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IMPROVING THE QUALITY WORK OF PRINTING PRESS OPERATORS FROM AN ERGONOMIC POINT OF VIEW

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***Abstract:** The paper presents ergonomic aspects regarding the work of press operators in a printing house. It is proven that the organization and logistics of the workplace influence the comfort and efficiency of workers on the technological flow. The problem of lateral cutting of the stamped roll has been solved by adding two longitudinal knives on the die, thus eliminating the use of disc knife holders. Thus, the auxiliary adjustment time and the postural effort of the printing operators were reduced, who, for each stamping, adjusted the disc knives from unfavorable positions, imposed by the construction of the stamping machine.*

***Keywords:** ergonomics, printing houses, quality of work of operators*

1. INTRODUCTION

The paper presents ergonomic aspects related to the work of press operators in a printing house, as it is clear that the organization and logistics of the workplace influence the comfort and efficiency of workers in the technological flow. The purpose is to improve operators' comfort and safety, reducing the risks of injury and fatigue.

The aim is to increase the quality of work (reduction of work efforts, uncomfortable positions) and thus increase workers' performance. In the printing house, workers spend long hours in front of equipment, leading to fatigue, discomfort and health problems. An ergonomic approach to work can reduce the risks associated with repetitive work and improve productivity.

It is essential to organize the workspace in such a way as to reduce physical effort by adjusting the height of the workbench, positioning the equipment at eye level, ensuring good lighting and avoiding awkward operator positions when adjusting the work equipment.

Although the use of modern technology in printing, such as digital printers, can also help to improve the work process, it is also necessary to find solutions in traditional printing house, where workers repeatedly make a series of adjustments

to the printing equipment, often from uncomfortable positions that put strain on certain parts of the body.

Ergonomics and workplace productivity are complementary. The implementation of ergonomic principles can have a significant impact on the efficiency and satisfaction of employees, thus [1,2]:

- An ergonomic workplace configuration helps prevent back pain, neck problems and other musculoskeletal disorders. Employees who feel comfortable are less prone to absenteeism and can work more efficiently;
- Reducing fatigue, by implementing regular breaks but also by reducing physical efforts or excessive concentration, thus reducing mental and physical fatigue. This improves well-being and overall work efficiency;
- Constant monitoring and evaluation of the working environment is essential to identify new opportunities for ergonomic improvements.

Therefore, integrating ergonomic principles into the working environment not only improves the health and comfort of employees, but also contributes to increased productivity in the printing house.

2. EXPERIMENTAL CONDITIONS: CUTTING WITH DISC CUTTER-HOLDER DEVICES IN THE PROCESS OF FLEXOGRAPHIC DIE-CUTTING OF COMPLEX PRODUCTS

Stamping is involved in industrial manufacturing processes and can be found in the most diverse fields such as cutting paper rolls, cutting metal materials, cutting natural or synthetic leather, etc., with the aim of increasing productivity and obtaining superior finished products. The punches are resistance pieces designed for long-term use and constant pressure.

The printing industry applies die-cutting to obtain products with diverse destinations: tickets, book covers, art design, decorations, banners, gifts and many more. In this process the consistent quality of the finished product is the most important [3].

The efficiency of the die-cutting process in the profile industry is constantly being improved. The durability of the knives is influenced by the material from which they are made, the die-cutting process and the disposal of the waste resulting from die-cutting [4].

The knives are designed with a specific geometry depending on the shape of the product to be obtained. Depending on the material to be punched, both the geometry of the knives and the material from which they are made vary and the quality treatment applied (chemical or thermal) can influence its performance [4].

Flexographic stamping is a finishing process specific to printed products. It is used to obtain products in rolls: stickers, tags, folding paper or cardboard products of various thicknesses (Fig. 1) [5, 6].

In flexography, stamping depends on the type of material to be finished and the cutting direction, in practice two types of punches are used: cylinders engraved and flexible dies [7].

In quality printing [8], to control the pressure with which the inks are printed on the printing sublayers, control markers are printed on the edges of the roll. These markers become waste which, after die-cutting the material, is removed by two rotating knife-holders that cut the roll on each edge.

