

# IMPLEMENTING ELECTRONIC DOCUMENT MANAGEMENT SYSTEM FOR A LEAN DESIGN PROCESS

André Carneiro Giandon<sup>1</sup>, Ricardo Mendes Junior<sup>2</sup> and Sergio Scheer<sup>3</sup>

## ABSTRACT

This paper analyzes how the implementation of the Electronic Document Management (EDM) can contribute for a lean management in AEC sector, particularly in the design process. The main concepts of EDM are presented and illustrated with examples of its application in the design process. Some considerations are shown on the document management problems in design process. The most common errors embedded on documents are: Inconsistency in design information, mismatch between connected parts, component malfunction. The authors propose how to use EDM systems for a lean design process based on the ideas proposed earlier by Koskela and Tzortzopoulos and Formoso. The lean concepts discussed here are: Reduce the share of non-value-adding activities, reduce variability, reduce cycle time, simplify by minimizing the number of steps and parts, increase output flexibility, increase process transparency, balance flow improvement with conversion improvement. The paper ends with a brief description of an implementation of EDM for a lean design process. The purpose of the paper is to bring the discussion on Information Technology (IT) usage on a lean management context. The ideas presented here is an initial step on this research in order to have a theoretical framework to analyse case study under development in a construction company in Curitiba.

## KEY WORDS

Document management, information systems, workflow, design process.

---

<sup>1</sup> M.Sc. Candidate, Civil Engineer, Civil Construction Post-Graduate Program, Federal Univ. of Paraná, Caixa Postal 19011, 81531-990 Curitiba, PR, Brazil, FAX 5541-361-3110 PHONE 5541-361-3110, giandon@cesec.ufpr.br

<sup>2</sup> Assistant Professor, Civil Construction Department, Federal Univ. of Paraná, Caixa Postal 19011, 81531-990 Curitiba, PR, Brazil, FAX 5541-361-3110 PHONE 5541-361-3110, mendesjr@ufpr.br

<sup>3</sup> Adjunct Professor, Civil Engineering Research Center, Federal University of Paraná, Caixa Postal 19011, 81531-990 Curitiba, PR, Brazil, FAX 5541-2669174 PHONE 5541-3613218, scheer@ufpr.br

## **INTRODUCTION**

The use of updated information to support decision-making is one of the main challenges of several business processes. Information sharing in industry is made using many kinds of technology bases, but the most reliable form to evidence a business transaction, internal or external in offices, are documents. A document is everything that has been stored into an accessible source (Eleoranta et al. 2001).

Information Technology and networks are changing the way professionals face many business processes, and, the use of electronic documents and office automation systems make us think how to evaluate the enterprise content management problems. Electronic Document Management Systems (EDM) are been used in several industry sectors, such as banks, manufacturing, pharmaceutical, insurance, engineering and others (Joia 1998). The EDM systems can be used from strategic levels to the operational ones. Construction document management is an essential component of the overall project management function (Hajjar and AbouRizk 2000). Furthermore, the increased volume of document production, publication, and corporate-wide distribution through e-mail systems and workstation-based file managers has aggravated problems in document security, control, tracking, and retrieval (Sutton 1996)

Design management is getting lot of attention in the Architectural, Engineering and Construction (AEC) sector due to its strong implications for the entire project (Chua and Tyagi 2001). Among the factors discussed, communication and information fragmented flow are often present. Poor communication, lack of adequate documentation, deficient or missing input information, unbalanced resource allocation, lack of co-ordination between disciplines, and erratic decision making have been pointed out as the main problems in design management (Tzortzopoulos and Formoso 1999). The problems associated with poorly coordinated document management are present not only in early stages of the design development, but also in the entire building project. The growing complexity and magnitude of constructions projects have resulted in an increase in the problems associated with manual document management and retrieval (Hajjar and AbouRizk 2000).

This paper analyzes how the implementation of the Electronic Document Management can contribute for a lean management in AEC sector, particularly in the design process. The main concepts of EDM are presented and illustrated with examples of its application in the design process.

