ROBOTICS INFLUENCING HUMAN SOCIETY[⊗]

A ROBOTIKA BEFOLYÁSA AZ EMBERI TÁRSADALOMRA

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***Abstract**: Major technological innovations have had influence on human life at many points in history. The invention of the wheel as well as machines that introduced the Industrial Revolution, not to mention the great advances during the 20th century have left traces in our lives and determined the way society has gone since then and will go. This essay deals with one of these determining factors. The history of robotics, including development of industrial as well as civil robots and the advances in computer sciences, gives several examples that have had major influence on society.*

***Keywords:** robotics, industrial robots, development of robots, robotics in training and in teaching*

***Kivonat:** A műszaki találmányok nagymértékben hatottak a társadalmak fejlődésére. A cikk bevezető részében a szerző meghatározza azokat tényezőket, amelyek alapvetően befolyásolták az emberi társadalmat. A szerző egyik kiemelt fontosságú területként említi a mesterséges intelligencia kutatásokat. A szerző bemutatja, hogy a technikai-technológiai eredmények, és azok alkalmazása mellett tekintettel kell lenni a fejlődés társadalomra gyakorolt hatásával.*

***Kulcsszavak**: robotika, ipari robotok robotok fejlődése, robotok az oktatásban, és a képzésben.*

1. INTRODUCTION

Technological developments and their effects on human society can only be analyzed in retrospect. Whether a certain innovation will change the world, cannot be predicted. The Apollo missions to the moon, for instance, have influenced our lives much less than the invention of the mobile phone. History, however, shows that the mobile phone would not have been invented without the IT knowledge that scientists had pushed in aerospace or other industries. Thus, looking at the past might help us to assess the possible influences of new technologies like robotics. The performance and capability of modern robots increase continuously which asks schools, colleges, and universities to integrate such technologies into their schedules. This essay gives an overview the technological interactions in history, the effects on society, and future challenges in teaching how to deal with robotics.

The first chapter of this essay introduces briefly the history of robotics. A lot of authors have worked on this topic, from which only a few are mentioned here. [3] *Needham*, for example, in *Science and Civilisation in China*. In *Hidden History: Lost Civilizations, Secret Knowledge, and Ancient Mysteries* describes Chinese water clocks, whereas [2] *Angelo* gives a whole overview in *Robotics: a reference guide to the new technology*.

The question what influences robotics has had on society is answered in the second chapter. Industrial robots on the one hand and technological innovations in the private sector are of major importance here. Looking at the developments in both robotics and computer sciences it becomes obvious that the matter of artificial intelligence has to be mentioned in this essay, too. One author that has to be mentioned here is [4] Nilsson, who gives in *The Quest for Artificial Intelligence* an introduction to this topic.

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In the third chapter we consider the consequences for training and teaching because the changes resulting from advances in robotics require researchers and students to think forward not only seeing the technological possibilities, but also the demands in society and economics.

2. LITERATURE REVIEW

A lot of publications deal with the history of robotics. Among these there are scientific works, journals, books, and technical literature. Apart from these novels and movies have had this topic for almost hundred years. Additionally, conferences give space for presentations on robotics like [15] Szabolcsi and Mies with *Robotics in Nutshell – Past and Future*. [3] Needham, J. 1959 wrote in "Science and civilisation in China" about the beginnings of automation while [2] Angelo looks at the more recent past. [4] Nilsson in „The Quest for Artificial Intelligence" describes the common basis of computers and robots. The news magazine [14] DER SPIEGEL contribute this subject an article how to implement Artificial Intelligence to robots.

In "*Die Herrschaft der Mechanisierung*" [5] Giedion talks about the first flow-production of the industrial age, i.e. the production in slaughterhouses in Cincinnati and Chicago. [6] Hounshell with „The Development of Manufacturing Technology in the United States" and [7] Lacey with "FORD" give a look at the rapid development of conveyor systems and the assembly line production. In his autobiography [8] Ford describes how much time a company can save by changing the working level to the height of the arms.

Already in 1913 [9] Homburg studied working places that got separated into individual working steps and paid related to performance. The German news magazine [12] DER SPIEGEL in 1964 published a story on threats to jobs because of the use of robots in a large bakery. Many political unions called roboters "job killer", which had negative effects on society. The public opinion had changed for the better by 1987. The [13] COMPUTERWOCHE quotes comments made by unions that saw the robot as an instrument for better working conditions.

