REFLECTIONS OF THE "LEAN PRINTING AND PACKAGING" APPROACH IN THE FINAL PAPERS OF GRADUATING STUDENTS

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ABSTRACT

One of the major initiators of the application of lean management in the printing industry was the publication of K. Cooper, M.G. Keif and K.L. Macro's book written on the topic "Lean Printing: Pathway to Success" in 2007. Earlier this decade, teachers and researchers of Óbuda University relied on this publication and other works of the above-mentioned authors to incorporate this knowledge base into the curriculum and educational materials for printing engineers. At the same time, teachers promoted and advertised this new way of production-related and organizational thinking among businesses in professional journals in Hungary.
As an outcome of this double effect, in the past two years several final papers topics of graduating students have discussed lean printing solutions with a focus on discussing actual problems that companies face. The authors of the present paper are teachers and supervisors of this specific topic at Óbuda University. The study presents the methodology of "lean printing and packaging" education at the institution. The present paper focuses on three recent, successfully completed final papers in case of which the authors acted as supervisors and advisors. The paper reflects on the new ideas and attitudes students have brought into the implementation of the projects, and the positive impacts and difficulties experienced in the process of cooperation with businesses. In conclusion, it can be assessed and stated that these final papers belong to the most successful and influential studies of the past two years at Óbuda University's printing industry education.
KEYWORDS: lean printing, lean packaging, final papers, education of graphic communications

INTRODUCTION

The ultimate goal of all business activities is value creation. Value creation is a process that yields a product or service for which a customer is willing to pay. However, in the process of value creation there are activities not representing any value. Although they are parts of the process, it does not mean that the customer is willing to spend money on them.
Lean Manufacturing is a philosophy of production that has a focus on rationalizing and optimizing value-adding processes, reducing and eliminating potential losses. It puts the production system in a place that allows production of high-quality products at moderate costs and with short lead times. The aim is to align the process of production with the expectations of the customer. Consumers tend to demand increasingly better quality, lower prices, short lead times and a broader selection of

products. Developed by Toyota, the efficiency of Lean Manufacturing is inherent in its underlying principles; its rules, means and philosophy operate in harmony in order to eliminate losses from the processes.

OBJECTIVES OF THE RESEARCH AND FINAL PAPERS

The fundamental hypothesis of the present paper is that Lean Principles are value-centred, and facilitate the elimination of losses. In our case, a graphic enterprise can considerably improve the efficiency of its printing process (from the customer to the prints) with the application of Lean Manufacturing, promoting an increase in the profit. Our objective is to examine the losses incurred within the printing processes of cardboard packaging materials by the company under examination, and investigate how the application of the means of Lean Manufacturing can cut back or fully eliminate the revealed losses. In addition to looking at the printing process, we also want to know what impacts these changes may have on the reduction of costs.
The objective of this study is to support the introduction of lean management and the use of modern printing technologies by assessing the loss-making constituents of AR Carton Packaging Group's printing processes, offering solutions to mitigate or fully eliminate these impacts, as well as confirming the actual implementation of cost reduction.

Lean printing

In the printing process, customers value the creation, reproduction of the conceived design, colour, while for the printer the satisfaction of these demands in a cost-efficient manner. For the customer, the essential aspects are the colour, form and deadline of delivery, whereas for the printer the keys to profit lie in the short adjustment time and quick printing of the requested number of useful copies. In the printing process, the Lean Philosophy is embodied in the efficient and inexpensive satisfaction of customer expectations. The specific working process of Lean Manufacturing and the printing technology should work together effectively. It means that Lean proves to be insufficient if the management of the printing technology fails, while without the lean component even the best technology will be less effective. They together provide the best environment for the operation of a competitive printer.

RESEARCH METHODS

Procedure and methodological approach:
- analysis of the principles, means of Lean Manufacturing,
- study of the values, losses of the printing process,
- determination of the measures to improve efficiency, actual steps to accomplish the objective
- implementation of the enhancement of efficiency,
- explanation of results.

