PLM IMPLEMENTATION: CASE STUDY

Bojcetic, Nenad; Salopek, Damir; Marjanovic, Dorian
University of Zagreb, Croatia

Abstract

Nowadays modern company that strives to excel in an ever growing competitive market has to embrace new technologies. One available technology that can distinguish a company from others and bring about advantages is the Product Lifecycle Management (PLM). The Product lifecycle Management is the management of all product related information and processes. The PLM system through database technology and intranet or internet network manages the production process in all product-related information and processes. This article brings a case study of the ongoing implementation of the PLM system in a company that produces power transformers engineered to order. The process and the experience gained in the implementation of PLM software are presented.

Keywords: Product lifecycle management (PLM), Computer aided design (CAD), Information management

Contact:
Prof. Nenad Bojcetic
Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb
Design and Prodcut Development
Croatia
nenad.bojcetic@fsb.hr

Please cite this paper as:
Surnames, Initials: *Title of paper*. In: Proceedings of the 20th International Conference on Engineering Design (ICED15), Vol. nn: Title of Volume, Milan, Italy, 27.-30.07.2015

1 INTRODUCTION

Nowadays modern company that strives to excel in an ever growing competitive market has to embrace new technologies. When the product portfolio is based on low number of manufacturing units, the company has to develop products that fit specific customer demands. In such cases, product platforms are used so as to design products engineered by order. Designs are tailored to meet particular needs, and market pressure results in a need to develop a high number of different designs and production plans. Traditional approach to coping with such demands and remain competitive has been based on product platforms and parameterised modules that reduce design time. Such modules used as scalable building blocks inherit complex knowledge that covers not only the design but embraces all phases of product development. The standard CAD systems are not designed to support such complex information sets that include the needs of manufacturing, procurement, delivery, installation, on-site legal requirements and more. Therefore more advanced technology is a prerequisite in order to support company attempts to satisfy customer requirements and stay competitive.

One available technology that can distinguish a company from others and bring about advantages is the Product Lifecycle Management (PLM) [Stark 2011, Antii 2005.]. The Product Lifecycle Management is the management of all product-related information and processes. The PLM system through database technology and intranet or internet network manages the production process in all product-related information and processes [Burden 2003]. Furthermore, the PLM integrates and manages processes, applications, and information that define products across multiple systems and media throughout the entire lifecycle of a product in a more efficient and organized way [CIMdata 2001].

In this article a case study of the ongoing implementation of the PLM system in a company that produces power transformers is presented. The process and the experience gained in the implementation of PLM software solution shows that, regardless of experience and planning capacities, each application of such technology is an individual case. In the particular case, the company has a long time experience in the usage of 2D and 3D (AutoCAD for 2D and Creo for 3D) software applications to create computer models of their products. They also use a range of software solutions for the exchange of information among participants in the product development process. In recent years, the scope of activities, especially in office design, has increased significantly. Thus, the workload of the design department increased resulting in additional tasks in the management of documents generated by or used by designers at work. The frequency of exchange of information and documents both within the design office and other offices in the company has also increased. Large amount of information and documentation traffic imposes additional noise in already intense communication between designers. In such environment verification and change management, processes require additional efforts in order to reduce the possibility of errors. Company management recognized that the current software solutions were not sufficient and cannot keep track of the increased pace and scope of work in the product development process.

In order to cope with emerged problems the company searched which methods and tools could be used in order to increase efficiency in design office particularly with concerns to:

- File management and data retrieval.
- Reduce data redundancy, errors and incompatibilities of documentation.
- Increase collaboration quality within design office.
- Ensure better change management process.
- Ensure efficient document verification and promotion mechanisms.
- Reduce product documentation development cycle.

A well implemented PLM system should eliminate the need for oral communication and discussions during the Product Life Cycle [Riitahuhta 2002.]. With the strategic decision of top management, the steering committee was established. The steering committee formed the project team with the members from the:

- Design office,
- Company’s IT department,
- Planning and organisation department,
- Software vendor,
- University.

