'FIND-THINK-WRITE-PUBLISH' – LEAN THINKING IN SCIENTIFIC PAPER WRITING

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ABSTRACT

Construction research supports long-term development of the construction industry and the society. Thus it is important to evaluate research against existing knowledge and to constantly develop new knowledge. The main mechanism for doing so is publishing scientific papers. In Sweden, praxis has developed that a Ph.D. consists of a handful of scientific papers. The average time period for a Ph.D. is five years after which the funding situation changes drastically.

Previously, the duration of Ph.D. studies at Luleå University of Technology, Sweden often exceeded the planned five years, disrupting the flow of Ph.D. examinations. To increase awareness and interest in paper writing, a method was sought to visualise and manage the writing process. This paper investigates how an Oobeya room can be implemented in construction research to support paper writing.

Experiences of working with the Oobeya room in three separate research divisions prove that it is possible and fruitful to better manage knowledge in academic institutions. Even though research is creative, it can be properly managed without hampering scientific freedom. Evidence from managing scientific paper writing using the Oobeya room shows that proper management of research will actually create better research that is more publishable with shorter lead times!

KEYWORDS

Big room (Oobeya), Knowledge organizations, Construction research, Higher education, Visual management

INTRODUCTION

To apply Lean requires a Lean culture. In some organizations it is required that the majority of the personnel accepts the rethinking brought by Lean, while in others it is merely required that key personnel has a 'change of heart'. In this regard, many studies report on Lean work within production facilities, for example, 5S (Höök and Stehn 2008) and standard work (Bhasin and Burcher 2006), and in site-based construction, e.g., production planning (Simonsson et al 2012) and site-based flow management (Hamzeh et al. 2012). However, studies on successful implementation and application of Lean in knowledge organizations are scarcer.

A knowledge organization is an organizational structure that provides practical implementation of knowledge management, or knowledge governance (Foss et al. 2010). Even police enforcement can be considered a kind of knowledge organization

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(Gottschalk, et al. 2010). Knowledge thus encompasses a mix of framed experience, values, contextual information, and expert insight, providing a framework for evaluating and incorporating new experiences and information (Baskerville and Dulipovici 2006). In the context of construction there are plenty of organizations that can be defined as knowledge organizations, ranging from design departments in construction firms, to construction consultants and even academic institutions.

Construction research in academic institutions is a typical example of a knowledge organization in construction as it supports the long-term development of the construction industry. The role of an academic institution is to create knowledge of long-lasting value to support the evolvement of society. Therefore, it is important to evaluate research results against existing knowledge and to constantly develop and describe new knowledge. The main mechanism for doing so is publishing scientific papers, which are peer-reviewed to bring the current state-of-the-art forward.

In Sweden, a Ph.D. dissertation consists of a handful of scientific papers compiled and cross-analysed in a thesis. The time period for a Ph.D. is five years, including a year of institutional duties. After five years the funding situation drastically changes as the normal duration of funding is five years. Thus, it becomes important to have scientific papers written and published in a timely manner. Some years ago, the duration of the Ph.D. studies at the Timber Structures research group at Luleå University of Technology, Sweden often exceeded the planned five years resulting in a disruption of the flow of Ph.D. examinations and a general feeling of “fire-fighting”.

As the research group had a long tradition of working with Lean in construction research projects (e.g., Björnfot and Jongeling 2007; Höök and Stehn 2008) it was a natural thought to transfer this experience to the situation in the research group. To increase awareness and interest in scientific paper writing, a method to visualise the paper writing process was sought, intended also to serve as a template and guide for writing a paper. It was decided to test an Oobeya (Horikiri et al. 2009), a control room originally intended for product development. In an Oobeya, the most important processes are visualised along with the time plan and major project targets.

Applying Lean to paper writing aims to improve the flow of publications, i.e. to improve the quality of produced papers and to improve the robustness of the paper writing ‘production system’. Thus improving the flow of paper writing would need that one first regards the publication process as a production system. This paper investigates how Lean, expressed by an Oobeya room, can be implemented in an academic research group producing scientific publications. We relate for experiences of working with Oobeya in paper writing at three separate research divisions.

