

How to attract children to mechatronics

The experiences with mechatronic after school classes

Ing. Renata Janošcová, PhD.
Alexander Dubček university of Trenčín
Trenčín, Slovakia
janoscova@tnuni.sk

Abstract - The tool of technical disciplines popularization for children can be free-time activity – after school classes for schoolchild of primary schools from 5th to 9th class. Schoolchild ponders the choice of secondary school although they have not concrete opinion on their future work. Suitable support of their interest to technical disciplines by playful form in after school classes can distinctly influence their following drift. If the schoolchild will chose technical oriented secondary school so then will chose technical faculty of university probably. Motivation of schoolchild to technical fields is one of the primary goal neither of this conference nor complete activity of mechatronics after school classes that are realized in Trenčín and its vicinity from 2003.

Key words - Mechatronic; MC - Mechatronic after school classes; building set Lego MINDSTORMS; programming language NQC - Not Quite C, ADuT – Alexander Dubček university of Trenčín, LMS – Learning Management System.

I. MOTIVE

Mechatronics is a new field of science and technology. She deals with the development and use of machines and systems with computer control [20]. It is based on knowledge of mechanics, electronics and microprocessor technology, information and computer control. The word “*mechatronics*” is for amateurs unknown. The faculty of mechatronics as part of ADuT exists from 1997. In spite of it children of primary schools don't know what this term means, someone thought that means sometimes prehistoric. Nobody was near to right answer. At this time the Slovak technical faculties feel interest decrease of study. This reality brought us to belief that right time is for change [4].

II. PRIMAL IMPULS

No activity can run without primal impulse and enthusiasm of people. This is our case too. Others possibilities were positive too. One of them were no-useable LEGO MINDSTORMS building sets in The primary school at Na dolinách street in Trenčín – Zlatovce and active parents council that had demand on technically oriented out-school activities for their children [6].

The 2nd one positive factor were the students of mechatronic engineering who suggested leading of groups and processing of school-year-work in Lego MINDSTORMS models programming in NQC theme.

And still one factor is here – expert teachers of faculty who had courage to do collaboration of type: university – primary schools. When the right people meet right people new quality can be bored. If impulse on lower organizational level arose it doesn't disappear when it is supported by leading management level. The rector was on the ADuT side, director and his assistant were on the side of primary school. After two meetings the agreement of

collaboration was arose. Then co-ordinator for all group activities was named. Then LMS support for groups was appointed together with period and periodicity. For each group the suggestion for teaching documentation was created with graduate profile, teaching plan, organization of study, teaching points and time-thematic plan [2] (the demonstration of teaching documentation part for group “Programming in NQC language” - The mechatronics basis II., in Tab.1).

III. POWER OF RECIPROCITY

In September of 2003 the children of two primary schools were acquainted that new “*Mechatronic after school classes*” are opened, oriented on mechatronics popularization through robotic building set LM programming. Parents of children were acquainted. The final models attracted children the models were created by students of The faculty of mechatronics. The interest of children was enormous [7].

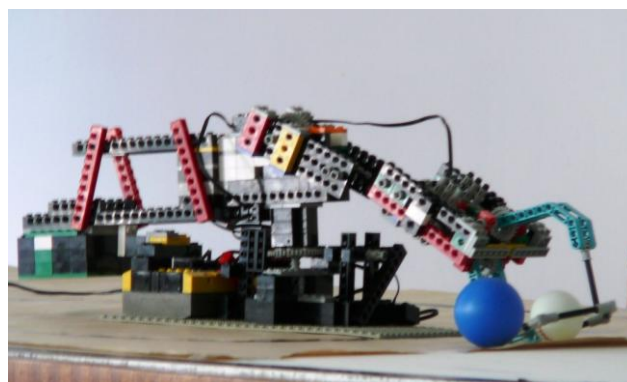


Figure 1. Manipulator model [1]