## **ELECTRONIC DOCUMENT MANAGEMENT SYSTEMS**

Document management systems are used to control the document life cycle. The systems often are modular, found as a set of hardware and software that manage creation, approval, distribution and others phases of the document life cycle. Managing documents electronically does not mean to use only electronic documents. There are several concepts on EDM, although only the concepts that are related to the objectives of this paper are presented below.

## **DOCUMENT**

It is easier to define documents starting with examples, generic documents can be illustrated by briefing notes, correspondence, e-mail messages, memorandums, spreadsheets, studies and so on (Sutton 1996). According to Eleoranta et al. (2001) document is defined as everything that has been stored into an accessible source. People

usually associates document to papers, but it can be found in many forms. Based in the definition above, texts, recorded sounds and images (of scanned papers or video-tapes) can be documents. In construction industry some examples of documents are: drawings, design specifications, quality control reports, and others (Hajjar and AbouRizk 2000).

### **DOCUMENT MANAGEMENT**

Document management can be defined as the process of overseeing an enterprise's official business transactions, decision-making records, and transitory documents of importance, which are represented in the format of a document (Sutton 1996).

### **WORKFLOW**

This technology is used to control the approval and distributions tasks in the document life cycle. The workflow is based on rules that will transmit electronically a task with a document or some documents to the desktop of the professionals. They typically separate work activities into well-defined tasks, roles, rules, and procedures, which regulate most of the work in manufacturing and the office (Mentzas et al. 2001). The enactment of a workflow may include activation, tracking, status monitoring, messaging, queue handing and routing of documents. It becomes possible to monitor management process and track and route the associated documents (Zantout and Marir 1999).

Workflow management involves: *process modelling*, that requires workflow models and techniques for capturing and describing a process; *process reengineering*, that requires techniques for optimising the process; and *workflow implementation and automation*, that requires methodologies and technologies for using information systems and human performers to implement, schedule, execute and control the workflow tasks as described by the workflow specification (Mentzas et al. 2001).

### **ELECTRONIC DOCUMENT MANAGEMENT SYSTEMS**

Electronic document management systems are a set of technologies linked to accomplish a target. The following technologies are, usually, embedded in an EDM (Joia 1998): Imaging, that deals with the need of transforming documents on paper into digital ones, by using scanners; Full-Text-Retrieval, that retrieves documents searching for words within them; Workflow, that allows the innovation of productive processes by reengineering them, making it possible to control a document route within a company; and Multimedia, the last developed EDM technology that allows the storage and retrieval of frames of animation, sounds, etc.

The EDM is usually based in two main systems: Document Management, that manage the dynamic documents, like a file of the word processor, and Document Imaging, that deals with static documents, like images of documents obtained by the use of the scanner. The system can also include databases to help the organizing of paper documents. EDM is a toll for the storage and retrieval information. These can include faxes, scanned images or documents, drawings, word processed documents, spreadsheets, database reports, letters, specifications, and, in fact, any kind of document (Vidogah and Ndekugri 1998).

### **DOCUMENT MANAGEMENT PROBLEMS IN DESIGN PROCESS**

Successful management of design is critical to cost-effectiveness, timeness and quality of the entire project (Chua and Tyagi 2001). It is not an exaggeration to say that the management of design and engineering is one of the most neglected areas in construction

projects (Koskela et al. 1997). Many researches were done on the design process, but it is faced as complex and unstructured in terms of the information flow.

The design process involves a large number of project participants with different objectives, who have to derive a consistent design solution, satisfying the constraints imposed by the design requirements (Chua and Tyagi 2001). The construction design process usually is not well planned, and the participants do not have enough time to discuss the solution adopted and the design fails are only discovered during the construction phase.

Poor communication and lack of procedures to transmit the design changes often becomes critical problem during the entire project. Most of the design errors generate change orders, contractual disputes, cost overruns, time delays, compromise to quality, frustration, and client dissatisfaction (Mokhtar et al. 1998).

If the production of the technical documents during the design stage is poorly coordinated, incompatibility errors are embedded; common errors are (Mokhtar et al. 1998):

- Inconsistency in design information. For example, the location of a specific column is not identical when the architectural and the structural drawings are compared;
- Mismatch between connected parts. For example, heating, ventilation, and air conditioning (HVAC) duct dimension, which are given in the mechanical drawings, do not match the dimensions of the related pass-hole in the structural beams, which are given in the structural drawings;
- Component malfunction. For example, the electric supply in a room is designed to serve a classroom activity, whereas architectural drawings indicate that the same room has been redesigned as a computer lab.