SCIENTIFIC PAPER WRITING AS A PRODUCTION SYSTEM

To improve the flow of paper writing it is crucial to define the paper writing process in terms of a production system, where different actors in a chain supply knowledge and information necessary for the completion of a paper. Consequently, it becomes necessary to define the “supply chain of paper writing”. An accepted framework to describe a supply chain is the Supply-Chain Operations Reference (SCOR) model that is an accepted diagnostic tool for supply chain management (Bolstorff and Rosenbaum 2007). The tool identifies the unique processes a supply chain requires to support the objective of fulfilling customer orders. In the SCOR framework there are three main interdependent levels (Figure 1); scope, structure, and process network.

CHARACTERIZING THE PAPER WRITING PROCESS

In accordance with the SCOR framework, the scope (Level 1) of the paper writing production system is to increase knowledge and to deliver state-of-the-art knowledge to the community (Figure 1). Knowledge in the form of research papers represents products produced in the paper writing production system. As the content and quality of created knowledge vary, as well as the ability of organisations to utilise it, the challenge for an organization is to create, administer (store/retrieve), disseminate (transfer) and utilize (apply) knowledge (Alavi and Leidner 2001; Kasvi et al. 2003).

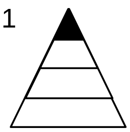
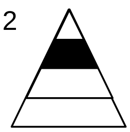
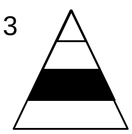
LEVEL	DESCRIPTION	APPLICATION TO ACADEMIC RESEARCH
1 	<u>**TOP LEVEL**</u> PROCESS TYPES	<u>DELIVER SCIENTIFIC PAPERS</u> CREATE, ADMINISTER, DISSEMINATE, AND UTILIZE KNOWLEDGE
2 	<u>**CONFIGURATION LEVEL**</u> PROCESS CATEGORIES	<u>ENGINEER TO ORDER</u> DELIVER STATE-OF-THE-ART KNOWLEDGE USING A PRE-DEFINED CONCEPT (PAPERS)
3 	<u>**PROCESS ELEMENT LEVEL**</u> DECOMPOSE PROCESSES	<u>DEFINE PAPER WRITING SEQUENCE</u> THE MAIN RESOURCE IN PAPER PRODUCTION IS THE RESEARCHER

Figure 1: The SCOR model used to define an academic research group as a production system. Figure inspired by Lockamy III and McCormack (2004).

The second level of the SCOR model (Figure 1) concerns the configuration of the supply chain, i.e. defining the point of customer order (Gosling and Naim 2009). As academic research delivers state-of-the-art knowledge it can be defined as an engineer-to-order system, that is suitable for highly specialized, often unique products (Tolone 2000). Paper writing as an engineer-to-order system implies that the concept is already set (a scientific paper) but the contents are not defined as they cannot be predicted before the research has actually been conducted.

The customer (see e.g., El-Sayed et. al 2005), or customer value (see e.g., Erikshammar et. al. 2010), of scientific work calls for elaboration. The scientific society is of course the end user of the results, but there are also other stakeholders. The customer could be the professor in the research group who sets the goals for paper publication, or it could be individual researcher who wants to build an academic career. These customers all have different expectations on production time, where the two latter have a shorter time frame than the research society at large.

The third level of the SCOOR framework (Figure 1) defines processes and resources needed to complete the product. The production resources are researchers and common 'tools' used to produce papers (computer software, scientific methods, data collection/analysis, etc.). In most cases, humans are the bottleneck as the 'tools' don't have any access limitations or lead times. However, in some cases this is untrue as for example advanced analysis requires substantial computer resources. The researcher as the main resource is a challenging thought as the product content is new knowledge, which is a ‘product’ that is not straight-forward to define. There is no such thing as a production line to follow to obtain new knowledge. However, there are some steps that need to be undertaken to write a scientific paper so the production sequence can be determined, but it cannot be quantified with lead times.

