Using Robotic Kits and 3D printers at Primary (Lower Secondary) Schools in the Czech Republic

Radek Nemec, Petr Vobornik

***Abstract*—**This article describes the results of the phone interviews across the Czech Republic at primary (lower secondary) schools focused on mapping the using robotic kits and 3D printers. The article contains the second part. The design and development of robotic hand. The robot hand will be first designed by means of the CAD system and then printed out by a 3D printer. Arduino and 3D printers will be used on the construction. The Arduino platform, which will control small electronics (servo motors) and mechanics parts (printed by the 3D printer). The article presents a robotic hand design using the Adobe Inventor CAD system. The results of the phone interview present that schools possess minimum robotic construction kits and 3D printers. However, if school have 3D printer they used to create their own robots or replacing parts for robotics.

***Keywords*—** Robotic Kits, Lego Mindstorms, 3D printers, model, robot hand, construction, CAD, education.

I. Introduction

LONG-THERM pupils are not interested in technical and natural education. Pupils are not interested in technical education. Technical and science subjects is it difficult and they do not understand them. Unfortunately, this trend is worldwide. But there are ways to change this state. One way is to engage in teaching or at least outside the technical education of toys or new technologies.

One of the toy is Lego Mindstorm. In recent years, this has gone into after school activities. [1] Another option is new technology. An example is 3D modeling.

Industry 4.0 (also called the Fourth Industrial Revolution) is also an indication of the current trend of digitization, the associated automation of production and changes in the labor market that it brings. [2]. New technologies are rapidly changing the face of our economy and our way of life. The Fourth Industrial Revolution does not bring about fundamental changes only in the area of industrial production. Although it stands at its center, the overlap of the fourth industrial revolution is much wider. It is a completely new philosophy that brings about a change across society, and covers a whole range of areas ranging from industry, technical standardization, security, the education system, the legal framework, science and research to the labor market or the social system. The Czech Republic is one of the countries with the longest industrial tradition and our ambition is that its future will remain connected with industry. The Fourth Industrial Revolution brings a number of challenges but, in particular, a unique opportunity to ensure the long-term competitiveness of the Czech Republic in a global competitive environment. We live in an exceptional time, and our ability to take advantage of this opportunity will have an impact on the quality of life of generations. [3], [4], [5] See figure 1 and 2.

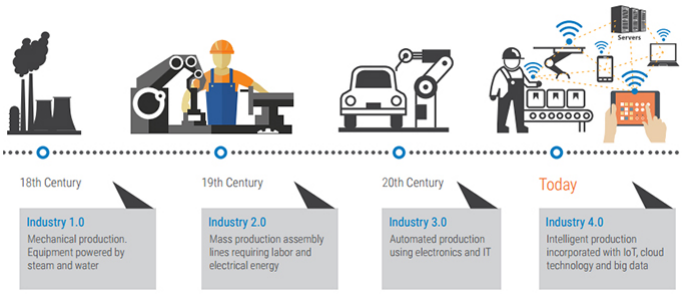

Fig. 1 Industry 4.0 [6]

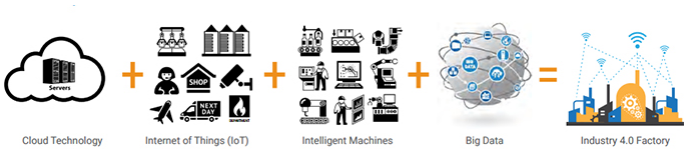

Fig. 2 Industry 4.0 [6]

II. Mapping the using Robotic Kits and 3D printers

A. Research Methodology

Analysis was performed using a telephone interview at randomly selected primary schools in each region of the Czech Republic. For each region 3 schools were randomly selected. There are 13 regions plus capitol city. The list of schools was selected from the register of schools of the Ministry of Education, Youth and Sports. [7] A random analysis was

The paper has been supported by Specific Research Project of Faculty of Science, University of Hradec Kralove, No. 2102, 2017.

