

Research on designing a manufacturing cell for the Disk Limiter

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Abstract. The paper presents the results of the experimental researches carried out in order to increase the productivity of the processing process for part of the automotive industry. Thus, by increasing the volume of parts ordered by the recipient, research has been done to make a manufacturing cell having the ability to obtain a competitive unitary time. Manufacturing cells that are equipped with one or more industrial robots, machine tools with numerical control and auxiliary components (conveyors, equipment, etc.) have a rather old concept that has evolved and has reached a high level today. The machines integration in a flexible manufacturing cell is the way of making profitable the use of machines with numeric control. If they exist alone, the human users, that works on the cell, would be forced to make manually the download of machining programs, and to take decisions themselves, in real time. These decisions are related with the complex resources management, as machining time, machining tools and raw material.

1. Introduction

Manufacturing cells have been one of the main solutions to several problems caused by change in the world context in manufacturing systems [1]. Some of these changes are: reduction in lot sizes, increase in the product variety, improvement of quality, cost reduction, market competition, flexibility, relationship with customers (for example, consumer's satisfaction), etc. Manufacturing systems need a quick answer to the changing market, due to the variety that the customers bring to the market. They can look for other alternatives in product, quality, time and cost [2].

This paper presents the adoption of flexible manufacturing systems in industry. In recent years, advances in machining and new CNC tools has given rise to a stiff competition in the manufacturing industries. The economic and social justification of Cellular Manufacturing System (CMS) lies on the cost effectiveness over years.

In all situations, where traditional machines are used for operations on parts, concurrent formation of part-families and machine-cells is necessary [3]. This cell is a combination of microelectronics and mechanical engineering in manufacturing process that adapt automatically to random changes in every possible aspect. It combines the flexibility of job shop with the high-volume production of fixed automation. [4] In this paper a cost-volume-profit analysis is done to justify the initial cost of CMS. Flexibility in product design and manufacturing are necessary in today's ever-changing socio-economic society [5]. This research paper proposes replacing a current manufacturing process served by an operator with a manufacturing cell serviced by the robot. Most of the researchers worked on major

In the present stage of machining, OP10 and OP20 are simultaneously processed on a vertical machining center, DMC MillTap700, from the company. The positioning, orientation and fixing of the workpiece is performed on a mechanically operated device with two positions (a position for OP10 and a position for OP20). This assembly of metal inserts is performed on a mechanically assembled mechanical device assembled manually by an operator.

The production sequences presented above are performed in the CNC processing department of SC FaistMekatronik SRL under the following structure, as shown in figure 6. For the execution of the product in the current manufacturing layout in the CNC department, we need technological resources that compete with the finished product execution.

2.3 Results of the current state of manufacture. Classic version.

The results of the current manufacturing stage are reflected in unit execution time of 135 sec /piece. This unit manufacturing time is obtained directly by the machining center on each operation on each cutting tool. The results of the mechanical processing are shown in table 1.

Table 1. Machining operations from the technological machining itinerary

OP	Operation	Tool	Machining parameter: Spindle (rot/min) /Feed (mm/min)	Machining time/tool (s)
10.1	Roughing the central zone	T101 Mill_D20	8000/3000	5
10.2	Rear piece milling	T7355 Mill_T	2500/500	9
10.3	Thread Milling	T2410 Thread-mill	7000/1000	11
10.4	Chamfer back- thread	T1645 Dovetail cutter	7000/1000	8
10.5	Roughing the hole d11.287	T634 Mill_D8	8000/1500	6
10.6	Reaming d11.287	T7329 Reamer_D11.29	1000/2000	4
10.7	Chamfer hole d11.287	T7056 Chamfer_D10	8000/1500	3
10.8	Roughing the hole d4.98	T480 Drill_4.8	8000/2500	3
10.9	Reaming D4.98	T7349 Reamer_D4.98	2000/1000	3
20.1	Drilling D5.5	T526 Drill_D5.5	10000/3500	6
20.2	Thread M6	T7760 Thread_M6	3000/3000	10
20.3	External milling D94.8	T101 Mill_D20	9000/2000	22
20.4	Milling of metal inserts	T7338 Mill_D8	4400/560	15
20.5	Face milling	T1140 Mill_D40	12000/4000	15
20.6	Marking part	T6063 Chamfer_D6	6000/1500	15

Machining time (s): 135= Time OP10 (s): 52+ Total time /OP20 (s): 82

It is worth mentioning that the manual assembly process of the two metal inserts is 15 seconds, it is performed in parallel with the mechanical processing and does not influence the unitary manufacturing time according to the product operating standard in the fabrication classic

3. Researches on the design of the flexible manufacturing cell

Considering a significant increase in customer demand in terms of several parts, it is a question of identifying solutions for organizing the manufacturing process so that the production volume is about 1000000 pieces/year. To determine the actual time of manufacture of a piece under the possible constraints (restrictions) that may occur, a calculation of the processing time was made. The results of the calculation are: 134 parts / hour- 1 and 26.89 seconds/ part.

The processing variant, by equipping the classic multi-function device, solves to some extent the manufacturing time but does not allow the expected volume of products (1 million parts per year). To achieve this, research has been carried out to improve processing technology by modifying the cutting

regimes and the use of new tools. Another step in optimizing the production of this piece was the new technologization of the manufacturing section for the CNC department.