The aim of the research is to rely on certain technical processes and printing technologies in combination with the lean methods towards the improvement of efficiency of the printing process, and thus to reduce costs at AR Carton Packaging Group. As specific aspects of these examinations, means of lean methods, operating safety and printing technology have been selected that have the potential to improve the efficiency of the process to the greatest extent, eliminate or reduce losses.

Establishment of orderly work conditions, effective base material flow

In order to make the working environment of the printing presses more orderly and safer, 5S was applied. The objective was to establish an efficient, safe and high-standard work environment. Whatever was not needed for the performance of daily tasks in the printing press was sorted out and removed. After this process of selection, it was re-considered whether such materials and devices had been retained in the work area that were integral parts of daily work, and whether their quantities had indeed been effectively cut back. For the required tools, expedient storage places were accurately defined and created, while other objects were stored in an easily recognizable arrangement. As a fundamental rule, objects, base materials that were necessary for adjustment or production were placed so that they should become accessible in the quickest and shortest way. *Figure 1* demonstrates the working environment of the KBA Rapida 142 sheet-fed offset printing press. Following the completion of the 5S process, only the necessary tools remained in the work area, in an ergonomic, visually recognizable arrangement.

Figure 1: Surroundings of the KBA Rapida 142 sheet-fed offset press

The established system was designed to sustain and develop the existing work environment. With the use of a questionnaire, the surroundings of the printing press are now reviewed on a monthly basis. The questions are scored in order to quantify the existing conditions, whether they are perceived as improvement and/or regression. Beside the work environment of the printing press, the 5S method was also applied to the base material flow of the manufacturing process.

The existing material flow was assessed and visualized as shown in *Figure 2*. Having reviewed the given material flow for print carriers, we had to admit that neither the location of the in-process inventories, nor the place of the roll warehouse was optimal. The movement of print carriers demanded considerable time and energy due to the considerable distances. The base materials were not available where they were actually needed.

Thanks to the new arrangement, the distance between the printing press and in-process inventories was reduced from 100 meters to 20 meters. Therefore, the base material can now be carried to the printing press in a shorter time, with smaller loss from the operators' time. The achieved time saving can be utilized to perform other operations within the printing press.