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conducted in scientist calculator from the list of schools.
The exact procedure for finding schools was as follows. There has to be contacts with school management. First, researcher finds a list of Czech primary schools on the website http://rejskol.msmt.cz/, where under "Type of school / facility" "B Primary-schools" is selected, then under "county / district:" the schools from particular regions can be found. After the list of schools was created, a scientific calculator was used to select 3 schools randomly from each region (plus Prague). These schools were subsequently searched on the Internet (to locate the school management´s phone number or teachers' lounge).

Questions for the interview were determined as follows:

1. Does the school possess any robotic construction kit (LEGO Mindstorms, programmable Merkur etc.)?
1.1. How many robotic construction set do you have at school?
1.2. How often do you use them? 1x a week, ...
2. Does the school possess 3D printers?
2.1. How many 3D printers do you have at school?
2.2. How often do you use them? 1x a week, ...
3. Do you use the 3D printers in order to create your own robots, or alternatively, do you print spare/expanding parts for a robotic set by means of 3D printers?

B. The Results

The results are processed using quantitative-qualitative research methods and are shown in the following tables and graphs.

Table I shows the results of question Does the school possess any robotic construction kit (LEGO Mindstorms, programmable Merkur etc.)?

Table I. Does the school possess any robotic construction kit (LEGO Mindstorms, programmable Merkur etc.)?

1. Does the school possess any robotic construction kit (LEGO Mindstorms, programmable Merkur etc.)?	
Yes	No
2	40

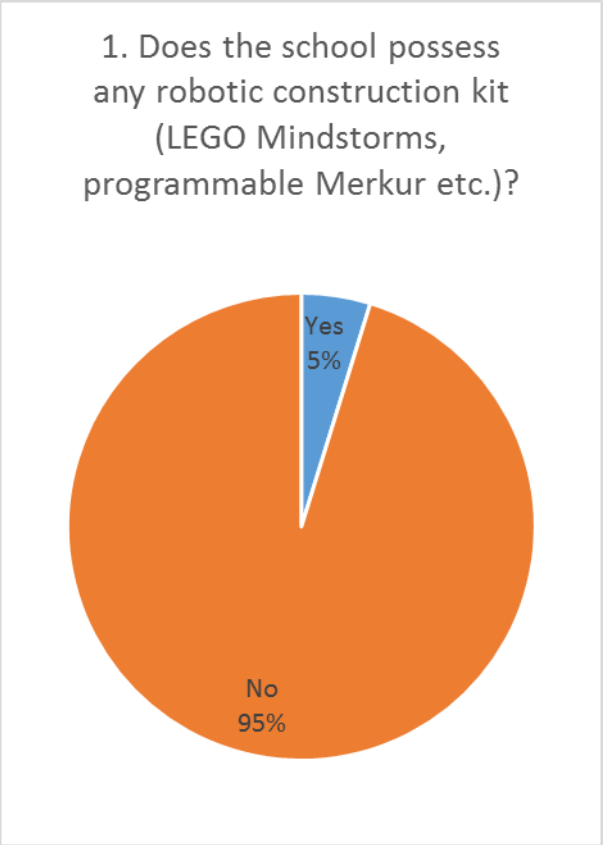

Fig. 3 Does the school possess any robotic construction set (LEGO Mindstorms, programmable Merkur etc.)?

It is clear from Table I and Figure 3 that 95 % of schools do not possess any robotic construction set. In two cases, the answer was positive for robotic construction set. They have Lego Mindstorms.

The next question How many Robotic kits do you have? presented answer for two schools. There were 4 robotic sets in one school. They had 2 at the second school. At both schools, it was Lego Mindstorm.

On the 1.2. question How often Robotic kits do you using? the schools replied that in the one school using robotic kits every day. At the second school they use robots once a week. Both schools use robotic sets in after school activities.

Questions about 3D printers are these. Does the school possess 3D printers? Table II and figure 4.

Table II. Does the school possess 3D printers?

