SOME ASPECTS OF OPTIMIZATION FOR PRINTING AND FINISHING OFFSET PROCESSES

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Rezumat. *Pentru a rămâne competitive, companiile tipografice trebuie să-și îmbunătățească continuu activitatea, atât în domeniul tehnic cât și în cel organizatoric. În această lucrare sunt prezentate câteva aspecte legate de optimizarea proceselor tehnologice de tipărire. Produsele de tip reviste, broșuri, caiete sunt produse realizate frecvent prin tehnologia offset. Pentru realizarea tipăririi propriu-zise sunt necesare atât mașini de tipărit cu alimentarea în bobină cât și în coli. Lucrarea prezintă varianta inițială de flux de producție care ține cont de dotarea actuală, atât materială cât și umană a tipografiei în care s-a realizat studiul de caz. În urma studierii timpului necesar pentru fiecare ciclu de lucru al mașinilor s-a propus o nouă variantă, automatizată, a fluxului de producție. S-au analizat avantajele și dezavantajele fiecărei variante propuse și s-au stabilit criterii de optimizare a fluxurilor de producție.*

Abstract. *In order to stay competitive, printing companies need to continually improve their business, both in the technical and organizational fields. In this paper are presented some aspects related to the optimization of the technological processes of printing. Printed products such as magazines, brochures and notebooks are often made by offset technology. In order to achieve the actual printing, both web and sheet-fed printing machines are needed. The paper presents the initial version of the production workflow taking into account the available current endowment, both equipment and human resources of the printing house where the case study was conducted. After the study of the time required for each machine cycle, a new, automated production workflow was proposed. The advantages and disadvantages of each proposed option have been analyzed and criteria for optimizing the production flows have been established.*

Keywords: offset technology, optimization, workflow, magazines.

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1. Introduction

Today, printing companies are often confronted with the necessity to adapt quickly to the emergence of new products and technologies and to the increasingly diversified demands of their customers.

In order to stay competitive, companies need to continually improve their business, both in the technical and organizational fields.

Based on production requirements and the production workflow analysis, for optimizing the production workflow one must take into account the specific production constraints in a printing company, such as: a very large number of orders are managed at the same time; the raw materials and materials used to make a product are very varied; the finished products are in a wide range of formats and involve different finishing operations; the necessity of a period of time to acclimate the paper before it is printed and another one for the ink to dry on the printed sheets [1, 2].

In this paper are presented comparatively two variants of the production workflow for magazine products, printed by offset technology: the original one and the improved one.

The production workflow studies and research allows the possibility to choose the criteria for the workflow's optimization in terms of time and labour saving and therefore, the final cost of the finished product.

2. Description of Production Workflow

Each process imposes different constraints and different ways to apply the optimization strategy criteria with the aim to constantly increase the quality of printed products.

The diversity of production workflows led to the need of implementing modern printing machines, the fast increase of their degree of automation, to important changes of the production cycle structure and to the introduction of hybrid technologies [3].

Products such as magazines are frequently manufactured by offset technology [1].

The components of a magazine are signatures (4, 8, 12, 16...pages) and cover, sewn or stapled together (Fig. 1).

The sheets of printed paper from which the signatures forming the inside pages of the magazine are printed on web-fed offset printing machines and the cover of the magazine is printed on sheet-fed offset printing machines.

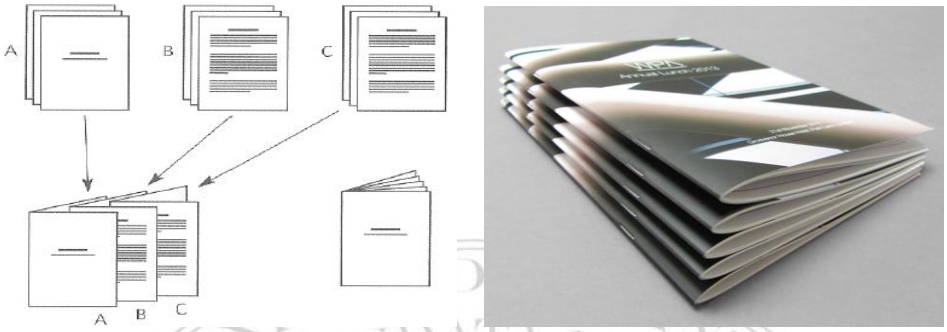


Fig. 1. Components of magazine-type products (cover, signature, magazine) [4].

