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MACHINING AND MANUFACTURING SYSTEMS EVOLUTION

Milan Jurković[1], Zoran Jurković[2], Mehmed Mahmić[1], Edina Karabegović[1]
[1]Faculty of Technical Engineering Bihać
Irfana Ljubijankića bb, 77000 Bihać
Bosnia and Herzegovina
[2]Faculty of Engineering Rijeka
Vukovarska 58, 51000 Rijeka
Croatia

ABSTRACT
Evolution of machining and manufacturing systems is a process of continuous inovation and advancement of existing technologies, processes and systems and the survival of numerous manufacturing and business systems depend on the efficiency of their application. Today, in world exist completely new trends in build up the machine tools and the machining systems.
The review of some characteristics of existing machines and some main trends in the development of machine tools with special regard of parallel kinematic structures, intelligent machining systems, reconfigurable machines and machining systems is given here.
Keywords: machine tools evolution, development, parallel kinematics, high speed machine tools, intelligent machining, manufacturing systems, reconfigurable machines

1. INTRODUCTION
Industrial manufacturing is realized with a continuous intensive changes that is consisted in the adaptation of new circumstance and of the market request. Modernization of production is a process of continuous inovation and advancement of existing products, technologies, production processes and machining systems. A general trend as regards the growth of production in this technological developed world is more and more based on modernization and application of modern machining systems and new technologies, flexible automatization, computer-integrated production, what is the main aim to achieve a higher-quality, cheaper and faster production. Modern concept of the machine tools design are characterized by development: machine tool modules, intelligent and integrated manufacturing systems, reconfigurable machines and systems, parallel kinematic mechanism of machine tools and high speed machines [1 – 13].

2. LENGTH EVOLUTION EPOCH IN MANUFACTURING
The Old Epoch in Manufacturing:
- **1700-1870** Pre-automatic cutting machines epoch - handling control of cutting machines epoch.
- **1870-1900** Automatic cutting machines epoch.

The New Epoch in Manufacturing:
- **1900-1955** Rigid automatization epoch and pre-computer-numerical control (CNC) epoch.
- **1955-1990** NC and CNC automatization epoch (1952 first NC machine, 1958 first machining centre and 1960 Chicago Fair (90 models of NC machines).
- **1990-2005** Knowledge epoch. Parallel kinematic mechanism of machine tools /Parallel kinematic machines, high speed machines.
- **2005-2007** ***today***: Intelligent and integrated manufacturing systems, Rapid prototyping epoch.
- ***Nearer the future*** **(to 2020)**: Reconfigurable machines, reconfigurable machining and manufacturing systems, intelligent control, intelligent manufacturing and intelligent factories epoch.

3. EVOLUTION OF MACHINING SYSTEMS

The machine tools from first lathe by 1717 years (England) drilling machine by 1774 years (England) have almost build up with similar concept for 250 years (Fig.1) [3,4,5]. Development of science and technology in the last 50 years have a large influence on manufacturing systems.

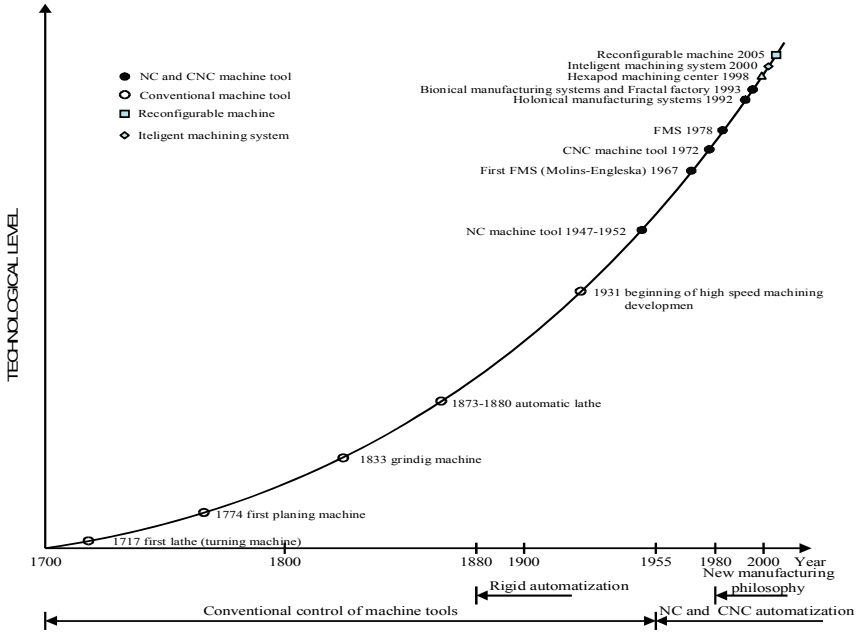

Figure 1: Evolution of machine tools, machining and manufacturing systems

4. CONVENTIONAL AND AUTOMATIC MACHINING SYSTEMS (NC, CNC, DNC, FMS)

During the 50 years, machine tools have designed and developed basis on conventional methods and improvement of existing technical decisions at machine tools (design form, drive, control, transmission mechanism, etc.). The most marked changes are realized in control system (NC, CNC, DNC, AC, FMS). Rapid development of NC and CNC has influenced on new approach in designed modern high speed machining tools, industrial robots and flexible machining systems with parallel kinematic mechanism. The appearance of modern machines starts in year 1952 (first NC machine). The degree of process independence are presented [2,9] by figure 2. The type of flexible systems in function of production volume is shown in figure 3.