Misselhorn describes the effects of robotics on society by considering the sociological background [10]. He focuses on the research of human emotions compared with the lack of emotions regarding androids. [11] Christaller looks at another issue concerning society, namely legal aspects in case of malfunctions of robots. He asks who is responsible in such situations and who has to bear liability.

In [16] Szabolcsi gave introduction to developing military robotics, and derived dynamical model of the UAV. In article [17] Szabolcsi had shown computer aided preliminary controller synthesis using LQR method for the quadrocopter. In [18] Szabolcsi derived methods and main algorithms for deriving normal and emergency flight phases.

3. HISTORICAL OVERVIEW

The origins of modern robotics may be found in Greek and Egyptian history, when people had the idea of intelligent mechanisms. The first robotic application in the history of mankind, however, is said to be the Babylonian water clock, the clepsydra. Similar works appeared in China. [3](Needham, 1959, 313) When it comes to the Middle Ages, engineers designed more complex mechanical arrangements like clocks or in Leonardo da Vinci's case even a first humanoid robot. Such, as well as later inventions are important parts in robot history as they show how people thought about mechanical possibilities, but they have not had major impacts on human society. This impact was caused during the Industrial Revolution in the 18th and 19th century.

3.1. Robotic devices in industrial environments

During the second half of the 18th century several innovations have changed the important industries forever. In the textile industry, for instance, three men had great influence on the ways of spinning. Richard Arkwright invented the water frame, James Hargreaves came up with his Spinning Jenny, and Samuel Crompton combined both inventions in his Spinning Mule that was finally patented in 1783. Of course, people profited from these developments: From now on cotton mills helped to produce

different kind of textiles faster and in larger amounts, which made the final products cheaper for any consumer.