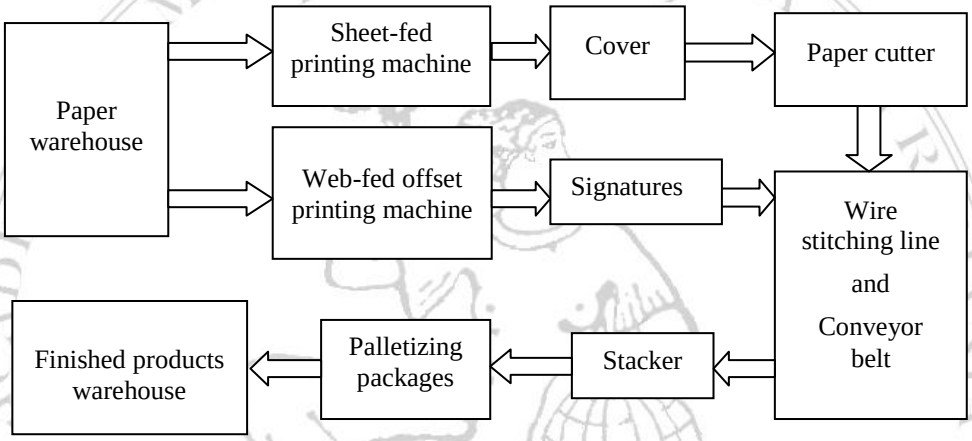


Fig. 2. The production workflow chart of a magazine.

Figure 2 presents a schematic view of the production workflow of a magazine.

It can be noticed that the required paper quantities for both offset printing machines (sheet-fed & web-fed) are delivered from the paper warehouse in order to carry out the entire print run.

The two printing machines are working simultaneously. Subsequently, the printed covers are cut to the gross format dimensions on paper cutting machines. Next, the inner sheets and covers, all in the raw format, are placed in the appropriate feeder of the wire stitching line. Here the sheets are interleaved, the cover is added and the magazine is stitched and cut on three sides (head, foot, lateral) to the requested size. Finished cut magazines are delivered via a conveyor belt to a stacker that counts, stacks and bundles them. The packages are then placed on pallets and sent to the finished product store.

This paper analyses the optimal way to obtain a number of 7,000 pieces print runs of a 64-page magazine. To achieve this number of pages, 4 printed standard sheets of paper 500×700 mm properly folded are needed.

Taking into account all this, two workflow variants are proposed considering the available current material, as well as the human resources of the printing house where the case study was carried out.

For the first variant, variant **A**, the production line consists of (Figure 3):

- web-fed offset printing machine - Harris M1000 (16 pages);
- sheet-fed offset printing machine - KBA Rapida 75;
- paper cutting machine;
- semi-automatic wire saddle stitching line for magazines;
- three-knife trimmer;
- off-line stacker;
- semi-automatic bundling machine.

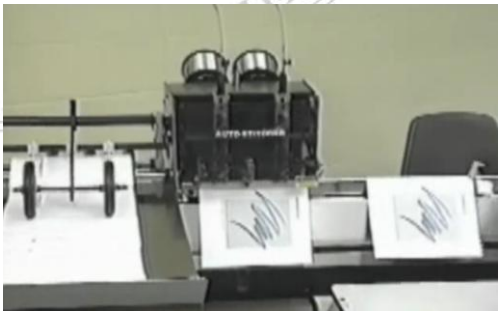
Printing of the 64 interior pages [5].

The inner signatures delivery [5].

Cover printing [6].

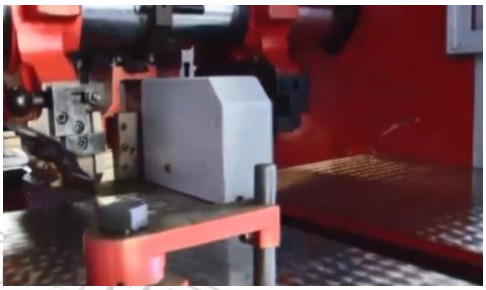
Cover cutting to the gross format [7].

Manual feeding of the semi-automatic wire [8].



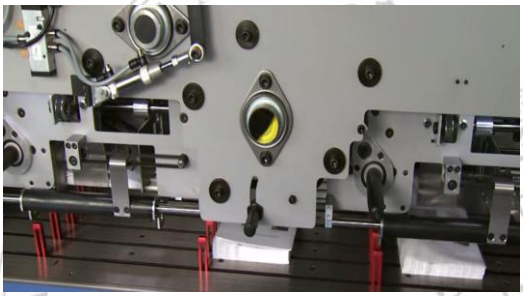
Magazines wire stitching [8].