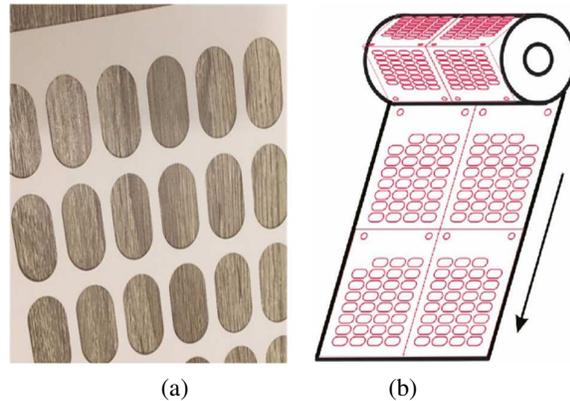


Fig. 1. Final product: (a) cardboard sample with layered composition and (b) sketch of a finished roll [5]

Thus, after stamping, the cardboard passes through the cutting group (Fig. 2) where it is cut laterally with the disc knife-holders.

Cutting with a disc knife (Fig. 2) is done by shearing [9] using a ring-type counter-knife mounted on a rotating lower shaft (Fig. 2) [7], which is the solution recommended by the manufacturer [10].

The knife-holder devices can slide crosswise on a guide provided with a millimetre scale (Fig. 3), for positioning at the required distance for the cardboard width.

The two knife-holders necessary for cutting the edges of the roll are positioned at an angle (Fig. 2) [6] so that by rotating tangentially to the counter-knife they cut the material by shearing.

The products are in rolls and are cut laterally with disc knife holder devices positioned in the machine, immediately after the printing groups.



Fig. 2. Cutting group with disc knife-holders.

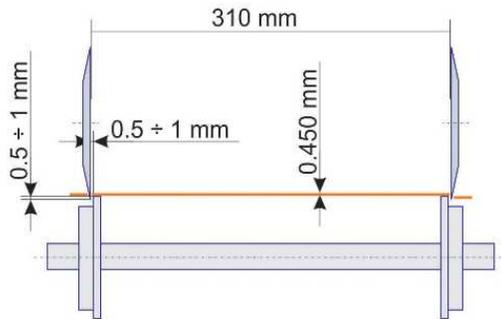


Fig. 3. Positioning of disc knives and of ring-type counter-knives.

When using the cutting unit, the printing worker goes through the following steps necessary to prepare the 0.450 mm thick cardboard for cutting:

- Mounting the ring counter-knives on the lower shaft and the disc knives in the devices;
- Spacing of the knife-holders to achieve the finished product width of 310 mm (Fig. 3);
- Adjusting the knife-holder to the depth of the counter-knife and to the side of the counter-knife (Fig. 4, 5), at a distance of $0.5 \div 1$ mm;
- Adjusting the angle of the knife-holder from 1° to 3° , which varies as the disc knife wears (Fig. 6);
- Checking the working pressure setting in the control panel, value 3.7 bar.

Finally, the two knife-holders are positioned at an angle (Fig. 7) so that by rotating tangentially to the counter-knife they cut by shearing the cardboard.

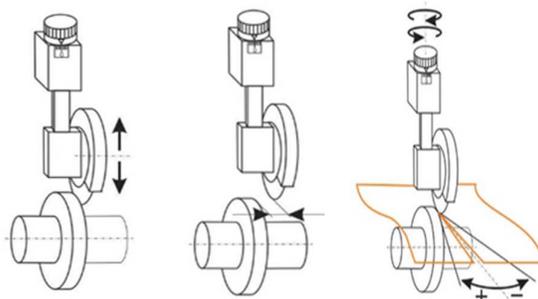


Fig. 4. Vertical adjustment of the disc knife-holder.

Fig. 5. Lateral adjustment of the two knives.

Fig. 6. Angle adjustment depending on printing support.

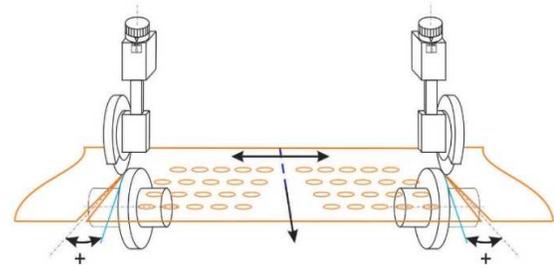


Fig. 7. Angular positioning of disc knives.



Fig. 8. Disc knife.

Fig. 9. Concave shape.