TABLE I. EXAMPLE OF TIME-THEMATIC PLAN

n	T.	Theme title	Teaching method	Teaching aids and didactic technology
1	1.	Safety instructions, Acquainting with Learning Management System	Frontal lecture	Lego MINDSTORMS Dacta, RoboLab, PC, Internet – http://clearning.tnuni.sk/moodl/course/category.php?id=11
2	2.	Acquaint with RoboLab, Lego MINDSTORMS Dacta, own building	Frontal lecture, discussion	Building set LEGO MINDSTORMS Dacta
3	3.	Lego MINDSTORMS Dacta, own building	discussion	Building set LEGO MINDSTORMS Dacta
4	3.	Programming environment RoboLab, basis of work with RCX a motors	Frontal lecture, discussion	PC, programming environment RoboLab
5	4.	Programming environment RoboLab, basis of work with sensors	Frontal lecture, discussion	PC, programming environment RoboLab
6	5. – 6.	Programming environment BrixCC, jazyk NQC, basis of work with motors and sensors	Frontal lecture, discussion	Building set LEGO MINDSTORMS Dacta RoboLab, PC, prog. environment BrixCC
7	7.	Robot that can stay on table (photically sensor using)	Frontal lecture, discussion	Building set LEGO MINDSTORMS Dacta RoboLab, PC, prog. environment BrixCC
8	8.	Preparation for <i>Robotic day of Trenčín</i>	Team work	Building set LEGO MINDSTORMS Dacta RoboLab, PC, prog. environment BrixCC
9	9.	Robot that can stay on table (tactile sensor using)	Frontal verification of knowledge	PC, prog. environment BrixCC
10	10. – 12.	Preparation for <i>ISTROBOT</i> match	Team work	PC, prog. environment BrixCC
11	13.	Robot that can know colours (photically sensor using)	Frontal lecture, discussion	Building set LEGO MINDSTORMS Dacta RoboLab, PC, prog. environment BrixCC
12	14.	Robot that can play melody (photically sensor using)	Frontal lecture, discussion	Building set LEGO MINDSTORMS Dacta RoboLab, PC, prog. environment BrixCC
13	15.	Using of RCX and positional sensor	Frontal lecture, discussion	Building set LEGO MINDSTORMS Dacta RoboLab, PC, prog. environment BrixCC
14	16.	Robot on remote control	Frontal lecture, discussion	Building set RoboLab, PC, prog. environment BrixCC
15	17. – 19.	Self-reliant project of group no. 1	Team work	Building set LEGO MINDSTORMS Dacta, PC, prog. environment BrixCC
16	20.	Self-reliant project of group no. 2	Team work	Building set LEGO MINDSTORMS Dacta, PC, prog. environment BrixCC
17	21.	Self-reliant project of group no. 3	Team work	Building set LEGO MINDSTORMS Dacta, PC, prog. environment BrixCC
18	22.	Terminatively repeating – presentations preparing	Discussion	PC, prog. environment BrixCC
19	23.	<i>Presentation of mechatronic after school classes</i>	Presenation	Building set LEGO MINDSTORMS Dacta Dataprojekt
20	24. – 26.	<i>Open university conference preparing</i>	Team work	Building set LEGO MINDSTORMS Dacta RoboLab, PC,

IV. COURSE

In academic year 2003/2004 the 1st two mechatronic after school classes were realized, these were focused on work with building set system Lego MINDSTORM, *RoboLab* system and *NQC* language in *Brixcc* environment. The groups were led by students of FM. The children met their teachers from 2 to 4 hours per week during winter and summer semester. Their were interested in mechatronics basics by way of building set Lego MINDSTORM, *RoboLab* system and *NQC* in accordance with applicative time-thematic plan from paced pedagogic material. Single groups were divided into three categories in accordance with sophistication:

The basics of mechatronics I., II., III. For example when some student wanted go to group that related under The basics of mechatronics II., firstly he must graduate course I. of these thematic category. The two of teachers paced and edited the guide that was the suitable aid for next teachers [19].