Figure 2: Non-optimal material flow

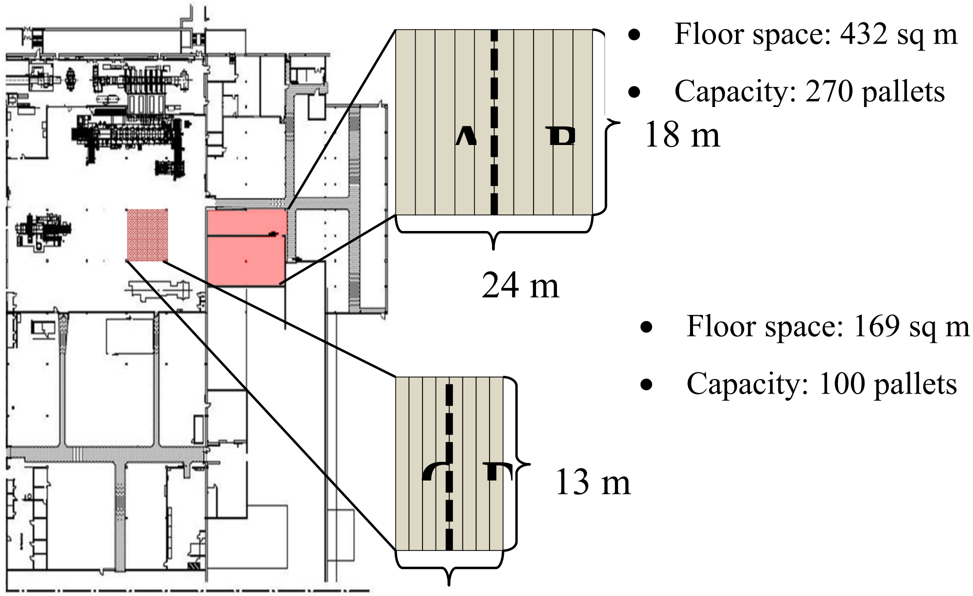


Figure 3: Optimized material flow

Improvement of the reliability of the printing press

As within the plant no sufficient expertise is available, the maintenance and servicing of the KBA Rapida 102 sheet-fed offset printing press were outsourced to the supplier of the printing press. Throughout detailed counselling and negotiations, the terms and conditions of maintenance and repair servicing activities were defined and set forth in the form of a contract. The partner program implemented in the framework of the given contract was aimed at reducing the time losses arising from machine failures, and guaranteeing an appropriate level of operating safety. The contract consisted of three modules. The first module was designed to ensure the monthly servicing of problems with the machines to maintain the initial conditions of the equipment, and sustain the perfect operation of all the functions of the printing press. The second module allowed remote servicing all around the clock. The last module covered the assessment of the prevailing conditions of the machines on a half-yearly basis. The printing press was not set to be inspected only for mechanical problems, but diagnostic test printing was required to be executed. The defined checks included the printing characteristics, reproduction capabilities of the press, as well.

To cut setup times, the SMED (Single Minute Exchange of Die) method has been applied.

When the setup process is optimized, the following actions can be taken:

- reduction of the number of steps/components to be completed,
- reduction of the number of setups,
- improvement of the accuracy of setups,

• reduction of the amount of waste generated during the printing process.

To clarify the setup time and unveil the processes, causes of the excess time demand, the Fishbone/Ishikawa Diagram was used (Figure 4).

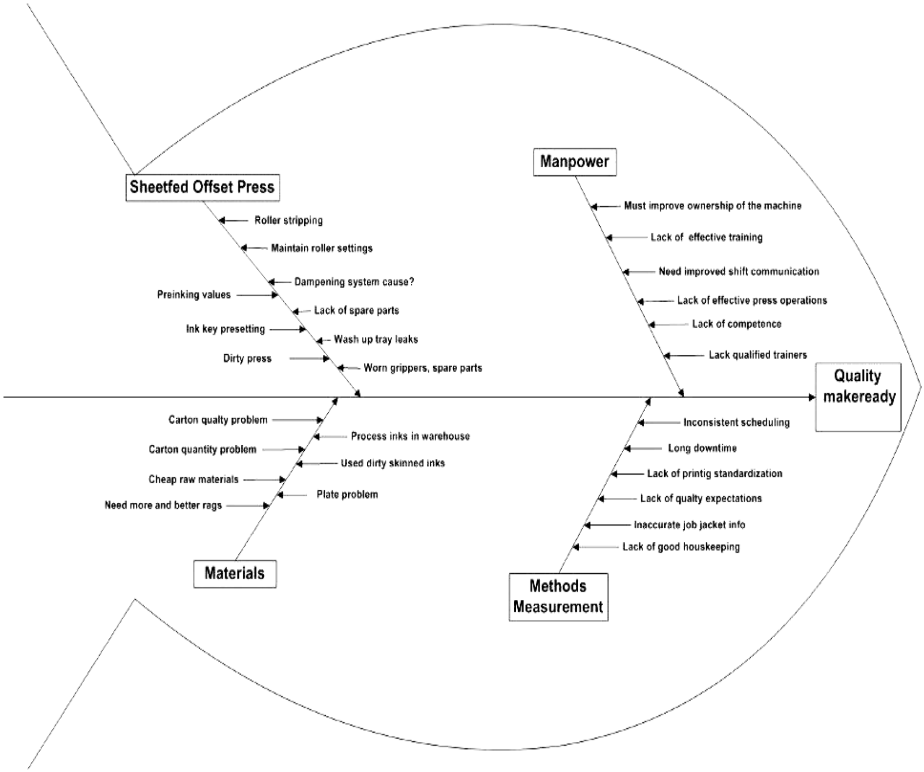


Figure 4: Makeready Fishbone diagram

The SMED makes a distinction between so-called external and internal operations that jointly form the setup process. Internal operations can be executed when the press is in standstill, for instance during the replacement of the dye plate. External operations can be completed in the course of the printing of the actual copies, when the printing machine generates marketable products, for example during the preparations for the replacement of the dye plate.

