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PROFITABILITY AND MARKET ANALYSIS FOR A FLEXIBLE MULTIFUNCTIONAL MACHINE TOOL

Alexandru V. RĂDULESCU*, Gheorghe MARIN, Aurel COSTEA*****

*University POLITEHNICA Bucharest, Dept. Machine Elements and Tribology,
e-mail: sandu@meca.omtr.pub.ro

**S.C. ICTCM S.A. Bucharest, Dept. Technologies, Manufacturing and Control,
e-mail: corasanu@ictcm.ro

*** SC AL PLAST CONF SRL Campulung, jud Arges
e-mail: nrachieru@yahoo.com

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Abstract: The objective of the present research is to develop a new type of flexible and multifunctional machine tool which is applicable to the integration of such manufacturing processes as machining, inspection and heat treatment of mechanical products. The functional requirements of the multifunctional machine tools are initially analyzed based on the questionnaire to both the users and the designers of machine tools. The basic configuration of a machine tool is proposed with the aim of realizing the functional requirements. Finaly, the profitability and the market analysis for the multifunctional machine tool are proposed.

1. INTRODUCTION

Depending on the market, the demands that must be fulfilled by manufacturing firms vary in terms of the product to be sold, and for a specific product, sales volume may fluctuate over time. For those firms that can not afford producing a narrow range of products based on already mature technologies, so as to fulfil a more stable demand in large volumes by means of mass production systems, flexibility is a critical manufacturing capability.

According to [1], flexibility concerns the extent to which a process can be changed to meet customer requirements in terms of specification changes, product development and delivery requirements. Other authors, [2], [3] define flexibility as the ability to change or react with little penalty in time, effort, cost or performance and points out that the characterization of each important type of flexibility comprises the identification of the “dimension” on which change is required. The general “time horizon” of the changes or adaptations, and the determination of “elements” of flexibility are required. Under a time horizon perspective, the periodicity according to which changes will occur may call for an operational, tactical or strategic flexibility. Operational flexibility is the ability to change day to day, or within a day as a matter of course. Tactical flexibility is the ability to occasionally change or adapt, say every quarter, and to make changes which, on average, demand some effort and commitment. Finally, strategic flexibility is the ability to make one-way, long-term changes which, in general, involve significant change, commitment or capital, and occur infrequently, say every few years or so.

Flexibility can also be defined as the capability or responsiveness to change and points out three dimensions that are of general importance to a high-mix, low-volume manufacturer as follow: mix flexibility (the result of being able to build different types of products using the same production resources), work-force flexibility, and volume flexibility, [4]. This view provides a perspective to evaluate different flexibility dimensions based on time. The efforts undertaken by manufacturers to comply with the expectations of enhanced flexibility have sustained the building of more flexible resources, processes, and organizational structures. Nevertheless, the flexibility gains already achieved seem to be bounded to sustain enduring competitive advantage.

As complexity of marketing patterns keeps on evolving and competitors innovate or catch up, the role of production systems in manufacturing firms is becoming even more challenging. In some businesses, more innovative competitors are, for instance, embarking firmly on the deployment of even more flexible arrangements so as to sustain mass customization processes, [5].

