were recorded on a VSM that measured the overall cycle time for the activity and the hours spent on the activity compared with the project estimate. The cycle time for the concrete activity was measured similarly to what is shown on a VSM and differentiated the "value" or touch time on the activity versus the "waste" or wait time incurred to complete the step. Moreover, the consistent performance observation (Figure 5) provided valuable feedback from field personnel to foster a continuous improvement environment on the project.

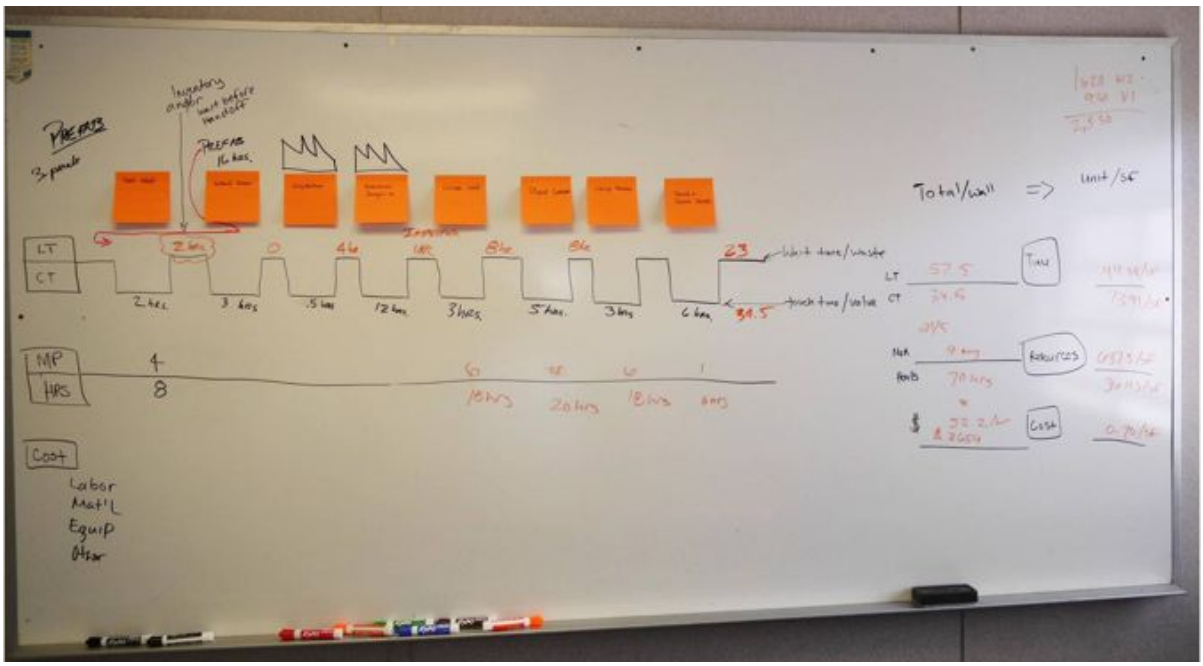


Figure 4 – Value stream map – concrete

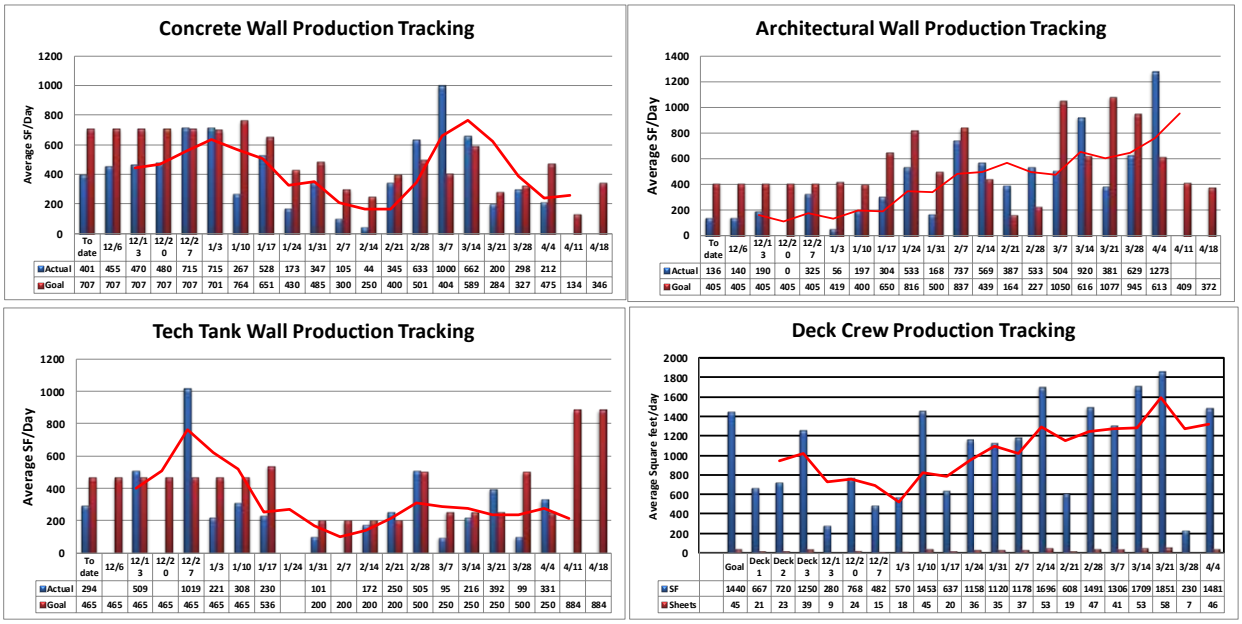


Figure 5 – Production tracking (Avg SF/day: actual/left/blue bars vs. goal/right/red bars)

The graphs shown in Figure 5 illustrate the evolution of the production indicator in average SF/day since December 2010. The production goal is indicated by the right bars versus the actual production. The analysis of the indicators for the "concrete wall production" and the "tank wall production" still indicate much variation in actual vs. goal. The indicators for "wall production" and "deck crew production" revealed a trend of improvement (increase in average of SF/day delivered); however, most of the time they still lag behind the desired output.

The process was not employed during the first two deck pours. The team discovered that for the wall crews the demand fluctuates on a weekly basis based upon the available work. Over time the team began to get closer to (or exceed) the production goals and were able to forecast the future demand and better assess manpower assignments between the crews. The performance observation was conducted multiple times throughout the day to provide thorough knowledge of events occurring on the project and resulted in some benefits. First there was an acute awareness of the impacts of constraints on productivity. This facilitated a more accurate understanding of the priority of outstanding constraints and a more intimate knowledge of the details to communicate the importance of resolution to the team. Second, the time in the field afforded the ability to perform daily validation of the weekly plan. Moreover, it helped to temper frustration that often is felt by field personnel when changes occur by having the perspective and purpose that generated the changes articulated. The communication of this information helped to deter discouragement and maintain morale in the field. Workers are honest when asked about the process and are willing to actively participate in the definition of the plans and the improvement of the processes. Talking to workers enhances one's ability to manage the project as they like to make a difference by giving inputs.

Seeking to define *takt* time

After observing production for several weeks it was evident that additional manpower was needed for the self-performed concrete crew. The team struggled to develop an objective way to determine adequate manpower levels for the various crews on

the project. The concept of *takt* time was considered, however the way to apply this principle to self-performed concrete had to be developed. Leading indicators on production rates were assessed based on the collected data. The production quantities were evaluated for current state *takt* time, which analyzed contact square feet of wall installed/per man/per day. Although there remained some variation in this metric based on the skills of individual craftsman, it provided a starting place for adequately planning proper manpower for form crews.

The metric was then applied to future demand based upon the weekly work plan and helped to plan concrete production needs throughout the week. The formwork demand for the deck crews stayed relatively constant on a weekly basis, so a weekly square footage goal was established and measured (Figure 6).

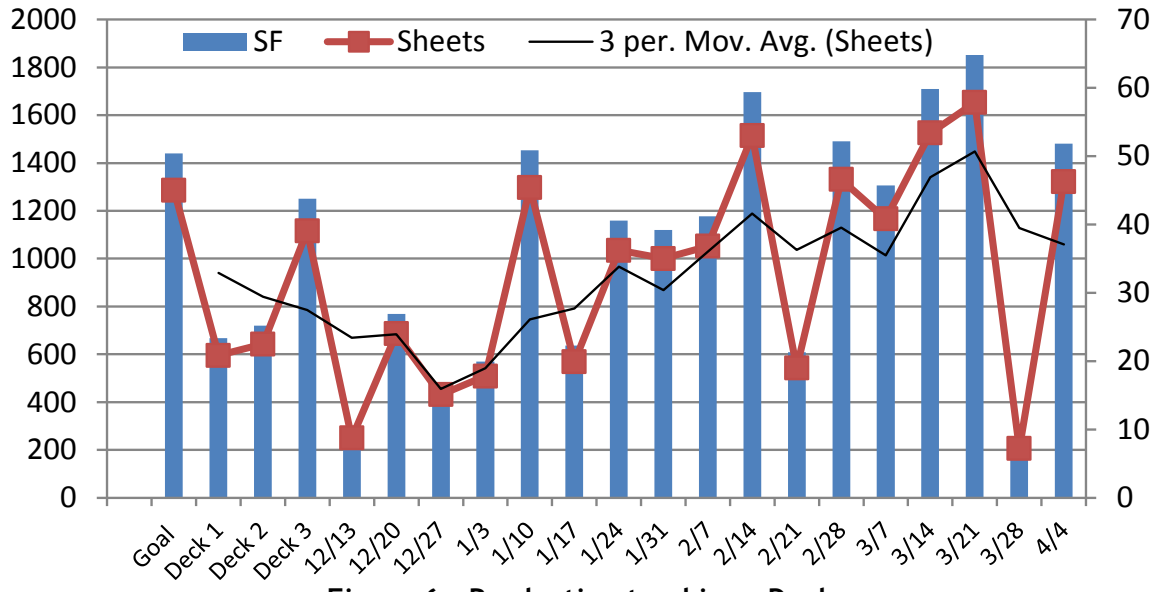


Figure 6 - Production tracking - Deck

This square footage goal was then converted to sheets of plywood needed on average per day, which allowed a tangible metric to help the crew determine whether they had a good day or not. As shown in figure 6, the process of communicating expectations coupled with implementation of LPS demonstrated a production improvement.

Due to the building geometry and differing beam depths between levels, each deck pour had its own unique characteristics. Thus, it would not be appropriate to attribute the improvements solely to the learning curve. Moreover, the Level 3 suspended deck included the setting of anchor bolt templates to receive structural steel columns for the upper levels. The construction of these decks was tracked from 2/28 - 3/21, which incidentally were the best performing weeks. The dips in production (1/17, 2/21, 3/28) were caused by lack of available work to meet demand. Essentially, these weeks followed large deck pours where available work had to be made ready before proceeding with full production. During these weeks the crews would be assigned to other tasks such as stripping or concrete columns. During the week of 3/7 a challenge related to design changes impacted production and is discussed later in this paper.

The application of *takt* time to the wall form work crews proved to be a bit more challenging. The metric of average contact square feet set per day on a weekly basis was the same, however shortly after implementing this metric it was recognized that the

demand fluctuated on a weekly basis due to available work and work completed the previous week. As a result the process had to be adapted to account for this fluctuation, which required complementing the lookahead planning process by adding a demand component. This allowed the concrete foreman to manage and plan crew levels more accurately. Moreover, it facilitated a more informed commitment to weekly work plan activities.

At the outset of implementing *takt* time to manage the concrete production process, the team assumed that it would provide a necessary balance to the implementation of LPS™. The metric motivated foremen who truly wanted to understand their expectations and plan manpower levels more effectively. It also challenged the foreman to seek ways to achieve production goals in light of the inherent challenges on the project. The most notable challenges were demand for crane time, site logistics due to limited laydown area, and continuous revisions to the design. The visual tool helped the management team to measure and document progress on the site. During daily production observation walks, quantity of formwork set was documented. These walks also presented opportunities for interaction with field personnel to discuss opportunities to increase weekly production and identify constraints hampering production.

Balancing the line and setting real expectations to the crew

The development of a more structured process to track productivity in the field alleviated the emphasis of cycle time as a driving metric and led to a more balanced approach to determining success. Essentially, the team realized that in certain instances a prolonged cycle time could improve reliability of workflow on the project and still allow production goals to be met. This is illustrated in figure 7.

1. Window sills formed and placed prior to deck. Handset forms used to reduce demand on crane.
2. Wall panels set to help production goals and create workable backlog for rebar subcontractor. (Elevator 1)
3. Since window sills were poured prior to the deck, wall panels were set the same day as the deck pour.
4. Forms ready to be closed and pour the next day after deck pour. (Elevator 1)

Figure 7: Field operations – Understanding formwork cycle times

Although cycle time for the individual wall pour was increased by proceeding with the architectural starter walls prior to the deck pour, it allowed gang panels to be set the day of the deck pour reducing the overall combined cycle time for these activities by 4 days. A similar condition took place with the level 3 elevator 1 wall pour as summarized in the following two options.

Option 1: It was more cost effective to place walls after the deck below was placed. This would avoid the need for an added block for the close up panel to account for the slab

thickness. Thus, to reduce cycle times on the process the initial setting of one side panels would be deferred until the deck was poured.

Option 2: There were some benefits, however, to setting the one side panels in this situation. The need for a deck edge form was eliminated, which saved time and additional labor. Moreover, it provided additional available backlog for the rebar subcontractor to complete if other planned activities were unavailable. It also provided additional contact square footage during the week to improve production units.

In this scenario, the latter option (2) was implemented and the work associated with the level 3 elevator 1 wall pour was completed as fill in work for the rebar and electrical subcontractor. It then opened up additional opportunities for portions of the wall to be closed with forms that were not dependent on the deck pour. This improved production units for the week and helped to reduce the combined cycle time between the wall and deck pours. The deck was placed and the walls were able to be placed 2 days after the deck pour, which was a reduction of about 5-7 days if the former option were to be employed. Another benefit was the improved workflow on a congested site, where down time waiting on the crane was a major impediment.

The events described were made possible by the implementation of "going and seeing" and were the result of several conversations with the general foreman and foremen from the deck and wall crew. The general foreman also advocated an integral aspect that improved the balancing of work flow in a production setting. Although the various crews specialized on certain aspects of the concrete scope of work, they were not treated as competing silos on the project. Based on the production demand during the week, crews were mixed or supplemented with personnel from other crews to ensure achievement of goals. This assisted in improving collaboration amongst the various crews and reduced the tendency of counterproductive rivalries.