2. Does the school possess 3D printers?	
Yes	No
2	40

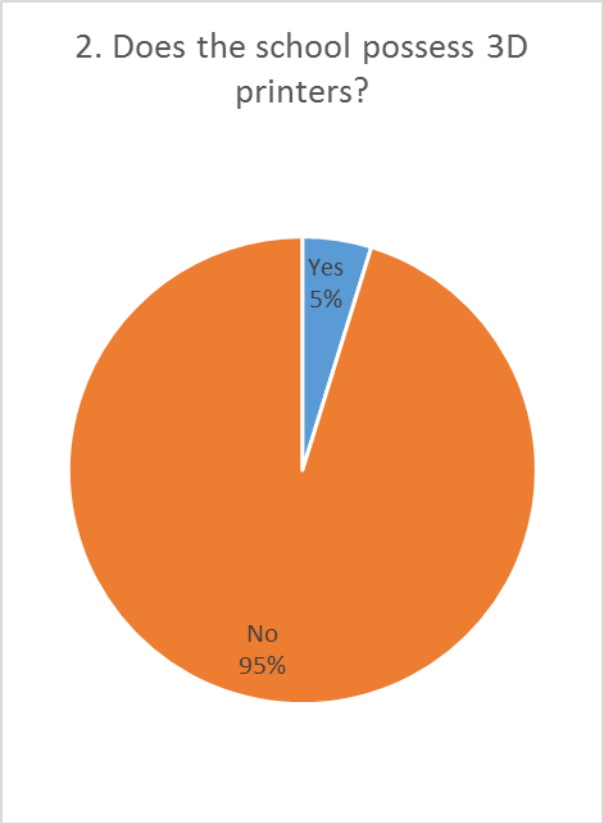

Fig. 4 Does the school possess 3D printers?

The results show that only two schools have 3D printers. 95 % of schools do not possess any 3D printers.

The next question was again about the number of pieces. How many 3D printers do you have at school? Due to the price of 3D printers, the answer is predictable. At both schools, 3D printers have 1 piece.

Frequency question about usage. How often do you use them? He has the answer once a week at both schools.

The last question was the use of 3D printers for robotics. Do you use the 3D printers in order to create your own robots, or alternatively, do you print spare/expanding parts for a robotic set by means of 3D printers? At one school they use the 3D printers to create your own robots. At the Second School, they are printing and replacing parts for robotic kits on 3D printers.

It may seem that robotic kits and 3D printers in schools in the Czech Republic are not very powerful. But there are AMAVET Youth, Science and Technology Associations, leisure groups. Amavet is focused on the development of scientific activities in the free time of children and youth in the Czech Republic. Currently, there are 14 Center for Children and Youth, which regularly attends about 3,000 young people. At Amavet there are approximately 40 after school activities focused on mechatronics and robotics. The advantage is that some after-school activities are already partly equipped with the Mercury kit. Every after school activity is led by enthusiasts in robotics and experience with children's leadership. [8], [9]

III. Modeling of Robotic Hand

This section introduces the design and development of a robotic hand. The robot hand will be first designed by means of the CAD system and then printed out by a 3D printer. [10], [11] Arduino and 3D printers will be used on the construction. The Arduino platform, which will control small electronics (servo motors) and mechanics parts (printed by the 3D printer). The article presents a robotic hand design using the Adobe Inventor CAD system.

The proposal consisted of creating a beta model of the human hand. First, technical drawing of one finger segment was made. Figure 5. Then a 3D object was created in the modeling CAD system. Figure 6. Other finger segments were created in the same way. Figure 7. The last segment of the finger was ended with a sphere. Figure 8. The finger segments differ in length. Each segment was 1 cm shorter than the previous one.