Trimmers manual feeding [9].



Magazines trimming to the requested size [9].

Fig. 3, a. Phases of operations on the production workflow - variant A.



Magazines wrapping and bundling [10, 11]

Fig. 3, b. Phases of operations on the production workflow – variant A.

Below are the stages of the production workflow and the working times required for the entire magazine run for variant **A**:

Step 1:

- preparing the web-fed offset printing machine: 45 min;
- making paper runs: 3 hours;
- preparation of the sheet-fed printing machine: 20 min;
- making the cover run: 40 min;
- drying of printed sheets: 4 hours.

Step 2:

- cutting the covers to the raw format: 45 min;
- preparing the paper cutter: 30 min;
- interleaving folded sheets (signatures), covers and setting wire saddle stitching machine: 3 hours;
- preparation of magazines for cutting to the requested format: 45 min.

Step 3:

- preparation of the three-knife cutters: 45 min;
- cutting magazines to the requested format: 8 hours;
- packaging and palletizing: 2 hours.

The total working time is of 24 hours and 45 minutes and the staff distribution is as follows:

- web-fed offset printing machine team - 4 workers;
- sheet-fed printing machine - 1 worker;
- paper cutter - 1 worker;
- interleaving-stitching magazines - 2 workers;
- trimmer cutter - 1 worker;
- packaging-stacking operators - 2 workers.

Modern printing solutions provide not only added quality to printed products, but also increased productivity, easy control over printing machine components, reduced technological losses or less effort for the operators [3].

For the second variant, version B, the production line consists of:

- web-fed offset printing machine - Harris M1000 (16 pages);
- sheet-fed offset printing machine - KBA Rapida 75;
- paper cutting machine;
- automatic line for finishing magazines - Müller Martini Primera C 130;
- stacker (including packaging-strapping).

Step 1 (printing):

- the operations are identical to those shown in case of variant A.

Step 2:

- automatic saddle stitching line feeding: 25 min;
- saddle stitching line setting: 15 min.

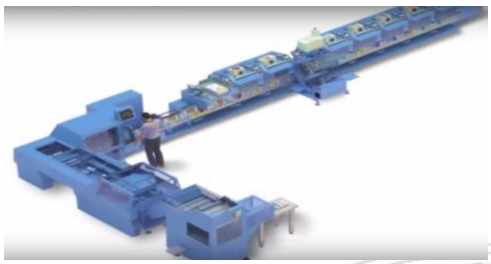
Step 3:

- interleaving, stitching, trimming magazines to requested format, sorting, stacking and wrapping packages, strapping packages. All these operations are performed automatically.

The high-performance automated magazine finishing line Müller Martini Primera C130 is a multi-processing machine with quick settings via touch screen, ideal for products with frequent format changes (Fig. 4).

The saddle stitching line is equipped with imaging or barcode recognition systems, inserting station, signature inspection and thickness measuring systems, inline hole punching.

It also allows for the detection of defective magazines and their automatic removal (no need for manual sorting) [12].



Müller Martini saddle stitching automatic line.

Placing signatures in the near feeding station.

Double wire stitching head.

Automatic sorting device.

Fig. 4, a. Phases of operations on the production workflow – variant B [13, 14].

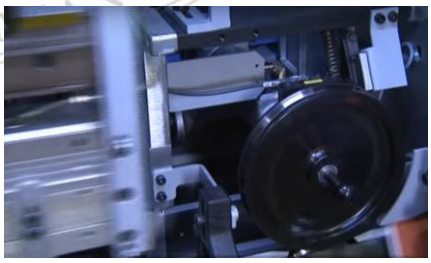
Programming the automatic line functions from the processor console.

Automatic synchronization of feeding stations.

Signature stop.

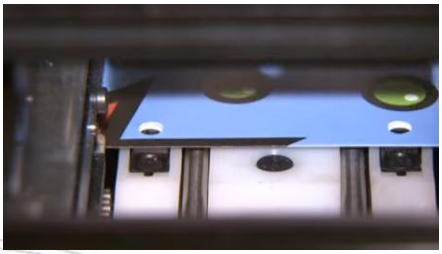
Change over from gripper to suction opening.

Cover sensor.



Automatic magazine thickness detection.