The project team responsibility was to govern the project of the PLM implementation [Siddiqui 2004, Shih-Chih 2012] and to understand and interpret goals defined by the steering committee. Steering committee planned the PLM implementation process in a several phases or stages. Implementation plan respected the constraints of regular day to day tasks. Project stages have been synchronized with forseen activities and customer demands.

Three main phases have been identified in the implementation process (Figure 1.). The preparation stage, test phase and production phase. In the first phase, software installation and basic configurations are done. The project team also completed the task of going throughout documentation of the recent company project that documented the process and documentation flow within a company.

During the second phase, a small group of designers (one senior, two experienced designers and two of novice designers) was formed whose purpose was to test PLM implementation in regular daily tasks. This phase was considered crucial in the process of making decision of PLM implementation process advances because much of arguments for or against process continuity we depend on responses from the test team.

In the third phase, the whole design department was planned to be included. The timeframe for the entire project was defined and established. Completion of the first phase was expected in three months, the second phase in one year and the final phase also in one year. Although different PLM solutions have been considered since the company 3D CAD application was Creo (PTC) the team selected Windchill PLM software solution from the same producer. As stated in [Cederfeldt 2003.] the CAD customers (and even their component suppliers) become extremely dependent on their respective vendor as the system does not offer much support for the integration of third-party tools. Windchill is not a single application; it can be seen as a collection of various technologies and applications.

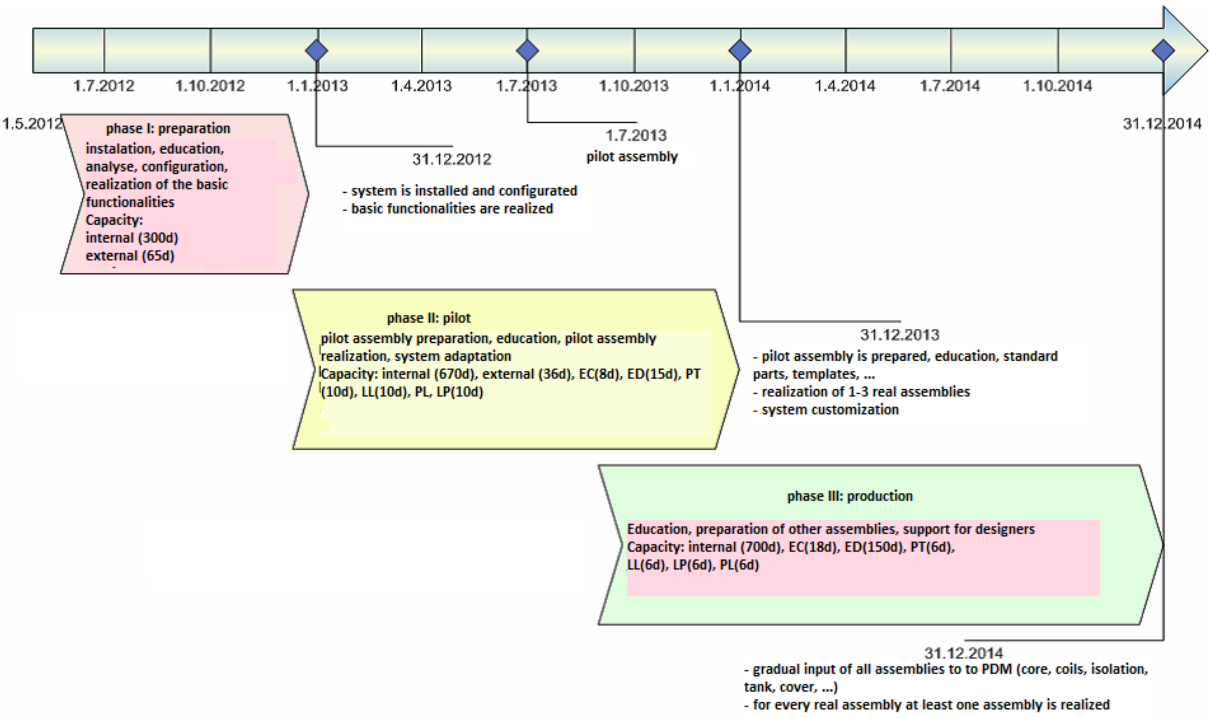

Figure 1. Project main phases

2 IMPLEMENTATION

Research literature [Brian 1995, Mansson 2002, Avatech 2001] indicates that management commitment is a crucial factor in the successful implementation of PLM. The implementation of PLM software solutions at KPT had a firm foothold in the management of the company from the beginning.. The project team had an advantage in the PLM implementation process that was due to the company having just finished an evaluation for the adoption of new ISO standards. From the project start, information about processes, employe responsibilities and task assigments were already available and