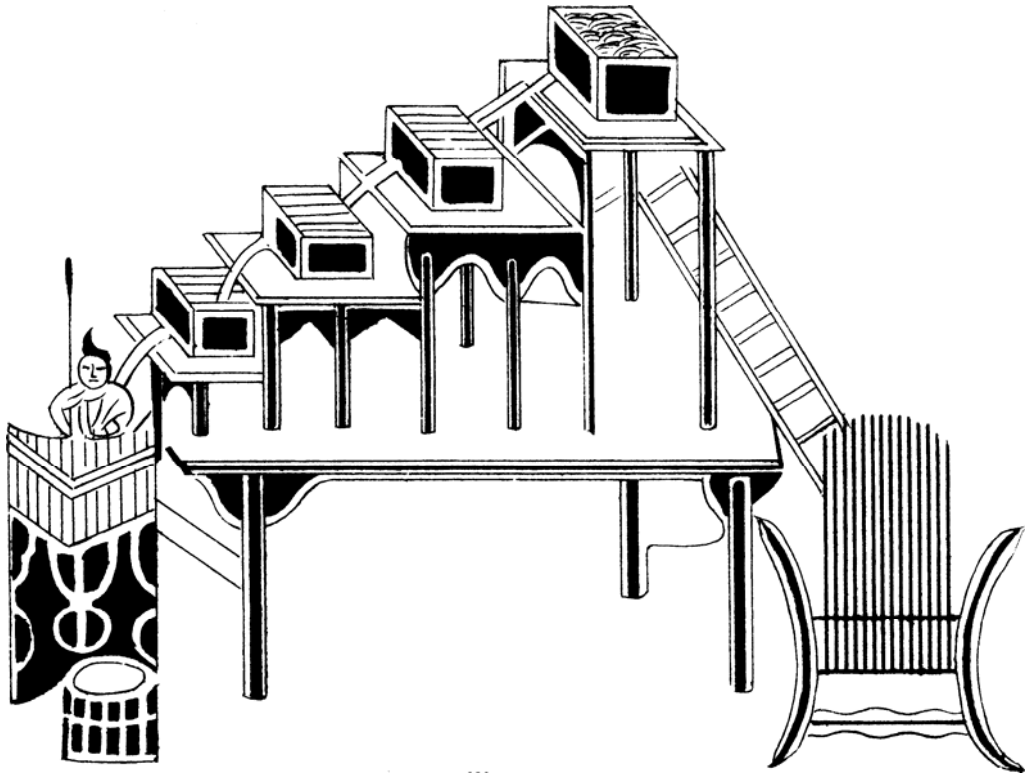

Figure 1. Needham, 1959, 313f, Babylonian water clock

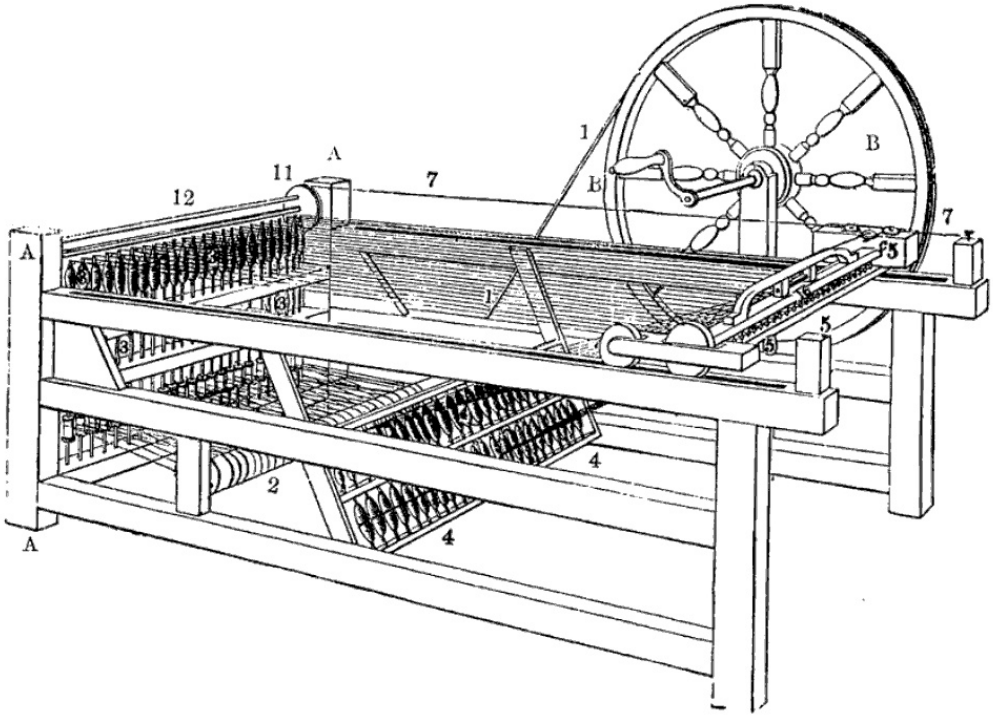

Figure 2. James Hargreaves' Spinning Jenny (commons.wikimedia.org)

James Watt's steam engine of 1775 has had a similar impact on the industry. Had it been initially used to power pumps that where needed to get water out of mines, it soon became an efficient power source for other machines as well. Now, companies were able to build factories in places without waterpower. These factories soon became bigger and semi-automated, which – like the cotton mills, too – also influenced the way people worked. Human labour in factories was organised in a way that people were trained to do special tasks in the process and afterwards give the product to next employee who performs his task. This change in working processes is seen as the birth of assembly lines that gained even more importance in the following decades and centuries.

3.2. Robots enable mass production

The assembly line as well as the use of more machines helped to improve automated manufacturing throughout the industrialization. One of the most prominent examples is Ford's Model T. Henry Ford managed to reduce the complexity in each of the 84 areas the production consisted of. These measures shortened the assembly time of one car from over 12 hours in the beginning to 93 minutes in 1914. In the end the production volume increased to 2 million cars annually. Henry Ford not only built more and more cars, he also designed the Model T in the interests of his customers including an attractive price of 240 Dollar. The enormous success proved that Ford was right. Summed up there are enough reasons why the model T can be considered as the first mass product in industrial history.

Fiure 3. Ford's Model T (commons.wikimedia.org)

In spite of all this automated labour the word robot was not used back then. The Czech writer Karel Čapek coined this term meaning "compulsory labour" [1](Christensen, 2007) in his play "R.U.R. – Rossum's Universal Robots" from 1921. It dealt with artificial humans that today are known as androids. In 1926 Fritz Lang's "Metropolis" showed the first robot in film. Although humanoid robots did not play a major role in the industry, companies later took this term for their robotic inventions. In the first years those robots were built mostly for public relation purposes. They may have shown people what some day would be possible, but it was not long until the rise of computer technology has changed a lot.