DEFINING THE PAPER WRITING PROCESS

Paper writing can be divided into four parts; conceptualization, data collection, analysis, and formatting where the resulting experience is of value for the researcher. A comparison with the general activities (planning, sourcing, making, delivering and returning) of planning a production system as defined by the first level of the SCOR framework (see Figure 1) (Bolstorff and Rosenbaum 2007) reveals a good fit (Figure 2). The main parts can be further broken down into activities that can differ between different research disciplines. However, if all activities are completed with sufficient quality, the result is a manuscript fit for submission.

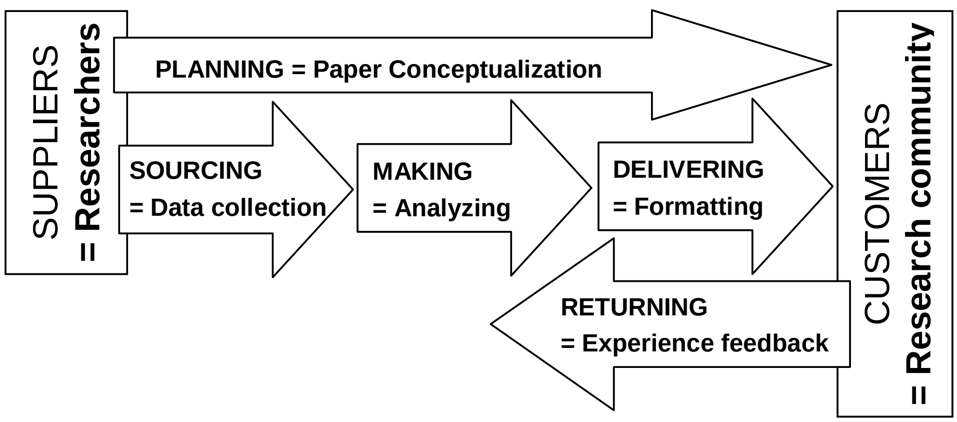


Figure 2: Characterising the paper writing process in accordance with the first level of the SCOR model. Figure inspired by Bolstorff and Rosenbaum (2007).

Papers have a certain cycle time when they are in production; from when the idea is formulated (scientific gap, authors and tentative title) until the paper is published and available to the scientific community. A typical cycle time could be from ½-2 years depending on lead times in writing, reviewing and printing. The planned cycle time for paper publication is determined by the number of papers needed for a Ph.D. thesis and the number of papers set as a goal for the research group.

When viewing scientific writing as a production system, quality control is vital. Without it, manuscripts can be produced that follow the production sequence, but are of no value, i.e. far from fit for publication. In an academic research group, quality control is made by the supervisors, i.e. professors and other faculty members. A main role of supervisors is to control scientific quality and determine when papers are fit for publication, and when Ph.D. students are ready for dissertation. It should be noted that supervisors are also part of the production system as they also publish papers.

MANAGING SCIENTIFIC PAPER WRITING

Managing the paper writing process is basically about managing knowledge as the paper is a manifestation of new knowledge based upon existing know-how. However, knowledge that resides in people's minds is difficult to manage (Dasgupta and Gupta 2009). It is this implicit (tacit) knowledge which poses the biggest challenge for most organizations to manage, in contrast to explicit (formal) knowledge that can be stored. Thus, an organization needs to instead manage its structure, culture and processes so as to promote an environment of learning and creativity (Dasgupta and Gupta 2009).

Knowledge management thus depends on the ability, motivation, and opportunity of the organization to perform (Argote et al. 2003). Properties of the knowledge management context could impact an *individual's ability to create, retain, or transfer knowledge*, or the context could provide people with the *motives and incentives to participate in the knowledge management process*. To be successful, management of scientific paper writing thus has to both support the individual researchers' paper writing process as well as to provide an environment facilitating participation and engagement. For this purpose, Lean organizations utilize visual management, often supported by project room called Oobeya (Andersson and Bellgran 2009).