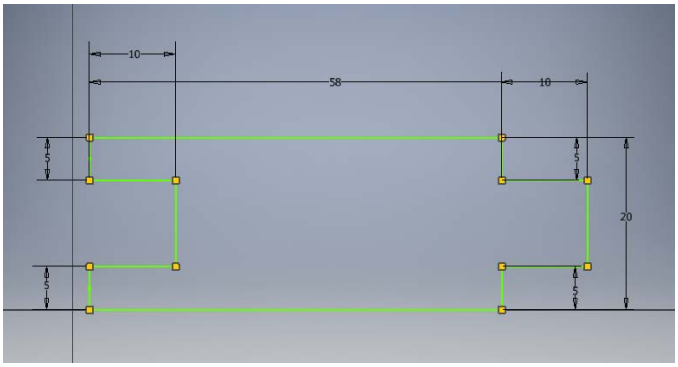

Fig. 5 Finger segment

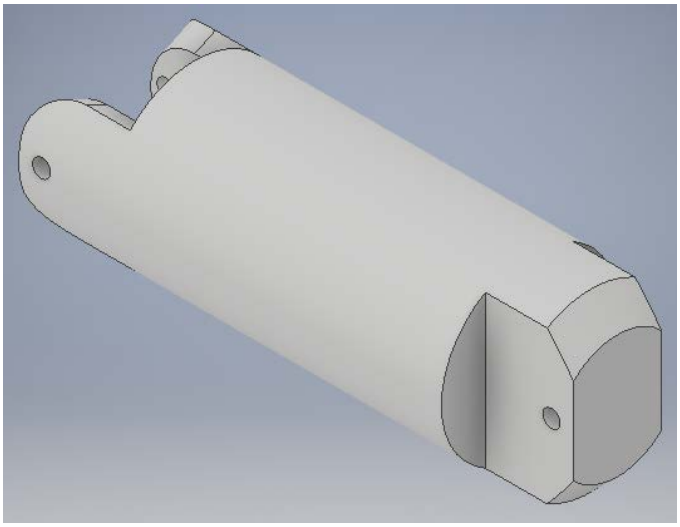

Fig. 6 Finger segment

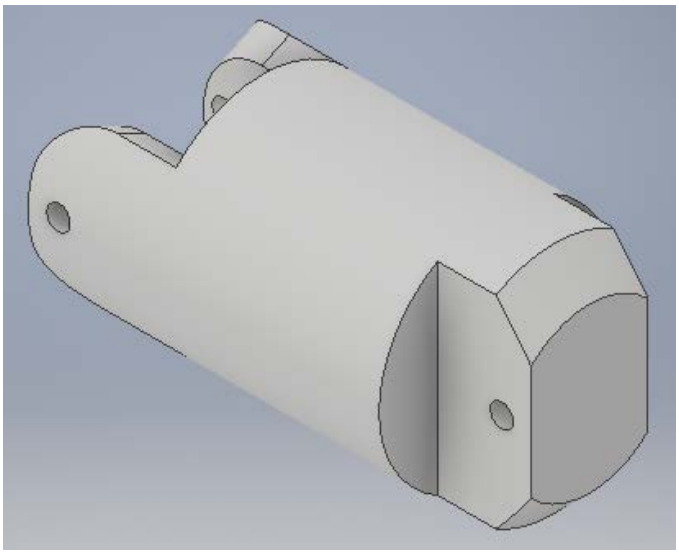

Fig. 7 Finger segment

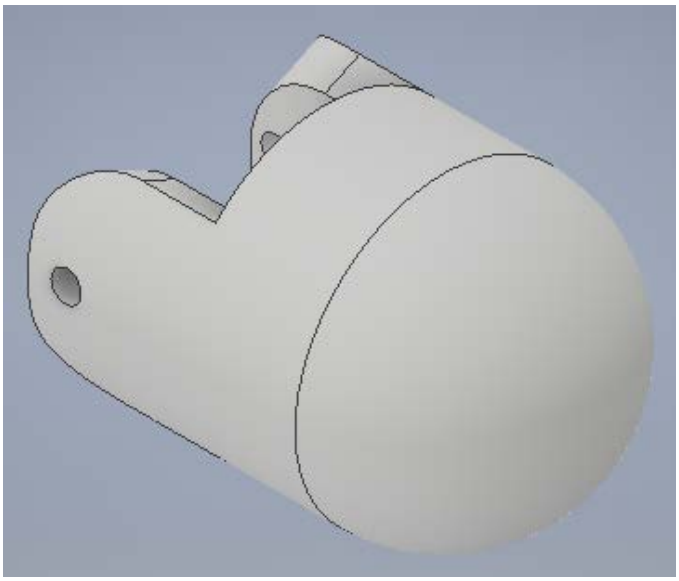

Fig. 8 Finger segment