Some techniques to manage the design problems include, coordination meetings, information changes send by e-mails, checklists verifications, but the professionals are looking for a tool to solve the documentation errors problems. The industry is at an exploratory stage on how to organize design information in a structured database (Mokhtar et al. 1998).

## **ELECTRONIC DOCUMENT MANAGEMENT SYSTEMS FOR A LEAN PRODUCTION MANAGEMENT**

We propose to discuss the implementation of EDM for a lean design management, based on the ideas presented earlier by Koskela (1992) and Tzortzopoulos and Formoso (1999). The analyses presented here probably could be used for any process which involves documents, and not only for a design processes.

### **REDUCE THE SHARE OF NON-VALUE-ADDING ACTIVITIES**

It is possible to directly attack the most visible waste just by flowcharting the process, then pinpointing and measuring non-value adding activities (Koskela 2000). Thus, before implementing the workflow, people have to think on process, mapping the information flow, making it possible to reduce non-value-adding activities.

Using the workflow system, the system will make available the information necessary in the desktop of the worker. The system “gives added value with a profile of metadata to

ensure that the document *can* be found again. The retrieval and search capabilities of EDM let an employee win back time that would otherwise be lost in trying to find paper-based files” (Sutton 1996). EDM also eliminate duplicated information and reduce re-creation time (Song et al. 2002).

In a manual management process, some non adding-value activities can be, for example: call someone to find a document, to go to the file room, prepare or wait for a fax transmitting, and others.

If it is not possible to eliminate the non-value-adding activities, an alternative is to make it more efficient. In this respect EDM is a solution for increase collaboration and better integration for decision-making.

### **REDUCE VARIABILITY**

This principle can be implemented trough the clear definition of the process, including the activities that must be performed, their dependence relationships, roles and responsibilities and the main flow information (Tzortzopoulos and Formoso 1999). By the definition of the workflow, this principle is applied in the workflow system.

### **REDUCE THE CYCLE TIME**

Koskela (1992) represented cycle time as adding (1) processing time, (2) inspection time, (3) wait time and (4) move time.

One approach to reduce the cycle time is to reduce the distances between the steps of the process (move time). One great advantage in the use of the Information Technology is the distances reduction. There is a distance that the documents runs during a paper based process. With electronic documents and using the workflow, these distances are reduced or even eliminated. An EDM eliminates geographical boundaries in organizations (Sutton 1996).

Using the workflow, when the person has a decision to do based on a document, this document will be available in his/her desktop (move time, wait time). A worker is presented with a document only when his input is required. This is an example of push technology whereby information is automatically pushed to the user without his active intervention (Zantout and Marir 1999)

Another benefit of the implementation of a workflow system is when people criticises the process the change of activities order. Using electronic documents, the information flow can be in parallel order, even the approvals.

### **SIMPLIFY BY MINIMISING THE NUMBER OF STEPS AND PARTS**

Simplification here can be understood as (1) reducing of number of components in a product or (2) reducing the number of steps and linkages in the information flow (Koskela 1992). In this case simplification can be realised by eliminating non-value adding activities from the document flow process using EDM and workflow tools.

### **INCREASE OUTPUT FLEXIBILITY**

Manufacturing flexibility can be grouped into four basic types: mix flexibility (number of different products produced), new product flexibility (speed of product introduction), volume flexibility (ability to vary production), and delivery time flexibility (Suarez et al.1995 apud Koskela 2000). In construction industry these types of flexibilities produce design changes in the various stages of the production process (design and construction).

One practical approach to increase flexibility is customizing as late in the process by procedures which clients could submit demands for design changes. EDM allow designers to make more design changes accurately by lead-time compression and increasing transparency.

#### **INCREASE PROCESS TRANSPARENCY**

One objective is to make the process transparent and observable for facilitation of control and improvement (Koskela 1992). The graphics workflow allows people to control the status of each activity. It is possible to determine exactly where are the process failures, like where the document is waiting for approval or who starts or ends him/her task after the scheduled time.