Automatic trimming station - head, foot, lateral.



In-line hole punching.

Barcode recognition device.

Automatic stacking, wrapping and strapping.

Fig. 4, b. Phases of operations on the production workflow – variant B [13, 14]

The total working time is of 12 hours 15 minutes, and the working team consists of 7 workers distributed as follows:

- web-fed offset printing machine team – 4 workers;
- sheet-fed offset printing machine – 1 worker;
- automatic saddle stitching finishing line – 2 workers.

3. Simulation of Production Workflow Variants

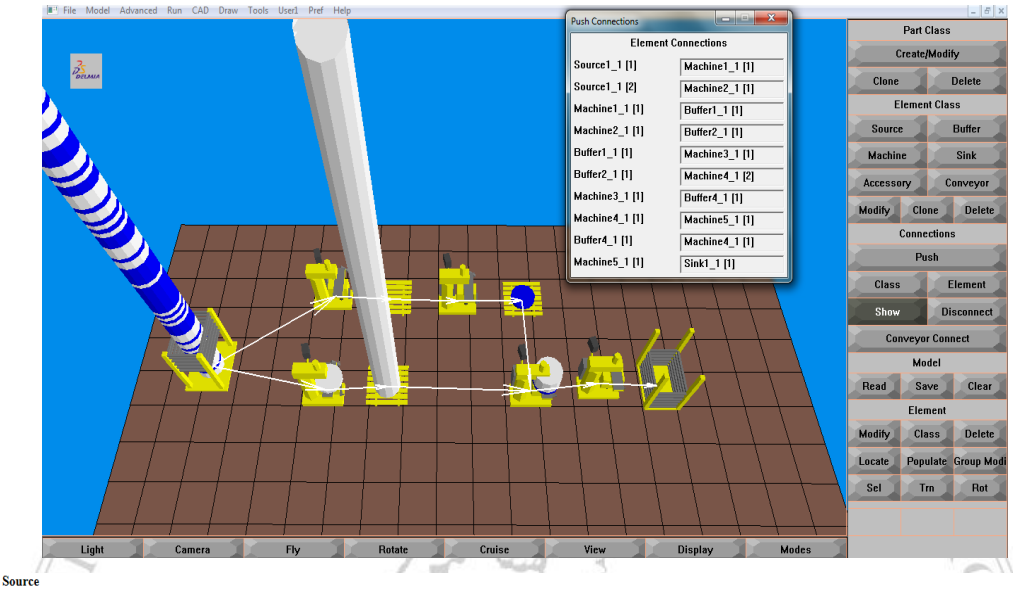
Simulation of the production workflow of a magazine was done using the Delmia Quest software [15].

The programme input data have been set according to the production workflow description above.

Table 1 shows the working cycle times for each operation.

It was considered that the simulated time period is of 8 hours (1 work shift), the 30 minute lunch break, the average MTTR repair time of the machines is 0 hours and the MTBF average running time is 8 hours.

For the implementation of the production line in the Delmia Quest software the following elements are created (Figure 5): the product (PART), the SOURCE, the MACHINE, the BUFFER intermediate storage warehouses, the final warehouse (SINK) and their connections (CONNECTION).



Source

Name	State Times		Created Parts	Creation Rate
	Idle	Blocked - Wait Block		
Source1_1	8.000	8.000	28800	3600.000

Sink

Name	State Times	Finished Parts
	Idle	
Sink1_1	8.000	1336

Fig. 5. Workflow components.

Table 1. The required time for each operation

Operation No.	*Operation*	*No. of machines*	*Machine type*	*Working cycle time (s)*
Op. 01	Cover printing	1	KBA Rapida 75	2
Op. 02	Printing interior pages	1	Harris M1000	20
Op. 03	Cover cutting	1	Schneider Senator 115	1
Op. 04	Signatures interleaving	1	Kolbus	15
Op. 05	Magazine stitching		Kolbus	
Op. 06	Package bundling	1	Civiemme	8

Figure 6 also shows the creation of the 5 operators (LABOUR) in the simulation software.