This practice was also an example of balancing the production line between work stations based on *takt* time. The expectations were discussed during weekly production meetings and commitments were made based upon available resources and available work. The foremen then organized the crew levels in order to meet commitments and demand for the week. This collaborative process was continuously refined by the "go and see" procedure and produced a fairly high weekly average PPC (reliability) of 77% that has improved over time (Figure 8).

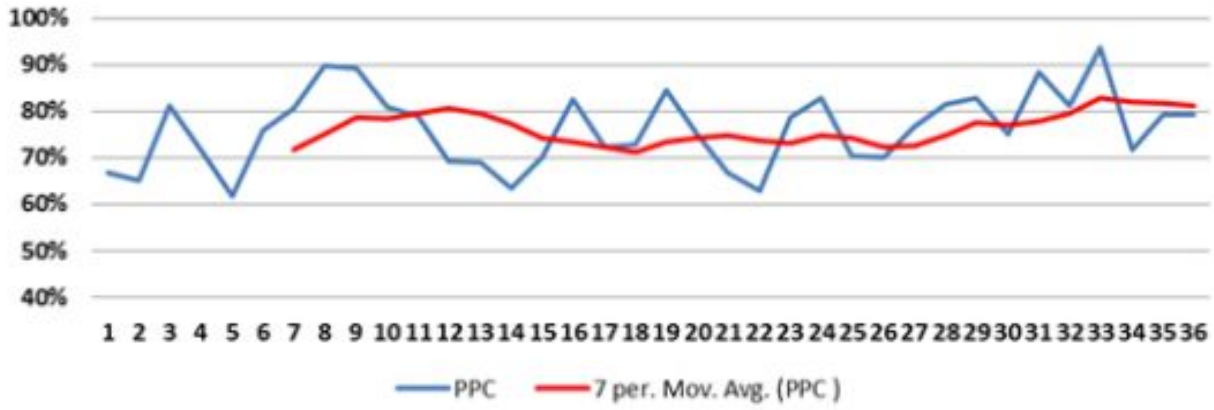


Figure 8: Percent Plan Complete (PPC) evolution

The structural design and the reality on the field

The completion of Level 3 cast-in-place concrete was a major milestone for the project, which paved the way for the setting of structure steel for upper levels. In the midst of this challenge a significant design change impacted progress by approximately two weeks. It had to do with the coordination of concrete beam depths and widths at steel anchor bolt locations. Due to the complex geometry of the project, it was difficult to ascertain these conflicts on two-dimensional plans. As a result, the team built in some schedule contingency to review these potential conditions.

In order to allow production to continue the team decided to form beam sides wider and deeper to provide flexibility to coordinate anchor bolt template embedments that occurred on angled gridlines. In the event that dimensions needed to be adjusted the forms could be "padded" or filled in accordingly. This allowed time for layout of actual anchor bolt templates to occur, conflicts to be discovered, and resolutions to be proposed without schedule impact. An RFI was written approximately two weeks prior to this action; however the final response took some time to be provided due to the complexity of the issue. Ultimately, in order to resolve the issue the structural engineer's local office was sent out to review conditions and provide a response to the Kansas City office (figure 9).

Figure 9 - Reviewing RFI with structural engineer

After reviewing the conditions in the field, the response was received as anticipated in all aspects except for one issue. The unexpected item included the lowering of an intermediate structural beam, which had already been built per the original plans. The implementation of this direction would have had a severe impact on the project, so the engineer was contacted. After getting to the reason for this change it was discovered that it came from a reviewer in the Kansas City office who was only trying to help make construction of the beam easier by making it level with an intersecting girder. The team clarified that both the beam and the girder had been constructed and that the question was only regarding concrete coverage of steel anchor bolt template. Since there was no other structural value for the change, the beam elevation in question was restored to the original contract documents.

Observing the processes and stopping the line

The "go and see" process also assisted a manager in identifying undisclosed problems that impacted production in the field, in many instances these problems would go unnoticed. Take for instance, a problem that was discovered during the "go and see"

process where the installation of rebar manifested a problem that would have been unknown. In reviewing job progress it was noted that a critical wall pour (1-line), had been set 5 days prior and rebar installation was still incomplete. Nonetheless, rebar installation had proceeded in other non-critical areas that were designated as workable backlog (Elevator 2 and L3Q1 wall pour 5 at Y.3 line). After discovering the problem the foreman for the rebar subcontractor was sought out for additional information. He indicated to the team that a mistake by detailing had occurred and they had missed the corbel in the wall. The steel would ultimately arrive four days after the expected date.

This information helped to adjust manpower levels to accommodate the critical missed commitment. The crews were then reassigned to complete wall panels in future areas to reduce overall cycle time for upcoming wall pours. A limited crew remained to complete the 1-line wall close up panels. This adjustment afforded the crew to complete other critical wall pours a week ahead of anticipated completion. This allowed the extra week to be used for breakdown of rented panel material in much needed laydown area prior to the installation of structural steel.

Conclusions

This paper presented examples from a project that used the principle of going and seeing to continuously improve production and increase the reliability of weekly work plans. The team managed production using real time data collected directly from field observations and feedback from workers, and used it make adjustments every week. Metrics collected by the project team indicate that the team's efforts have in fact improved their performance and that the use of the LPS™ and continuous cycles of timely data collection, analysis, and the implementation of improvement actions have helped the team to focus on processes (e.g., constraint removal) and tasks (e.g., design/configuration of concrete operations) that needed to be improved.

Acknowledgements

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References

Ballard, G., and Howell, G. (1998). "Shielding Production: An Essential Step in Production Control.", *J. of Constr. Engrg and Mgmt*, ASCE, 124 (1), pp. 11-17.

Goldratt, E.M. and Cox, J. (1992) *The Goal: A Process of Ongoing Improvement*. Second Revised Edition. North River Press: Great Barrington, MA, 351pp.

Ohno, T. (1988). *Toyota Production System: beyond Large-Scale Production*. Productivity Press: Cambridge, Mass. 142pp.

Rother, M. and Shook, J. (2003). *Learning to see*. The Lean Enterprise Institute, Cambridge, MA. Version 1.3., June 2003

Shingo, S. (1988) *Non-Stock Production: the Shingo System for Continuous Improvement*. Cambridge, Mass.: Productivity Press. 454 pp.

The Lean Enterprise Institute - LEI (2008). *Lean Lexicon: a Graphical Glossary for Lean Thinkers*. Version 4.0, March 2008. Cambridge, MA. 98pp.

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Modelling the network of commitments in the Last Planner System

Daniela Dietz Viana[1], Carlos Torres Formoso[2] and Eduardo Luís Isatto[3]

Abstract

Research Question: Can Language-Action Perspective (LAP) contribute to a more robust theory for project management?

Purpose: to show how the (LAP) underpins the management of commitments in the Last Planner System (LPS).

Research Design/Method: Observation of two projects in different companies, both experienced with LPS; mapping the network of commitments for medium and short term planning levels; an in-depth analysis of planning meetings, who effectively participated in decisions and how the commitments were managed.

Findings: some evidence of the utility of LAP for describing and evaluating production planning and control systems

Limitations: only two projects were observed and only formal meetings within those projects.

Implications: Further research is required to test the robustness of these findings

Value for practitioners: LAP encourages project participants to ensure mutual understanding of each commitment in the network. The study shows that this two-way communication plays a key role in getting a mutual understanding on the tasks and their constraints. When this type of communication is missing plans that do not match work force.

Key words Last Planner System, Language-Action Perspective, Network of Commitments, Production planning and control

Paper type: Case Study

Introduction

The Last Planner System™ (LPS)[4] The Last Planner System (LPS) has been successfully applied in construction industry since the early Nineties in different parts of the world, such as Chile (González et al. 2007), Korea (Kim and Jang 2005), Middle East (AlSehaimi et

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[4] Last Planner System is a trademark from Lean Construction Institute

al. 2009) and others. In Brazil, the number of companies that have adopted Last Planner is fairly high, although the level of implementation varies to a great extend among them (Bortolazza and Formoso 2006; Formoso and Moura 2009).

The worldwide success of the Last Planner System has called the attention of the research community regarding the need to understand its underlying ideas, since this system has been developed through a series of industrial experiments. Koskela and Howell (2002) pointed out a strong connection that exists between Last Planner commitment planning and the Language-Action Perspective (LAP). According to those authors, LAP seems to be suitable to explain the two-way communication mechanism that exists at short term planning meetings, when representatives of production crews meet in order to assess the performance in the previous week and negotiate the work packages for the following week. Moreover, Koskela and Howell (2002) pointed out that this theoretical approach could contribute to build a more robust theory for project management.

The Language-Action Perspective considers human work as a network of commitments, therefore the work coordination should be based on the appropriate management of commitment flows (Winograd and F. Flores 1986). The trigger to start a commitment is a request made by one person and needs that another person promises to perform it. For Slivon et al. (2010), at short term planning meetings, the participants usually make promises in public, risking their reputations or personal identities when a commitment is established. According to those authors, this fact increases the likelihood the working crews to fulfil their promises, enabling the participants to develop trust on each other.

Although several papers from the Lean Construction community have suggested the strong connection between the Last Planner System and LAP (Koskela and Howell 2002; Macomber and Howell 2003; Howell, Macomber, et al. 2004; Howell and Macomber 2006; Slivon et al. 2010), none of them are founded on empirical studies. This paper describes two case studies in which the Language-Action Perspective has been used for assessing the effectiveness of planning and control systems, emphasizing medium and short-term planning. The aim of this investigation was to devise a method for modelling the network of commitments, and analysing planning meetings.

Language/action perspective

The Language/Action Perspective (LAP) is a way of representing the network of commitments of an organization. This approach was originated in Fernando Flores thesis (Flores 1981). LAP emphasizes what people do while communicating, how the language is used to create a common reality and how activities are coordinated through language (Kethers and Schoop 2000).

One important underlying theory of LAP is the Speech Act Theory. Searle (1969) structured some rules to systematize the context conditions that make the speech acts appropriate to any utterance. Based on this theory, Winograd and Flores (1986) suggested that the Language-Action Perspective can guide organization design according to what they named a “conversation-for-action model” that would be developed through the performance of some specific speech acts.

According to Medina-Mora et al (1992), one of the methods to model LAP is the Action Workflow. They state that it takes two people to establish a commitment. The first one acts as a customer and the second as a performer. The commitment loop they describe

has four phases (Figure 1). An action starts with a request and is only considered done after acceptance by the customer. The negotiation phase aims to establish the conditions of satisfaction of the action. Some authors (Cleary et al. 2008; Cleary et al. 2010; Slivon et al. 2010) stress that this phase regards a mutual promise between customer and performer.

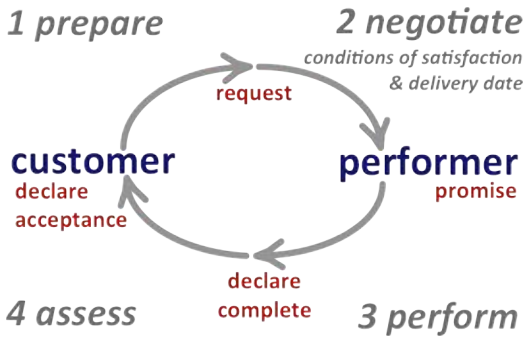

Figure 1: the Action Workflow (promise) cycle (after Flores)

Another important underlying idea was based on the studies of the philosopher Heidegger about the breakdowns. Heidegger argued that the existence of a thing depends on the individual perception about it (Winograd and F. Flores 1986). According to the referred authors a breakdown is not necessarily something to be avoided, since it is a non obvious situation in which the acknowledgment of how something went wrong may aware people involved about a different aspect of doing so. Regarding a hypothetical network of commitment of an organization, a breakdown in one of the loops can be the trigger to start new commitments apart from the common network.

Method

The case studies were undertaken in two different companies. Both of them were selected due to their willingness to participate in this investigation and also because they had previously used the Last Planner System in several projects. Company A is medium sized and has used Last Planner since the 1999. Unlike many other construction companies in Brazil, most labour was directly hired by the company and only 20% is subcontracted. Company B is a large sized construction company operating in most Brazilian states. This firm has used a planning and control system based on Last Planner since 2007. In contrast to company A, the majority of its work force is subcontracted.

The main evidence sources were participant observation in planning meetings, interviews with meeting participants, and document analysis. Eight short-term planning meetings were observed in each company. The meetings of company A were chaired by the site manager, being usually attended by eight people, including crew leaders, foreman, and engineering interns. The subcontractors did not participate on that meeting. The meetings of company B were led by an engineering technical assistant and by a health and safety specialist, depending on the stage of the meeting. All subcontractors should have a representative at the meetings, although this was not always observed. On average, only 23.9% of the subcontractors attended the meetings. Altogether, around twelve people attended weekly meetings.

The focus of analysis was the understanding of how the commitments were managed during the meetings, and how each company created a trust environment to make

promises. The meetings were recorded and transcribed. Each speech was classified according to the type of activity that had been performed, as show in Table 1. Although there is a holistic analysis through the interviews, the problems that were pointed out in the networks of commitments were based on the problems that came out during the planning meetings. Moreover, the networks shown in this paper are simplified in order to underline the specific problems that are discussed.

Table 1 - Types of activities performed in the speeches, during the planning meetings.

Activity	Definition	Source
Information sharing	Informative discussion that does not propose the performance of an action.	-
Requests	A customer request an action, or the performer offers, according to a condition of satisfaction.	Medina-Mora *et al.* (1992)
Negotiations	Discussions that intend to change the conditions of satisfaction to perform the action.	Medina-Mora *et al.* (1992)
Identifications	Discussions about a specific execution matter, without requesting an action.	-
Recommendations	Can be understood as an advice. It refers to the way an action should be performed, but it is just a suggestion, instead of an order.	Searle (1969)
Verification	Refers to declaration about the execution of the action, that can be satisfactory or not.	Medina-Mora *et al.* (1992)

The network of commitments was mapped using the action workflow method. However, the preliminary analysis revealed some limitations of this method: it was not possible to map activities that were started and performed by the same person, based on the assumption that a commitment needs two people. For that reason, some symbols were developed for individual activities in order to indicate triggers for subsequent commitments. Also, the relationship proposed by Van Reisjwoud and Dietz (1999) was used to understand some loop phase interactions. This study adopted, as well, a differentiation between a failure on the loop phase and a breakdown on it. The former represents a critical problem during the establishment of one commitment that the process is not able to deal with. The latter, in turn represents a problem that the process had created some mechanism to deal with. These symbols are shown in Table 2.

Results

Company A

In Company A, the production manager is in charge of producing a master plan, which is represented by a Gantt bar chart. When construction starts, the site manager analyses all long-term constraints that cannot be removed within the look-ahead planning horizon. He is also in charge of updating the master plan and producing a four-week look-ahead plan. No formal medium-term planning meeting is carried out: electronic messages are sent to different company departments requesting the removal of constraints.