THE OOBEYA ('BIG PROJECT ROOM')

"Oobeya" (the Japanese word for "big project room") aids in product development as it helps to build collaboration across teams and optimize the project from a team perspective (Horikiri et al. 2009). With Oobeya, productivity is gained by identifying and removing wasteful activities so as to be able to see the value-added work. This can only be done when the value has been properly defined. Then it is possible to use pull techniques to accomplish work more quickly (Horikiri et al. 2009). Visualisation of value-adding work (Figure 3) is obviously an asset of working with Oobeya as scope, accountability and schedule issues become clear. Also, the importance of proper decision making and problem solving is elevated for the whole organization.

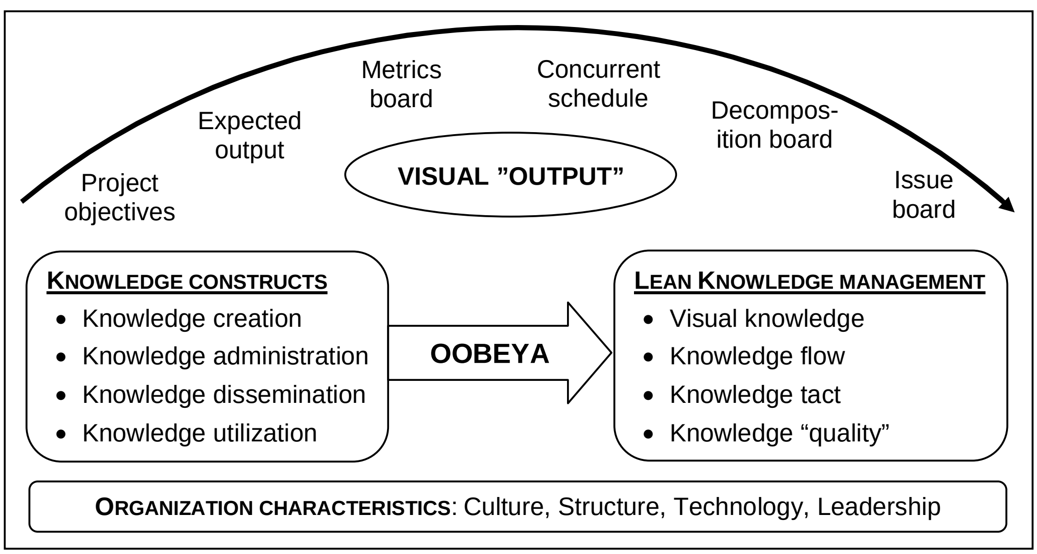


Figure 3: The main "ingredients" of the Oobeya as well as its role in "Lean transformation" of an organizations knowledge management.

The board layout (Horikiri et al. 2009) of an Oobeya room is generally composed of seven parts (Figure 3); in the centre is a Visual "output" (a prototype model, mock-up, drawing, or some other visual representation of the output) surrounded by boards for Project objectives (background, objective technical specifications, and organization), Expected output (clear and credible targets based on customer values), Metrics (specific, quantified metrics by which the project is measured), Concurrent schedule (shows the activity of all project members or teams), Decomposition (shows sub-projects or areas needing attention), and Issues (displays critical problems).

Consequently, using Oobeya to manage knowledge in paper writing applies Lean management to the traditional knowledge constructs (knowledge creation, administration, dissemination and utilization) as presented in Figure 1. Lean knowledge management (Figure 3) thus implies visualizing value-adding activities so that everyone can see everything, arranging for a flow of knowledge so that corrective actions are triggered for emerging issues, asserting that a publication tact of value is defined and maintained, and assuring that papers 'produced' are actually publishable, i.e. with good enough quality. The organizational structure, culture, technology, and leadership are all crucial for successful knowledge management.

METHOD – CASE STUDIES OF SCIENTIFIC WRITING PROCESSES

This paper presents results from three case studies of events leading up to the creation of Oobeya in three research groups (Timber Structures, Structural Engineering, and Construction Engineering and Management) at Luleå University of Technology, Sweden (Table 1). Currently, research is conducted on many different topics ranging from materials to supply chain management and construction management. The authors have had an active part in the dissemination of Lean in the organizations and the creation of the Oobeya rooms. Initially the Oobeya was implemented in the Timber Structures research group, then in Construction Engineering and Management and finally in the Structural Engineering research group.