prepared (according to adopted ISO 9001 and ISO 14001 procedures). This facilitated the implementation of the project. During preparations for the ISO standard adoption, a series of workshops were conducted targeting particular groups and individuals within the company to gather information about processes and workplaces. The project was done according to the LEAN methodology [Bendell 2006].
During planning the team had to define deliverables for project tasks and evaluation metrics for a particular task conclusion. Although it appears quite natural to establish quality metric for project tasks evaluation, this might be true for tasks wich are easy to quantify. While dealing with complex tasks, where content of formal document notation was not elaborated in details, quality metrics was an per case based on evaluation by project team members.
The PLM implementation process has been tailored according to the product building modules (main subassemblies of the power transformer): core, tank, equipment, cover and conservator
The rationale for such segmentation of the implementation process lies in the concurrent customisation of the PLM system. With such approach work on templates, library and document preparation and analysis could be done concurrently. In order to be able to manage clearly information flows over the entire product life cycle, it is necessary to understand the specific features of communication in individual phases [Tavcar, 2004]. Even though much ground work in preparation of information on people and processes was done, that information had to be analysed and scrutinised from a PLM point of view.
A particular care had to be taken in the transition of relations between information objects, captured during adoption of the ISO procedures, to relations used by PLM application. One of the primary considerations were the relations that are missing or not suitable for PLM implementation. The project team conducted a series of workshops to gather missing or incomplete information. In these workshops, questioner templates provided by the vendor of the PLM software was used (Figure 2).
At the beginning of the project implementation, user education was scheduled to start after the completion of the third phase. In order to be more efficient, the steering committee decided to push the education ahead of schedule to speed up the project. One compelling argument for this was that informed worker (one has to have the feeling of being part of the project) is more forthcoming in embracing new technologies or methods. This proved to be a good decision because workers that completed the education, some even during education, came with their ideas as to how to improve particular processes or how to deal with design errors or other issues.
Based on the literature research the main reasons for unsuccessful PLM projects [Larsen 2001] are:

- Little or no involvement from senior managers during implementation.
- Project team members are trying to do two jobs at once.
- Senior managers need to find the time to develop their personal understanding of the subject.
- Senior management typically delegates too much responsibility to technical experts. They mistakenly view the PLM implementation endeavour as an information technology project, not a business project.
- Senior management is simply unsure of the role they should play. They focus on objectives and issues while engineers implementing the PLM system expect to focus on processes. Neither side can ask the right questions.

	INPUT DOCUMENTS					
Document Title	*Comment*	*Required information (attributes)*	*Created by: (department / role / person)*	*Organization*	*subject of approval*	*The initiator of the action*
A request for technical proposal		Number of offer, the document name, the name of the object, the name of the customer	Sell / Officer	KPT	yes	yes
Tender		Number of offer, the document name, the name of the object, the name of the customer	Sell / Officer	KPT	no	yes
Transfer of obligations	QF 9473.09	contract number, serial number (the holder of the cost?), object name, document name	Sales / Project Manager	KPT	no	yes
Request for production	template	contract number, serial number (the holder of the cost?), object name, do	Sales / Project Manager	KPT	no	yes
Contract		contract number, serial number (the holder of the cost?), object name, do	Sales / Project Manager	KPT	no	no
Correspondence by the customer	e-mail;	contract number, serial number (the holder of the cost?), object name, do	Sales / Project Manager	KPT		

Figure 2. Example of captured information

The project team followed the best practice procedures based on the experience and literature. However the workload in design office (number of customer orders significantly increased during the project execution) tripled. This becomes a problem because regular work precedes project needs, and the result was a project delay of about 30%.