Regarding short-term planning, weekly meetings are carried out for assessing the performance of the previous week and negotiating the plan for the following week.

The Network of Commitments

The analysis of the network of commitments indicates how complex the networks have become, mainly due to the lack of medium-term planning meetings. For example, the network of commitments for removing materials and equipment constraints is presented in Figure 2, which shows that many commitment loops had to be created, making the management of constraints very complex.

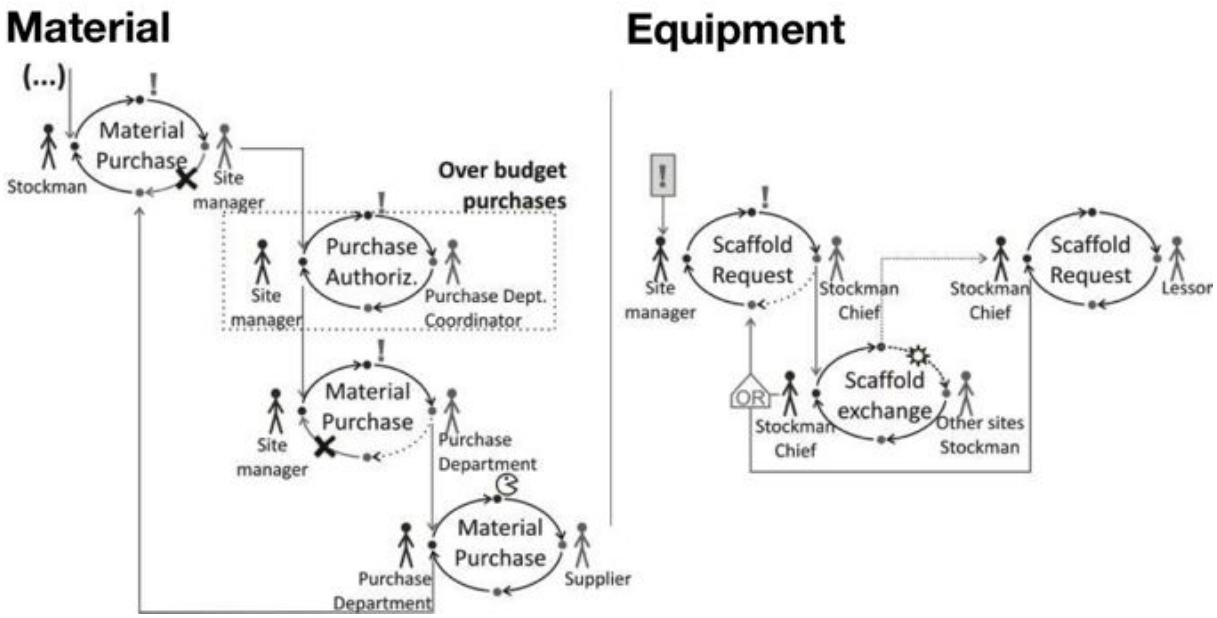

Figure 2 – Networks of commitments to remove material and equipment constraints

Table 2 – Symbols adopted for mapping the network of commitments

✕	Failure on the loop phase		Workflow loop
----✳---->	Breakdown	(...)	Hidden workflow loop
——→	Causal relationship between loops	!	Previous system evaluation by the actor
·····→	Conditional relationship between loops		Previous problem perception by the actor
	Verbal communication	**PPP**	Communication through the work packages document
!	Communication through internal system	OR	Indicates that different paths can lead to the same point

There were frequent failures along the loops at the medium-term planning level – for instance, the site manager sometimes was not aware of the status of materials delivery, resulting in planning errors, such as the assignment of tasks that did not have their constraints removed.

The network of commitments for removing equipment constraints shows an example of breakdown. In order to remove equipment constraints, such as renting scaffolds, the inventory chief manager is in charge of the negotiation with the rental companies. He contacts other sites of the company to see whether the equipment needed can be made available shortly. If this workflow loop cannot be completed, due to the lack of equipment available, this manager has to contact the rental company and rent what is needed.

In the short-term planning, the control of the completion and of the quality of each work package was undertaken separately, since the trigger to perform each control was different. The former depends on the short-term planning horizon, which is one week. The quality control depends on the completion of production stages. Thereby, different people carried out those controls at different times, as shown in figure 3. This separation resulted in the possibility of considering completed work packages that have not had their quality checked, which may distort PPC results or cause the need of rework packages in the following week.

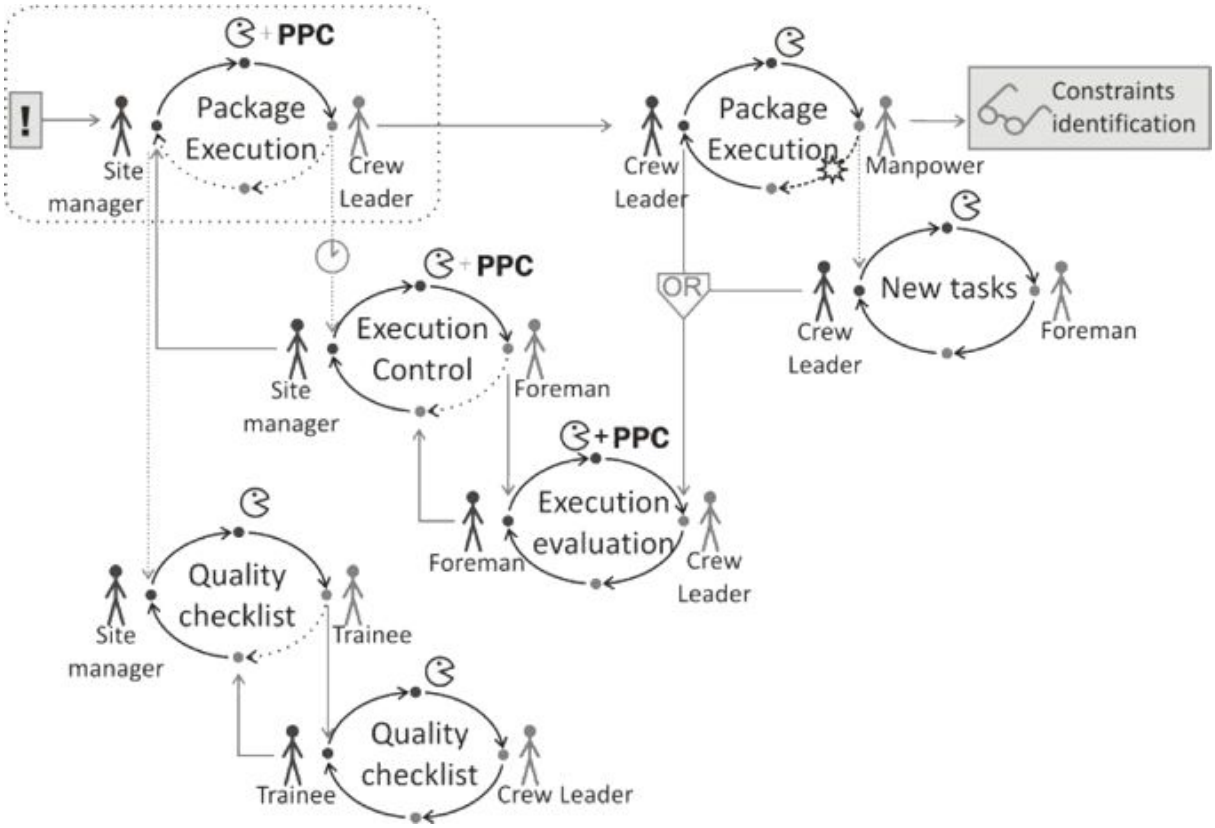

Figure 3 – Network of commitments of the short term planning meeting (for key see table 2 above)

Analysis of the meetings

The short-term planning meetings were divided into two main stages. In the first stage, named verification, the site manager looks for the causes for the non-completion of work packages from the previous week. The second stage, named new packages, is when new assignments are discussed with crew leaders. The meetings also have moments in which the discussions are not related to any package - these moments were classified as discussions. Those stages of the meetings are not necessarily carried out sequentially, as shown in Figure 4.

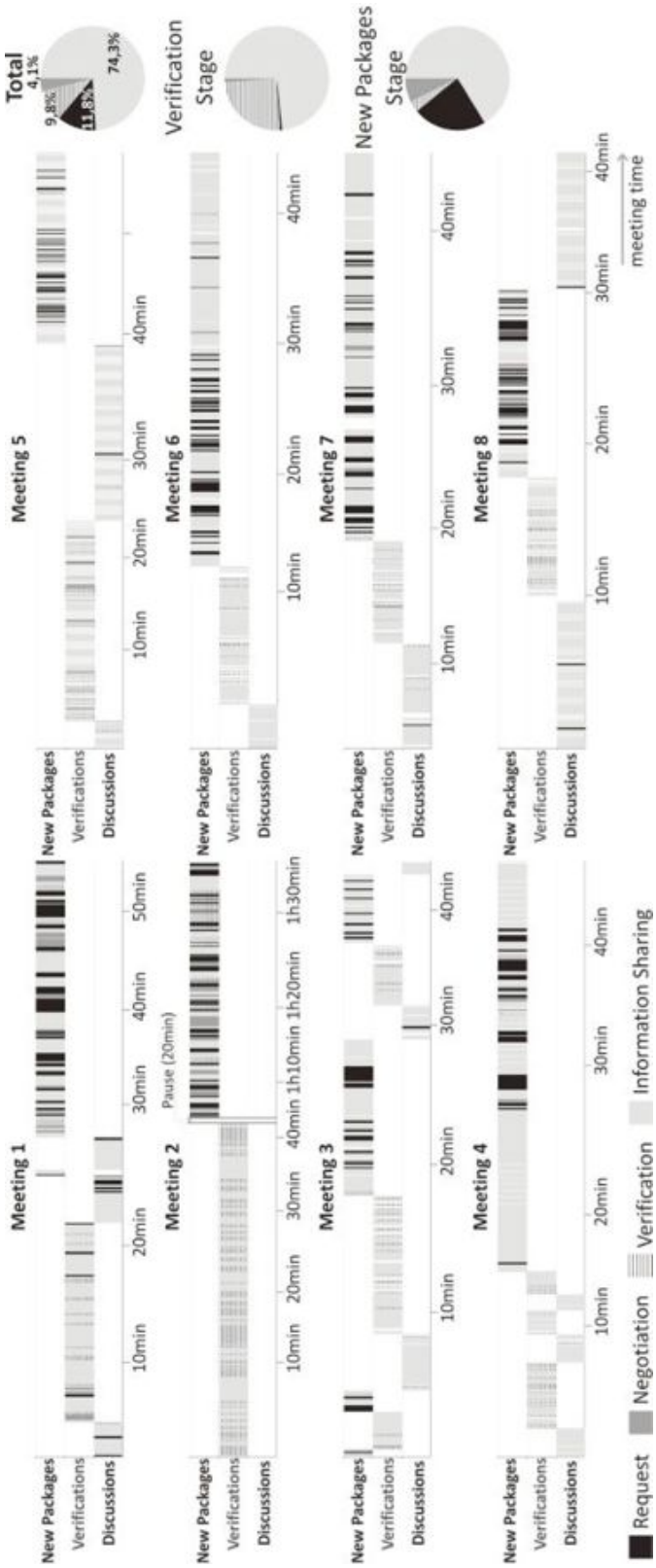

Figure 4 - Activities performed along the meetings steps, Company A

Much negotiation is carried out between crew leaders and the site manager in the new packages stage. During the discussions, the site manager informs the crew leaders about the activities that are expected to be carried out, thus making the teams aware about possible interferences among tasks. This would enable the group to find a solution

together. Besides, at this stage the site manager discusses with the crew leaders whether their labour teams are performing satisfactory.

An analysis was made on the kind of activities performed during the meetings, resulting in the profile shown in 3. Although information-sharing is the most frequent activity, since it takes 74.33% of the meeting time, the two main stages have a clearly different patterns according to the phase of the workflow loop that is performed: the acceptance phase in the verification stage takes 24% of the stage and the requesting and negotiations phases in the new packages stage is 30% of that stage.

It is also possible to identify the impact of the lack of look-ahead planning meetings in the short-term planning. Much time was spent on discussions about tasks constraints, (21.8% of the meetings duration). The time spent in those discussions could be reduced if there were a meeting to deal with the constraints issues, which would also provide more transparency on the process, avoiding the communication problem pointed out in the networks of commitments to remove material constraints.

Company B

The planning and control process in Company B was much more centralized, compared to Company A. The master plan of each construction site is initially produced at the company head office. If necessary, this plan is adapted to the context of a specific region of the country. This is decided in a meeting that involves the site manager, the head-office planning manager and the regional planning manager.

Regarding the look-ahead planning, the company has two different kinds of meetings for identifying and removing constraints. The constraints for short lead-time items are discussed in a weekly meeting, while for items that present a lead-time longer than a week there is a monthly meeting in which the managers from the company's central office also participate.

Regarding the short term planning meetings, it is divided into three stages: safety issues, product quality issues, and the definition of packages. The first part is chaired by the health and safety specialist, who makes a brief presentation of safety problems observed on site. A discussion involving also crew leaders, foremen and the site manager is then undertaken with the aim of defining solutions for those problems.

The second part of the short-term planning meeting is led by the site manager technical assistant (usually a civil engineering intern). He makes a brief presentation of quality problems during the execution of the tasks, and discusses with the crew leaders their causes and how they can be avoided. Finally, the third part of the meeting is focused on planning and control. However, as it is carried out at the end of the meeting, the assignment of packages are made during a very short period, without much discussion.

Network of commitments

The network of commitments maps pointed out again the high degree of complexity of the planning and control process. In Figure 5a, for instance, the network of commitments for removing materials constraints presents several transactions, which are the result of the decomposition of the first task and a series of approvals that need to be given by different instances of decision-making. When there is a break in the loop between the supply department and the supplier, the site manager starts a new loop in order to request the site administrator to remake the material request to the supply department.