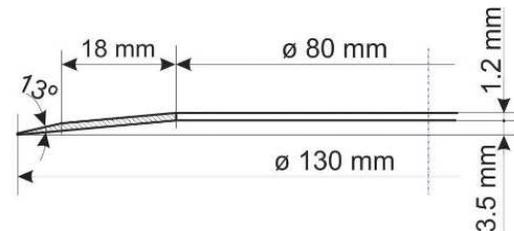


Fig. 10. Physical dimensions.

The geometry of the disc knife used (Fig. 8) shows specific characteristics, namely: • concave shape (Fig. 9); • outer diameter 130 mm; inner diameter 80 mm (Fig. 10).

The disc knife is made of tool steel 90MnCrV8 (Werkstoff: 1.284) with good machinability and dimensional stability [11].

However, the following problems were found when side cutting rolls of abrasive material, cardboard was performed:

- rapid wear and tear on knives, and in unforeseen situations, the difficulty of finding a local supplier specializing in knife sharpening services;
- manual adjustment of the knife-holder devices does not allow accurate positioning of the devices, cutting to the correct width of the roll depending on the skill of the printing worker and the correct positioning of the field of vision when reading the graduated scale on which the devices are sliding; for this reason it is necessary to check the cutting width of each roll by measuring the material cut after leaving the cutting group, followed by periodic corrections applied to the knives.

The finished product thus obtained involves five successive phases: printing, die-cutting, side cutting and repetitive calibration of the roll width, the last three of which are for finishing only.

3. ERGONOMIC CONTRIBUTIONS ON INCREASING THE QUALITY OF WORK OF THE PRINTING OPERATOR

We have proposed and designed the role of the disc knives to be taken over by the lateral longitudinal knives arranged parallel on the die-cut at the distance necessary to obtain the width of the finished product (Fig. 11).

As more than one finishing operation to obtain the finished product is costly, the disc knife holders were replaced by two longitudinal knives placed on the flexible die-cut, which took over the functional role of the disc knives.

It was found that all the auxiliary time consumed in the adjustment of the disc knives is saved, on average a total of 40 min.

So, for the adjustment of the knives at the beginning of the press run, the auxiliary time is 10 min. and calibration of the finished roll width on average is 30 min. (repetitive movements of the printer).

By equipping the flexible die with lateral longitudinal knives, cutting the product to the required width is done by simple stamping. The punching group is positioned last in the printing machine, and the flexible die is mounted on the magnetic cylinder of the group and does not require interventions during production. Thus, after the cutting unit, the cardboard product is cut and trimmed laterally to the required width.



Fig. 11. The die-cut mounted on the magnetic cylinder: left longitudinal knife and right longitudinal knife.

In this way, in addition to eliminating the auxiliary time of 40 minutes, the inadequate physical posture of the operator has been eliminated, who no longer must adjust the disc knives from uncomfortable and tensioning positions, being an obvious gain from an ergonomic point of view, reducing the risks of injury and fatigue.

The geometry of the knives on the die-cut ensured that the functions of the disc knives (angular position and depth of cut) were fully taken over. This eliminated two of the finishing operations (cutting with disc knives and repetitive calibration), reduced the roll execution time and increased the quality of the finished product by obtaining a constant roll width.

The finished product is in a roll with a width of 310 mm and a diameter of 80 – 90 cm and is obtained directly from the printing machine that ensures both processes: graphic printing and stamping (side cutting, thorough cut, perforation).

Flexographic printing machines can be equipped with punching groups (one or two) which are always positioned after the last printing group. They can have a modular construction or they can be self-standing groups in the machine. When they have a modular structure, the punching groups can be taken out of the machine's printing line (for example when foils are printed) in order to be prepared in advance for the stamping of the next product scheduled in production.

After passing through the punching group, the products that are supplied in rolls are rerolled to the form of semi-finished rolls or are picked up on a conveyor when they are delivered to the piece [6].

Machines that are built with two stamping groups, and which have two magnetic cylinders of the same diameter, allow obtaining complex products by using paired flexible dies as follows [12]:

- The flexible dies are successively mounted in the stamping groups as follows: in the first group the die-cut is mounted on the magnetic cylinder positioned at the top (the die-cut acts from top to bottom), and in the second stamping group, the die-cut is mounted on the magnetic cylinder positioned at the bottom (the die-cut acts from the bottom up); the method is used

especially for stickers, for distinct front-back stamping.