In research literature [Pikosz 1997, Wildeman 2009, Weiss 2004.] the spectra of PLM functionalities are described ranging from core functionalities to ones that satisfy the needs of particular tasks (supply, marketing, manufacturing …). Example of PLM core functionalities:

- Data Vault and Document Management,
- Workflow and Process Management,
- Product Structure (Configuration) Management,
- Parts and Components Management (Classification),
- Communication and Notification,
- System Administration, etc.

Taking the pragmatic viewpoint project team head to made decisions about what can be done vs. what must be done to meet deadlines. Therefore the following Windchill modules (functionalities) were considered for implementation during the second phase: Windchill PDMLink (Data Vaulting, Document Management, Product Structure Management, Parts and Components Management and Workflow Management). Also Change Management and Product Approval and Promotion processes are considered for implementation.

Even though the project team tried to use all OOTB (Out Of The Box) options available to fulfil task requirements in order to minimise the customization needs, this was not possible so customization issues came up much sooner than anticipated. Following the best practices, additional requirements emerged that had to be dealt with. These requirements were primarily focused on individual or group methods and practices that are not a part of a formal process, but something people use or do to make their jobs easier or to complete the job faster. Many of these methods or practises had to be part of Windchill customization because they were not available in OOTB solutions.

2.1 Customization

Due to time and expenses involved customization is an important issue for every PLM implementation. The analysis showed that customization was necessary, especially to incorporate the best practices and inherited knowledge as integral part of the PLM implementation. On the other hand, complex product customization can potentially raise problems during updates or upgrades of the PLM. For the successful customization, it is important to customized functionalities already existing in the system if possible (extending their functionality) or to add a new functionality to satisfy new requirements. The scope of the customization done during the project will be presented through four examples:

- The first example depicts solution of the problem of part numbering and naming between Creo and Windchill.
- The second example deals with the customization of the process of product approval.
- The third case addressed the problem to relaying information from the PLM system to the ERP system.
- The forth customization have to be done in order to support current design and manufacturing process.

2.1.1 Example 1.

Windchill has an elegant functionality for this (Object Initialization Rules). Using a number of "if/then" rules, a numbering mechanism could be tailored to fulfil the requirement. However, a problem arose from the PLM application itself. One of the project requirements was to have the product number in the head of the drawing. To achieve this, the information about the product number have to be passed from Windchill to the Creo. Typically this is performed using PTC_WM_NAME and PTC_WM_NUMBER parameters. However, these parameters are not accessible from Creo so we had to create DocumentNamingDelegate and ModeledAttributesDelegate scripts whose job was to convey information about CAD model numbers and names to the drawing. This is evidence that even when using products from the same vendor, they do not have to exchange all the necessary information.

2.1.2 Example 2.

This customization was done in two ways. The first was to enable designers to browse the product drawings and the second addressed the process of product approval. The process of product approval is of high importance during the product promotion process (Figure 3.). The project benefited from the well-established rules and procedures for product approval and document promotion within the company. In this process, technical documentation in PDF (Portable Document Format) format is used by senior designers to approve the design (Figure 4.). Windchill does not support product structure tree browsing with drawing visualizations in PDF format so this had to be achieved through customization. In creating this customization *pdf.js* [pdf.js] library was used for PDF document visualization. It proved to be an incorrect decision because the new internet browser (Chrome) update changed the way it works with the browser cache and we encountered problems with the visualization of the PDF document.