In the scientific work [9] is presented a variant of improvement of the production sequence in the CNC department machining the piece with the help of special tools combined. The scientific paper presented the advantages of using combined tools. After the new technological itinerary, which also includes the new combined tools, the CNC machining time for the first OP10 operation is 67 seconds, and for the OP20 operation is 21 seconds.

To make these parts, it is necessary to provide hydraulically actuated guiding and fastening devices.

The design of the manufacturing cell was done starting from the machining technology specified in the above rows. From a relatively simple mathematical calculation, a manufacturing cell has been designed to meet customer requirements, figure 5.

After the improvements made to meet the volume of parts necessary for customer satisfaction, it was necessary to simulate and manufacture a new manufacturing cell that will include:

- Three CNC machines to carry out operation 10 (OP10) of three workstations;
- A machine with three automatic assembling posts for metal inserts;
- A CNC machine for operation 20 (OP20) with three workstations.

The technological itinerary for this manufacturing cell works on the same concept as the classic one presented above. In the case of the manufacturing cell, the machines are serviced by two industrial robots synchronized with the machining centers and the automatic assembly station.

4. Design and simulation of the robotic cell using the program - ROBOT STUDIO

For the design and simulation of the manufacturing cell, we used the ABB Robot Studio program. Robot Studio provides the tools to increase the profitability of your robot system by letting you perform tasks such as training, programming, and optimization without disturbing production. This provides numerous benefits including Risk reduction; Quicker start-up; Shorter change-over; Increased productivity.

Having the structure of the manufacturing cell and knowing the succession of its specific sequences, it is a question of studying the function of the cell as a whole. More specifically, the reduction of dead times, auxiliary times of time intervals due to defects and maintenance activities will be considered.

Starting from the proposed layout of the proposed manufacturing cell, a manufacturing cell assembly was made in modeling and simulation software- For the design and simulation of the robotic manufacturing cell, we used Robot Studio Robotic Cell Simulation Software.

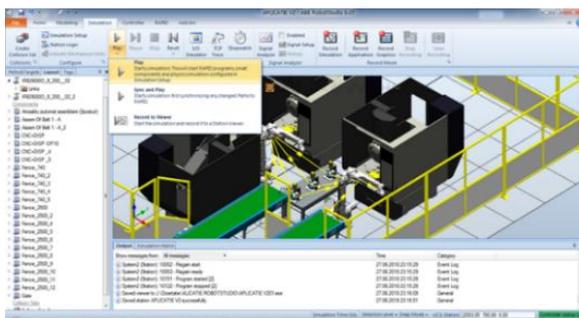


Figure 6. ABB Robot Studio - Synchronization of the manufacturing cell

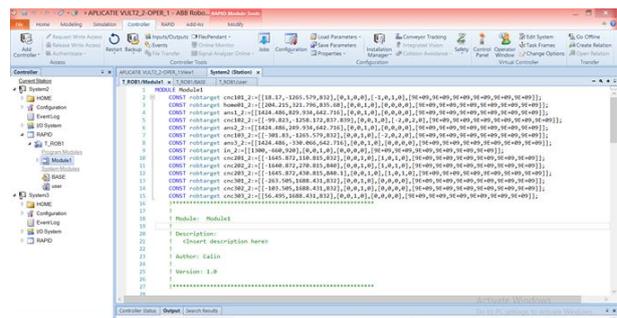


Figure 7. ABB Robot Studio - The manufacturing program of the manufacturing cell

An essential action in simulation is the synchronization of the created cell with the robot's virtual controller. An important step is to select the Simulate Run button from the ABB Robot Studio software menu, used to start cell simulation, where the robots will follow the paths, depending on the trajectories and the operating mode. This is shown in figure 6. The last sequence is the production of the manufacturing cell program. The result of the simulation is the generation of the manufacturing cell program shown in figure 7.

Offline programming is the best way to maximize return on investment for robot systems. ABB's simulation and offline programming software, Robot Studio, allows robot programming to be done on a PC in the office without shutting down production [10].

5. Conclusions

Manufacturing cells that are equipped with one or more industrial robots, machine tools with numerical control and auxiliary components (conveyors, equipment, etc.) have a rather old concept that has evolved and has reached a high-level today.

The manufacturing sector has become increasingly competitive as markets become more globalized. Consequently, there have been significant shifts in the design of manufacturing systems using innovative concepts. The adoption of cellular manufacturing (CM) has received considerable interest from both practitioners and academicians that offers several significant advantages, including a reduction in lead times and work-in-process inventories, and reduction of setup times due to the similarity of part types produced. Reorganizing the cell layout to meet the changing needs, however, may be time-consuming and costly. Further, if these changes occur very frequently, reconfiguration becomes impracticable or even infeasible. In such an environment, it appears that manufacturers tend to adopt a traditional job shop layout combined with the benefits of cellular manufacturing systems.

The machines integration in a flexible manufacturing cell is the way of making profitable the use of machines with numeric control. If they exist alone, the human users, that works on the cell, would be forced to make manually the download of machining programs, and to take decisions themselves, in real time. These decisions are related to sophisticated resources management, as machining time, machining tools, and raw material.

6. References

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Acknowledgments

We, the authors of this scientific paper, wish to express our great appreciation to colleagues of the technical department at SC.FaistMekatronik.SRL Oradea for valuable and constructive suggestions in the planning and development of this research work.