All segments of the fingers were folded into one finger. Individual segments were collected using the axis. Figure 9.

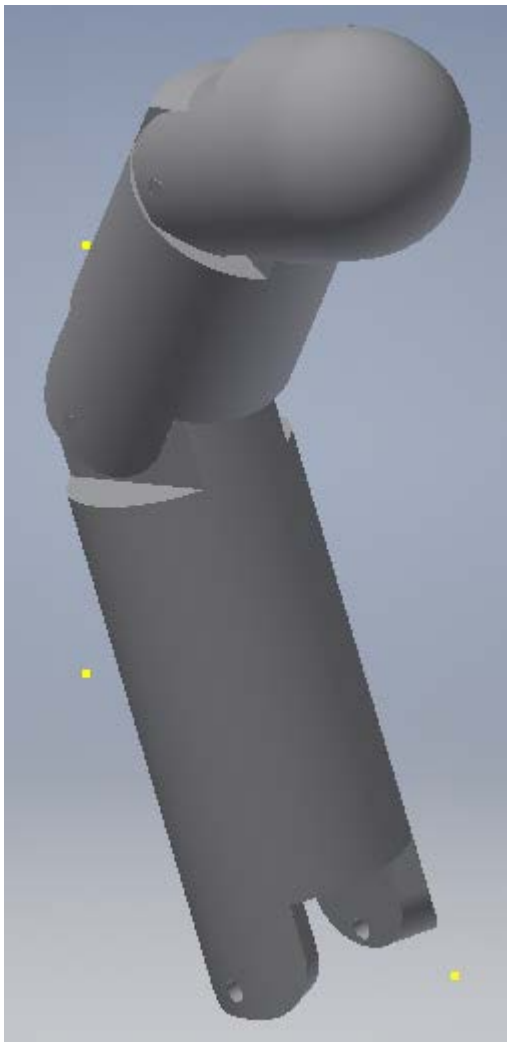

Fig. 9 Finger

The next step was to create a palm. Again, a technical drawing was first created. Figure 10. From there, a 3D model was created. Figure 11.