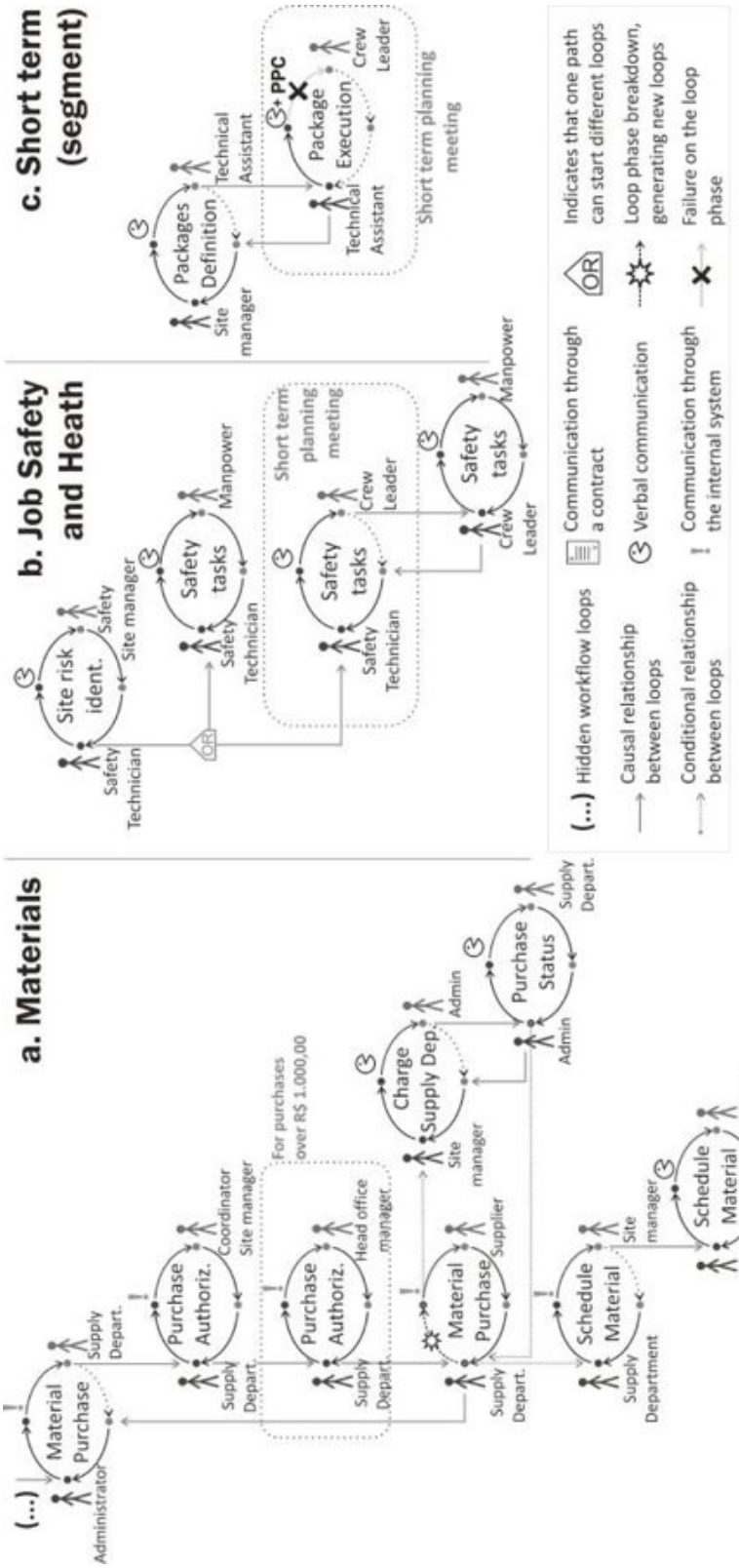

Figure 5 - Networks of commitments to remove material (a); job safety and health constraints (b); and short term planning commitments (c)

Figure 5b shows the network of commitments related to the health and safety phase. The role of the health and safety specialist is very important, since he is allowed to change task procedures, and to ask directly the crews to perform safety-related tasks.

The failures along the loops were more critical for short-term planning commitments. In figure 5c, a segment of the complete network is presented, showing that there is a failure in the loop established between technical assistant and the crew leader, at the negotiation phase. It happens because the weekly packages definition and control that should be a site manager responsibility are assigned to the technical assistant, who has to discuss these packages with the crew leaders. However, this assistant was not allowed to change the weekly plan according to the crew leaders claims. If it was necessary to make a change in the packages definition, the site manager needed to be present at the meeting.

The set of medium-term networks of commitments from Company B showed that there are fewer failures in the loops, but breakdowns often happen, caused by the lack of effectiveness of upstream processes, which are managed by the company's head office. Those networks indicated that there is a general awareness in terms of ensuring the integrity of the workflow loops: when a failure is detected, managers apply procedures to deal with them. However, the failures that were pointed out in short-term planning process seem to happen due to the lack of negotiations with crew leaders.

The Meetings Analysis

Company B meetings were very different from the ones carried out in Company A, as shown in Figure 6. The number of negotiations and requests during the safety issues stage indicated that this was usually a period for open discussion among the meeting participants. By contrast, in the stage of definition of packages, a large percentage of the time was spent on requests, leaving much less time for negotiations of work packages – in fact, in some of the weeks no negotiation happened. Moreover, as there was not enough time for discussing the causes of the planning failures, the metrics were mostly used to communicate the central office the problems observed on site.

Conclusions

This paper provided some evidence of the utility of LAP for describing and evaluating production planning and control systems based on the Last Planner system. Although the literature prescribes how the Last Planner system should be carried out, LAP provides a conceptual framework that can be used for describing and understanding how commitments are managed. The analysis of planning meetings provided additional evidences on how LPS is really implemented, which are not usually provided in other studies on the implementation of this system.

A method for modelling the network of commitments, based on LAP, and analysing planning meetings was devised. Some changes were made in the action workflow method in order to make it possible to map all the interactions and breakdowns that need to be considered. Such method provides a comprehensive description of planning and control processes, and produces evidences on different ways of undertaking the Last Planner System in constructions projects.

The analysis of the network of commitments revealed the complexity that construction managers have to deal with to achieve a specific goal. In some cases, there are different ways of starting a process, which increases the need for an effective coordination method. Moreover, the maps stressed some failures along the networks that can be seen as improvement opportunities, since these may cause disruptions in the

project. Based on patterns found in the meetings, misunderstandings of some underlying ideas of Last Planner were identified in the case studies. For instance, in Company B the technical assistant who chair the short-term planning meeting, should discuss the packages but did not have decision making power to negotiate changes in the plan with crew leaders.

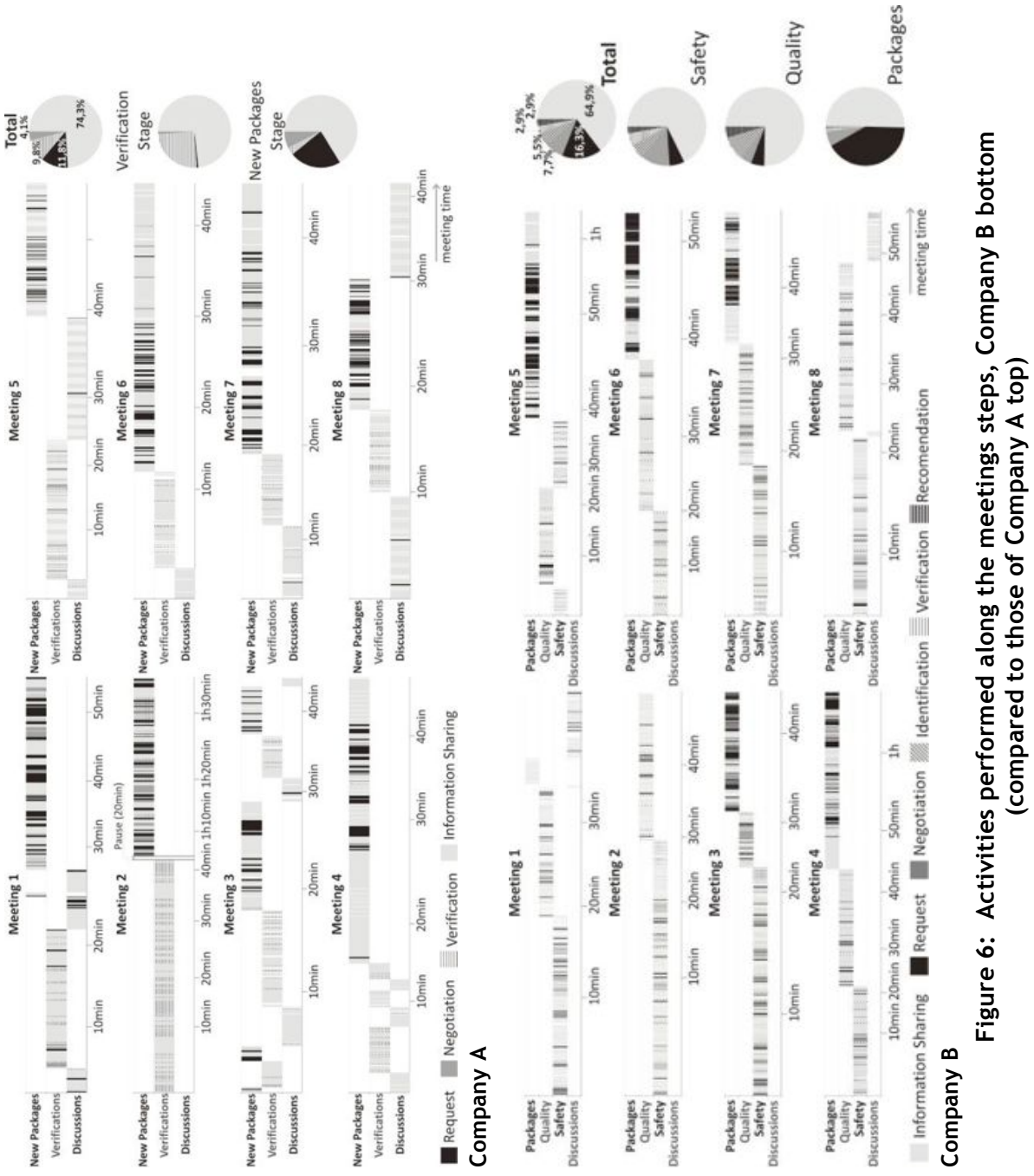

Figure 6: Activities performed along the meetings steps, Company B bottom (compared to those of Company A top)

Regarding the LPS underlying ideas, the use of LAP emphasized the importance of ensuring a mutual understanding of each commitment in the network. LAP assumes that an organisation work through the successful management of this small transactions. The studies provided evidences that this two-way communication plays a key role in getting a

mutual understanding on the tasks and their constraints. By contrast, the lack of this type of communication results in plans that do not match to the capacity of the work force.

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References

AlSehaimi, A., Tzortzopoulos, P., and Koskela, L. (2009). "Last Planner System: Experiences from Pilot Implementation in the Middle East." *Proceedings 17th Annual Conference of the IGLC*, Taiwan, 53-66.

Bortolazza, R., and Formoso, C. (2006). "A Quantitative Analysis of Data Collected from the Last Planner System in Brazil." *Proceedings of the 14th Annual Conference of the IGLC*, Santiago, 625-635.

Cleary, M., Owen, R., and Koskela, L. (2008). "Promise-Based Management as an enabling Factor In Lean Construction – Towards A Clarification." *Proceedings of the 16th Annual Conference of the IGLC*, Haifa, 366-375.

Cleary, M., Rooke, J., and Koskela, L. (2010). "On a Road to Promises that Work." *Proceedings of the 19th Annual Conference of the IGLC*, Haifa, 366-375.

Flores, F. (1981). "Management and Communication in the Office of the Future." Thesis, University of California at Berkeley.

Formoso, C., and Moura, C. (2009). "Evaluation of the Impact of the Last Planner System on the Performance of Construction Projects." *Proceedings 17th Annual Conference of the IGLC*, Taiwan, 153-164.

González, V., Luis, A., and Mundaca, F. (2007). "Investigating the Relationship between Planning Reliability and Project Performance: a Case Study." *Proceedings of the 15th Annual Conference of the IGLC*, Michigan, 98-108.

Howell, G., and Macomber, H. (2006). "What Should Project Management be Based on?" *Proceedings of the 14th Annual Conference of the IGLC*, Santiago, 41-50.

Howell, G., Macomber, H., Koskela, L., and Draper, J. (2004). "Leadership and Project Management: Time for a Shift from Fayol to Flores." *Proceedings of the 12th Annual Conference of the IGLC*, Helsink, 1-8.

Kethers, S., and Schoop, M. (2000). "Reassessment of the ActionWorkflow Approach: Empirical Results." *Proceedings of the Fifth International Workshop on the Language-Action Perspective on Communication Modelling (LAP 2000)*.

Kim, Y.-W., and Jang, J.-W. (2005). "Case Study: an Application of Last Planner to Heavy Civil Construction in Korea." *Proceedings 13th Annual Conference of the IGLC*, Sydney, 405-411.

Koskela, L., and Howell, G. (2002). "The underlying theory of project management is obsolete." *Proceedings of the PMI Research Conference*, 293-302.

Macomber, H., and Howell, G. (2003). "Linguistic Action: Contributing to the Theory of Lean Construction." *Proceedings 11th Annual Conference of the IGLC*, Virginia, 1-10.

Medina-Mora, R., Winograd, T., Flores, R., and Flores, F. (1992). "The Action Workflow Approach to Workflow Management Technology." *CSCW 92 Proceedings*, 281-288.

Van Reijswoud, V., and Dietz, J. (1999). *DEMO Modelling Handbook*.

Searle, J. (1969). *Speech acts: an essay in the philosophy of language*.

Slivon, C., Howell, G., Koskela, L., and Rooke, J. (2010). "Social Construction: Understanding Construction in a Human Context." *Proceedings 18th Annual Conference of the IGLC*, Haifa, 2-11.

Winograd, T., and Flores, F. (1986). *Understanding Humans and Cognition*. Addison-Wesley Publishing Company, Inc.

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The End-Customer Value Loss in a Construction Project

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Abstract

Question: How the value of work environment is managed in a construction project?
Purpose: Lean construction papers have shown a great deal of interest in project management and delivery. The end-customer/end-user perspective has not yet had similar attention in the lean construction literature. This paper focuses on end-customer value creation of a work environment construction project. The purpose of the paper is to assess how the end-customer value is managed in such a project.
Research Method: The value flow and its management are analyzed through value stream mapping in a descriptive case study. A generic map of value creation with the case specific investment management process is constructed from semi-structured interview data, case documents supplemented by value workshops.
Findings: The value stream analysis showed that a work environment project can potentially produce significant additional value for the end-customer, but inadequate value management during the investment process can waste that potential. The work environment service was added to the investment management process solely as a separate sub-process and the optimization of the whole value creation was not attended to. Therefore, the studied process was found not to support value management. Instead, it focused on optimizing the delivery and managing the investment costs of sub-processes.
Limitations/Implications: Because there was only one case study, more research is required to generalize the conclusions.
Value for practitioners: The paper makes it contribution by presenting a new approach to assess how the value in the built environment is created.
Keywords: value creation, value management, work environment
Paper type: Case Study

Introduction

In lean construction, the literature has shown a great deal of interest in project management and delivery. According to the keywords analysis of Alves and Tsao (2007),

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the top three focus areas (c. 20% of the key words) during 2000-2006 in lean construction have been

1. project management,
2. design management, and
3. costs, performance measurement, and implementation.