The optimization of the setup time consists of three main phases.

Phase 1: Separation of internal and external operations.

Phase 2: Conversion of internal operations into external operations.

Phase 3: Harmonization of all the elements of the setup operations.

To *separate internal and external operations*, the process of changeover was subjected to value stream analysis by making and evaluating a video recording. After the making the recording, the video shots were replayed in the presence of the work team, each of the operations performed was identified, and they were also quantitatively defined (in terms of time). In addition to the video recording, a motion diagram was also compiled (Figure 5) in order to visualize and easily recognize losses.

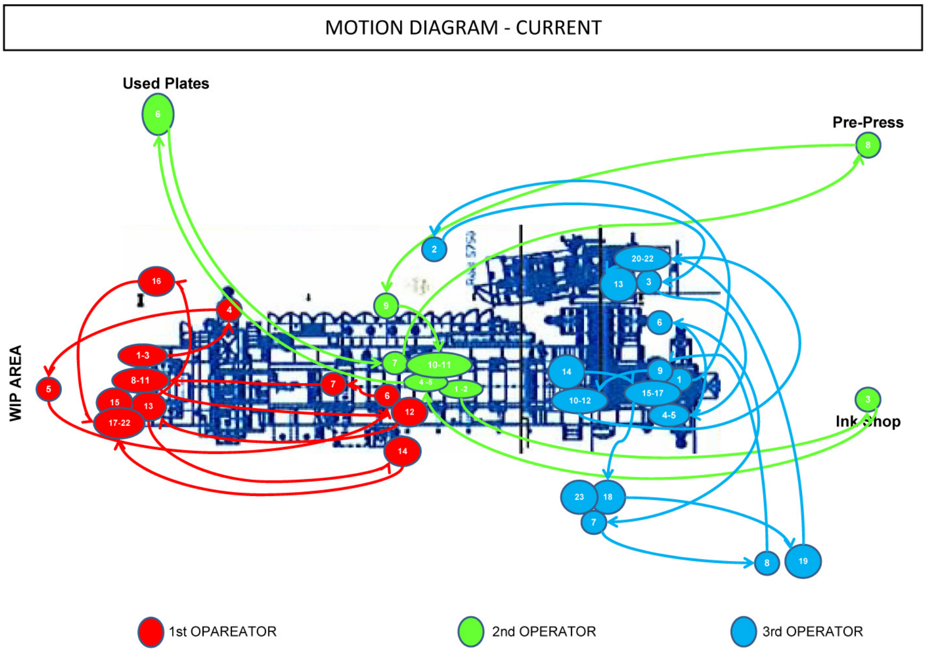


Figure 5: Spaghetti map - current

During the conversion of internal operations into external operations, the following questions had to be answered in the light of the steps that had already been identified.
What is the purpose of the operation?
Why should the machine be in standstill to perform the actions?
Is the operation convertible from internal setup to external setup?
We tried to form the largest possible number of operations in the external setup, as irrespective of the weight of the operation, thereby minimizing the time loss.

The steps included here are:

- documentation steps (completion of the work dossier),
- preparation of the dye plate, bending, checking, preparations for the replacement of the plate,
- uploading, checking CIP3 data,
- interpretation of the work dossier,
- preparation of the lacquer form,
- preparation, unwrapping of the print carrier,
- preparation of detergents, materials,
- preparation of printing colours, etc.

Once there was a clear view as to which operations should be performed when and where, we started to *harmonize the operations* and simplify more complex steps. Conventional tasks, such as the development of the dye plate and the machine washing process, did not convey considerable challenges, because the printing presses included in the target group are characterized by a significant level of automation. On the other hand, the synchronization of the work steps of printing engineers proved to be a more difficult task. It brought about changes, and initially they were hardly accepted. Nevertheless, they recognized that if they were working as a team, more steps could be performed in the same time, in parallel. By showing the video recording to the team, i.e. how they had been working, it was easier to convince them. The losses were shown before their own eyes. During the SMED project, merely joint team work contributed to the success, because the workers themselves planned the work processes, and optimized their operations. Difficulties were experienced as the competence levels were differing. Certain printing engineers were capable of performing only certain steps, thereby deteriorating flexibility, but within the framework of the lean training program the differing competence levels could also be resolved. We tested the newly framed work processes in practice, with success. The same steps were taken by the printing engineers, but in a different order, and thus the actual time demand of setup was cut down (Figure 6).