In the following content is demonstration of the code that children learned during 5th and 6th week of teaching (TABLE I. :

```
// Basis of work with motor, bulbs, audio, forward and reverse

task main() // basic task
{
  while(true) // non-ending cycle
  {
    start Blikac_Vpred; // calling task Blikac_Vpred...
    start Motor_Vpred;
    start Hudba_Vpred;

    Wait(600); // stops running the program for 6 second
    stop Blikac_Vpred; // stops task Blikac_Vpred...
    stop Motor_Vpred;
    stop Hudba_Vpred;

    Off(OUT_A); // output off (A – motor)
    Off(OUT_B); // output off (B – bulb)
    Wait(250); // stops running the program for 2,5 second
    start Blikac_Vzad; // calling task Blikac_Vzad...
    start Motor_Vzad;
    start Hudba_Vzad;

    Wait(600); // stops running the program for 6 second
    stop Blikac_Vzad; // stops task Blikac_Vzad...
    stop Motor_Vzad;
    stop Hudba_Vzad;

    Off(OUT_A); // output off
    Off(OUT_B);
    Wait(250); // stops running the program for 2,5 second
  }
}
/*-----*/
task Blikac_Vpred() // flashing lamps B
{
  SetPower(OUT_B,7); // setting output B the maximum
  while(true) // non-ending cycle
  {
    OnFwd(OUT_B); // lamp on
    Wait(5); // pause 0,05 second
    Off(OUT_B); // lamp off
    Wait(5); // pause 0,05 second
  }
}
```

```

/*-----*/
task Blikac_Vzad()           // flashing lamps C - slow
{
  SetPower(OUT_C,7);        // setting output C the maximum
  while(true)               // non-ending cycle
  {
    OnFwd(OUT_C);           // lamp on
    Wait(50);               // pause 0,5 second
    Off(OUT_C);             // lamp off
    Wait(50);               // pause 0,5 second
  }
}
/*-----*/

task Motor_Vpred()          // move the engine forward
{
  SetPower(OUT_A,7);        // setting output A the maximum
  OnFwd(OUT_A);             // forward movement
}
/*-----*/

task Motor_Vzad()           // move the engine rearwards
{
  SetPower(OUT_A,1);        // setting output A the 1
  OnRev(OUT_A);            // backward
}
/*-----*/

task Hudba_Vpred()          // plays a melody when moving forward
{
  while(true)               // non-ending cycle
  {
    PlayTone(262,40); Wait(50); // tone plays 0,4 seconds and waiting 0,5 sec.
    PlayTone(294,40); Wait(50);
    PlayTone(330,40); Wait(50);
    PlayTone(294,40); Wait(50);
  }
}
/*-----*/

task Hudba_Vzad()           // plays a tone when moving backward
{
  while(true)               // non-ending cycle
  {
    PlayTone(1000,40); Wait(100); // tone plays 10 seconds and waiting 1 sec.
  }
}
/*-----*/

```

At the end of school year the public „*Presentation of members activities of mechatronic after school classes*“ was realized.

Each group presented its all-year work. Children showed the practical illustrations of their models, they informed about models creation and programming [8].

After successful presentation the superfine students received certificate, which encompass information of successful Mechatronic after school classes graduating in range of *The basics of mechatronics I, II, III.*, duration in hours (minimum is 72 hours), the list of teaching themes, the name of teacher. Certificate was signed by the rector and dean of The faculty of mechatronics and children obtained them from hands that the big experience was for them. The holders of certificates received bonus – the entry to the university computer laboratories under view of faculty teachers. This was

used by children mostly for access on internet during all academic year and mainly during holidays. Similarly these activities run during others years 2004-2009.

At the beginning of school years 2007, 2008 and 2009 *OPEN UNIVERSITY [10]* conference was organized (Fig.2).



Figure 2. Receptive auditorium of Open university conference 2009

The goal of this conference based on students interest encouraging for science and technics, mechatronics popularization, learned knowledge and skills presentation and robotic equipment exposition united with match. There, on conference, the contributions of popular mechatronics were presented. Other participants presented their experiences with groups leading oriented to technical fields. Selected mechatronics groups members presented their contribution, sometimes in English too.