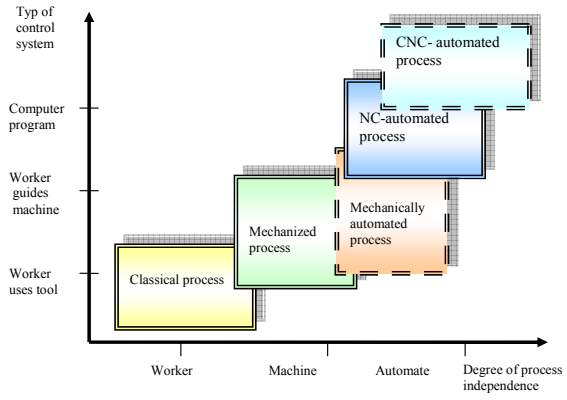

Figure 2. Degree of process independence in relation to control system type

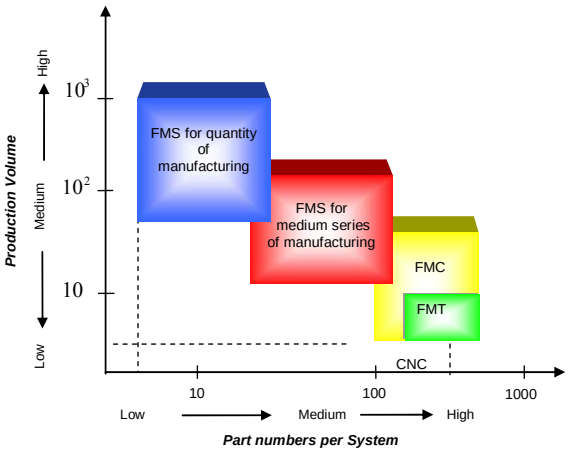

Figure 3. Type of flexible systems in function of production volume and number of parts, FMC - flexible manufacturing cell, FMT - flexible machine tool

5. PARALLEL KINEMATIC MECHANISM OF MACHINE TOOLS

Stewart mechanism has six degrees-of-freedom (Fig. 4). The upper plate is direct connected to spherical and lower plate with universal joint. On upper plate are mounted end-effectors and on lower plate worktable, chuck [3,4,10].

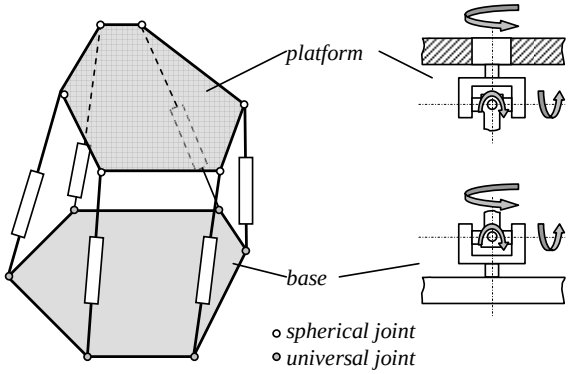

Figure 4. Main model of Stewart mechanism

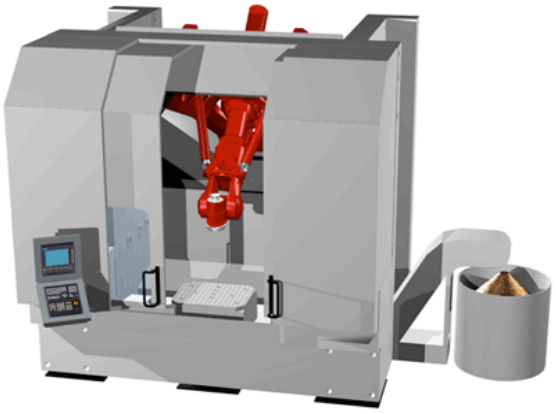

Figure 5. Parallel kinematic machine tools

6. HIGH SPEED CUTTING MACHINES

Although, German research Carl Salamon was carried out the first investigations of applying high speed cutting: 440 m/min for steel, 1600 m/min for bronze, 2840 m/min for copper and aluminium up to 16500 m/min still 1931, for commercial use need to wait a half century [13].

High speed cutting (HSC) machines in recent 30 years has been mostly researched from the following aspects: motor spindle designs (mounting, bearings, high frequency up to 100000 rpm, stiffness); high dynamic feed drives (linear motors); framework and kinematic structure designs; fast CNC-control.