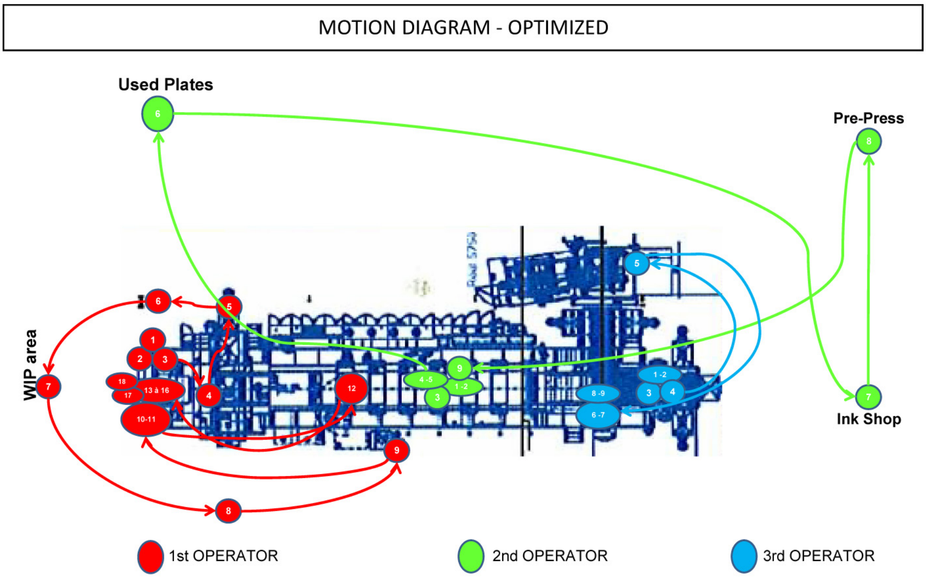
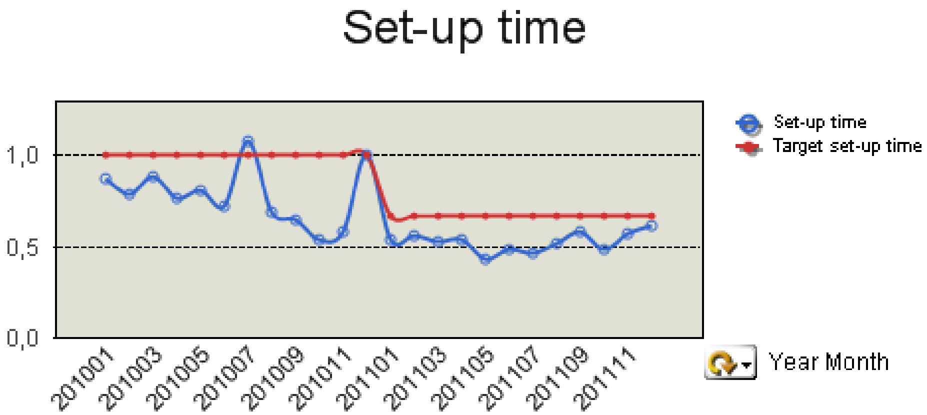


Figure 6: Spaghetti map - optimized

SUMMARY OF THE RESULTS

In 2011, the optimization of the printing process proved to be the key achievement in the life of the plant. Our aim has been accomplished, as the setup times and the number of reject sheets (waste) has been substantially reduced and minimized on a long-term basis (Figure 7). Figure 7 points out that problems associated with the speed of the machine and time losses are still to be tackled. However, it is again an outcome corresponding to our step-by-step approach. For the upcoming year, we plan to make progress in this latter field, as well. Our successes so far underline the efficiency of the application of *lean management*, and as a consequence we have experienced an increasing trust in our research projects and the related, practical organizational work.