The value and customer themes have a surprisingly low share of 3.8% of all the key words in the papers (Alves and Tsao 2007), although it is one of the primary features of lean (e.g., Liker 2004; Morgan and Liker 2006).

This study uses the lean approach to assess the end-customer value creation of a typical work environment construction project in Finland. Since the role of work environments has been highlighted in the rapidly changing business environment, both academia and business have shown a great interest in understanding the potential of work environments. The undergoing digital revolution has brought even more attention to the subject. Schriefer (2005) even stated that organizations that ignore the changes in the work environment, work patterns, and the workforce will likely confront problems in the future. In the case, there are two end-customers: the end-users of the work environment, such as employees, and the organization of the building, which is the tenant.

The paper is divided into four sections. The first section discusses the theoretical background of the customer value, value creation, and the value of a work environment. The second section presents the methodology, background information of the case, and data collection and analysis. In the third section, the results are visualized through a generic value stream map, the discontinuations in value management are described, and potential ways to improve the value creation are discussed. Finally, conclusions are drawn and future research is suggested.

Theory

Customer value and its creation

Value is a complex and broad concept. According to Salvatierra-Garrido et al. (2009), the definition and understanding of value changes according to the project features and authors' perspective and thus a widely used definition of value is not established. Value is often associated with issues such as product or service features, exchange, costs, quality, and design (Salvatierra-Garrido et al. 2009, Erikshammar et al. 2010) and increasingly, value is also linked to sustainability in terms of economic, social, and environmental contexts (Bae and Kim 2007, Huovila and Koskela 1998).

The subjective nature of value has been accepted in lean and non-lean literature. Customer value is seen to be defined by the customer, not by the service provider. Value has been recognized to be a dynamic concept and thus customer value changes over time (e.g. Khalifa 2004, Emmit et al. 2005, Salvatierra-Garrido et al. 2009). Khalifa (2004) even states that customer value is the source of all other values.

According to the lean literature, customer value should be identified in order to recognize what should be produced and what should be eliminated (e.g., Liker 2004; Morgan and Liker 2006). Because of the connections between value and waste, simply eliminating the waste from the process does not mean that the customer value is captured (Koskela 2000, Salvatierra-Garrido et al. 2009)

In lean construction, products and services are designed to bring the maximum value for the end-customer (Ballard et al. 2001). Koskela (2000) originally presented three production concepts (called TFV theory) that have different approaches to value: concepts of transformation, flow, and value generation. In the concept of transformation, the focus is not on customer value; it is on the transformation of input into output through independent sub-processes, which are optimized separately. In this concept, the underlying assumption is that the customer value is related to the value of the input: by having high-quality and expensive materials, the value of the output increases. In the second concept, the focus is on flows, as the name indicates: how to create a flow by eliminating the non-value-adding activities of production. In this concept, the idea is to eliminate anything that creates no value for the customer. In the third concept, the focus is on value creation, and the goal is to ensure that customer-defined value is created (Koskela 2000).

In the use of the three concepts, the balance, integration and synergy between the concepts should be taken into account; the weight of the concepts in different situations is not necessarily the same. It has been suggested that the management of the concepts consists of three parts: contracts, processes, and value are managed independently but in co-ordination (Bertelsen and Koskela 2002). Another challenge is the fundamental ontological difference between the transformation concept and flow and value concepts, but coherence between the concepts might be achieved by reinterpreting the transformation concept to match the process-based understanding of production, as Koskela et al. (2007) have presented.

Value of the work environment

The role of real estates, premises and spaces has been transformed from a necessary cost to an organisational support function. Krumm et al. (1998), Krumm and Vries (2003), Appel-Meulenbroek and Feijts (2007), and Lindholm (2008), for example, have identified the added value of real estate for an organization's core business: it can decrease costs and increase the value of assets, employee satisfaction, and flexibility, to name a few. In addition, an efficient work environment supports knowledge sharing that will enhance productivity, quality, and innovations (Schriefer 2005). In addition to the physical space, value can also be created through virtual and social space (Nenonen 2005). Especially Joroff (2002) has highlighted the role of virtual spaces: digital technologies change the traditional way of thinking about how, when, and where the work is done. This means that the way work is done by employees needs to be supported by new work environment solutions and opportunities.

The focus of this paper is on service related to work environment change and management.

The value of the work environment has been identified as being created on three levels, and similarly, in this service case (see next section), there are three levels to generate the value:

- throughout the history, efficiency and productivity have been the driving forces for work environment change and value creation (Bell and Joroff 2001). Similarly, in lean construction, the driver in transformation concept of Koskela (2000) has been the efficiency of the production and thus cost minimizations.

- in workplace management, organizations have become aware of the alignment of space and work: the physical aspects of work environment have been matched with the work (Joroff et al. 2003). This idea has a similar core idea as in the flow production in lean construction: to build up a work environment that supports employees' core activities by reducing the elements that cause non-value-adding activities such as interruptions and lack of interaction.
- Joroff et al. (2003) add that the cost minimization and alignment of space and work are not enough. So-called agile workplaces have been recognized to be the next level in workplace evolution. In the agile workplace, the continuous improvement is possible in the work and the place where the work is done. As Joroff et al. (2003) stated, the workplace becomes an integral part of work itself.

By using the terms of Koskela's (2000) value generation concept, this means that in the agile workspace, the aim is to continuously eliminate value losses.

Method – case study

Due to the exploratory nature of the research, a single detailed case with a service provider (the owner of the value creation process) and an end-customer was selected for the study. The focus is on the service provider's processes: how the value is managed through the investment management (IM) process to generate value for the end-customer. In the case, the actual construction phase is a sub-process of the IM process.

Background of the case

In this case, the process owner is one of the largest property asset managers in Finland and it is an active owner. The process owner is a publicly owned organization and therefore regulated by public procurement legislation when buying goods and services. There are two end-customers in the case: users of the work environment (i.e. the employees) and the organization as a tenant, which is a large research organization that occupies office and research premises in several cities in Finland and, thus having a strong real estate (RE) unit. The process owner purchases some of the services for the end-customer, but the end-customer also purchases some services for itself.

The selected case service, called strategic workplace management (SWM), is structured according to the levels of Joroff et al. (2003): efficiency, alignment, and agile workspace. The aim of the case service is not only to provide workplace solutions but also to support the organization's core strategies and activities. The SWM service is used in all kinds of processes related to investments. Small repairs, such as modifying one large meeting room into two, are not included in the SWM services but handled by the end-customer according to the agreed procedure. In the value creation process, external consultants conduct the workplace study, but the process owner's task is to manage the strategic workplace changes and thus to manage the value of the work environment through the IM process. The studied value stream begins in its current form when the process owner receives a request of needs from the end-customer and ends when the change has been made and is being maintained.

Data collection and analysis

The data was collected through multiple sources. The triangulation of data sources allows studying the same phenomenon in a more accurate way (Yin, 2003). The customer value data and value creation data were collected separately with specifically designed processes.

The customer value, how the end-customer perceives the value, was collected through 13 end-customer interviews: eight actual end-users and five employees of the organization's RE-unit who were involved in the decision-making. Both types of interviews, the end-user and RE-unit interviews, included a Kano model based questionnaire. The Kano model is used to pinpoint the quality attributes in five dimensions. The theory is also known as attractive quality (Löfgren, 2008). (See Löfgren (2008) for more information on the Kano model.) The end-customer value was also studied from another perspective: the real estate and working environment preferences were studied through another questionnaire survey called the preference study, in which approximately 400 responses of the end-users were analyzed. However, these more generic results of the customer value are not presented in this article.

To understand the value creation process, data was collected through semi-structured interviews and workshops. The primary value creation data comprises three main parts: preliminary interviews, value operator interviews, and a value workshop. Five preliminary interviews were conducted to understand more deeply the selected service, customer-ship, and organization structures. The actual value creation process was formed based on 12 value operator interviews with those people who were part of the value creation process: nine interviews from the process owner's side and three interviews from the end-customer's side. The saturation point was achieved by interviewing value operators with similar tasks, such as three project managers and four real estate managers. Although the focus in the case is on the process owner's value creation, the three value operator interviews at the end-customer's side were inevitable because the end-customer has a daily role in the value creation process due to the lease and other agreements. All the value operator interviews were semi-structured and lasted from 1 to 3 hours. The length of the value operator interviews depended mainly on the scope of the tasks of the interviews, the interviewees' personality, and possible demonstrations with software or other tools. The interviews were structured to gain knowledge about the value operator's work: for example, what activities he or she is doing, how the work is done, who are involved, how the work process progresses, how information is communicated, and how the responsibilities are divided.

The two-day value workshop was arranged with the case process owner and end-customer. In the workshop, the results of the end-customer and value operator interviews were discussed, supplemented, and validated through four topics:

- end-customer value,
- process owner's role in the value creation,
- the actual value creation process and its discontinuations and other waste types, and
- the development of ideas for the future to improve the value creation process.

In total twelve members participated in the workshop: five process owner members, one end-customer representative, and six research team members. The process owner members were from all the levels of the organization: from assistant to chief specialists

and management. A final workshop was arranged to discuss the results of the case study report.

A detailed timeline of the data collection can be seen in Figure 1. In addition to the two workshops, a total of 30 interviews were conducted in the case. There were also a couple meetings in which practical arrangements of the case (such as planning a workshop or defining the case's timetable) were discussed. Altogether the data collection lasted a year.

Value creation interviews were analyzed through coding. After the data was collected and reviewed, coding was implemented through five perspectives according to the research aim: search of process elements (such as wastes, process flows, turning points), roles and social structure, strategies and tactics, ways of thinking to understand the interviewees assumptions behind the statements, and elements of surroundings to understand the larger context (after Miles and Huberman 1994). Ten major themes were composed of the coding, and relationships and trends were found.

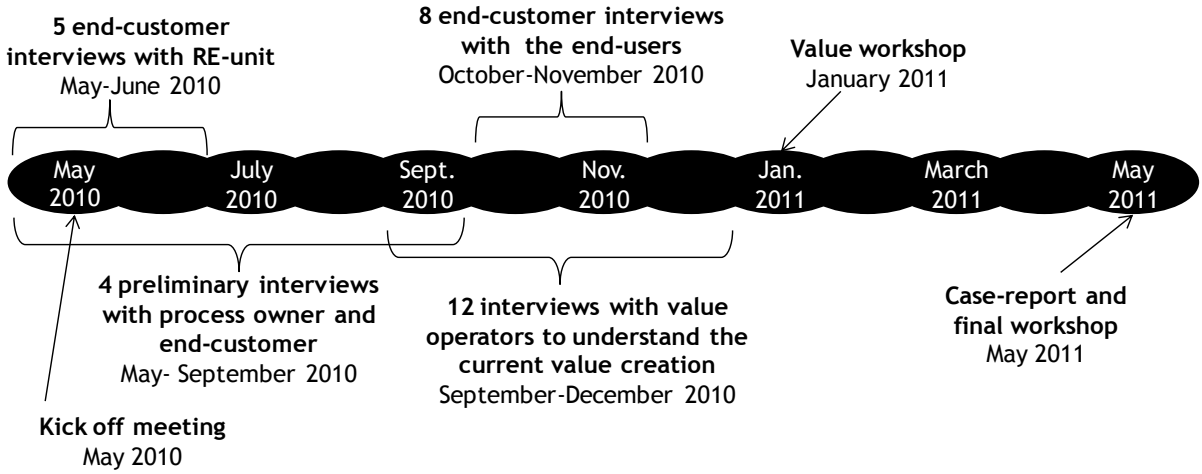

Figure 1: Timeline of the case

Results

Next the results of this study will be presented. First, the identified and verified value creation process is descried. Then the key discontinuations in the value creation are mirrored towards the concepts of production: transformation, flow, and value generation. After this, the discontinuations are reflected against the conclusions made in the value workshop. Finally, the ideas to develop the value creation are drawn.

Current value creation process model

The IM process, in which the value of SWM service is created and managed currently for the end-customer, can be divided into several sub-processes, which all consist of sub-sub-processes. Figure 2 illustrates a simplified version without detailed sub-sub-processes of the IM process.

In the value workshop the visualized model of the value creation in the IM process was supported with small supplements by the process owner. In general, an analogy between the value operator interviews and the workshop discussion was found. For example, a great concern in both data sets was the separate role of the workplace study:

it was noticed to be a study among other studies, and some of its value might have been wasted due to the flood of information. In addition to the similarities, there were some issues that divided the understanding between the value operator interviews and workshop discussion. For example, a deviation can be found in how the end-customer was seen. The value operators perceived the end-customer as a client that they serve, but in the value workshop, the end-customer was paralleled to a partner, whose possible expertise and knowledge should be used in the customer-ship. Another example of a deviation is related to information. According to the value operator interviews, information was merely used as an exchange. The information was given and received, but it was not used or stored systematically as a strategic management tool to influence the decision-making of the end-customer, as was suggested in the value workshop.