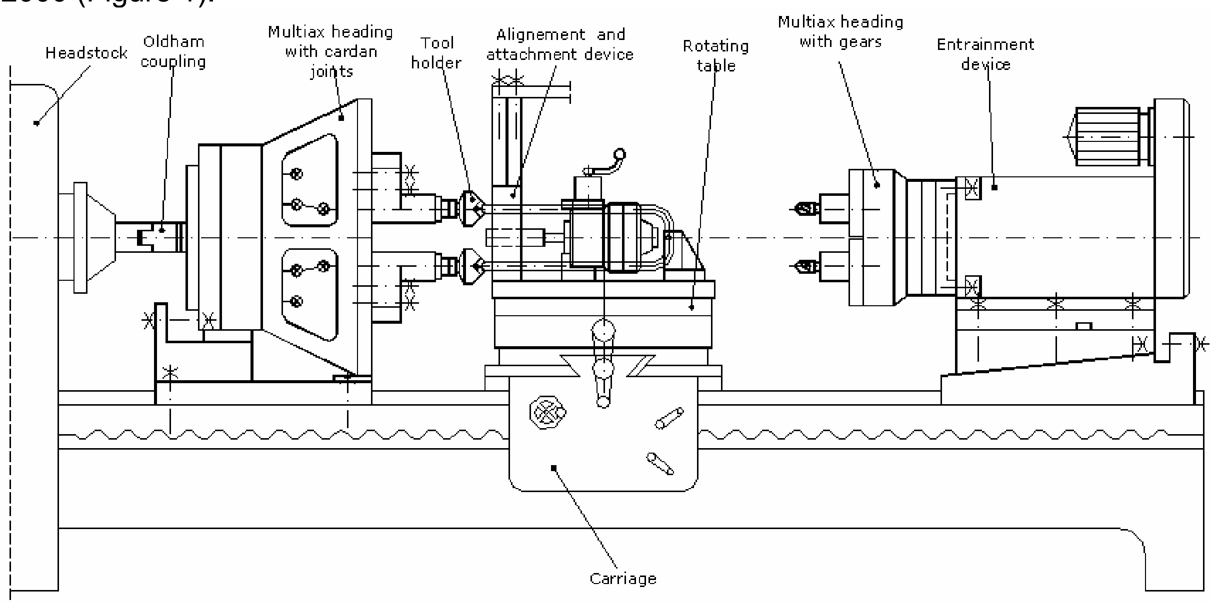
Agility has been increasingly mentioned as one key organizational concept that has to be challenged given the volatile nature of today's globalized markets and increasingly dynamic performance requirements. Developing customer responsiveness and mastering the uncertainty, for instance, depend critically on agility related capabilities. The concept of agility has attracted increasing interest among researchers and professionals in industry. The agility can be defines as "the successful exploration of competitive bases (speed, flexibility, innovation, pro-activity, quality and profitability) through the integration of reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast changing market environment", [6].

The objective of the present research is to develop a new type of flexible and multifunctional machine tool which is applicable to the integration of such manufacturing processes as machining, inspection and heat treatment of mechanical products. The functional requirements of the multifunctional machine tools are initially analyzed based on the questionnaire to both the users and the designers of machine tools. The basic configuration of a machine tool is proposed with the aim of realizing the functional requirements.