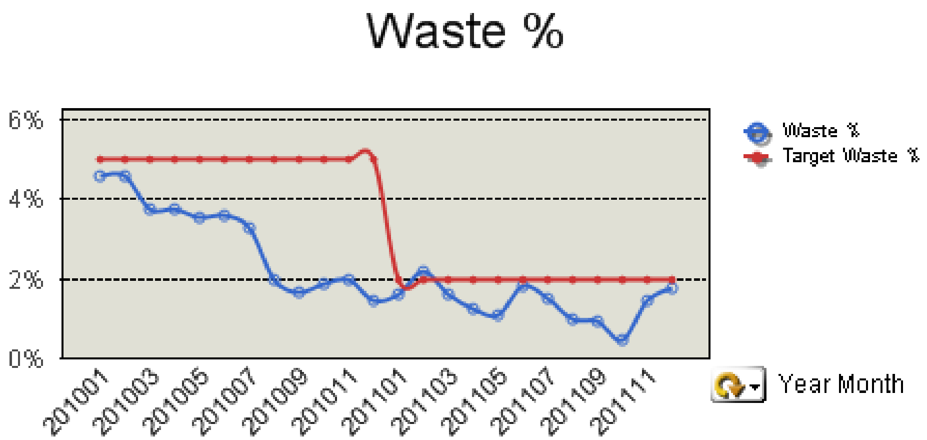
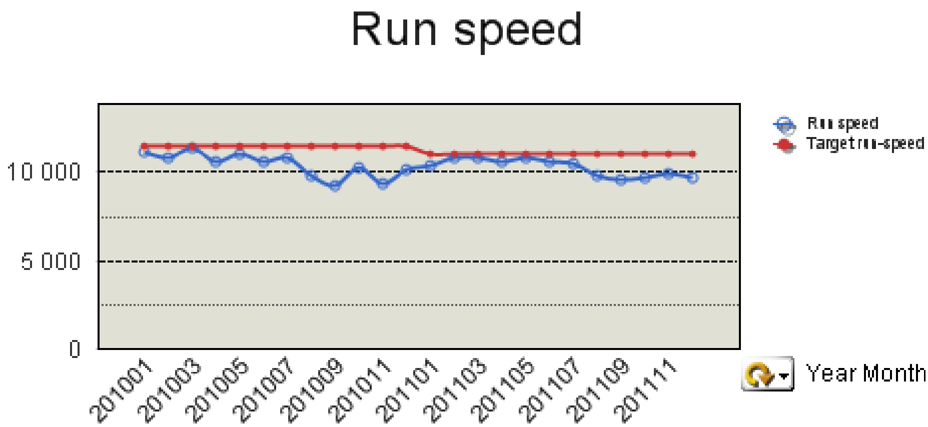


Figure 7A: Utilization properties of the printing presses taken as the target group



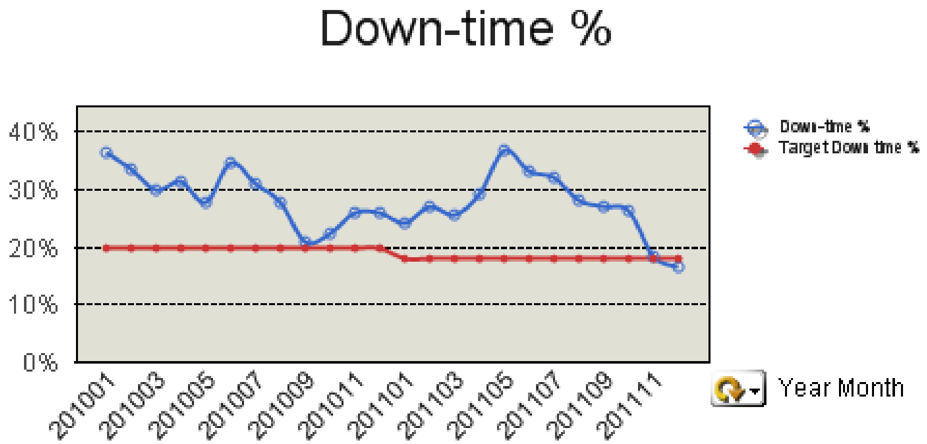


Figure 7B: Utilization properties of the printing presses taken as the target group

