

TECHNOLOGY TRANSFER IN MECHATRONICS

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ABSTRACT. At the present stage of the scientific, technological, technical development of a nation, geographical region, communities etc, technology transfer is the main lever for progress, mastery, improving people's living conditions etc. Mechatronics is a top branch of science and technology. Technology transfer in the fields of mechatronics concerning products, equipments, technologies etc, combines harmoniously and at the same time in a complex way knowledge of mathematics, mechanics, electronics, systems analysis etc. From this perspective, in the paper, are studied from a systemic point of view the main aspects that define the concept of technological transfer in mechatronics.

Keywords: mechatronics, technology transfer.

REZUMAT. În prezent transferul tehnologic este esențial pentru dezvoltarea științifică, tehnologică și tehnică a națiunilor. Mecatronica reprezintă o ramură de vârf a științei și tehnologiei. Transferul tehnologic în domeniul mecatronicii comportă aspecte privind: produsele, echipamentele, tehnologiile care urmăresc armonizarea unor cunoștințe complexe de matematică, electronică, analiza sistemelor etc. Din această perspectivă, în lucrare este prezentat un punct de vedere sistemic privind aspectele principale care definesc transferul tehnologic în domeniul mecatronicii.

Cuvinte cheie: mecatronică, transfer tehnologic.

1 INTRODUCTION

Technology transfer and intellectual property insure important bounds for the development and the management of the scientific domains with the most important role in the progress of the human society [1], [2], [14]: In this sense, technology transfer is a real strategic "lever" [12] on the role of technology in the domains or/and components of the human society progress [3], [2], [21]:

- the science of life;
- knowledge transfer between public and private domains;
- information and communication science and technology;
- nanotechnologies and nanoscience;
- mechatronics;

- aeronautics and space;
- the quality and safety of food;
- lasting development and ecosystems;
- the citizen and the government in a society of knowledge;
- "border science".

Theoreticians and partitions define the concept of technology transfer in many different ways. These definitions can be grouped into two categories: synthetic or comprehensive. The first category, for the sake of brevity, shows in a few words the characteristic feature of the concept of technology transfer.

They generally appear as those below:

- "Technology transfer is a process by which existing technology is transferred or transformed to fulfil the user's needs," after Robert Krull [11];

– Technology transfer „can be defined as the transfer of intellectual property (patents, copyrights, trade secrets, know-how, etc.) from the laboratory to the marketplace” after [19];

– “Technology transfer is the application of information (a technological innovation) into use”, after M. A. Martsenyuk [15];

– Technology transfer is “the process by which science and technology are diffused throughout human activity, after H. M. Haug [9].

– “Technology transfer can be either information transfer, technology transfer or knowledge transfer”, after W. G. Hubbard, and C. W. Dangerfield, Jr, [10]

The comprehensive definition provides more information on the content of technology transfer.

In this sense there is only two examples.

– Technology transfer is defined as „The process by which technology, knowledge, or information developed in one organization in one area, or for one purpose is applied or used in another organization, or area, or for another purpose.” after W. G. Hubbard, and C. W. Dangerfield, Jr [10];

– Technology transfer is defined as the movement of technological and technology related to organizational know-how among partners (individuals, institutions, and enterprises) in order to enhance at least one partner’s knowledge and expertise and strengthen each partner’s competitive position [27]. Technology transfer occurs at all stages of the technology innovation process, from initial idea to final product. These processes integrate multiple functions, including organized research and development, design, production engineering, manufacturing, marketing, and other value-adding activities in a complex web containing multiple feedback loops” after L. H. Irwin [11].

At present, the notion of technology transfer is used to systematically describe the making available of technology to industry, financed from private funds, public and/or public-private (university) in the conditions of securing the intellectual property rights [4]. In terms of technology transfer, technology is approached by two representations [25]: hard (equipment, machine, accessories and infrastructure) and soft: nature-based technologies (natural processes/mechanisms and materials/restoration capability) and management tools (systems/regulatory frameworks, capacity and enhancement).

In essence, technology transfer is a complex process that develops in the area: design (innovation), dissemination, application in the enterprise and marketing.