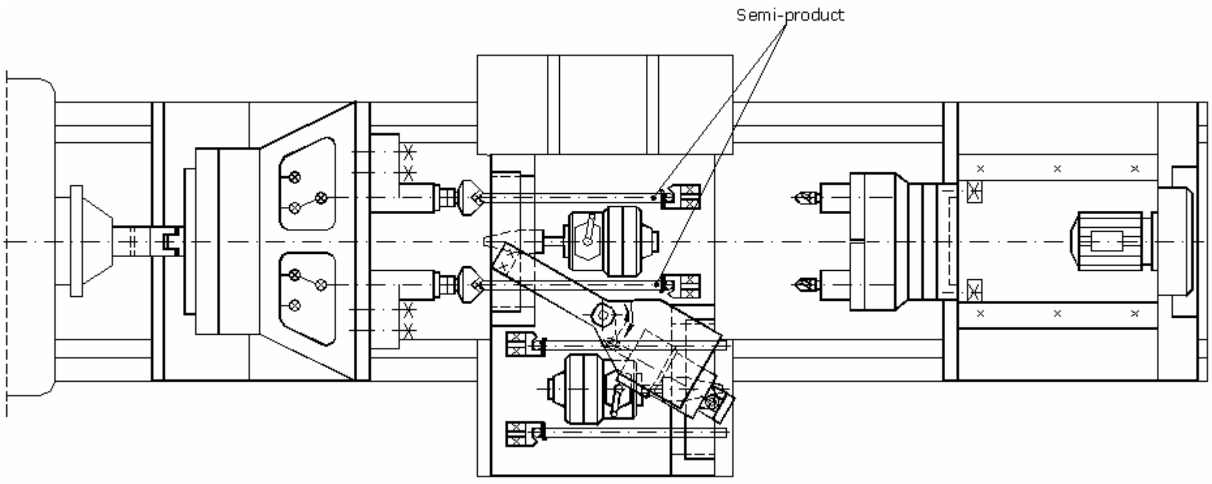
2. TECHNICAL DESCRIPTION OF THE MULTIFUNCTIONAL MACHINE TOOL

The multifunctional machine is based on a few modular structures of components, units, devices, transfer and entrainment systems, which can be attach to an universal working machines, in order to realise flexible working equipments, with characteristics and performances superior to those existent.

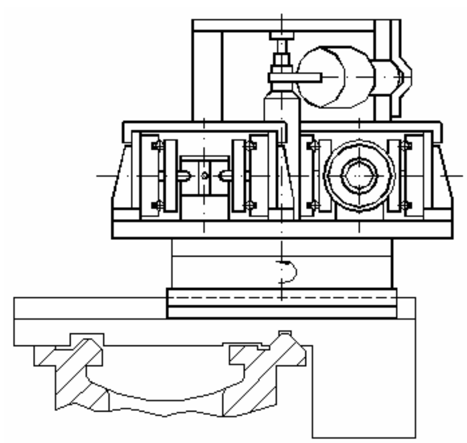
The proposed multifunctional machine represents an optimised modular structure which configures a flexible machine tool, conceived on a turning machine type SNA 560 x 2000 (Figure 1).



a) Front view



b) Upper view



c) Lateral view

Fig. 1. General description of the multifunctional machine

An allignement and attachment device for the semi-product is coupled with the turning machine carriage, which has two posts (one for loading and the other one for working). The device is rotating and modularied and execute the working phases in automatic regime, according to the cyclogram presented in Figure 2.

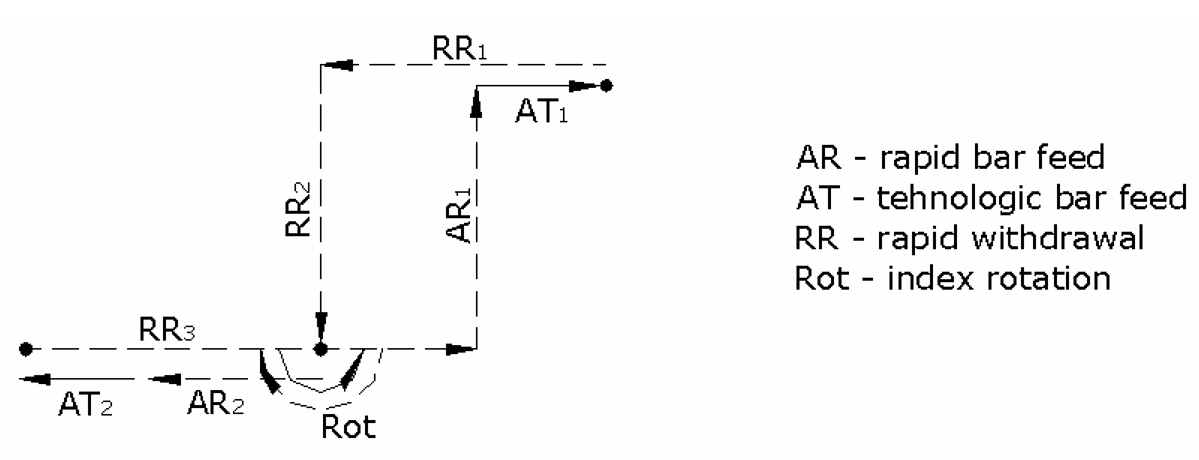


Fig. 2. Working cyclogram

The multifunctional machine tool has the possibility to process cylindrical surfaces, spherical surfaces and centring holes, using normal or shaped cutters and combination drills. The main technical characteristics of the machine are:

- Optimum cutting regime for the semi-product:
    - Spherical turning operation: s= 0,12 mm/rot, n= 500 rot/min
    - Centring holes operation: s= 0,12 mm/rot, n= 700 rot/min
- Technical parameters for the multiax heading with cardan joints (spherical turning):
    - Rotative speed (rot/min): 250, 320, 400, 500, 630, 800
    - Bar feed (mm/rot): 0,08; 0,08; 0,1; 0,112; 0,125; 0,14; 0,16
- Technical parameters for the multiax heading with gears (centring holes):
    - Rotative speed (rot/min): 400, 560, 680, 760, 900
    - Bar feed (mm/rot): 0,08; 0,08; 0,1; 0,112; 0,125; 0,14; 0,16

3. PROFITABILITY AND MARKET ANALYSIS

In order that the technology and the equipment proposed should be viable, a cost-benefits analysis must be carried, and also a marketing study.

The benefits of the multifunctional machine tool are determined and demonstrated in terms of :

- The processing of both rotation and parts with sophisticated configuration;
- High concentration of technological operations (turning, milling, drilling, etc.);
- Process more than one part in the following combinations: two rotation parts, one rotation and profilated part or two profilated parts;
- Automatically change the tools and parts;
- Using the advantages of the different machine structures – with vertical or horizontal position of the spindle unit.

All the costs involved in the implementation of this equipment need to be calculated, as well as their direct and indirect benefits. It is necessary to take into account installation, operation, and maintenance costs of the equipment, as well as the benefits of using the new technology.

The main parameters of the costs-benefits analysis, regarding the technical equipment realized are presented in Table 1.

Table 1. Main economical data of the investment

No.	Characterisitc data	
1	Instalation value	250000 Euro
2	Production volume	1 ... 4 pieces/year
3	Fabrication price	40000 Euro/piece
4	Time of operation	6 years
5	Mode of operation	220 days/year
6	Working schedule	8 hours/day
7	Recovered value of the investment	40000 Euro
8	Annual amortizate	8400 Euro/year
9	Profits tax	25%

The energetic consuming, drinking water and industrial water, and also the costs involved, are presented in Table 2.

Table 2. Main consuming and costs involved

No.	Characterisitc data		
1	Energetic consuming	180 kWh/day	0,118 Euro /kWh
2	Air compressed consuming	500 m^3/day	0,332 Euro /m^3
3	Drinking water consuming	2 m^3/ day	0,620 Euro / m^3
4	Industrial water consuming	2,3 m^3/ day	0,459 Euro / m^3

The exploitation costs (fixed and variables) which appear are shown in Table 3.

Table 3. Exploitation costs

No.	Characterisitc data	
1	Maintenance cost	2,81 Euro/hour
2	Salaried cost	3.12 Euro / hour
3	Material cost	2,22 Euro / hour
4	Utility cost	250 Euro / month
5	Maintenance cost	120 Euro / month
6	Auxiliary person salaried cost	250 Euro / month
7	Administrative cost	180 Euro / month

Concerning the market analysis, the researches attend two different directions:

- to know the quantitative dimensions and qualitative structural of the market in the study domain and most of all the request and supply of this market mediated by the price;
- to understand the motion of the market, which means the firm adaptation to the market request by examination;
- to offer the capable solution to satisfy and to adapt the market to the capabilities and available assets of the company.

The product designed is addressed to a selective segment of market, that means that it can not be sold en-gross or by shops. The only possible way of buying the products will be to sell them directly to the customers. This distribution is imposed because each customer has his needs and the equipment is modified and adapted in order to satisfy his purpose.