3.3. Industrial Robots as they are known today

During the 1930s several scientists and engineers worked on the first machines that paved the way to the first real computer. Vannevar Bush, for instance, developed the so-called Differantial Analyzer that was able to solve differential equations. The more important milestones in computer technology, however, was Konrad Zuse's Z3 in 1941 and in 1944 Howard Aiken's and Grace Hopper's Mark 1. With these first programmable computers science and industries were able to enter a new age of technology.

The first industrial robots as we know them today resulted from robotic achievements on the one hand and computer development on the other. The combination of both scientific fields enabled researchers and industrial companies to develop teleoperated robots that could do work that was too dangerous or too heavy for human workers. In the beginnings, for instance, industrial robots were used by the Atomic Energy Commission to handle nuclear material. Raymond Goertz was the one who designed this teleoperated robot in 1951. Teleoperated robots were soon followed by programmable robots – the first step to automation.

Only a few years after Goertz' construction, in 1954, George Devol designed the first programmable robot. The engineer not only coined the term Universal Automation but together with the engineer Joseph Engelberger he founded the first robot company two years later. It was named Unimation. Joseph Engelberger knew about the importance of robots and the use for companies. Automobile manufacturers, for instance, were facing a growing demand for cars and, thus, looking for more efficient ways to work at the assembly lines. Unimation, finally, delivered a solution, the one-armed Unimate robot. General Motors has used this robot from 1959 onwards to unload hot die casts, to cool the components, and to process them to a trim press. ([2] Angelo, 2007, 41f.)

3.4. Computers conquer the world

Over the years computers have become much smaller than the first models had been, more powerful and more affordable, too. They soon entered daily life in fields of work and entertainment. This changed workflows considerably as many processes that had been done manually before now were automated with help of the computers. Databases were able to not only save important data, but also manage them, which saved a lot of time when they had to be found. Today society would hardly be able to live without computers. The rise of this technology in the 80s and 90s has had effects on practically every field of life. Innumerable computer servers organize website and e-mail traffic, bank transfers or, in recent years, social networks. Today all of these internet products and services are important parts of our lives and will experience further development in the future.

Many of today's common technologies have been used and developed in military environments first. Sooner or later people recognize economical potentials and offer solutions for the private sector. The use of GPS satellites is an example of recent history. Still important in modern warfare navigation systems have become popular in civil products as well. More and more cars are sold with GPS technologies or customers buy mobile navigation systems. Even in sports like hiking and cycling people use GPS devices. There are numerous advantages to profit from. Traffic members can concentrate on driving their cars instead of being distracted by reading a map. That is a plus in safety and people can save a lot of time.

All of these modern technological solutions are the result of many years of research in future sciences. Beside robotics and computer development we have to mention the issue of artificial intelligence here, too. In 1950 Alan Turing was one of the first to think about the possibility that computers, one day, might be more intelligent than humans. Today [4] Nilsson (2010) gives one of several definitions: "For me, artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment." Thus, the matter of artificial intelligence plays a major role in the development of automation systems and robots. Thus, the future of robotics will be influenced by advances in this scientific field as well.

Figure 4. Alan Turing (1912-1954) /commons.wikimedia.org)

Looking at the ancient beginnings of technological history and what has happened in the last 100 years it is easy to see the rapid development in modern times. Major inventions always had major influences on society, but today technological improvements happen faster and in a greater number. It is hard to say what exactly will happen in the next decades, but it is certain that the speed of development will rise. Speaking of robots again, manufacturers will not reinvent the wheel, but new technologies will help them to raise the performance, the precision and the capabilities of industrial robots.

4. CHANGES IN HUMAN SOCIETY LEAD BY AUTOMATION AND ROBOTICS

The first industrial robots that fulfilled certain tasks in manufacturing had been installed in order to raise production volume. Ford's Model T, as mentioned above, might be the best example. The increased production of goods allowed manufacturers to offer things at affordable prices. This had the consequence that more and more people bought those goods, which led to a higher demand and, again,

to higher production volumes. Robots and automation solutions supported this development – with the effect that production has become ever more efficient always keeping up with the increasing demand of consumers.

Robots not only increased production volumes, but also the speed of the production. Consumers did not have to wait endlessly for new products, because automated processes guaranteed that goods were manufactured in shorter times. Thus, companies were able to ensure a fast and reliable supply of products.