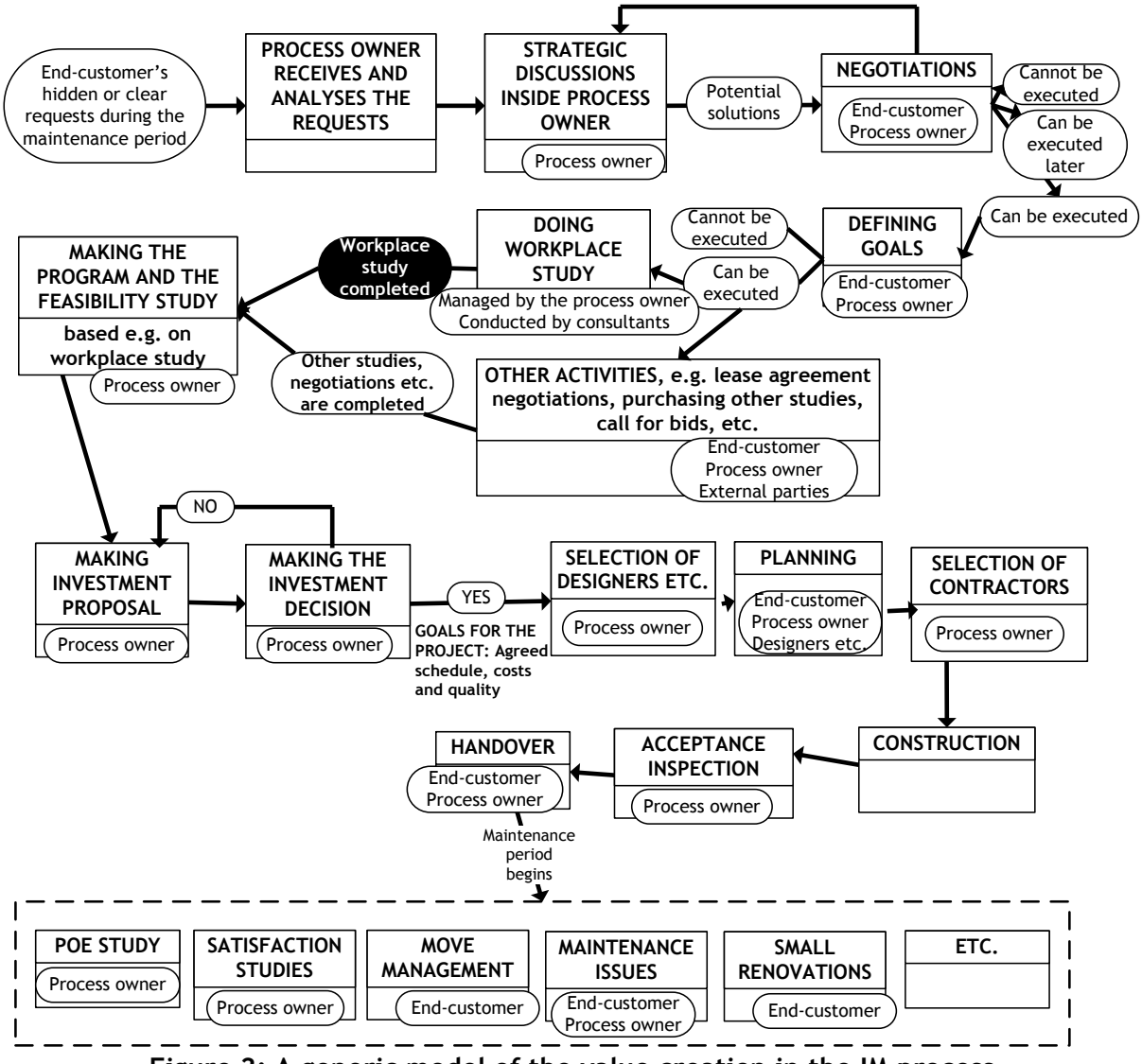

Figure 2: A generic model of the value creation in the IM process

Analyzing the value creation

Next, theoretical analysis of the discontinuations in the IM process is presented. After this, the workshop discussion is reflected against the identified discontinuations.

Theoretical analysis on the IM process

In the case, value management is especially taken care of in the beginning of the IM process on the strategic level: the process owner has invested on its interface to the end-customer especially on the strategic level. Through this interface, the communication has been made easy and information is delivered.

Even though the value losses in the case are eliminated at the beginning of the process, there is no mechanism that ensures that same kind of approach is applied in the other of the sub-processes. Therefore, the value management may be cut down to remind flow production or even transformation production. This is typical in construction and real estate processes. A large number of people, end-customer's changing needs, public procurement, etc., all mislead the value creation. Next, the main reasons that create discontinuations in the IM process in the case are discussed (Table 1).

Table 1: Discontinuations in the value creation in the case

Value creation…	What this means in the case?	Outcome
…is organized around people with tasks	▪ People optimize their own sub-processes. ▪ The responsible person changes 3-4 times while the process goes on. ▪ Separating strategic and operational levels e.g., separating decision-making from doing.	▪ The whole value creation is not optimized. ▪ Tacit knowledge is not transferred. ▪ The amount of sub-sub-processes increases and the process gets longed.
…approach is changed during the process	▪ First, the approach is to create value for the end-customer by work environment. At the end, the aim is to achieve the goals of the investment decisions (costs, schedule and quality).	▪ Planned issues are delivered. ▪ Planned issues ≠ end-customer's value
…is built through outsourcing	▪ Outsources sub-processes are managed by separate people. ▪ The importance of purchasing know-how increases.	▪ Instead of integrating the sub-processes, only the results are integrated.
…is handed over for the end-customer	▪ Process owner evaluates the use of work environment, but cannot impact on it. ▪ The work environment can be misused.	▪ The value of a work environment can decrease.

First, the IM process in the case is organized around people with tasks and, thus the person who is in charge in the value management changes approximately three to four times in the process. This creates a lack of information to eliminate the value losses. The more the tasks are separate, the more sub-sub-processes are generated. In addition, people with separate tasks lead to optimizing the sub-processes or sub-sub-processes, as in the transformation concept. Optimizing one part does not necessarily lead to a better outcome. For example, by optimizing the work of the workplace consultant and the actual planning as separate processes does not necessarily enhance the whole value creation process. Second, value generation approach at the beginning of the process is changed in the case because the goals, which are set in the investment decision, encourage

implementing the transformation and flow process approaches. The focus is on costs, schedule, and quality. According to the value operator interviews, if all the goals cannot be achieved, the quality is vulnerable to adjustments. Third, most of the sub-sub-processes are purchased through a bidding process. The integration of the purchased services as one service might be challenging in the current value creation process due to the separate responsibilities among the sub-sub-processes. This can lead to a situation in which only the results are integrated and some value might be lost. Fourth, during the maintenance period, the value management is handed over to the end-customer because the process owner has little power (if any) to affect how the premises are used. It is possible that in some cases the value of the work environment will deteriorate significantly because the work environment is not used by the tenant according to the original plans. For example, a small change that is not linked to the workplace study can have a negative impact on the whole working environment, employee satisfaction, and productivity as experienced by the employee. These four issues that cause discontinuations in the case usually do not emerge alone, and the problems will pile up and result in more waste.

Reflecting the workshop discussion against theoretical analysis

In general, the workshop discussion was in line with the theoretical conclusions, but as the comparison below demonstrates, the theoretical conclusions as such were not completely reached in the workshop. Table 2 summarizes the conclusions reached in the workshop. Four workshop conclusions can be strongly linked to the theoretical analysis and identified discontinuations, but the link of one workshop conclusions is not as strong as the others.

Table 2: Comparing workshop conclusions towards theoretical analysis

	Discontinuations based on the theoretical analysis	Workshop conclusions
Strong link	**Separate people with separate tasks**	▪ The variability of separate individuals and groups of people causes discontinuations and value losses. ▪ The co-operation between the strategic and operational levels inside the process owner could be more efficient.
	Changed goals in the value creation process	▪ The goals do not remain constant throughout the value creation process due to the separate people.
	The impact of outsourcing	▪ The competition legislation causes discontinuations in the IM process.
Weak link	**Handed-over value creation responsibility**	▪ The process owner should be more visible in the daily life of the end-customer after the hand-over.

In the workshop, separate people with separate tasks and related constant handovers were found to disturb the value creation process because the value management is on the responsibility of several individuals or groups of people. However, the idea to optimize the whole IM process was not attained in the workshop, but the improvement potential was focused on how the co-operation between the value creators could be organized to deliver more end-customer value through the SWM service. Also, the traditional organizational structure with separate management and operational levels is strongly held by the process

owner. Therefore, the traditional idea of separating decision-making units from action units has lasting prospects.

In the workshop, it was also concluded that the goals throughout the IM process do not remain constant. This discontinuation was indicated to be a result of the separate people with separate tasks. However, the detailed model of the IM process suggests that the goals are changed due to the mechanisms of the process, not solely by the separate people. Therefore, if the mechanisms in the IM process are not adjusted, the goals would still vary, although there would be only one value manager throughout the process.

Related to the outsourcing of value creation activities, the discussion in the workshop was strongly dominated by the legislation on competition. It was concluded that the legislation results in a lot of work without value in the process, and that it does not fit all situations. It was not concluded that the legislation does not actually generate the sub-sub-processes that are outsourced.

The handed-over value creation responsibility was partly discussed in the workshop, but no strong suggestions were presented. The discussion stressed the visibility of the process owner: after the service or product is delivered, the process owner should be more involved in the daily life of the end-customer. According to the discussion, the active value management of the SWM service by the process owner is not possible because it is the duty of the RE-unit of the end-customer.

Ideas for the future

To improve the IM process, future steps and ideas were developed and introduced for the IM process in the value workshop. Many of the ideas were related to the development of the service. First, it was suggested that the studied SWM service should be used continuously as a strategic planning tool throughout the IM process in the interface of the end-customer and inside the process owner. In the current IM process, the strategic role of the SWM service is not fully utilized. Second, a pioneering idea to minimize new construction was widely discussed in the workshop. Instead of generating the value of an SWM service through new construction, the best value for all stakeholders (including the environment) could be generated by using the existing building stock. The most sustainable building is the building that has not been built. Third, if the existing building stock is used, the SWM service should be extended to also cover the possible relocation process, either in terms of permanent relocation or temporary relocation during the renovation period.

The remaining two of the five ideas were related to the operational value creation level. First, a value manager's position was suggested to make the process flow, for example, by integrating the sub-sub-processes, by aligning the value creation process along with the end-customer value, and by maintaining the information. Similarly, external consultants and designers should be aligned with the IM process from the beginning to the end. Finally, workshop participants discussed insourcing some of the value creation activities (which nowadays support the activities of the employees of the process owner) as a way to minimize some of the sub-processes, to remove the potential duplications, and to standardize the tasks. However, insourcing was not discussed along outsourcing; it was connected to the combining tasks for one employee rather than having separate people for separate tasks.

Conclusions

The starting point in lean is to provide customer-defined value. From the end-customer perspective, the focus in value creation can be seen in a broader context than project management and delivery: more customer value can be achieved by viewing production as fulfilling end-customers' needs and expectations.

In this paper, the aim was to assess how the end-customer value is managed in a work environment construction project. The generic map of value creation of an SWM service through the IM process was visualized based on the interviews and other material and analyzed towards the concepts of production: transformation, flow, and value generation. Four discontinuations in the IM process were found: the way the value creation is organized, the changed value creation approach during the process, building the process through outsourcing, and handing over the value creation for the end-customer without control.

In the case, the process owner has already noticed that the work environment can create value for the end-customer and, thus the SWM service has been established. Of course there are external factors such as organizational changes that might be difficult to manage from the process owner's side, but in general, the SWM service has a huge potential to create value for the end-customer because the highest level of the service aims to eliminate value losses in the context of the work environment.

Because the value creation in the IM process faces a lot of discontinuations, value losses are evident. One of the major causes for this is the glued nature of the SWM service: it is not integrated into the main IM process but added on the process as a separate sub-process. Also, the process owner has noticed this and the motivation to tackle the challenge has begun to increase. Although the ideas discussed and developed in the value workshop are in line with the theoretical conclusions, they lack behind and, therefore most of the root causes may remain unsolved.

In order to avoid discontinuations and other waste types in the value creation process in the long-term, it was concluded that the process owner needs to especially focus on four issues, which in this paper are called the lean principles of case. First, the whole value creation should be managed instead of the sub-processes. Second, the whole value creation should be aligned with the end-customer value, not solely on project management and delivery. Third, the value creation process should be improved systematically on a daily basis and continuously from bottom to top, instead of waiting for rare eureka moments. Finally, the role of the SWM service should be shifted from a layout design to a strategic weapon of the company, for example, to prevent new construction. The ideas for future described in this paper would contribute to implementing the lean principles.

There is a clear need to further study the value creation processes in the built environment. Because only one case was studied in this paper, more studies should be conducted in a similar frame, but within different context, for example by changing the target value creation process and service.

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References

Alves, Thais da CL & Tsao, Cynthia CY (2007) "Lean Construction – 2000 to 2006". *Lean Construction Journal*, 3(1), pp46-70.

Appel-Meulenbroek, Rianne & Feijts, Ben (2007) "CRE effects on organizational performance: measurement tools for management". *Journal of Corporate Real Estate*, 9(4), pp218-238.

Bae, Jin-Woo & Kim Yong-Woo (2007) "Sustainable Value on Construction Project and Application of Lean Construction Methods". *Proceedings of the 15th Annual Congress, International Group for Lean Construction*, Michigan, USA, July 2007, pp312-321. Also available at www.iglc.net (20 July 11)

Ballard, Glenn & Koskela, Lauri & Howell, Gregory & Zabell, Todd (2001) "Production system design in construction". *Proceedings of the 9th Annual Congress, International Group for Lean Construction, Singapore, Singapore, July 2001, pp1-15.* Also available at www.iglc.net (20 July 11)

Bell, Michael A & Joroff, Michael L (2001) *In The Agile Workplace: Supporting People and Their Work*; Gartner and Massachusetts Institute of Technology; Boston, USA

Bertelsel, Sven & Koskela, Lauri. (2002) "Managing the Three Aspects of Production in Construction". *Proceedings of the 10th Annual Congress, International Group for Lean Construction, Cramado, Brazil, July 2002, pp.*1-10. Also available at www.iglc.net (20 July 11)

Emmit, Stephen & Sander, Dag & Christoffersen, Anders K (2005) "The Value Universe: Defining a Value Based Approach to Lean Construction". *Proceedings of the 13th Annual Congress, International Group for Lean Construction, Sydney, Australia, July 2005, pp.*57-64. Also available at www.iglc.net (20 July 11)

Erikshammar, Jarkko & Björnfot, Anders & Gardelli, Viktor (2010) "The Ambiguity of Value". *Proceedings of the 18th Annual Congress, International Group for Lean Construction, Haifa,Israel, July 2010, pp.*42-51. Also available at www.iglc.net (20 July 11)

Huovila, Pekka & Koskela, Lauri (1998) "Contribution of the Principles of Lean Construction to Meet the Challenges of Sustainable Development". *Proceedings of the 6th Annual Congress, International Group for Lean Construction,* Guarujá, Brazil*, July 1998.* Also available at www.iglc.net (20 July 11)

Joroff, Michael L. (2002) "Workplace mind shifts". *Journal of Corporate Real Estate*, 4(3), pp266-274.

Joroff, Michael L & Porter, William L & Feinberg, Barbara & Kukla, Chuch (2003) "The agile workplace". *Journal of Corporate Real Estate*, 5(4), pp293-311.

Khalifa, Azaddin S (2004) "Customer value: a review of recent literature and an integrative configuration." *Management Decision*, 42(5), pp645-666.

Koskela, Lauri (2000) *An exploration towards a production theory and its application to construction*; Doc. Diss.; Technical Research Centre of Finland, VTT Publications 408; Espoo, Finland

Koskela, Lauri & Rooke, John & Bertelsen, Sven & Henrich, Guilherme (2007) "The TFV Theory of Production: New Developments". *Proceedings of the 15th Annual Congress, International Group for Lean Construction, Michigan, USA, July 2007, pp.*2-12. Also available at www.iglc.net (20 July 11)

Krumm, Peter J & Dewulf, Geert & de Jonge, Hans (1998) "Managing key resources and capabilities: pinpointing the added value of corporate real estate management". *Facilities*, 16(12/13), pp372-379.