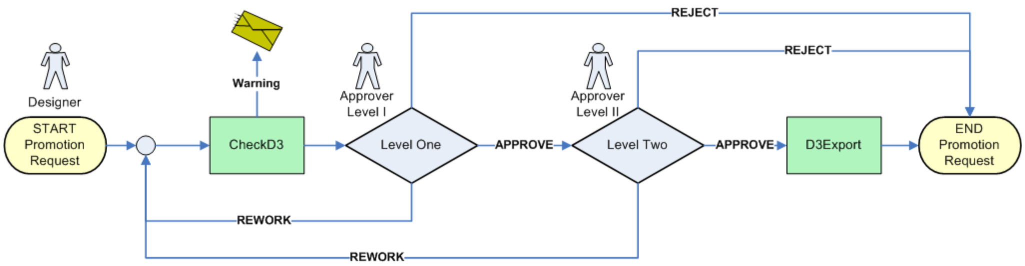

Figure 3. Promotion process

Therefore, this customization had to be changed before it was in full testing. The technical documentation approval process is driven by a promotion request process through two levels approving. This can be described, in a way enabled by the application itself, using Windchill Workflow Editor features. However, the whole aspect of the required workflow functionality could not so this had to be also customized . In a particular place in the workflow, if the right conditions are met, the BOM had to be created and exported in the PDF format. This is later used as a way of relaying information about the product to the suppliers' and companies' workshops. The PLM vendor brought to our attention that the PLM application has a module for supplier management. However, the cost of the implementation of this module, in the current project stage, was not accepted for two reasons. The first reason was that the project had already reserved funds that could not be changed without changing the company financial plan, and this was something that was rejected by the management of the company. The second reason was that the scope of the project had to be updated and would prolong the full implementation phase. So the benefits to the new module implementation would be negligible because suppliers are not at the right IT stage to fully embrace module potential.

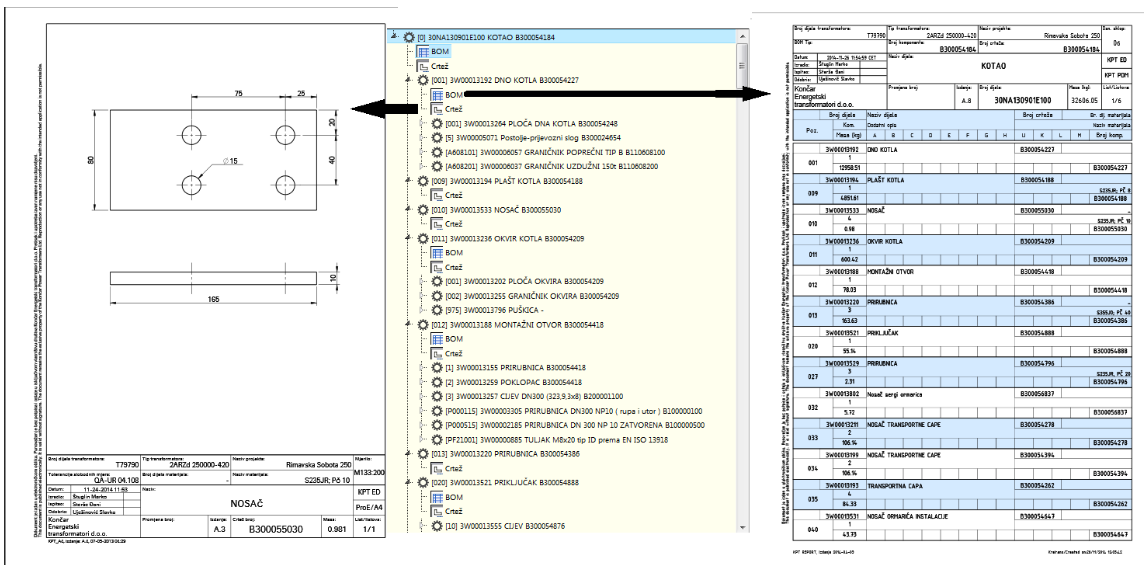

Figure 4. PDF documentation browser (during reviewing process)