Colour calibration of the printing press

The aim of the colour calibration process was to define, and then standardize the technological parameters of the devices used in the printing process (sheet-fed offset printing press, subcontracted colour proofing) on the basis of the test prints. The parameters determined in the course of test printing (CIE L*a*b*colour space, tone value increase) were examined on the basis of the target values set by Standard ISO 12647-2.

After the drying of the prints, the tone value increase of the printing press was determined from the average of the measurement results of several prints. On the basis of the measured values, the tone value projected on the form was modified so that in the course of printing the tone value increased by the printing press in the print should comply with the value specified in Standard ISO 12647-2.

Calibration was also performed for the subcontracted proofing, i.e. the inkjet printer. The effectiveness of calibration was verified by making the test print again.
In addition to instrumental evaluation, prints were subjected to visual checks, because the majority of customers would judge the colour spectrums of printed products in the same way. The prints of the plates that had been scanned with the settings originating from the process calibrations were compared with the similarly calibrated, subcontracted colour proofs, and eventually it was concluded that the calibration was successful.
In the course of digital pre-processing, appropriate colour separations could be made for printing. The two work processes became harmonized, and – as a very important aspect – mutually verifiable. The roots of problems now proved to be distinguishable, and the efficiency of the process improved. The settings of printing became unambiguous, individual, occasional adjustments in the machine room could be avoided, reproducibility greatly improved.

CONCLUSIONS

Using the means of lean management and the development of the processes of printing technology applying a common approach has clearly visible and measurable outcomes. In consequence, it can be stated that the use of lean methods with proper view of industrial characteristics, i.e. "lean printing" is a truly useful tool. Without a thorough knowledge of the technology, the means of lean management may be successfully applicable, though cannot ensure breakthrough.
The ways of practical usage described throughout the present paper undoubtedly underline this statement. Both cost reduction and the enhancement of production efficiency can be further continued. It is a never-ending process. There will always be new losses occurring, and they can be eliminated from the process to reach further improvement.

REFERENCES

1. Behringer, R. (2012), Sustainability as a Success and Competitive Factor (presentation), Lean & Green, International Environment Conference, DRUPA, Düsseldorf, May 12, 2012
2. Cooper, K. (2010), Lean Printing: Cultural Imperatives for Success, PIA/GATFPress, Pittsburgh, ISBN: 9780883626887
3. Cooper, K. - Keif, M. G.- Macro Jr. K. L. (2007), Lean Printing: Pathway to SuccessPIA/GATFPress, Pittsburgh, ,ISBN: 0-88362-586-5
4. Horvath, Cs.(2012), Leaner and better. How can the setup time and waste at the sheet-fed presses be reduced?39th International Research Conference of IRIGAI, Ljubljana, Slovenia, Vol. XXXIX of the Advances in Printing and Media Technology (published in November 2012), p. 139-144 (ISBN 987-3-9812704-5-7)

5. Rizzo, K .E.. (2008), Total production Maintenance: A guide for the printing industry, PIA/GATFPress, Pittsburgh, (3rd ed.), ISBN: 0883626209
6. Rothenberg, S. – Cost, F. (2004), Lean Manufacturing in Small- and Medium-sized printer, RIT Printing Industry Center
7. Weather, J.P. (2012), Lean & Green, Economic and Environmental benefits of Lean (presentation) Lean & Green, International Environment Conference, DRUPA, Düsseldorf, May 12, 2012
8. Wells, N. (2012), Leaner & Greener, Value Chain (presentation), Lean & Green, International Environment Conference, DRUPA, Düsseldorf, May 12, 2012
9. Wells, N. (ed), (2012), Print: seen lean&green!(1-2) PrintCity GmbH & Co. KG, Gröbenzell, Germany

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