# CAD/CAM system implementation criteria in the process generating of optimal and efficient models for clothing industry

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**ABSTRACT – REZUMAT**

**CAD/CAM system implementation criteria in the process generating of optimal and efficient models for clothing industry**

*The first part of the paper is a systematic explanation of the process of defining the most important parameters for generating optimal and efficient models of small and medium sized enterprises (SMEs) of the clothing industry, with the presentation of specific and adequate methods of research, i.e. with the evaluation of data for designing new models, and including previous research data. The following is an explanation of the final phase, i.e. a systematic and objective design assessment, through the implementation of preliminary results of exploitation studies of the modal experiment and computer simulation of the new model, based on which the criteria for efficient and optimal implementation of the CAD/CAM systems are defined.*

***Keywords:*** *criteria, CAD/CAM systems, modeling, optimization, SME*

**Criteriile de implementare a sistemului CAD/CAM în procesul de generare optimă și eficientă a modelelor pentru industria de îmbrăcăminte**

*Prima parte a lucrării este o analiză sistematică a procesului de definire a celor mai importanți parametri pentru generarea optimă și eficientă de modele de către întreprinderile mici și mijlocii (IMM-uri) din industria de îmbrăcăminte, cu prezentarea unor metode de cercetare specifice și adecvate, adică cu evaluarea datelor pentru proiectarea de noi modele, inclusiv a datelor de cercetare anterioare. Apoi, este prezentată o analiză a fazei finale, adică o evaluare sistematică și obiectivă a proiectării, prin implementarea rezultatelor preliminare ale studiilor de exploatare ale experimentului modal și simularea pe calculator a noului model, pe baza căruia sunt definite criteriile pentru implementarea eficientă și optimă a sistemelor CAD/CAM.*

***Cuvinte-cheie****: criterii, sisteme CAD/CAM, modelare, optimizare, IMM*

## INTRODUCTION

The progress of every society today means a successful and quality economy with fast and efficient implementations of technological and technical innovations, which implies the interaction of science, education and economy, long-term planning of technological development, extensive investment investments and permanent education of the necessary labor force, as well as a strategic shift in innovation policy at all levels. Today, the issue is redefining the strategic economic development program for developing countries, which must include the encouragement of research and development processes of enterprises with a focus on four areas of operation: product innovation [1–3], technological processes, innovation in the organization production and marketing. It is imperative that research activities generate a productive-economic valorization of innovation and the diffusion and implementation of new technologies [4], by the rapid and efficient transformation of scientific research into new technologies, innovations and products [5, 6].

## CAD/CAM SYSTEM AND OPTIMIZATION OF PRODUCTION

Implementation of ICT technologies [4] by itself leads to reengineering or generating new models of production processes and concepts of work and development, which requires the necessary study of all problems and specificities in order to eliminate or redefine them in the most efficient way, and then included in the generation of new and efficient models of clothing industry SMEs [7, 8]. The fact that ICT systems enable process optimization through time and cost parameters or through compatibility and alignment of components of efficient and quality business clearly indicates that the biggest improvements and improvements of production processes cannot be realized without their support. Research into the generation of efficient models of production processes [9] is primarily directed towards finding and defining optimal parameters, in order to obtain the best outputs with minimal use of available input resources. One of the key factors in business process optimization is business process management (BPM) [10], a discipline that combines IKT and management

[11–13], and applies either on operational business processes through the monitoring and execution of processes or management through design, simulation, and analysis processes, or through reengineering and optimization [1,2, 8, 14]. It means that the business process could be analyzed and improved, it is necessary to describe all of its relevant properties [2, 5, 15] using specific methods [6, 10, 16, 17], in order to exclude the possibility of different interpretations of the essence, and then by implementing new parameters perform simulation, monitoring and analysis of the process, along with the graphic representation.

## EXPERIMENTAL PART

The organization of the research relies on and follows the basic steps of business process reengineering, so the research process consists of several stages of obtaining relevant data:

- Phase one: identifying problems, defining the objects and objectives of the research;
- Phase two: presents specific methodological techniques for collecting and analyzing data and systematization of relevant parameters by the stages of production;
- Phase three: the creation and implementation of the model, with the computer modelling method as a research process of generating a model;
- Phase four: implies simulation, i.e. transfer of data from the model to a real phenomenon, and direct and indirect experimental measurements with variable parameters, that is, analytical study of cause-effect relationships with the systematic and deliberate change of certain parameters, in order to observe and measure other parameters and phenomena, while other relevant conditions are controlled or isolated;
- Phase five: monitoring, analysis and conclusions, as well as defining the criteria for optimal and efficient CAD/CAM implementation.