The market strategy and the possible trends in the next years are synthetic presented in Table 4.

Table 4. Marketing estimation

Year	2009	2010	2011	2012	2013	2014
Estimated production [piece]	1	2	2	3	3	4

Based on this estimation, the profitability analysis of the main economical rentability parameters was made:

- Ratio of the resources rentability, Figure 3;
- Ratio of the revenues rentability, Figure 4.

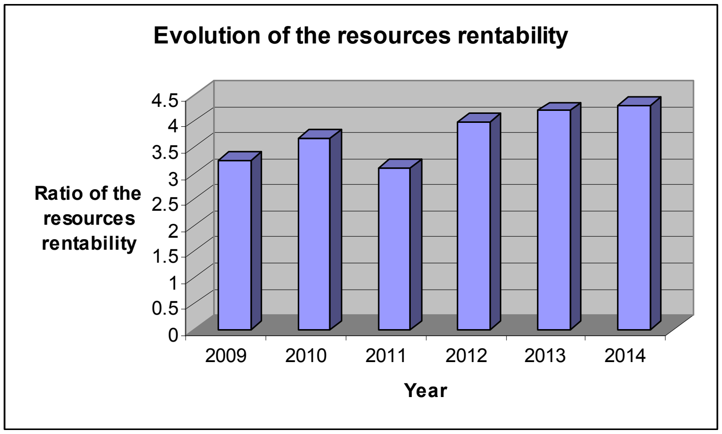


Figure 3. Evolution of the resources rentability

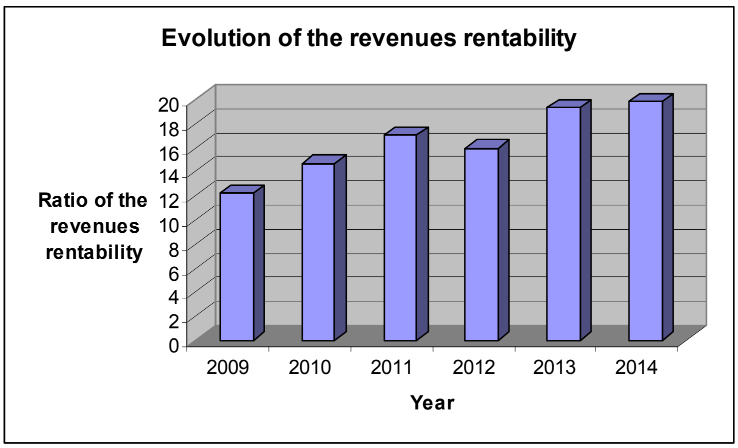


Figure 4. Evolution of the revenues rentability

4. CONCLUSIONS

In conclusion, behind the suitable domain of activity, the actual fabrication program, the serial manufacturing performance and the technological process used, assets that the multifunctional machine tool is a life-time product, with a lot of potential on the market.

REFERENCES

[1] Chambers, S. (1992) Flexibility in the context of manufacturing strategy. In: C.A. Voss (ed.) *Manufacturing strategy: process and content*, Chapman & Hall, London, p.283-295.
[2] Das, A. (2001) Towards theory building in manufacturing flexibility, *International Journal of Production Research*, v.39 (18), p.4153-4177.
[3] Lee, Q. (1992) Manufacturing focus – a comprehensive view, In: C.A. Voss (ed.) *Manufacturing strategy: process and content*, Chapman & Hall, London.
[4] Miyake, D.I. (2005) Development of rapidly reconfigurable production systems in an automotive systems manufacturer, *38th CIRP International Seminar on Manufacturing Systems*, Florianopolis.
[5] Upton, D. (1994) The management of manufacturing flexibility, *California Management Review*, Winter, p.72-89.
[6]Yusuf, Y.; Sarhadi, M.; Gunasekaran, A. (1999) Agile manufacturing: the drivers, concepts and attributes, *Int. J. Production Economics*, 62, p.33-43.