- When the construction of the stamping group allows the vertical mounting of the two magnetic cylinders, the flexible dies will simultaneously be stamping the material: the method is used to obtain foldable products, for example boxes.

4. CONCLUSIONS

The disc knife is made of tool steel 90MnCrV8 (Werkstoff: 1.284) with good machinability and dimensional stability.

In the case of width cutting of die-cut cardboard rolls, which is an abrasive material, these knives wear out relatively quickly, generating over time purred edges that are incompatible with the quality of the product to be obtained. To avoid this, the knives must be sharpened frequently if there are local firms equipped with devices that can sharpen the distinct geometry of these knives, or, in the most common case, they are changed directly at the manufacturer at set intervals, at very high cost.

To improve the die-cut process, the main problems encountered in the production of die-cut followed by side-cutting with disc knives were analysed as follows:

- The rapid wear of the disc knives used for side cutting the rolls to the width required by the customer and the difficulty in finding a local supplier specialized in knife sharpening services, familiar with parts dedicated to flexographic printing;
- The construction of the cutting assembly with disc knives does not allow an exact positioning of the knives, the appreciation depending on the skill of the print worker and the correct reading of the graduated scale on which the knife-holder devices are sliding; the verification is made by measuring the material cut and by repeated corrections of the position of the devices, so the safest way to eliminate errors is to measure the width of the material after leaving the cutting unit, this procedure involves loss of time and raw material;
- If the die-cut is rotated on the magnetic cylinder during die-cutting, after folding, the finished product has a slight tendency to twist, and the

holes are offset when overlapping; in production it is necessary to check on each printed roll that the two halves of the product fold correctly;

- When die-cutting the product with symmetrically positioned holes, waste removal by ejection from nests does not occur consistently.

The finished product thus obtained involves five successive phases: printing, die-cutting nests, cutting only for finishing.

Since several finishing operations to obtain the finished product means additional costs, the first author of the paper had the idea to cut the rolls laterally, replacing the disc knife holders with two longitudinal knives placed on the flexible die-cut, which took over the functional role of the disc knives. The geometry of the knives on the die-cut ensured that the functions of the disc knives (angular position and cutting depth) were fully taken over.

In this way, the exclusion of two finishing operations was obtained: the lateral cutting with disc knives and the measurement of each roll, the effect in production being the reduction of the loading time of the machine and the increase of the degree of finishing of the finished product by obtaining well-defined edges and constant width of the rolls.

The main difficulty encountered when completing the flexible die with lateral longitudinal knives, consisted in ensuring the continuity of cutting the material, considering that there is an empty space between the ends of the flexible die mounted on the magnetic cylinder. The size of this space can be controlled from the execution of the length of the flexible die, so that it can fulfil the following requirements:

1. Visually and tactilely, the edges of the flexible die seem to touch;
2. The ends should not overlap when mounting on the magnetic cylinder;
3. The die-cut must not rotate on the magnetic cylinder during the die-cutting process.

In print run production, the die cut is rotated, after bending the product has a slight tendency to twist and the holes are offset when overlapping.

By shifting the lateral cutting of the rollers from the disc knives to the longitudinal knives on the die-cut, the uncomfortable and tense positions

to which the operator was subjected during adjustments were totally eliminated and its comfort and safety were improved, the risks of injury and fatigue were reduced with the obvious elimination of the 40 min. auxiliary time consumed before, which was unhealthy from the ergonomic point of view.

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Îmbunătățirea calității muncii din punct de vedere ergonomic a operatorilor din tipografii

În cadrul lucrării sunt prezentate aspecte ergonomice privind munca muncitorilor din cadrul unei tipografii. Este demonstrat faptul că organizarea și logistica locului de muncă influențează confortul și eficiența lucrătorilor de pe fluxul tehnologic. A fost soluționată problema debitării laterale a rolei ștanțate prin adăugarea pe ștanță a două cuțite longitudinale, eliminându-se astfel utilizarea dispozitivelor port-cuțit disc. Astfel s-au micșorat timpul auxiliar de reglare și efortul postural al operatorilor tipografici care, pentru fiecare ștanțare, reglau cuțitele disc din poziții nefavorabile, impuse de construcția utilajului de ștanțare.

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