On the involvement and role of science and technology in the development of the today human society

progress, technology transfer may be present at eight levels: [12], [2]:

A. The levels of the technical development;

I) Scientific resources - The empiric postulation of a scientific theory;

II) Technological resources - Technology generating;

III) Individual technology - The combining of distinct technologies;

IV) Functional technological systems - The diffusion of a distinct technology;

B. Levels of the effects of the technology transfer accomplishment

V) The applications or\and service technology - Adjacent or supporting systems request;

VI) Environment - Getting into industrial sectors;

VII) Social systems - International programs for technical help;

VIII) Consuming society - Restrictions for the social objectives.

The involvement and role of technology transfer at the mentioned levels, manifests themselves through [23]: „technology promotion, technology deployment, technology innovation, technology development, technology research, technology information and communication, technology commercialisation” etc.

2. THE FORM AND METHODS OF TECHNOLOGY TRANSFER

Technology transfer is done at local, regional, national or international level, between a country and another, between an enterprise and another, between research laboratories, university or private, and existing or new enterprises etc. [28], [9].

The areas in which technology transfers are used are very different: civilian products, military products, technical expertise etc.

Technology transfer can be performed if simultaneously three components are present: (Fig.1): [24], [2]:

1) source (or donor): possesses the technology and is willing to transfer;

2) user (or receivers): exist. Is willing to receive the technology;

3) transfer mechanism: exists or is created to effect the transfer. The transfer takes place only when the beneficiary's interests require so. At present, the technology transfer mechanism is assimilated to a system that has as a main function the insurance of the functional strengths among science, technique and the productive system.

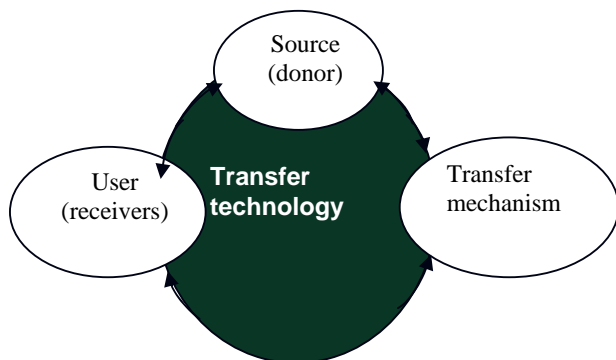


Fig. 1. The „classic” technology transfer model source [19].

The dynamics of technology transfer is determined by the triangulation: (Fig.2): creation (researchers) – dissemination – reception and application. In these conditions, the classic model of technology transfer, presented in figure 1, is completed [24] by the representation in figure 3 that highlights the main components that define the technology transfer process: Innovation; Implementation; Dissemination; Adaptation; Adoption.

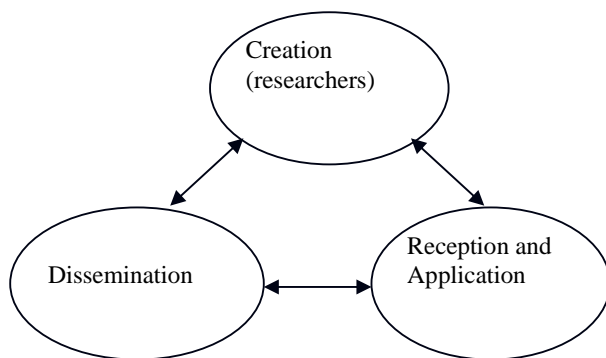


Fig. 2. The importance of a dynamic technology transfer paradigm.

Source: W. G. Hubbard, and C. W. Dangerfield, Jr [10].

Technology transfer mechanism can have different shapes and a variety of ways.

In practice, three main groups of the forms of technology transfer, are used:

- Through OEM and / or other intermediate goods;
- By individual experts’ help. It is recommended for simple and unpatented technologies;
- Through technical know-how. It occurs in patented or unpatented technologies or in technological processes / information that are subject to intellectual property law. [19] (patents or patentable invention, trade secrets or know-how, brands and trademarks, and copyright)

A variety of methods are being used for the technology transfer. The most common of them include [26], [9], [11]:

- foreign direct investment FDI [20]. It is a traditional method consisting of investments in branches that are wholly owned and controlled by the investor;
- turnkey packages (technology package, production plans etc.);
- direct purchases of OEM;
- subcontracting;
- strategic partners;
- technology license agreements (patent licenses, know-how agreements, joint ventures and technical assistance agreements);
- government assistance programmes;
- exchange of scientific and technical personnel;
- education and training (twinning, conferences, symposia and other personal contact, professional exhibitions etc.).