Table 1: Organization characteristics of the three studied research groups.

Characteristic	Timber structures	Constr. engineering	Struct. Engineering
Culture	Lean deeply rooted in research projects	Lean partly rooted in research projects	Lean partly rooted in research projects
Structure	5 senior researchers, 10 Ph.D. students	4 senior researchers, 7 Ph.D. students	8 senior researchers, 6 Ph.D. students
Technology	No significant technology used	Uses BIM in research and development	No significant technology used
Leadership	Group leader openly supports Lean	Group leader openly supports Lean	Group leader support Lean but not engaged

RESULTS – THE 'OOBEYAS' EMERGE

THE TIMBER STRUCTURES RESEARCH GROUP

The goal of working with Lean in the timber structures research group and specifically in paper writing was to decrease the cycle time and to increase awareness of the importance of scientific publication. Furthermore, it was important to visualize the paper writing process for the group to increase the understanding of what tasks needs to be completed in order to write and publish a scientific paper and to present to the group the extent of work the research group as a unit was engaged in, creating a team spirit. Finally, the visualization of goals for the research group was important.

This resulted in creation of an Oobeya in the spring of 2009, called "Think-Tank". The room is placed in the middle of the department corridor and is accessible by everyone. The walls of the room cover insight but not sound; nothing said in the room is secret! The words 'Find-Think-Write-Publish' are posted on a wall reminiscent of the paper writing process. The room (≈ 12 m^2) has a sofa and a bar table, but no office desk. There are two whiteboards for expressing ideas and two balanced scorecards are available (described below). Furthermore, all scientific papers that are published are displayed inside the room, as well as all Master theses supervised by the group.

Value was defined as a paper. The goal was set to publish nine peer-reviewed papers and six conference papers each year. As the cycle time for publishing papers is substantial (up to two years), the group needs to have papers in different stages of completion at all times. Paper progress was divided into activities to better understand the flow of paper writing. Three levels of paper completion were identified; submitted, accepted and published. These are visualized on a balanced scorecard on the wall (Figure 4, left). Papers in progress are visualised on another scorecard (Figure 4, right), which is more dynamic as it is updated every second week.

A) Published (Green), accepted (yellow) and submitted (white) papers

B) Supervised Master theses (Green = defended, Yellow = submitted, White = in writing)

C) Division specific values such as economic status, doctoral courses, etc.

D) Each paper currently 'under production' is presented as a separate line

E) Paper flow visualized by green, yellow, and red dots to indicated progress and crisis

Figure 4: Balanced scorecard for goal fulfilment (left) and paper writing (right).

The work breakdown structure of paper writing was defined as requirements for paper production; *Idea*, *Tentative title*, *Data collection*, *Method*, *Analysis*, *Conclusions*, *Formatting* and *Acknowledgements*. The work breakdown structure also includes work that is needed to complete the paper, for example, data collection or iterations of the main contribution of the paper. The breakdown was discussed at length and it was concluded that for the system to work, the interpretation and the meaning of the breakdown needs to be individual for each researcher. Some topics in the breakdown are also more or less important depending on type of research as the type of research is extensive, ranging from experimental engineering methods to methods based on social sciences methods, for example qualitative case studies.

Meetings in the Oobeya are of two types; every second Monday morning the balanced scorecards are updated jointly. Participation is mandatory if present on campus. A 15 minute walkthrough is made by a senior researcher where all scientific papers in production (D in Figure 4) are addressed and the goals updated (A in Figure 4). The second type of meetings is individual Ph.D. supervision that is held every other week and always is one hour long. The time for supervision meetings are set for the entire semester, i.e. twice every year. Meetings can be rescheduled, but only cancelled on the Ph.D. student's own initiative. What this means is that each Ph.D. project is aggregated to paper writing creating a natural relation between progression of the research project and publication of papers.