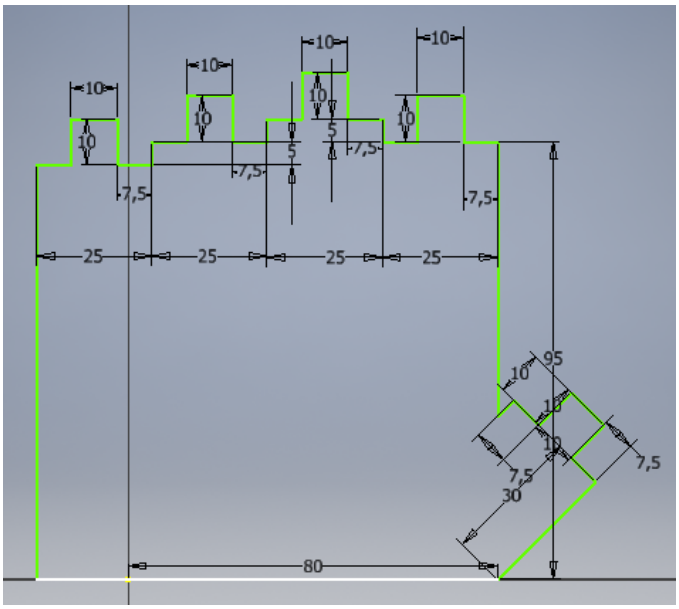

Fig. 10 Palm

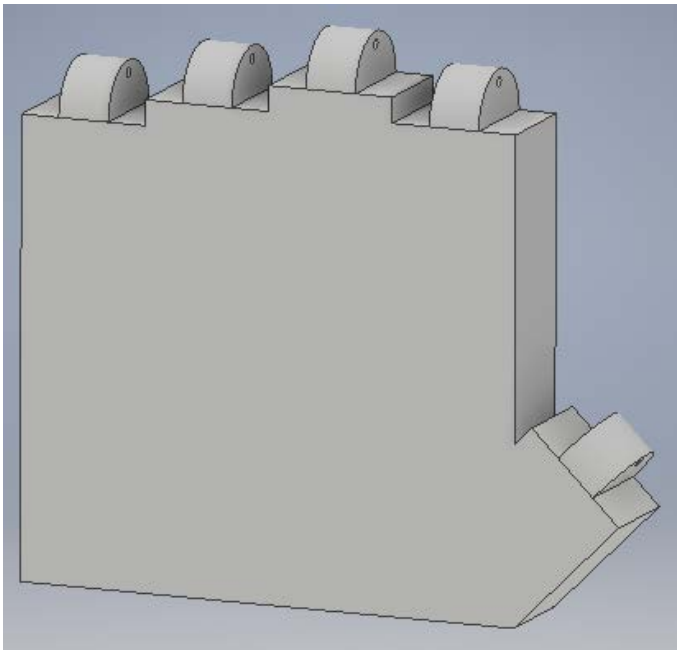

Fig. 11 Palm

Finally, the palm and the fingers were folded in one hand. Figure 12.

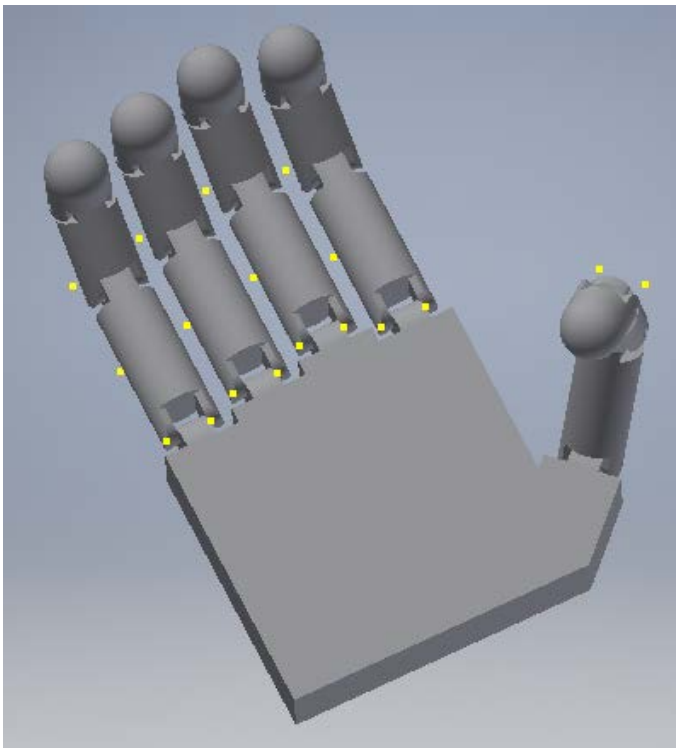

Fig. 12 Hand

IV. Conclusion

Technical and science education is perhaps more attractive to pupils due to robotic kits and 3D printers, as well as Industry 4.0. The future will also show how these technologies and trends will really improve this undesirable sector. Robotic kits and 3D printers are very simple clever utilities for increase to interesting pupils in technical and natural education. How we can in CAD design see, creating the parts for 3D printers are very simple.

Acknowledgment

The paper has been supported by Specific Research Project of Faculty of Science, University of Hradec Kralove, No. 2102, 2017.

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