For industry application are developed 5 axes CNC milling machines and high speed turn-milling machines (die&mold, aircraft industry). Some advantages of HSC machines are: reduction machining time; reduction of planning and manufacturing costs; reduction cutting force; improved of work surface quality; hard-to-machine materials, etc.

7. INTELIGENT MACHINING SYSTEMS

Inteligent machining and manufacturing systems integrate technologies related to sensing, modeling, control and monitoring. Figure 6. shows degree of automatization some machining systems [6].

8. NEW MANUFACTURUNG SYSTEMS

On account of the fast market changes and the market demands for new products it is necessary to conduct a research of the new manufacturing systems and technologies to satisfied the markets demands. However, the flexible manufacturing systems are reaching their prime in the industry, manifesting the need for new manufacturing systems such as reconfigurable manufacturing systems (RMS) [3,7,8].

Reconfigurable machine tools (RMT), are new type of machines modularity with modification of structure hardware with the goal to increase flexibility. The improvements obtained from the reconfigurable manufacturing system possess the following characteristics (reconfiguration cost-RC and reconfiguration time-RT):

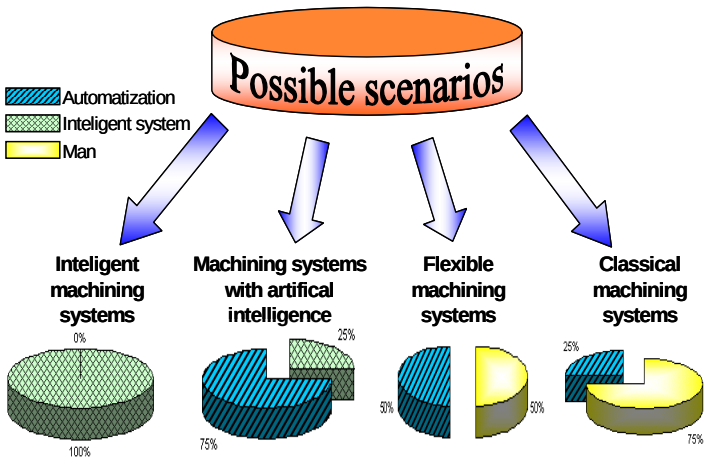

Figure 6. Degree of machining systems automatization

- Modularity: components are modular (RT).
- Integrability: interfaces for integration (RC and RT).
- Customization: flexibility limited to part family (RC).
- Scalability: capacity can be easily changed (RC and RT).
- Convertibility: functionality can be easily changed (RC and RT).
- Diagnosability: systematic embedded diagnostics (RC and RT).

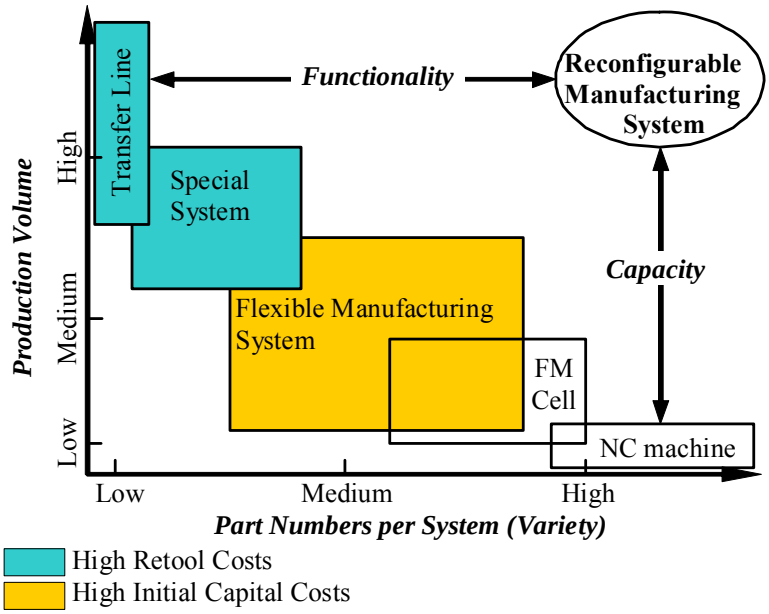

Figure 7. Review types of manufacturing systems and reconfigurable machine tools

9. CONCLUSION: TODAY AND THE FUTURE

On account of the fast market changes and the market demands for new products it is necessary to conduct a research of the new manufacturing systems and technologies to satisfied the markets demands. However, the flexible manufacturing systems are reaching their prime in the industry, manifesting the need for new manufacturing systems such as reconfigurable manufacturing systems.
The future development of machine tools and machining systems will be incremental and less radical. Above mentioned trends in machine tools development will be provide advanced manufacturing, manufacturing for new millennium with demands for the higher accuracy.
In the near future, we can expect rapid development and implementation of reconfigurable manufacturing systems that will be able to satisfy market demands.

10. REFERENCES

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