The document flows reveal whom actually uses and produce information, and, naturally who are not doing either activity in the organization (Eleoranta et al. 2001). It is easy the verify reports about any document flow when necessary.

#### **BALANCE FLOW IMPROVEMENT WITH CONVERSION IMPROVEMENT**

The flow and conversion aspects each have a different potential for improvement, the higher the complexity of the process, the higher the impact of flow improvement (Koskela 1992). The design process is complex and not well structured, this principle focuses the balanced flow and conversion improvement, and can be achieved during the implementation of the workflows.

#### **AN IMPLEMENTATION OF ELECTRONIC DOCUMENT MAMAGEMENT FOR A LEAN DESIGN PROCESS**

Some researchers presented before studies of the EDM use in constructions projects. Mokhtar et al. (1998) concluded that managing design changes is essential to ensure the production of technical construction documents free of incompatibility errors. Hajjar et al (2000) showed the significantly improve in overall document management process by the implementation of an electronic document management system, and argued the EDM revolutionized the construction document storage and retrieval process.

We argue the use of EDM can help design professionals to achieve great part of the lean production principles to manage design technical documents and also contribute for a better information flow during the building project.

The workflow showed below (Figure 1) represents the use of an EDM in the design process, during a drawing development. The Figure 1 is an example that shows part of a model to manage the design process using an electronically based information system.

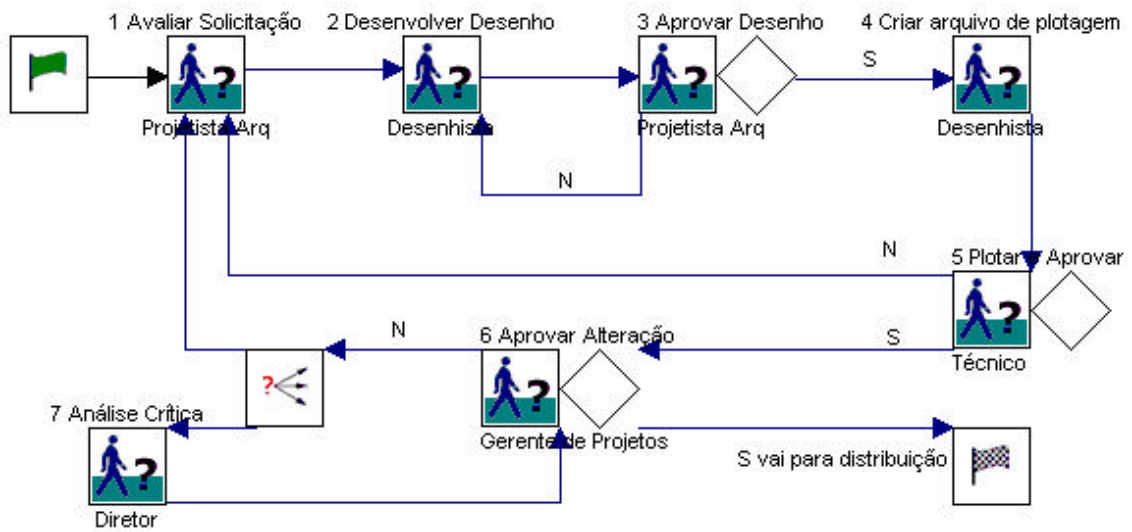


Figure 1: Workflow - Drawing Development

The table above shows the description of the tasks presented in Figure 1.

Table 1: Workflow Tasks

Task	actor	Description
1 to analyze the solicitation	design manager	The design manager analyses the problem and defines what will be done
2 to development the drawing	Designer	Drawing changes/development
3 to approve the drawing	design manager	Verify and approve the changes
4 to create plot files	Design	Create plot files
5 to print and approve	Designer / clerk	Print the plot file and approve the changes
6 to approve the changes	design manager	Verify if the solution is approved. If the drawings are approved they are distributed, if not, a coordination meeting is possible or another change can be done (restart the workflow).
7 critical analyses meeting	Director	the solution is analyzed with the technical director.

## CONCLUSIONS

The paper presented the use of the EDM in the construction sector, in the design process. The workflow presented is part of a larger research to develop a model to manage electronically the design documents at Federal University of Paraná, Brazil.