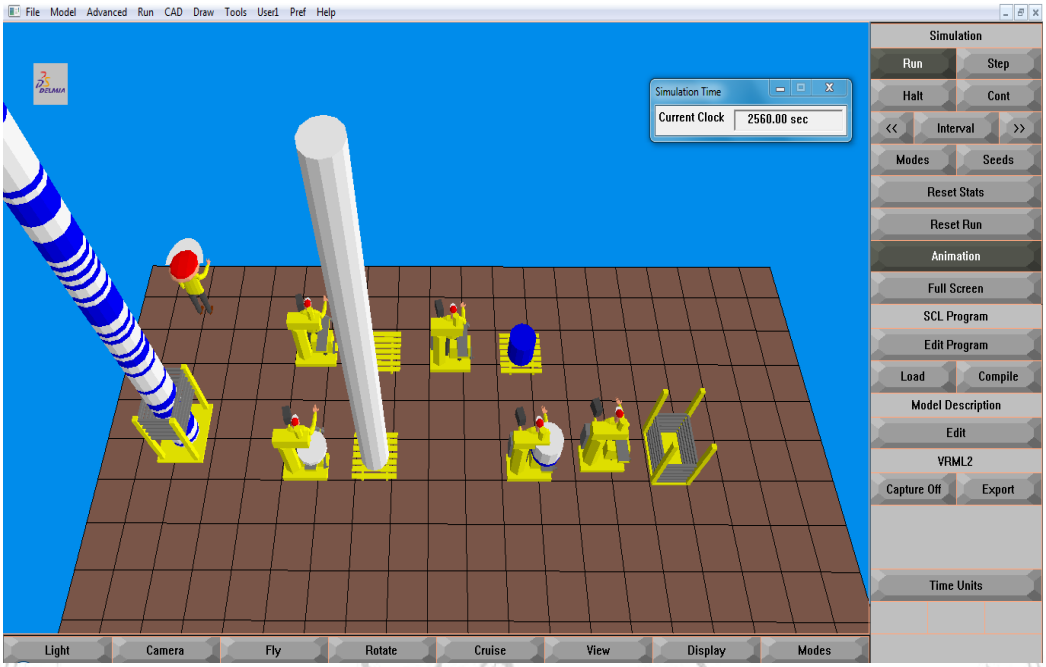


Fig. 6. Creating operators with the Delmia Quest software.

According to the simulation, for a working shift (8 hours, of which 30 minutes for the pause) 1336 pcs of magazines are finished (Figure 7).

4. Criteria for Optimizing the Production Workflow

Taking into account the operations specific to the production workflow of a magazine, the technical department must organise the production according to [16, 17]:

- availability of human resources; particular attention must be paid to the planning of the entire team, which must carry out simultaneous activities; their professional training will be also taken into account;
- arrival date of the raw material: paper, ink, cardboard, plates, etc.; as much as possible, integrate purchasing, production, delivery schedules;
- characteristics and reliable points of operations, for example: consider the working speeds of machines that work simultaneously; buffers will be created between covers, signatures, magazine operations; the drying times of the sheets should be taken into account; the time required to adjust the equipment and to check the correctness of the adjustments;
- machine maintenance; MTTRs and MTBFs specific to all machines will also be considered.