2.1.3 Example 3.

One of the main project requirements was to provide the transfer of the BOM data from the design department to the ERP system automatically. The preparation of BOM for the next office down the process production line was left, for now, to the PLM BOM management module. Before the PLM implementation, BOM preparation for the ERP system was done manually. A bill of material (BOM) is a complete, formally structured list of the components that make up a product or assembly. The list contains the object number of each component, together with the quantity and unit of measure (DIN 199, part 2, number 51). BOM reports together with drawings are a very important part of the technical documentation in the product creation process. As such, it is considered as the centrepiece of the BOM centric approach [BOM-CENTRIC PRODUCT DATA MANAGEMENT FOR SMALL AND MEDIUM MANUFACTURING ENTERPRISES]. The company is using SAP as the ERP system and had limited control on the possibility of ERP customization. So, a one direction approach was chosen, and the data were sent from the PLM to the ERP. For this to be possible, an additional custom application had to be created. The purpose of this application was to collect data from the PLM system, convert it to a format acceptable to the ERP system and to create files that can be read by the ERP system. During the training, a particular emphasis was put on the process of communication with the ERP system so the right data would be available when needed. Exchanging data bidirectional between PLM and ERP systems is a challenge for the future.

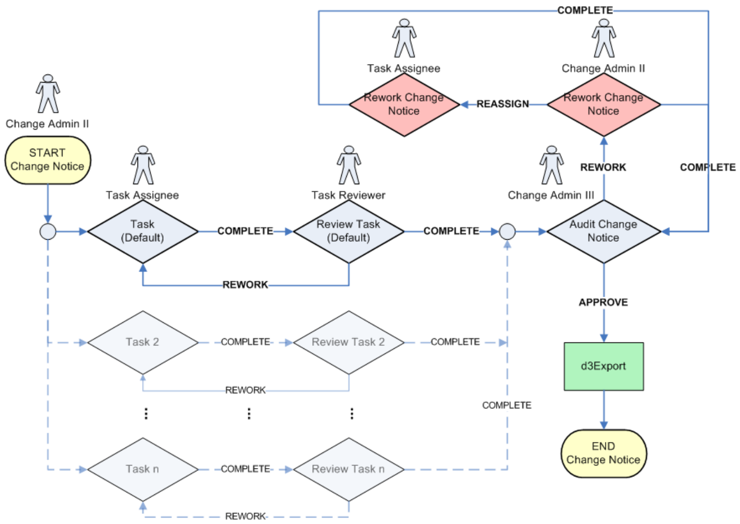

Figure 5. Change Management Process

2.1.4 Example 4.

This customization involved establishing communication, on the file exchange level, between the PLM system and the existing D.3 document management application (http://www.d-velop.de/en/). Communication had to be done by sending drawings and BOM reports in PDF format to the application. This was done by customization of the promotion workflow and creation of a BOM generation utility. When the senior designer approves the design, all the CAD models and supporting documentation had to be promoted to the next stage (Release). During the process of promotion documentation required by the D.3 application is gathered and sent to the D.3, BOM reports are also generated and sent with documentation. Change management process (Figure 5.) implementation did not require any additional customization apart from the standard process adaptation (roles and gates definition).

3 DISCUSSION

Project team consisting of company specialists, university researchers and PLM SW vendor conducted the presented PLM implementation case. Although planning of such project is well described and documented every project is a particular case that requires careful planning and support on all the company levels. In addition to well-documented PLM implementation issues, this case has pointed out the importance of project metrics, customization and education.

The project metrics is straightforward when tangible outcomes are evaluated, but verification of intangible outcomes has to be discussed thoroughly since the metrics are blurred. Broadening discussion beyond team limits increases awareness of the project progress in both directions: the company management and the future users. Impact of customization on project costs, implementation duration, are foreseeable, but the impact on system sustainability and overall security are hard to predict. Light customization involves attribute creation, profile cards adaptation, workflow creation and new object creation. On the contrary, the heavy customisation involves changing or adding new mechanisms or functionalities of the PLM software.
A special care should be taken if the PLM solution is based on the web and open source technologies. Frequent changes in web technologies could have a profound effect on the PLM solution performance and usage. During this project implementation, java security functionality, has changed significantly; thus the PLM vendor could not respond on time with updates on the new security level imposed by the changes. Consequently, customization plans had to be reconsidered in order to satisfy new security requirements. It is advisable to reconsider company practices rather than to extend software functionalities. Light customization is unavoidable in order to meet the company needs.
Education and involvement of all parties that will use software should be planned as early as possible, in parallel with project realisation. Such approach will ensure proper implementation acceptance and more important the users feedback might be used to reconsider decisions during project progress and improve the system performance.