The reason why goods have become more affordable is directly connected to the automation processes, too. For these newly developed manufacturing processes companies needed less human workers than before. Personal costs always had a great share in the overall production costs, which is why companies still try to get along with rather less than more workers. In automated working areas robots are able to substitute a lot of workers who otherwise would have to work in several shifts. Companies still need humans, but these are well-trained and only responsible for the control a programming of the robots. This means that human labour has become much more qualified compared with the work decades ago.

The use of robotic devices in manufacturing, however, had also effects on the development of goods. Designers had new possibilities to create products because the machines were able to produce them in other ways than humans could. Robots were stronger and soon became very precise in their tasks. Thus, over the years manufacturers invented new and more innovative products for their customers.

Figure 5. Navstar 2 GPS satellite (commons.wikimedia.org)

In factories robotic solutions led to yet another improvement looking at the matter of safety. Many tasks connected to heavy metal work, for instance, require a lot of people. Still the risk of accidents remains. This is only one example where robots contributed to the employers' safety. The same is valid for tasks that involve nuclear materials or dangerous chemicals. Robots handle them with ease and are not affected by their dangers.

Industrial robots have affected society a lot, but considering the development of computer technology there have been many more effects on daily life. As mentioned above the internet and GPS systems are two important examples that have changed life. The internet in particular is an instrument that has brought many comforts to daily life considering communication over thousands of miles, online shopping and matters of banking. Here it becomes obvious that these technologies have a great share in globalization processes that have become inevitable during the last decades.

In conclusion it is the continuously improving artificial intelligence of machines, i.e. robots as well as software, that has influenced and will keep influencing society in future. Robots are a good example here: today we have to program robots and teach them what they have to do. Future generations of robots may be capable of learning much more than today and they could learn things on their own. They even could act similarly to human beings, since one of the aims in artificial intelligence sciences is build machines that work autonomously – including the capability of making decisions.

We have observed that development in modern technology today is faster and that more products get invented. The consequence is that also changes in society lead by technological achievements happen faster and more often. However, it is hard to tell the difference between cause and effect, because the other consequence is that people rely on technological development and want to have ever better products. Thus, the challenge for manufacturers is to keep up with technological possibilities on the one hand and their customers' demands on the other hand.

5. TEACHING OF AUTOMATION AND ROBOTICS

The technological development over the last decades today influences manufacturing processes a lot. This is the reason why we have to teach automation and robotics in a way that considers those developments in every aspect of modern economics and production processes. Manufacturers have to adapt to changed demands of their customers, which is done by developing products the market requires, Manufacturers also have to develop goods that have the potential to be successful in order to keep up with competitors. The development of new products is followed by their production. At this point of the whole process automation and robotics come into play.

One consequence of the many new products that are developed today is their shorter life cycle. Still, these products have to be manufactured in great numbers. This requires intelligent automation systems that work fast and are reliable. However, there is also a major need for flexibility, since manufacturers have to react fast to changing demands and new developments. Without automation systems and industrial robots the production would not be able to react adequately because operating machines manually would take too much time. This refers to set-up times as well as changing work pieces. However, the advances in these technological fields show that the ever improving artificial intelligence of robotic solutions enables researchers to come up with innovations that work according to the demands.

As we see, the whole process of developing robots of the most different kinds – whether for economical reasons or as everyday helpers in society – is connected to improving the artificial intelligence of machines. The latter in this case may be mechanical as well as software-based solutions. Both parts, nowadays, are linked together and function as appropriately as they are meant to do. If this fact is understood and applied at an early stage of every development process, researches end engineers will be able to build the robots that are needed today.

Future employees in manufacturing environments will have to learn, that they have to include robotics and automation into their organization of production processes. It is the optimization of these processes that will them and their companies enable to keep up with market developments. This understanding and the resulting demand for more capable and powerful automation systems and industrial robots will help to develop ever better solutions.

6. CONCLUSION

History gives many evidences for major technological developments that have had lasting effects on society. One of these evidences is the Spinning Mule. This and similar machines were able to produce better fabrics faster and for a smaller price than manually run spinning machines. Smaller family business in this branch had more and more difficulties to sell their products. In the end poverty and hunger led to the uprising of the weavers in 1844.

The introduction of the assembly line by Henry Ford was a similar technological revolution – with the opposite effect on society, though. Lower production costs enabled Ford to sell cars at a better price. Now, much more people could afford an own car. The increased demand made way for millions of working places.