THE CONSTRUCTION ENGINEERING AND MANAGEMENT RESEARCH GROUP

The leadership of the Construction Engineering and Management research group has ideas and goals similar to Timber Structure. Research is also coordinated between the research groups. The room of the Construction management group is a part of a larger room separated by a bookshelf on one side and a dividing wall on the other. The Oobeya contains a balanced score card for paper writing, a white board for presenting ideas, a sofa and a table for discussions. A large TV is mounted on one wall where research and paper writing progress is discussed between supervisor and Ph.D. student simply by connecting a computer. A yearly goal of six scientific papers and four conference papers has been set for the research group.

THE STRUCTURAL ENGINEERING RESEARCH GROUP

In 2011, Structural Engineering established an Oobeya called "the brain cell". A balanced score card for paper writing was created and a score card is being developed for financing Ph.D. projects as writing a successful application requires consistent work over a longer period of time, similar to writing a scientific paper. In the Oobeya there is a sofa, a bar table with six chairs and two white boards. The goal of the room is to visualize paper writing and to make everyone aware of what "we" as a group are doing. Another important purpose is to enable discussions between supervisors and Ph.D. students. A yearly goal of ten scientific papers and six conference papers was set as well as a goal to have ten Ph.D. students constantly in the system which requires that papers are produced consistently and that funding can be secured.

ANALYSIS – KNOWLEDGE MANAGEMENT USING THE OOBEYA

Using the Oobeya room on a daily basis in the Timber Structures research group has increased the involvement of all supervisors and Ph.D. students in all research activities undertaken in the group. Applying the Oobeya has increased the number of papers published from four per year in 2008 to eight in 2011 (when the process is visualized everyone wants to be seen), improved quality of publications (the tasks of writing a publication is visible to all), and shortened the lead time from idea to submission (visual progress spurs increased involvement). Consequently, application of the Oobeya room has had a positive effect on the flow of paper writing!

The response from people involved has been diverse. People who enjoy having an overview of the group and adhere to systematic thinking have been very positive. People who instead focus more on their own work (loners) have been more reluctant. An event that took place during the first year was that people with deep knowledge of Lean tried to make the system more detailed by proposing performance measurements for paper writing. This was done when the rest of the group was still learning how to think Lean. The effort was therefore halted by senior researchers to make sure that the research group as a whole moved forward, not only those who were positive.

An important factor in the success of Lean Thinking is the engagement and long-term commitment of the management, the senior researchers. If they do not agree and fully support the Lean effort, then the implementation will fail. The responsibility for survival of the Lean culture thus lies at the management. New ideas and new ways of working can emerge in a bottom-up manner, but they will never be sustained unless management provides necessary support and resources using a top-down approach.

DISCUSSION AND CONCLUSION

It is fruitful to improve the management of knowledge in academic institutions; even though research is considered creative it can be managed without hampering the feel of freedom. Evidence shows that proper management of research will create better research! Why is that? Because, now all what people do is open to critique by peers, friends, or by anyone who only happen to walk by and show an interest. Also, every person has a sense of pride, when someone can see your mistakes you put in that little extra bit of effort to deliver high quality papers on time!

Critique has emerged that it is difficult to make a template for paper production that is valid for all research paradigms. This is true. The problem was resolved by allowing each individual to have their own interpretation of the activities. Another issue brought up is that the Oobeya supports paper writing, but not so much the Ph.D. process, which involves many additional activities. In Timber Structures a balanced scorecard is currently being developed that will be able to visualize the Ph.D. students' progress in their research projects. Other planned additions for the Oobeya are to visualize less obvious values delivered during the creative research process, such as involvement in education and personal development.

There are obvious differences between the research groups' leadership, the objectives of the rooms, and systems for managing Ph.D. students and paper writing. The Structural Engineering group has not seen the full potential of Lean.as Ph.D. supervision is performed ad-hoc and weekly meetings that are not mandatory results in low attendance. Also, the balanced score cards are only updated every now and then and the visualization of Ph.D. funding is not yet developed. Consequently, the results are not as convincing as for the other research group!

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