## Identifying problems and defining the goal of the research

Through compilation data on the automation and implementation of ICT technologies the problem of poor modernization was identified and raised as a subject of research, respectively poor or insufficient automation of production, or inadequate implementations of computer systems (CAD/CAM). The aim of the research is to define the criteria for the implementation of the CAD/CAM system [11], which, along with timely consideration and inclusion of the specifics of SMEs, clothing industry and developing countries, should be incorporated into the processes of generating new work and development strategies SME [5, 8, 14].

Compilation, SWOT analysis, brainstorming and Ishikawa research [6, 16] were used as methodological techniques for systematizing relevant factors, which are compiled, classified and systematized by similar features: participants, materials, means of work, work procedures and money, and based on this, make the Ishikawa diagram – the cause – consequence (figure 1).

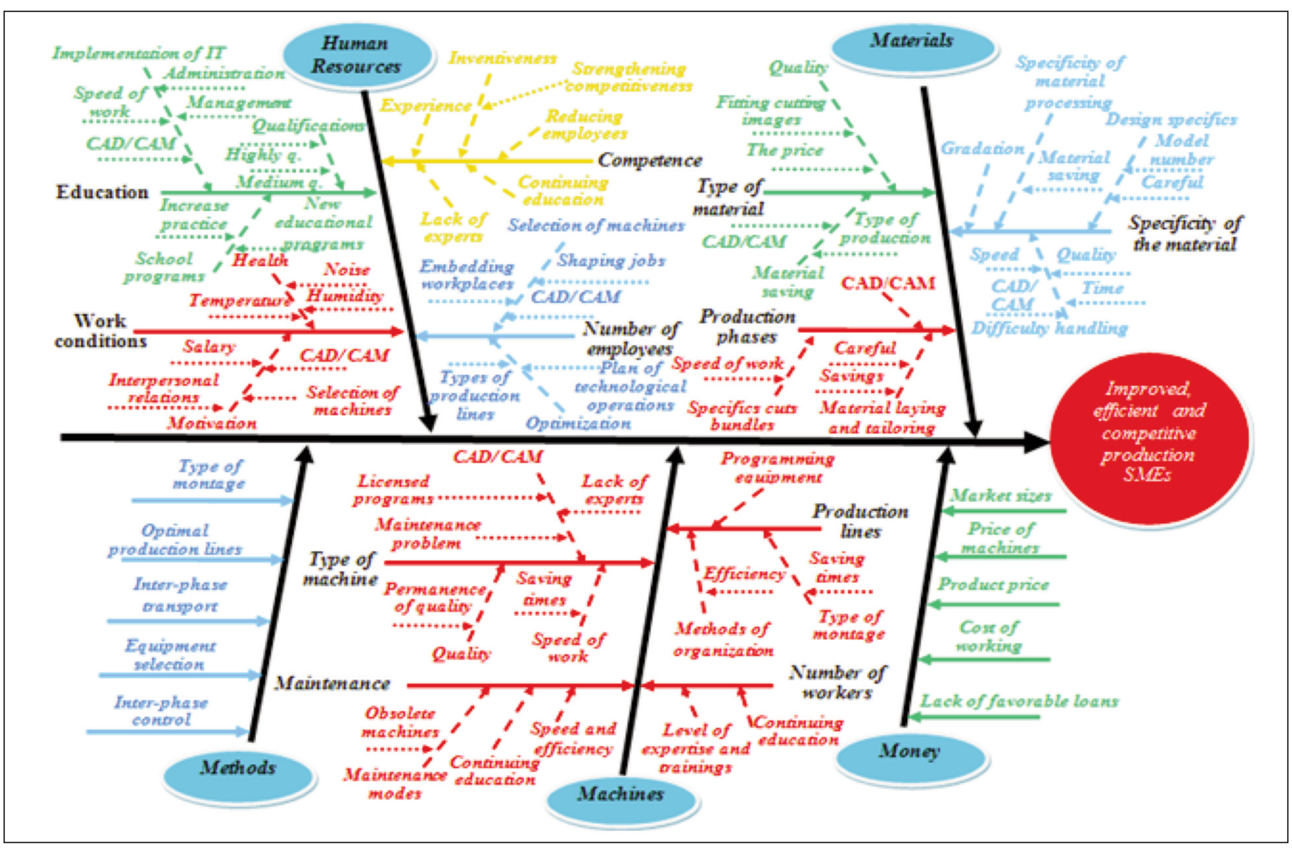


Fig. 1. Ishikawa Enumeration Diagram or the cause-effect diagram

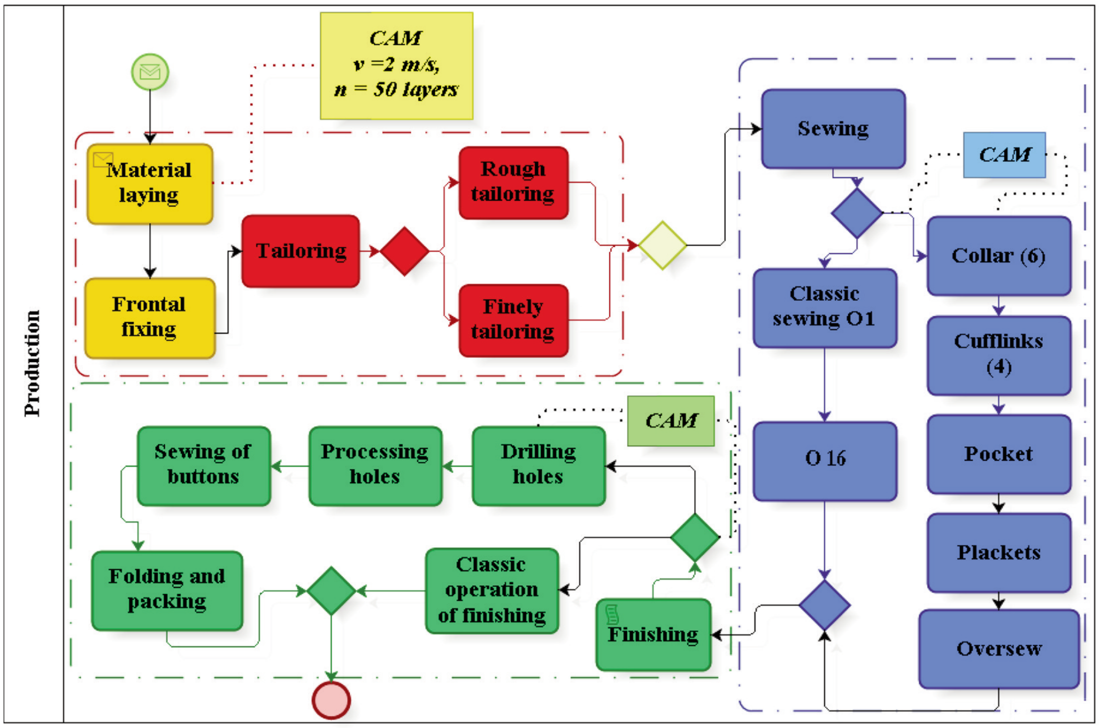


Fig. 2. Model proposal with implemented CAD/CAM systems

## Model proposal and comparative parameters

Making the model of optimum and efficient production of clothes in SMEs was based on the data of the study of the impact of CAD/CAM system implementation, compilation of works and professional literature about SMEs of clothing industry, direct contacts with owners and with employees, as well as on the basis of the sublimated results of SWOT analysis, brainstorming sessions and Ishikawa research. Selected most important parameters of the clothing industry SMEs and the effects of CAD/CAM implementation must significantly influence the production process and at the same time represent a special feature of automation and efficient operation at different stages of production: 1. Time, 2. Material and 3. Number of employees. As modelling [7, 8, 15] does not need to reproduce reality completely, but to formally describe or reveal part of the structure or behaviour of the real system, then further research and measurements will only refer to the selected parameters and phases of the production process. In other words, it is necessary in the database of the selected program for business process modelling to implement new parameters for improving the efficiency of selected resources, e.g.: type of production – specialized production, number of production lines: 3, arrangement – combined composition, the width of the material: 1.12 m, final ironing – pressing machines, transport: hanging tapes/slanted tables, etc., but above all based on the implementation CAD/CAM system – proposal: in constructional preparation (constructional, modelling, grading, fti), at material laying and frontal fixing of materials, at sewing (making the collar of a shirt, cufflinks, pockets, seams, plackets), and finishing (drilling and processing of holes, sewing of buttons, folding and packing.