4 CONCLUSION

The second phase completion is expected by the end of 2014. At the beginning of 2015, the final phase of the project of the PLM implementation will commence. Experiences gained during the project will be evaluated and used in further projects aimed to extend PLM implementation beyond the design department. Some of the benefits of the PLM implementation (analysed so far) are:

- A reduction of the design cycle time (DCT) – this can be evaluated because we captured information about the design time using PLM and not using one. The results show that for four principal components, time reductions were from 10% to 40% that is significant because we were expecting an average duration reduction of up to 10%. One other important indicator was the rate of time reduction increase. As users gained experience using PLM, the DCT grew almost 5% to 8% each month (on average).
- The second significant benefit was an increase in overall product quality – even during the design of the first product’s components decrease in a number of errors evident. This is not yet at the level that can be thoroughly analysed, but participants argued that this is true; another factor that supports this claim is a significant decrease of noise in the communication between designers, a reduction of the number of design errors was attributed to the fact that designers were following newly implemented procedures during the design process.

Realizirano kroz PLM

	Objekti	Sklop	Osoba	Plan (h)	Realizacija (h)	Δ (%)
1	Krasica 40	Kotao	Petrović S.	72	87,5	22%
2	Statnet 2 Spare 160	Kotao	Petrović S.	120	140	17%
3	Statnet 2 Spare 160	Poklopac	Simić Z.	0	0	#DIV/0!
4	Statnet 2 Spare 250	Poklopac	Petrović S.	120	115,5	-4%
5	Ain Arnat 30	Kotao (zvono)	Petrović S.	72	57	-21%
6	Ain Arnat 30	Poklopac (zvono)	Petrović S.	66	57	-14%
7	Ain Arnat 420	Kotao (dno)	Petrović S.	40	28	-30%
8	EDF 64 i EDF 64/A	Kotao	Kalamir M.	148	143	-3%
9	EDF 64 i EDF 64/A	Poklopac	Škrlin E.	64	94	47%
10	EDF 64 i EDF 64/A	Kupole	Simić Z.	16	17	6%
11	Azerbajđan 1 25/A i 25/B	Kotao	Bikić K.	80	133,5	67%
12	Azerbajđan 1 25/A i 25/B	Poklopac	Petrović S.	64	58	-9%
13	Azerbajđan 1 40	Kotao	Bikić Z.	90	159,5	77%
14	Azerbajđan 1 40	Poklopac	Petrović S.	92	70,5	-23%
15	Feda 210	Poklopac	Petrović S.	116	101	-13%
16	Feda 210	Kotao	Kalamir M.	138	137,5	0%
17	Nantere 200	Kotao (zvono)	Bikić Z.	90	62	-31%
18	Nantere 200	Poklopac	Škrlin E.	64	39,5	-38%
19	Zelenčuk TOZ 200	Kotao (zvono)	Bikić Z.	98	87	-11%
20	Zelenčuk TOZ 200	Poklopac	Kalamir M.	116	117,5	1%
21	Zelenčuk ARZ 200	Kotao (zvono)	Bikić K.	130	112,5	-13%
22	Zelenčuk ARZ 200	Poklopac	Škrlin E.	96	102,5	7%
23	Statnet 2 200 V	Kotao	Petrović S.	106	96,5	-9%
24	Statnet 2 200 V	Poklopac	Škrlin E.	116	93	-20%
25	Statnet 2 200 V	Kupole	Kalamir M.			
26	Prestice 2 200	Kotao	Bikić Z.	122	113	-7%
27	Prestice 2 200	Poklopac	Škrlin E.	100	117	17%
28	Prestice 2 200	Kupole	Baborsky E.			
29	Statnet 2 200 N	Kotao	Petrović S.	106	105,5	0%
30	Statnet 2 200 N	Poklopac	Škrlin E.	116	132	14%
31	Statnet 2 200 N	Kupole	Baborsky E.			