Krumm, Peter J & de Vries, Jackie (2003) "Value creation through the management of corporate real estate". *Journal of Property Investment & Finance*, 21(1), pp61-72.

Liker, Jeffrey K (2004) *The Toyota way – 14 management principles from the world's greatest manufacturer*; McGraw-Hill Professional; New York, USA

Lindholm, Anna-Liisa (2008) *Identifying and Measuring the Success of Corporate Real Estate Management*; Doc. Diss.; Helsinki University of Technology; Espoo Finland. Also available at http://lib.tkk.fi/Diss/2008/isbn9789512293605/isbn9789512293605.pdf (20 July 2011)

Löfgren, Martin & Witell, Lars (2008) "Two Decades of Using Kano's Theory of Attractive quality: A Literature Review" *The Quality Management Journal*, 15(1), pp59-75.

Miles, Matthew B & Huberman, A Michael (1994) *Qualitative Data Analysis - An Expanded Sourcebook*; 2nd edition; SAGA Publications; Thousand Oaks, USA

Morgan, James M & Liker, Jeffrey K (2006) *The Toyota product development system: integrating people, process, and technology*; Productivity Press; New York, USA

Nenonen, Suvi (2005) *The Nature of the Workplace for Knowledge Creation*; Doc. Diss.; Helsinki University of Technology; Turku Polytechnic, Research reports 19; Turku, Finland

Schriefer, Audrey E (2005) "Workplace strategy: What it is and why you should care". *Journal of Corporate Real Estate*, 7(3), pp222-233.

Salvatierra-Garrido, Jose & Pasquire,Christine & Thorpe, Tony (2009) "Value in Construction from Lean Thinking Perspective: Current State and Future Development". *Proceedings of the 17th Annual Congress, International Group for Lean Construction, Lima, Peru, July 2009, pp*.281-294. A Also available at www.iglc.net (20 July 11)

Yin, Robert K (2003) *Case study research: Design and methods*; 3rd edition: SAGE Publications, Applied Social Research Methods Series, Vol. 5; Thousand Oaks, USA

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Lean Construction Education: basic management functions workshop

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Abstract

Research Question/Hypothesis:
Purpose: to show that a five-day Basic Management Functions Workshop (BMFW) based on a Toyota teaching method and designed to train young Engineers in seven basic skills is both very effective and highly significant.
Research Method: description and evaluation of the development and deployment of BMFW within the host company and with supply chain members.
Findings: the BMFW builds participant abilities in production management, a predictive capacity while carrying out tasks, a balance of workload, the identification of constraints and productivity and other production management skills significantly faster than previous methods.
Limitations: The study looks at the application of the ideas in one company
Implications: further work to test application in other contexts.
Value for practitioners: ideas for developing and running effective training programs
Keywords: Lean, education, basic functions, Socratic method, feedback.
Paper type: Case Study

Introduction

Principles nine and ten of Toyota's working methods are: grow leaders who thoroughly understand the work, live the philosophy, and teach it to others; develop exceptional people and teams who follow your company's philosophy. (Liker and Meier 2006). These refer to the growth of leaders and how they align themselves with the work philosophy of the company. It is also important that leaders are keen to work in a team and commit themselves to convey and share their acquired knowledge with all the members of the organization. Attitude and a willingness to learn are even more important than the previously acquired knowledge of new workers.

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The Basic Management Functions Workshop (BMFW) uses the Socratic method, through which the participant is prompted, by his/her tutor to provide answers to questions arising from his/her own analysis and to use feedback as the main teaching tools, always bearing in mind that the hands-on approach is the best way to learn.

Thus, a real case was prepared meeting the necessary requirements to tackle each of the core ideas inherent in the management system. The driving ideas are the company's principles, allowing a better understanding of each of the processes within the management of a project. At the same time, the basic functions related to Lean Construction are developed in each of the stages of the workshop.

The results obtained from the three workshops carried out so far have been very encouraging.

Development

Every Project has different areas of support contributing to production. In conjunction, these areas guarantee the best possible outcome for a project, both for the client and the company. It is key to constantly maintain the client-partner relationship, an essential principle of the Lean philosophy.

During the BMFW, the aim was to raise awareness among participants of the direct relationship between production, the different support areas and the client. The BMFW is a management workshop, and as such, all basics taught can be used in any area or specialization.

Essentially, a Basic Function, rather than a work principle or methodology, is a way of reasoning, a style of thinking present in each and every member of a work team, helping them to focus always on the same objective.

The BMFW focuses on the identification and development of basic functions by participants, in such a way that, after the workshop, they can apply the basic functions to their everyday life, thus increasing productivity and efficiency at work, regardless of their field of endeavour.

Description of the seven basic management functions

As mentioned above, the objective is to demonstrate to participants that the basic functions represent the reasoning process, which will allow each to attain his or her optimal working performance. The seven basic functions, described below, are developed and/or consolidated in the BMFW. They are summary of the core functions that engineers implement while developing a project and, consequently, during their daily lives.

Identification of Targets

The development of this function aims to focus on the attainment of an objective, without wasting resources or effort on irrelevant issues.

A clear example would be the teamwork in a project, since each member pursues the same goal, which is to complete the project before the deadline, thus guaranteeing the profit of the project and the total satisfaction of the client. Bearing this in mind, every area uses only the information it considers necessary in order for the full scope to be

achieved and the work correctly orientated, focusing on specific issues that will allow optimal planned results to be obtained.

Balancing of Resources

This basic function properly allocates the workload among the resources used, always ensuring the resources are available. Using Last Planner, a production engineer can schedule and balance resources more efficiently and with clearer criteria.

As part of the programming process, production engineers estimate team size according to needs in the field. The estimate is done through a repetitive process, through which the programmer analyzes different alternatives until the optimal and most efficient is found. This process is simulated in the BMFW through the programming of activities related to the project, taking into account several coherent considerations and restrictions.

Calculation and Analysis of Gaps

This allows quantification and comparison of a given result versus a foreseen scenario, in order to understand the cause of the deviations and take timely corrective action. Under real conditions and in order to have a better understanding of the project status, gap analysis is performed comparing the actual results with those foreseen. However, the Project Directors and Managers need something more than positive or negative data (profit or loss). For this reason, each gap, no matter whether positive or negative, is analyzed. If some entries are found to have extremely negative gaps, it is then necessary to optimize to the fullest resource allocation in these entries in order to minimize losses. If, on the other hand, there are positive gaps, understanding the cause will allow us to further optimize those activities, and so increase the benefit by adopting the same work procedures and/or methodologies on other fronts or in other sectors.

Sequence Analysis

This aims to discover the optimal design of a production system, taking into account the relationships, real conditions and technical factors of the processes which compromise it. It shows how important a detailed analysis of the construction process is, in order to carry out more realistic and reliable planning.

Constraint Analysis

This allows identification of any impediment to the achievement of goals at a given moment. The purpose of this function is solely to detect each and every inherent constraint in the construction process.

Every production engineer knows that in order to execute planned activities, he must have the necessary resources and information at his disposal. He is therefore constantly analyzing constraints for the development of the construction process and guiding them towards the support areas. A proper constraint analysis allows the support areas to redress said restrictions on time and so maintain an ongoing production flow.

Monitoring of Constraints

The aim of this function is to ensure restrictions are redressed on the basis of a commitment to restriction analysis. Once the restrictions are established, it is important

to understand that their monitoring is a key basic function, which allows activities to continue.

Calculation of Ratios and Yields

This function is aimed at calculating the resources and speed of progress necessary to execute the activities efficiently. Through the development and consolidation of the calculation of ratios and yields, the participant can estimate resources required for any activity within the scope of the project, as well as estimate real deadlines within which to perform such activities.

It represents one of the basic functions most widely used in the fulfillment of the project since, while the project goes ahead, the ratios obtained in each activity are simultaneously calculated and compared with the planned ratios similarly, the project will establish the speed obtained in the construction process and will allow corrective actions to be taken or the maintenance and optimization of results obtained. This calculation can be used to project the results and obtain the project balance, bearing in mind the real requirements of the work, and thus obtaining a more reliable projection.

Optimum performance is attained by using and mastering all the basic functions mentioned above, either independently or jointly. This in turn contributes to the building of management capacities in the participants.

BMFW design

In his didactic work Tomaschewski (1966) clearly states and develops the teaching - learning process sorting rules, which conform a general rule for developing the educational process whether in school, factory or workshop. This rule attempts to focus on the formal aspect of the procedure rather than the relation circumstance, since the latter is not explicitly treated for the differential case of the adult; hence, it is understood as implicit within the general rule.

On the other hand, Freire (1978) presents an innovative paradigm with respect to the sorting of a teaching process for adults. However, his position converges with Tomaschewski in the sense that the rule generalization prevails over the teaching theory in adults.

Taking into account all of the above, the BMFW was designed following the teaching paths for adults, concentrating in following seven key points4 with respect to the way adults learn:

Adults should wake up a desire to learn, they resist when somebody simply tells them what to do. Therefore, the BMFW teaches and reinforces topics that motivate the participants, as those related to project management.

Adults learn only what they think they should know, are practical, want to know “how can that information or course will help me in this moment?” This being a workshop where activities related to their day-to-day are proposed, they feel they should make the most from this experience.

Adults learn when they do things, this was the main reason for creating the workshop as it is. It was decided that having its participants put into practice the theoretical

[4] Alan W. Moore (1993), “Mejorando nuestra habilidad para capacitar”, Washington

concepts and clear out every question as they appeared throughout the course of each stage was the best path to take.

The learning function for adults centers around problems, and problems need to be realistic, the workshop considered this premise as a starting point and centered around the development of a real construction project, where a series of considerations should be taken into account for the development of its various stages.

Adults learn better in an informal environment¸ dynamic group activities contribute to a good learning. Consequently, each stage is carried out in teams of four, presenting a friendly, informal environment that turns out being beneficial for the better understanding.

A variety of methods should be used to instruct adults, in this case the Socratic method (as explained later on) was chosen with positive results.

Adults want alignment and guidance, not notes or rigid marks, they are impatient with education formalism; yet require knowing how they are doing in the workshop, reason for the tutors to offer as much feedback as possible during each stage.

Finally, based on theories and experiences of researches, it was concluded that the most efficient way of developing the workshop would be the one where participants would put into practice everything learnt: participating actively by doing, rather than passively by "hearing" and "watching".

Table 1: Percent retention of the participant according to the activity learning level.

The person assimilates:	
▪ From what he reads	10%
▪ From what he listens	20%
▪ From what he sees	30%
▪ From what he sees and listens	50%
▪ From what he sees, listens and does	80%

Methodology of the basic management functions workshop

Development of a Real Project

The BMFW is based on a real construction project that covers a series of discussions, variations and limitations, allowing it to gain a level of complexity and difficulty normally present in a project.

It is important to mention that, although participants in the workshop will have already acquired knowledge and aptitudes due to past experience in different projects and/or jobs, this is not a restriction. On the contrary, it helps reinforce what has been learnt before while taking on board new concepts.

Key Issues of the BMFW

The workshop is based on four main features. The first is the often-mentioned basic function, the second is the fact that the BMFW is based on the Lean philosophy, the third

is the use of management tools used in the projects and the last (though not the least important) is the teaching methodology used.

As Figure 1 shows, those attending the workshop already possess a certain level of knowledge, and it is during the workshop that they gain a wide-ranging apprenticeship in the use of basic functions, management tools and Lean philosophy, all taught, within the framework of the BMFW, using the methodology that will be explained below. Finally, at the end of the workshop, the participant will have acquired the ideal knowledge, attitudes and culture to perform their duties under Lean philosophy. This statement is supported by the commentaries and results of surveys performed on its participants months after their participation.

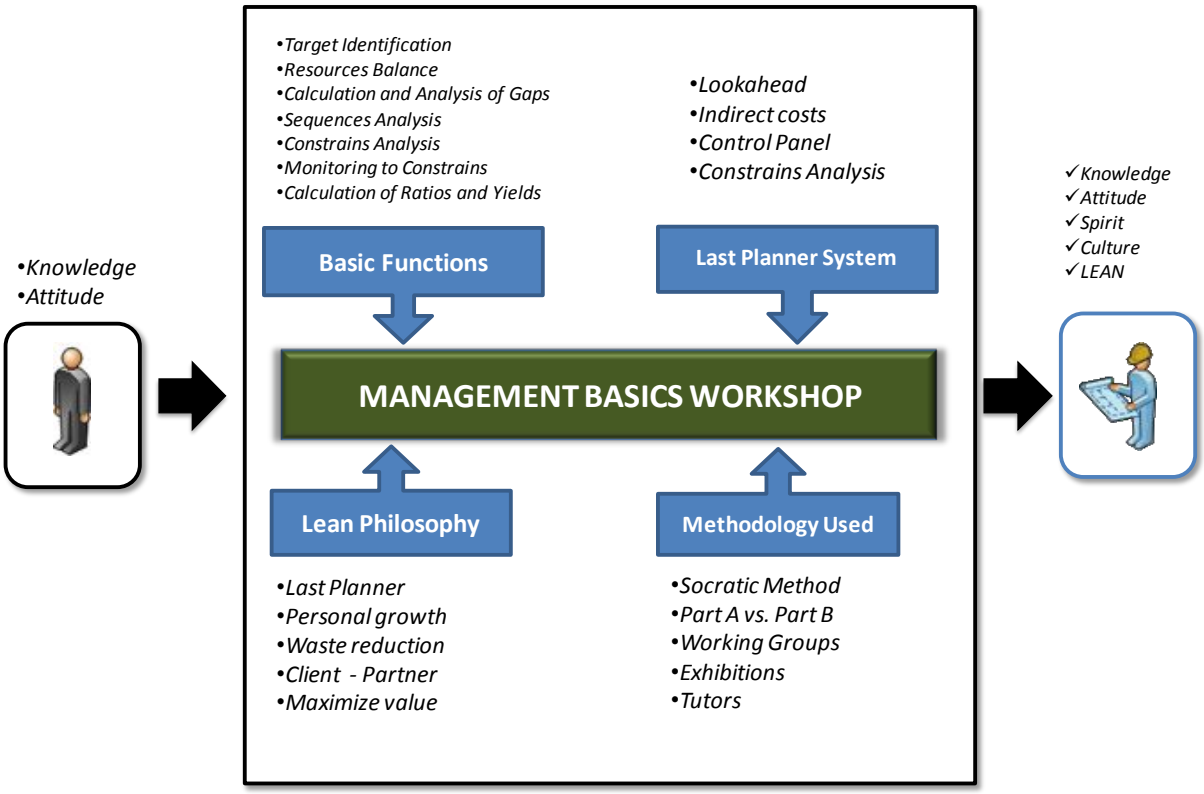

Figure 1: BMFW components

Structure of the management basics workshop

The workshop is split into five days or stages; each focused on a specific management and/or control-related theme which is complemented by the others. However, by performing each stage individually, concepts are better understood and consolidated because something new is learned each day, reinforcing what was previously assimilated thanks to the thematic developed. Table 2 shows the breakdown of the BMFW stages and the basic functions developed in each.