Most computer programs are designed to generate a model aim to create a framework for better understanding and optimization of production-business processes, as well as determining the impact of individual parameters and defining their mode of interaction with the enterprise. The aim, but also the task of the model, is to define and supply information on new business strategies, which should enable analysts to provide quality systematic analysis of the operations of an organization, focusing on tasks – functions that are regularly performed, monitoring the inputs and controlling the correct implementation of the necessary resources and carrying out tasks (figure 2). So it would identify and define bottlenecks in the production process and then propose adequate solutions or new concepts and strategies [10, 14, 17, 18].

## RESULTS AND DISCUSSION

Based on the set and defined parameters that determine the ways, but also the efficiency of the business, with the recommendation of formally describing the behaviour of the real system, as a result of all research and implementation of new or redefined initial parameters, a new model of SME for clothing production is shown. Model monitoring during simulation [8, 13], as well as measurement of parameter values, is analyzed and based on this and brings conclusions about the essential properties of a new or improved model. For this type of experiment and comparative measurements, three SMEs of clothing industry with specialized production (shirt production) were selected, with no (A) and with elements of automation (B and C) – CAD/CAM systems. As modelling requires simplified presentation of parts of the production processes that need to be changed and for which research will be carried out, table 1 shows measured values of selected parameters of the parts of the phases essential for defining new models of SMEs.

Number of employees for the production line: $N_{cl} = 43$, $N_{CAM} = 27$, is defined according to the number and type of necessary operations, as well as according to the number of perpetrators on the existing or proposed machines for the envisaged capacity: $K_{cl} = 610.25$, and $K_{CAD} = 626.88$.

Measurements by parameter Material were made for the average standardized consumption per unit of product of a men's shirt of about 0.97 $m^2$, a surface mass of material of 120 $g/m^2$, whereby the dimensions of the table of the for laying are 6×1.2 m, while material lenght is different owing to equalization of capacity and valid data comparison.

Based on the measurement of selected parameters (time, number of employees and material) and the obtained results, criteria of efficient implementation of CAD/CAM systems can be defined, in order to optimize and generate new and more efficient models the SME of clothing industry.

The best results of CAD system efficiency were obtained per parameter the Time, and as criterion taken as a value of max 6% of the time of preparation the construction in the classic way, while a criterion for the Material parameter would be: a min of 5% difference used material in the stages of grading and fitting of picture of tailoring. The results of the research indicate the obvious and large differences per parameter Number of employees so, without comparative elements, one employee in construction preparation can be defined as a criterion according to this parameter:

$$t_{CAD} \le 6\% \, t_{kl} \quad (1)$$

$$P_{CAD} \ge 105\% \, P_{cl} \quad (2)$$

$$n_{CAD} = 1 \quad (3)$$

The best results of CAM system efficiency are by parameter Time, and then the Number of workers, while savings per parameter Material in the direct production phase are negligible. Based on the obtained results, for the implementation of CAM system, operations with time of min 4% of the total time of that production phase were proposed, while criterion by parameter Number of employees in the phase

Table 1

THE TIME PARAMETER

| ***Time – construction preparation*** | | **Construction** | **Modeling** | **Grading** | **Fti and mti** | **Sum** |
|---|---|---|---|---|---|---|
| Classic | sec (s) | 32400 | 21600 | 108000 | 81000 | 243000 |
| CAD | sec (s) | 3600 | 1800 | 1440 | 5400 | 12240 |
| ***Time – producing*** | | **Laying materials** | **Tailoring** | **Sewing** | **Finishing** | **Sum** |
| Classic | sec (s) | 126 | 2988 | 1674 | 180 | - |
| CAD | sec (s) | 3.06 | 2988 | 1080 | 72 | - |