The use of EDM in construction projects still need further research, specially related with the human resistance for the use of new technologies. Using many computer softwares, like Office Automation Systems or CAD, it is easy to create and distribute design documents, but people are sharing or managing files updates manually. The analogy between an unused part in a work-in-progress inventory and a document waiting for approval or user is the same, they both enclose work and value that is not exploited to the extent it could be.

The lean concepts discussed here are: Reduce the share of non-value-adding activities, reduce variability, reduce cycle time, simplify by minimizing the number of steps and parts,

increase output flexibility, increase process transparency, balance flow improvement with conversion improvement

The main purpose of this paper is to bring the discussion on Information Technology (IT) usage on a lean management context. The ideas presented here is an initial step on this research in order to have a theoretical framework to analyse case study under development in a construction company in Curitiba. One of the main goals of this construction company is the use of IT wherever it would be possible.

## ACKNOWLEDGEMENTS

The authors acknowledge POLO de Software S/A, a Brazilian Company based on Curitiba responsible for the development of the system used in this research, GlobalDoc - Document Management Solution. GlobalDoc is a complete Document Management System that includes seven modules: Document Management, Workflow, Full text Search, Imaging, Mass Storage, Batch Check-in and Intranet/Internet.

## REFERENCES

- Chua, D.K.H., Tyagi, A. (2001) "Process-Parameter-Interface Model for Lean Design Management". *Proc. 9<sup>th</sup> Annual Conference International Group for Lean Construction, Singapore*, pp.1-12.
- Eleoranta, E., Hameri, A., Lati, M. (2001) "Improved Project Management through Improved Document Management". *Computers in Industry*, Elsevier, 45, pp. 231-243.
- Hajjar, D., AbouRizk, S. M. (2000). "Integrating Document Management with Project and Company Data". *Journal of Computing in Civil Engineering, ASCE*, 14 (1), pp. 70-77.
- Joia, L.A. (1998) "Large-scale Reengineering in Project Documentation and Workflow at Engineering Consultancy Companies". *International Journal of Information Management*, Pergamon, 18, (3) pp. 215-224.
- Koskela, L. (2000) "An Exploration towards a Production Theory and its Application to Construction". Espoo 2000. Technical Research Centre of Finland, VTT Publications 408. 296 p.
- Koskela, L. (1992) "Application of the New Production Philosophy to Construction". *Technical Report 72*, CIFE, Stanford Univ., CA, 75 pp.
- Koskela, L., Ballard, G., Tanhuanpää, V. (1997) "Towards lean design management". *Proc. 5<sup>th</sup> Annual Conference International Group for Lean Construction, Gold Coast*, pp.1-12
- Mentzas, G., Halaris, C. Kavadias, S. (2001) "Modelling Business Process with Workflow Systems: an evaluation of alternative approaches". *International Journal of Information Management*, Pergamon, 21, (2) pp. 123-135.
- Mokhtar, A., Bédard, C., Fazio, P. (1998) "Information Model for Managing Design Changes in a Collaborative Environment". *Journal of Computing in Civil Engineering, ASCE*, 12 (2), pp 82-92.
- Song, Y., Clayton, M.J., Johnson, R.E. "Anticipating reuse: documenting building for operations using web technology". *Automation in Construction*, Elsevier, 11, (2), pp. 185-197)



Sutton, M.J.D. (1996) "Document Management for the Enterprise: principles, techniques and applications". John Wiley & Sons: New York, NY, 369p.

Tzortzopoulos, P., Formoso, C.T. (1999). "Considerations on Application of Lean Construction Principles to Design Management". *Proc. 7<sup>th</sup> Annual Conference International Group for Lean Construction, Berkeley, California, USA*, pp.335-344.

Vidogah, W., Ndekugri, I. (1998) "A review of the role of information technology in construction claims management". *Computers in Industry*, Elsevier, 35, (1) pp. 77-85

Zantout, H., Marir, F. (1999) "Document Management Systems from Current Capabilities towards Intelligent Information Retrieval: an overview". *International Journal of Information Management*. Pergamon, 19, (6) pp. 471-484.