The order of the stages helps teach concepts steadily, starting with familiarization with the basic documents of any project, such as contracts, budget, drawings, statements of work, among others. Then, the management process begins and ends with the implementation of project monitoring controls, such as monitoring of progress and cost

control. This logically ordered structure helps all participants discover and strengthen their management capabilities, while also providing better understanding within the company.

Table 2: Relationship between each BMFW stage and basic management functions.

Day/stage	Basic Management Functions
1: Reading of drawings and Cost Estimates	Target identification Sequence analysis Calculation and analysis of gaps
2: Calculation of ratios, gaps and yields	Target identification Calculation of ratios and yields
3: Programming and Resource Balance	Target identification Sequence analysis Resource balance
4: Restriction Analysis and Contract Management	Target identification Sequence analysis Constraints analysis Monitoring constraints
Stage 5: Progress and Cost Monitoring	Target identification Calculation and analysis of gaps

Development of methodology

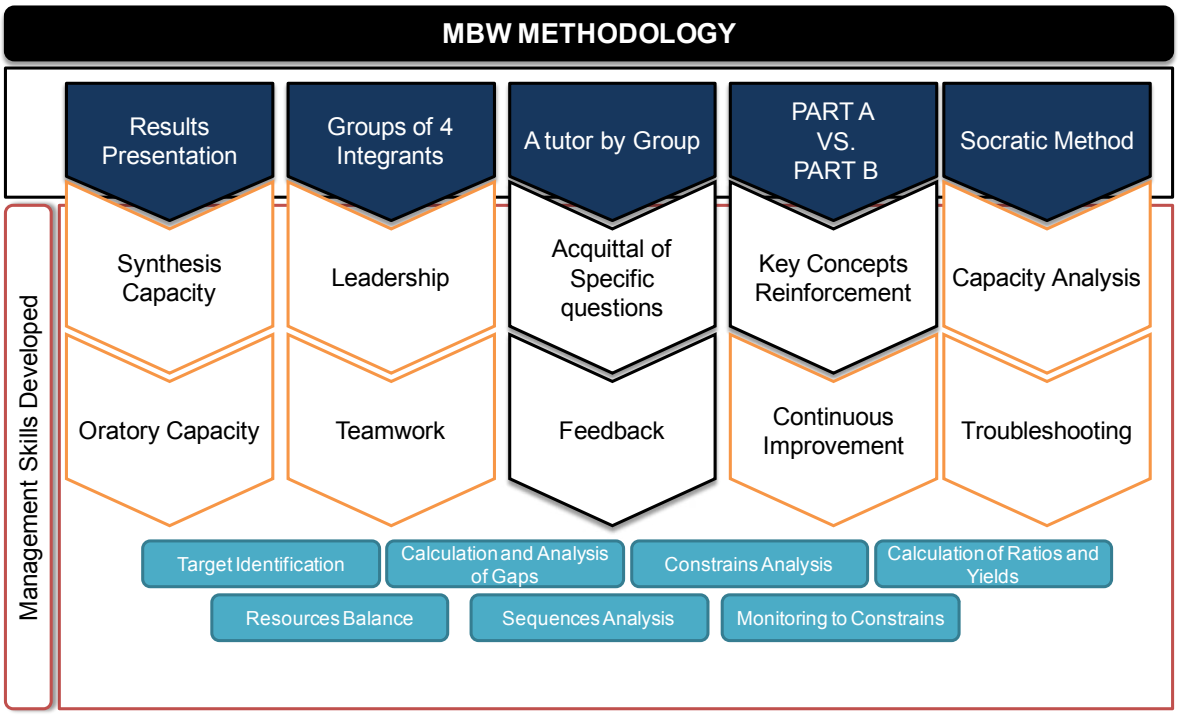

Figure 2: BMFW methodology

Figure 2 shows the methodology used in the BMFW, as well as capacities built up during its development, in order to consolidate the basic functions.

Management capacities to be developed during the BMFW focus on factors of social change within and outside projects. The workshop does not expect to turn participants into experts in the use of certain tools. Instead, the workshop plans to instill Lean principles, which will be used both in peoples' professional and personal life.

Groups within the workshop are monitored at all times and receive feedback from a tutor, who answers any question the group may have and provides feedback to point out mistakes made by the participants, while applying what they have learnt.

The use of four-member groups is relevant, since it contributes to better use of the interpersonal skills, such as leadership, communication and teamwork.

Each stage has two parts, A and B that strengthen the key concepts and expedite the ongoing improvement process. This is reflected throughout each part.

The presentation of the results obtained by each of the groups helps improve the knowledge acquired. Each member must be as concise as possible and present what he/she has learnt in the best way he/she can. Finally, by using the Socratic method, participants are prompted by their tutors to find out for themselves the answers to their queries. In doing so, a thorough analysis of the Model case is possible and participants can suggest different alternative solutions to the problems encountered, with the most suitable option being chosen.

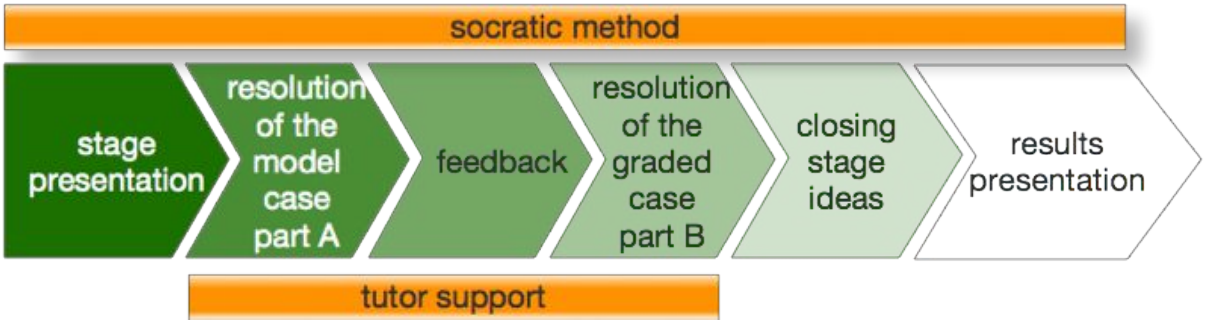

Figure 3: Development of the BMFW Stages

Stage Presentation

At the beginning of the workshop, the basic concepts are explained to ensure the participant's familiarity with the topics. The basic functions to be applied are also explained, to guarantee the understanding of the driving ideas. The presentation is totally interactive, using the Socratic method to build on the necessary concepts and then inviting everybody.

Resolution of the First Exercise (Part A)

Once this stage is presented to participants, the rules are explained so that the case can be tackled. Some requirements are explained and any questions posed are answered so that the activity is carried out in a clear and pedagogical way. The main objective of the model case is to allow participants at the BMFW to get to know the concepts, tools and working procedures required to develop this stage.

Feedback

The instructor analyzes the answers and asks about the considerations taken into account to obtain a certain result. Later on, the instructor explains what went wrong and

what could be improved in order to move on Part B. At this point, interaction between the instructor and participants is very important, as it raises the level of mutual understanding.

Resolution of the Graded Exercise (Part B)

When all doubts regarding the case study are explained, some additional circumstances are added to increase complexity.

By so doing, the driving ideas are consolidated, as well as the concepts of the basic functions used in the model case. However, it is important to get close to the right answer and/or result since, unlike the model case, this will be graded.

Closing Stage Ideas

Once the final feedback has been completed, the concept of the basic functions is reinforced once again, this time asking the participants to provide examples of when and how they have used the basic functions. Moreover, any query that arises during the session and that has not been explained in the previous stages is explained, thus contributing to enhance even further the quality of the workshop.

Results Presentation

Each group presents the results and the methodology used in front of the other participants. The goal of this stage is to analyze the ability of each participant to synthesize and present facts. On the other hand, it focuses on individuals showing their leadership skills, communication skills, teamwork and problem solving abilities. Instructors then challenge the group with concept-related questions (related to the results already explained), or asking for explanations on how to apply what they have learnt in a real project.

Previous experiences

The BMFW workshop has been carried out three times, attendances being 36, 60 and 64 successively. It was concluded that 60 was the optimal number of participants.

Once the workshop has taken place, all instructors meet to analyze the strengths and weaknesses of the workshop, and corrective measures are taken to improve forthcoming editions of the workshop, thus aiming for constant improvement.

Additionally, in special cases, BMFWs have been organized for small groups of workers as requested by the corresponding Management areas. This demonstrates its effectiveness and satisfaction by those who have participated in it and by their immediate superiors.

Each previous workshop has shown the potential of this teaching method to train and develop the personalities of both employees and teachers.

Results

When the managers of those employees who participated in the BMFW were interviewed afterwards, it was clear that, according to their observations, the efficiency levels achieved by the workshop were very positive. *“After attending the Workshop on*

Basic Functions, both the junior engineers and senior engineers were speaking the same language within the project", confirmed Diana Abarca, Construction Manager of the National Theatre Project. She was referring to those engineers that had recently joined the company, since they all attained high levels of understanding regarding management issues related to the company, and used the basic functions to carry out their daily activities.

All showed a high level of understanding regarding management issues and stated that part of the success was due to the teaching methodology used (Socratic method + Instructor guidance + Feedback). Through this, a faster and more efficient alignment of new staff with the management system was achieved.

"The BMFW was more useful than my Graduate School studies. This is a very successful teaching methodology. I have never experienced anything like this", said one Production Engineer, after he had participated in the workshop.

By the end of the BMFW, participants are asked to assess themselves, comparing what they previously knew to what they ended up knowing on management related issues after taking the workshop. Even though this is a predominantly subjective indicator, it is essential for identifying the participant's personal perception of the BMFW as a whole, a key component for a workshop that besides imparting knowledge focuses on forming persons and transforming their attitude. So far, the results have been very encouraging, reaffirming comments like the one above and evidencing their willingness to adopt Lean philosophy into their rationale. Participants report that their management knowledge on issues tackled at the workshop increase by more than 130%, more than doubling their knowledge on management concepts, but most important of all, evidencing a positive impact on their attitude; thus, confirming the workshop's success.

With regards to the Socratic method, between 70% and 80% of participants evaluated it as superior and the rest slightly superior to the traditional method of teaching.

Although these results show the perception of participants in relation to their own skills, it is an indicator of the approval level of the BMFW and the impact it has had on the people involved in it. Each of the participants, after self-assessing their knowledge, acknowledges the importance of participating in the workshop and the amount learnt having attended the workshop.

Results from surveys on participants, months after taking the workshop show that they all understood significantly the management concepts applied by the company, and they acknowledge large part of the success to the teaching methodology used.

Additionally, more than 80% of those surveyed stated that the BMFW allowed for a better understanding of the management concepts, and only a small percent said that this understanding was partially covered.

At the outset, the BMFW was aimed specifically at young and new engineers. However, this workshop works for both junior and senior engineers who are unaware of Lean philosophy.

Table 3: Effectiveness evaluation of each method used in the workshop

Effectiveness of Method	Percentage
Feedback	80%
Socratic Method	73%
Case Study	76%
Part A vs. Part B	78%
Presentations and expositions	77%

An external workshop for senior engineers outside the company has been recently taught, yielding results that support the findings of the internal workshop. The results of the percentage of the twelve tutors surveyed who managed to increase their knowledge on each of the following management concepts after teaching the BMFW is shown below.

Table 4: Reinforcement of tutees' management concepts after teaching the BMFW

Management Concepts	Percentage of the 12 tutors who increased their knowledge
Advance Control	77%
Cost Control	85%
Planning and Programming	62%
Constraint Analysis	54%
Calculation and analysis of gaps	62%
Contractual Management	62%
Calculation of ratios and yields	54%

Asked if they thought it would be useful to introduce the workshop's teaching methodology in universities and/or grad schools, all twelve answered *"yes."*

Conclusions

Through qualitative analysis authors can conclude that the alignment time with the management system based on Lean principles, company values and organizational culture was drastically reduced with the BMFW. Thus, it was found that the best way to transmit on the Lean Construction philosophy to people was by means of developing real case studies, where basic management functions were applied.

Additionally, the BMFW allowed its participants to build up management capacities: the ability to work in teams, lead, present facts and findings, and synthesize and communicate results.

Furthermore, the BMFW has become a selection filter for future management talents, since each time the workshop takes place it grades both the objective and subjective standpoints. Consequently, it is possible to assess the management capacities of each participant.

Taking into account the methodology used and the impact obtained, this teaching model has woken up the interest of different academic entities emerging as the first step to initiate conversations for including its topics in Civil Engineering under graduate and/or graduate syllabi. This demonstrates that the workshop goes beyond staff alignment, sharing knowledge that can be easily applied in the professional field. Its design allows for continuous update, and the ongoing improvement can be applied to the model case, whose complexity increases as the need arises, bearing in mind implementation and understanding of the seven management basic functions.

Lastly, the workshop provides a wider vision for each of the employees regarding the objectives of each of the activities they perform. One of the participants at the last BMFW stated the following: *"Thank you for waking me up. I now understand perfectly well each of the processes carried out in my project"*, which clearly shows his gratitude and personal satisfaction for all he had learnt at the workshop.

References

Tomaschewski Karlehin (1966) "Didáctica General", Grijalbo, México.
Paulo Freire (1978), "Una pedagogía para el adulto", Zero, Bilbao, pp. 39 – 48.
Alan W. Moore (1993), "Mejorando nuestra habilidad para capacitar", National Park Service, Washington.
Rogers R. Carl (1978) "Libertad y Creatividad en la Educación", Paidós, Buenos Aires.
Jeffrey K. Liker and David Meier (2006) "The Toyota Way Fieldbook", The McGraw-Hill Companies, New York, 11-247.
Jeffrey K. Liker (2004) "The Toyota Way", The McGraw-Hill Companies, New York, 180-198.
Control de Gestión de Proyectos – GyM S.A. (2008) "Manual de Gestión de Proyectos".
Virgilio Ghio Castillo (2004) "Productividad en obras de construcción. Diagnóstico, crítica y propuesta", Fondo Editorial de la PUCP, Lima, 196 pp.