Table 2

THE NUMBER OF EMPLOYEES PARAMETER

| **Number workers** | **Construction** | **Modeling** | **Grading** | **Fti** | **Mti** | **Sum** | **Saving** |
|---|---|---|---|---|---|---|---|
| Classic | 1 | 1 | 2 | 2 | 1 | 7 | 6 |
| CAD | 1 | | | | | 1 | |

| **Number workers** | **Laying materials and fixing)** | **Tailoring (and marking)** | **Sewing** | **Finishing** | **Sum - workers** | **Saving** |
|---|---|---|---|---|---|---|
| Classic | 2 | 3 | 30 | 8 | 43 | 16 |
| CAM | 1 | 3 | 18 | 5 | 27 | |

Table 3

THE MATERIAL PARAMETER – PREPARATION OF THE CONSTRUCTION (MEN'S SHIRT)

| **Material consumption – mens shirt ($m^2$)** | **Material length (m)** | **Materials width (m)** | **Material surface ($m^2$)** | **uks (%)** | **Usable material ($m^2$)** | **Waste** | **Saving per collections ($m^2$)** |
|---|---|---|---|---|---|---|---|
| Classic/0.97 | 12255.6 | 1.12 | 13726.3 | 81 | 11118.3 | 2608.0 | 1208.6 |
| CAD/0.97 | 12494.8 | 1.12 | 13994.2 | 90 | 12594.8 | 1399.4 | |

Table 4

| PERCENTAGE OF PARTICIPATION OF ALL OPERATIONS FOR THE SEWING PHASE | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Sewing** | | | | | | | |
| No. | The name of the operation | *t* | % | No. | The name of the operation | *t* | % |
| 4 | Decorative of sewing of the collar | 8 | 0.63 | 13 | Overlap of cufflink | 18 | 1.42 |
| 5 | Sewing the base fabric of the under-collar and among lining | 94 | **7.42** | 21 | Overlap and sewing a pocket | 68 | 5.37 |
| 6 | Assembling the collar and under-collar | 64 | **5.06** | 22 | Overlap and sewing a tape | 51 | 4.03 |
| 7 | Sewing of the under-collar | 14 | 1.11 | 24 | Sewing collar on neckline | 60 | 4.74 |
| 9 | Sewing the between- lining on the base fabric of cufflink | 32 | 2.53 | 25 | Closing the collar | 66 | 5.21 |
| 10 | Before sewing cufflinks | 111 | **8.77** | 28 | Sewing the cuff | 80 | 6.32 |
| 12 | Quilting cufflink | 51 | **4.03** | 29 | Making the hem of the shirt | 51 | 4.03 |

of production can be taken as: a max 65% of employees in production without automation:

$$t_{operations} \geq 4\% \quad (4)$$

$$t_{in\ total/production\ stages} \quad (5)$$

$$n_{CAM} \leq 65\%\ n_{cl} \quad (6)$$

In the specific case of manufacturing for automation, according to the above criterion, operations were proposed: 4, 5, 6, 10, 12, 21, 22, 24, 25, 28 and 29. Automation of operations 10, 24, 25, 28 and 29 are not proposed, and if it is adequate to the stated criterion, it is because comparative measurements are not possible due to the absence of such automated machines in the moment, while operations 4, 7 and 13 do not meet the condition of the selected criterion, but they are proposed for automation because they are of the same type as the operations they "rely on" (in technological and operational sense), which fulfil the condition of the defined criterion. It should be emphasized that the automation of Operation 14, by joining the automated Operations 12 and 13, is not proposed, since it requires the machine so-called two-needle, while Operations 12 and 13 are done with a single needle, so going forming a new CAM system with these requirements would be a difficult task.

## CONCLUSION

The results of the research clearly and unambiguously indicate the positive effects of the implementation of the proposed CAD/CAM systems and other parameters, in new models of SMEs of the clothing industry, so it can be concluded that:

- It is possible to improve the technical-technological performance of production, and to increase the competitiveness of SMEs, by flexible implementation of CAD/CAM systems;
- By implementing CAD and CAM systems, savings in the construction preparation and production process of the SME clothing industry can be achieved, by parameters: Time, Material and Number of employees;
- Business process modelling provides added value and support to decision makers in error prevention and remediation, reengineering and production optimization;
- Generation of new models of SME requires the identification and definition and then appreciation and incorporation of the all specificities of SMEs, the clothing industry and developing countries, which correlate with ICT implementation.

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