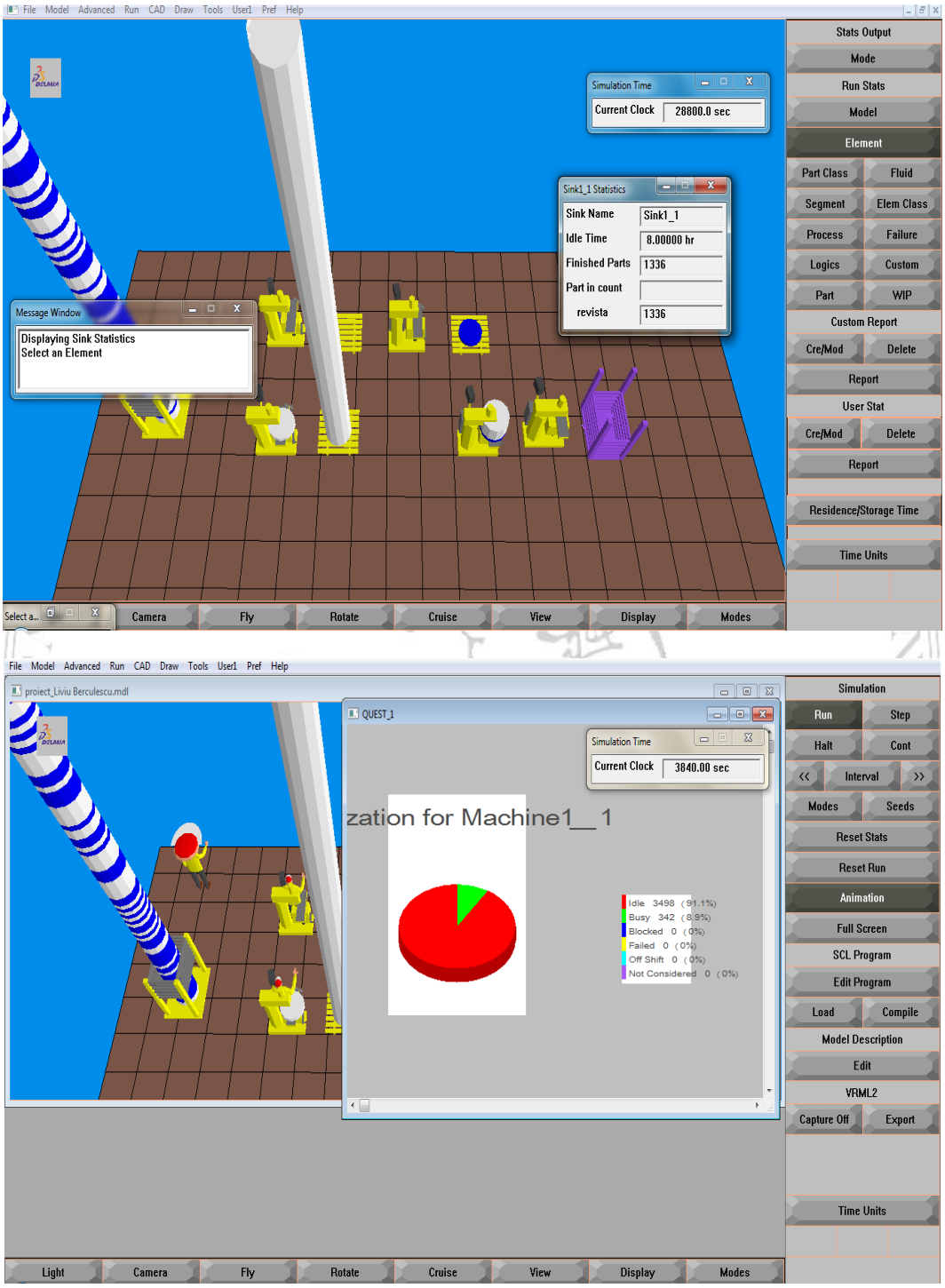


Fig. 7. Simulating results**.**

For example, another solution for shortening the production times of a 64-page magazine is the use a MAN Lithoman type web-fed offset printing machine that prints a double number of pages in a signature (32 pages instead of 16 pages).

This would allow reducing:

- the time required to adjust the machine and check the correctness of the adjustments;
- 50% of printing time, from 20 seconds to 10 seconds (only 2 sheets of 32 pages will be printed instead of 4 sheets of 16 pages);
- the number of operators.

At the same time, the interleaving-stitching time of the signatures that compose the magazine is reduced by 40%, from 15 seconds to 9 seconds (there will be only 2 signatures of 32 pages and the cover, instead of 4 signatures of 16 pages and the cover).

So you can get a magazine in 28 seconds instead of 44 seconds, and the number of magazines made in an 8-hour shift would increase from 1336 to 2099 pcs.

Conclusions

The optimal production programming in a company requires both a good knowledge of the processes and operations specific to the achievement of each product, as well as the coordination of all departments involved in the synchronization of operations.

The technological process must follow a path as short as possible to avoid shifting or crossing directions of movement in the main flows, respectively as little auxiliary times as possible.

When designing or diagnosing an existing technological flow, it is intended to achieve the three components of quality: the time of delivery of the product as short as possible, the low cost (which means fewer auxiliary operations) and the best technical characteristics [2].

In this paper we proposed to optimize the production workflow specific to a magazine by increasing the automation level of the finishing machines.

The production workflow described in variant **B** and obtained by replacing the separately operated machines with an automatic finishing line leads to a reduction in the total working time: a job originally performed in 24 hours and 45 minutes can be done in 12 hours and 30 minutes.

The automatic finishing line of the magazine brings a reduction in the labour involved in the finishing area: from 4 workers to 2 workers.

It is also possible to increase the working speed: from 3,000 pieces to 12,000 processed pieces/hour. At the same time, finished magazines can be sent, via a conveyor belt, directly to the stacker that counts and packages them, ready to be delivered.

It is important to choose the suitable alternative for each company linked to the financial possibilities and the market strategy.

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