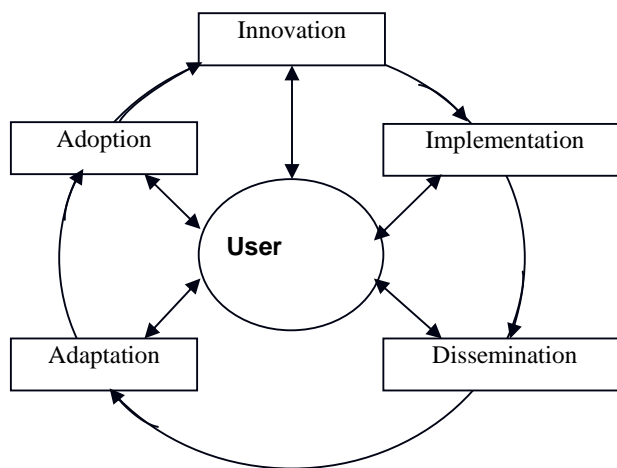


Fig. 3. Synergic model of technology transfer process.

Source: [19].

The technology transfer mechanism, in the various forms and methods that are used, operates „vertically” (vertical technology transfer) and „horizontally” (horizontal technology transfer)

The vertical transfer of technology (Fig. 4) is the technology transfer from research (invention and innovation), performed in research institutes or universities, to product development towards manufacturing company. To Stanford Research Institute, the vertical technology transfer includes the following phases of research and development [8]: a) discovery and creation, evidenced by invention and innovation; b) development and materialization through prototyping; c) the construction of a functional technical system that may be a material product, a technical or technological proceeding or an intellectual concept.

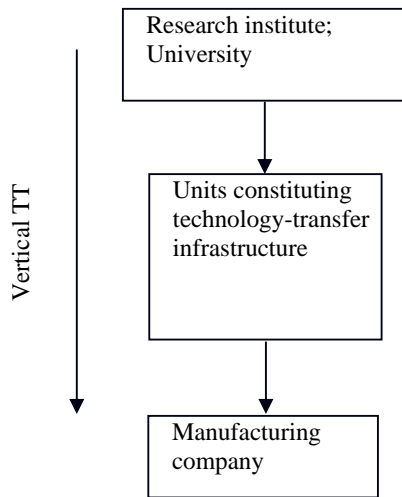


Fig. 5. Vertical technology transfer. Source [25].

The horizontal transfer of technology (Fig. 5) is the release (adaptation) of existing technologies (established) in order to apply it in other environmental contexts (economic, educational, political, resource, legal regulations etc.). It is possible for the new technology to have insignificant changes as compared to the „mother” technology”. In essence, it is about a change of "direction" in applying the technology in other operating environments [8]. Technology transfer is frequently encountered in cases of transfer of technology from industrialized countries to developing countries [3].

Of the two types of technology transfer, the vertical transfer is the most widespread.

An important aspect is related to the developing of the vertical or/and horizontal transfer within the clusters [17].

3. MECHATRONIC APPROACH IN TECHNOLOGY TRANSFER

Nowadays, the term „mechatronics” is widely accepted as the design and optimization methodology of new products, equipment and processes, that simultaneously and integrated combines the techniques of mechanical engineering, electrical engineering, electronics, automation, micro-informatics and systems analysis [18], [22], [5], [6]. It is an interdisciplinary field of engineering in which that new designed products (hybrid systems increasingly more complex) are characterized by performances superior to the traditional solutions, emergent functions and compact constructions that have sizes becoming smaller [7].

Mechatronic approach requires systemic browsing through the stages of the design process [22]: concept, modeling, simulation, optimization and prototyping. The mechatronic system is a closed „smart” system [6] that includes specific subsystems represented by [18] the mechanical subsystem, sensors, actuators, conditioning time and processing, and microcomputer.