These examples show that social effects by technological developments cannot be predicted in advance. In particular, such questions cannot be answered by technicians and engineers. At this point politics and society will have to look into these problems as well. Automation and the rapid development in robotics will influence our lives in the future considerably. Especially the universality of robotics makes this field an own discipline of technology. At colleges and universities automation technology in most cases is part of production technology. Robots are seen as a subgroup in engineering or tooling machines. The reason for the latter is that robots as well as tooling machines use – to a part – the same components like controls and drives. In addition, even business studies deal with robotics and automation from the economic point of view.

Today industry and the market give a clear direction. There is an increased demand for engineers who can implement holistic projects in production and manufacturing. They are supposed to know how manufacturing has to be organized with respect to technology, economics, quality, and flexibility, because they have to develop optimal solutions for the given tasks. Thus, they also consider the product's characteristics, its life cycle, production volume, changes in construction, quality, profitability, performance, energy consumption, re-usability of automation components, training of workers and flexibility of the whole installation. Nobody would expect a composition to know how to make instruments. But he has to know the sound range of these instruments in order to write good music. The training of engineers has not recognized this analogy yet. It rather concentrates on the building complex machines than on the rapid speed of the technological development. Engineers of automation and robotics have to focus on the capabilities of robots. Supported by universities this focus on application technology and robotics can create a whole new generation of engineers.

7. REFERENCES

[1] Christensen, A. G. (16. November 2007). *The Literary Encyclopedia.* http://www.litencyc.com/php/speople.php?rec=true&UID=728

[2] Angelo, J. A. (2007). *Robotics: a reference guide to the new technology.* Santa Barbara, United States: Libraries Unlimited.

[3] Needham, J. (1959). *Science and civilisation in China.* Cambridge, Great Britain: Cambridge University Press.

[4] Nilsson J. N. (2010). *The Quest for Artificial Intelligence.* Stanford, United States: Cambridge University Press.

[5] Giedion: *Die Herrschaft der Mechanisierung* [1948], Frankfurt M. 1987, (216-277, 101-153)

[6] Hounshell, David A. (1984), The Development of Manufacturing Technology in the United States, ISBN 978-0-8018-2975-8

[7] Robert Lacey, *Ford* 1986 - Little, Brown & Company ISBN: 0316511668

[8] Henry Ford, *My Life and Work*, 1923 ISBN-10: 1595478752

[9] HOMBURG, H. : *Rationalisierung und Industriearbeit. Arbeitsmarkt, Management, Arbeiterschaft im Siemens-Konzern* Berlin 1900-1939. Berlin

[10] Misselhorn, UNI Tübingen, http://www.uni-tuebingen.de/uni/f07/misselhorn/index.htm

[11] T. Christaller u. a.: Robotik. *Perspektiven für menschliches Handeln in der zukünftigen Gesellschaft*. Heidelberg: Springer 2001

[12] DER SPIEGEL 14/1964 http://www.spiegel.de/spiegel/print/d-46173388.html
[13] COMPUTERWOCHE 33/ 1987 http://www.computerwoche.de/heftarchiv/1987/33/1160824/
[14] DER SPIEGEL 02/201. http://www.spiegel.de/video/suche/tag/K%FCnstliche+Intelligenz.html
[15] Róbert SZABOLCSI – Gerald MIES: *Robotics in Nutshell – Past and Future*, CD-ROM Proceedings of the VIth International Conference „New Challenges in the Field of Military Sciences, ISBN 978-963-87706-4-6, 18-19 November 2009, Budapest, Hungary.
[16] Róbert Szabolcsi: *The Developing Military Robotics*, Proceedings of the 13th International Conference of "Scientific Research and Education in the Air Force", "AFASES 2011", ISSN 2247-3137, pp(1190-1198), 26–28 May 2011, Brasov, Romania. http://www.afahc.ro/sesiune/sesiune.html
[17] Róbert Szabolcsi: *UAV Controller Synthesis Using LQ-Based Design Methods*, Proceedings of the 13th International Conference of "Scientific Research and Education in the Air Force", "AFASES 2011", ISSN 2247-3137, pp(1252-1256). 26–28 May 2011, Brasov, Romania. http://www.afahc.ro/sesiune/sesiune.html
[18] Róbert Szabolcsi: *Extra-Cheap Solutions Applied for Non-Reusable Unmanned Aerial Vehicle Technologies*, CD-ROM Proceedings of the VIIth International Conference „New Challenges in the Field of Military Sciences 2010", ISBN 978–963–87706–6–0, 28-30 September 2010, Budapest, Hungary.