Figure 9. Reduction of the design cycle time per project

The process of PLM implementation is something that must not be taken likely. It can have a significant impact on the company design and work process. The important thing that has to be considered is that once the company is done implementing a PLM (or PDM), getting back to work without one is very difficult (with some PLM systems harder than others). A commitment from the company management and all stakeholders must be 100%. Flexibility in how existing procedures or methods will be used or implemented is crucial if the amount of work implemented is to be decreased. Customizations have to be avoided if possible, and OOTB functionalities have to be considered. The project team should be free of all regular tasks and focus on the process implementation. Reporting to the steering committee is important so the right decisions can be made at the right time.

REFERENCES

Antti S., Anselmi I., (2005), Product Lifecycle Management, Second Edition, ISBN-10 3-540-25731-4, ISBN-13 978-3-540-25731-8, Springer 2005.

An Avatech Solutions White Paper, (2001), A Planning Guide for Data Management Deployment: Defining Objectives and Implementation Strategies, http://www.internetviz-newsletters.com/eletra/mod_print_view.cfm?this_id=357886&u=avatech&issue_id=000070428&show=F,F,F,T,F,Article,F,F,F,F,T,T,F,F,T,T

Bendell T., (2006) A review and comparison of six sigma and the lean organisations, The TQM Magazine, Vol. 18 Iss: 3, pp. 255 – 262

Brian G., (1995), The product data management market. World Class Design to Manufacture, 4(4), pp. 18–22

Burden R., (2003) PDM: Product Data Management, Resource Publishing, SBN-10: 0970035225.

Cederfeldt M., Sunnersjö S., (2003), Solid Modelling With Dimensional And Topological Variability, ICED 03 Stockholm, august 19-21, 2003., pp. 1-10

CIMdata, 2002, Product Lifecycle Management (PLM) Definition, October 15, 2002.

Larsen, K. R. T., (2001), Antecedents of implementation success: a comprehensive framework. Proceedings of the 34th Hawaii International Conference on System Sciences.

Mansson P., Nyberg D., (2002), Implementing Product Data Management in Product Development Projects, Master of Science thesis, Chalmers, Goteborg, Sweeden 19-12-2002.

Pdf.js, https://github.com/mozilla/pdf.js

Pikosz P., Malmstrom J., Malmqvist J., (1997) Strategies for Introducting PDM Systems in Engineering Companies, Proceedings of CE, Vol. 97., August 1997, pp. 425-434

Riitahuhta A., (2002) Enhancement Of Collaborative Product Data Management, Third International Seminar and Workshop, EDIProD' 2002, pp. 91-96

Shih-Chih C., Chen-Yen C., Kuo-Shean L., Huei-Huang C., Szu-Hsiung Y., (2012), Implementing the Product Data Management Into Enterprise: Five Case Studies., Australian Journal of Business and Management Research, June 2012., Vol 2., No. 03, pp. 19-24

Siddiqui A. Q., Burns D. N., Backhouse J, C., (2004), Implementing product data management the first time, CIM, september 2004, vol. 17, pp. 520-533

Stark J., (2011), Product Lifecycle Management: 21st Century Paradigm for Product Realisation, Second Edition, ISSN 1619-5736, ISBN 978-0-85729-545-3, Springer 2011.
Tavcar J., Duhovnik J., (2004) PRODUCT LIFE CYCLE MANAGEMENT IN A SERIAL PRODUCTION, International Design Conference - DESIGN 2004, Dubrovnik, May 18 - 21, pp. 925 – 930
Wildeman R. C., (2009), The State Of Product Life-Cycle Management 2009. Forrester Research, Cambridge, USA.
Weber C., Werner H., Deubel T., (2002) A Different View on PDM and its Future Potentials, International Design Conference - DESIGN 2002, Dubrovnik, May 14 - 17, pp. 101-112
Weiss Z., Dostatni E., Diakun J., (2004) The Concept Of PDM And Agent System Integration For Design Management In Virtual Environment, Fourth International Seminar And Workshop, EDIProD'2004, Zielona Gora – Rydzyna Poland, p.p. 299 – 303

ACKNOWLEDGMENTS

This paper is supported by the KONČAR - Power Transformers Ltd. company. The authors would like to thank for their support.