Whitin the mechatronic system functioning, the physical and technical development of processes (defined according to the industrial environment) is controlled by computer. However, J. Steinbrunn shows [6] that man’s intervention in the mechatronic system (Fig.), is necessary because he has the power to make correct decisions in the event of a critical state of the process [13]

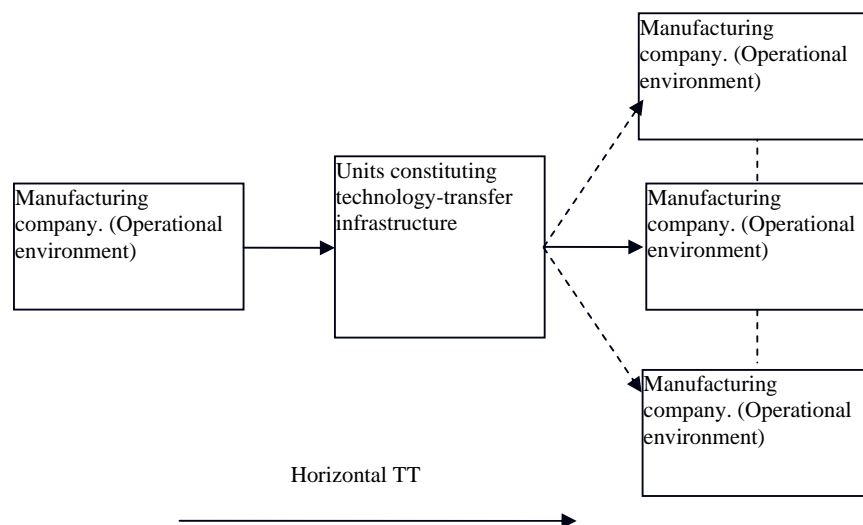


Fig. 6. Horizontal technology transfer. Source [25].

Mechatronic products have a wide variety to the market [16]: machine-tool construction and equipment for automation of technological processes, robotics (industrial and special); aviation, space, civil and military techniques: micro machines, medical equipment; photo and video equipment; control and measuring devices and machines; home appliances etc.

Competitive positioning of mechatronic products (Fig.7) is guided by four main conditions [6]: product characteristics (innovation, integration, customization etc.); cost / quality; location, distribution; promotion.

Mechatronic product characteristics are evaluated by experts, technicians and engineers. Their professional qualification is based on fundamental knowledge in mathematics, physics, mechanical engineering, electro-technics and electronics, materials technology etc.[9], [11]. To promote technology transfer of technological equipment, technological processes, control methods etc, mechatronics expert uses „a blend of mechanical, electrical, informational technologies etc.”, [5], which allows him a systemic analysis of the technology transfer object’s characteristics. In any case, the mechatronic approach is extended along three axes [5]: commercial gain by the originality of the offer; gain in developing technology transfer through the integration description of the product within the technology transfer receiver’s demands; gain in achievement and development of new products, technologies etc, by means of vertical and/or horizontal.

Mechatronics graduates of the Faculty of Mechanical Engineering, Transilvania University of Brasov have the opportunity to become experts in mechatronics on the technology transfer market because their main competences:

- strong knowledge of CAD (2D – AutoCAD și 3D – CATIA);
- thorough knowledge in micro and nanosystems technology;
- strong knowledge of programming robots and machine tools;
- strong knowledge in designing hardware and software microcontroller command solutions.

Knowledge of programming languages widely used in research, development and design (C, MATLAB, LabVIEW).

This knowledge is target by the Fine Mechanics and Mechatronics Department staff and by the students in mechatronics specialization towards the next main domains:

- sensors and transducers;
- manufacture, assembly, and control with automatic installation;

- microprocessors and microcontrollers comand of the mechatronic systems;
- using fuzzy logic and neural networks;
- biomechanical modeling and simulation of bio-systems.



Fig. 6. Examples of the mechatronics products.

The research directions are integrated in the technology transfer mechanism conducted by the University Transilvania Brasov, towards labor market.

4. CONCLUSIONS

Technology transfer is a complex process which allows an individual, production unit, research institute etc. to obtain machines, equipments, processes etc. in the conditions of intellectual property rights.

Technology transfer is realized through a mechanism that includes specific forms and methods. It has a complex character described, in essence, by the vertical and horizontal forms of technology transfer.

Today, mechatronics is an extremely beneficial space for technology transfer in favor of the market. In

the transfer of technology, competitive positioning of mechatronic products is determined by their characteristics: cost / quality, the location where the transfer, distribution and promotion.

Mechatronics expert plays an important role in the methods used for technology transfer. The expert's competencies are based on solid knowledge in the fields of mechanics, electrotechnics, electronics, systems analysis etc.

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