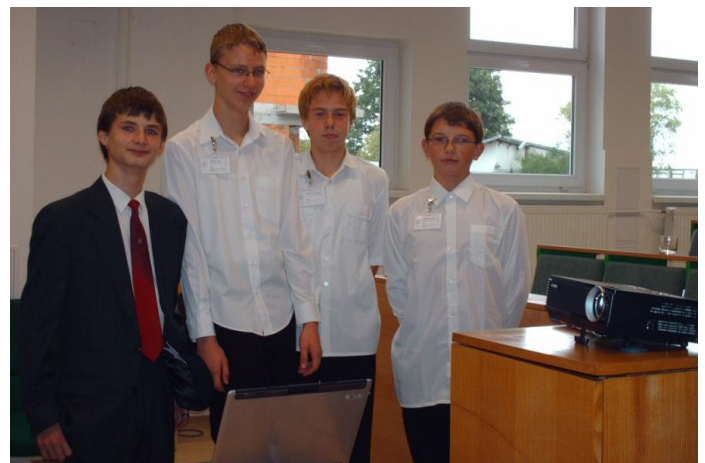


Figure 3. Conference organizational board – mechatronic after school classes members

Children even were in workshop board (Fig.3).

V. OUTCOMES

Between other activities of mechatronic groups - except periodical meetings – we can integrate active presence on activities:

- *Robotic day of Trenčín* (racing exposition of robots, organized by secondary school Stredná odborná škola Trenčín, in February¹);
- *ISTROBOT* (robotic match that is organized by Faculty of electrical and computer engineering of Slovak technical university in Bratislava, in April²);
- *Presentation of mechatronic after school classes activities* (it is presented that what children have learned during school year, organizer is co-ordinator of mechatronics groups activities in co-operation with The faculty of mechatronics ADuT, in June³) [5];
- *Open university* conference – forum on academic domain ADuT about youth motivation to technical sciences, about experiences with work in this area; organizer is co-ordinator of mechatronics groups activities in co-operation with Faculty of mechatronics ADuT⁴, in September [4];
- *Work-shop LMS* [9] (teaching for teachers with the most modern education methods using and e-learnig; organizer is co-ordinator mechatronics groups activities; in November⁵) [3].

At the present information about mechatronics groups are publish on portal <http://www.mk.tnuni.sk>, which contains rich photo-documentation of activity in section Galéria (Gallery).

VI. OVERALL VIEW

From 2003 to 2009 were groups realized which were oriented to:

1. The mechatronics basis I.
 - Models building with using Lego MINDSTORMS [18];
 - RoboLab;
2. The mechatronics basis II.
 - Programming in NQC language [19];
 - Basis of programming in C language;
 - Basis of programming in C++ language [12];
 - Basis of programming in OOP Visual Studio.NET – C#;
 - Basis of programming in OS LINUX;
 - Basis of programming – OOP language PYTHON [13];
3. The mechatronics basis III.
 - Progammig of robotic systems in Assembler [17];
 - Control system SIEMENS LOGO! [14].

Until 2009, 114 certificates were handed about mechatronic after school classes graduating. Certificates were nominated by

teachers in compliance of attendance and doings. Some children stopped their groups attending but their number was from 0 to 2 in every group.

Fig.4 illustrates number organizations connected to mechatronic after school classes activities according to types.

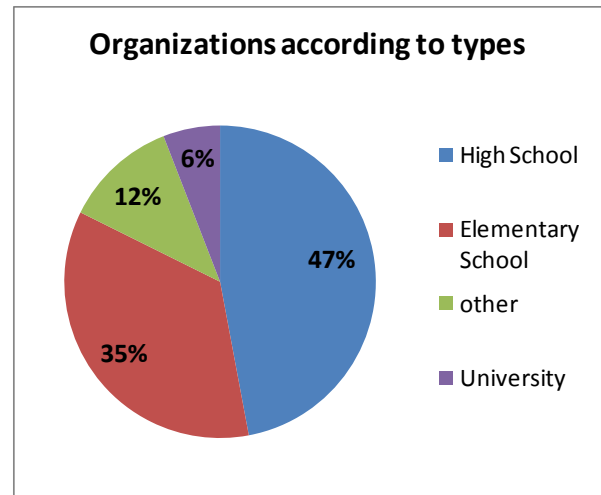


Figure 4. The number organizations according to types

Until 2009, 17 schools and organizations were connected in activities in active or passive approach.

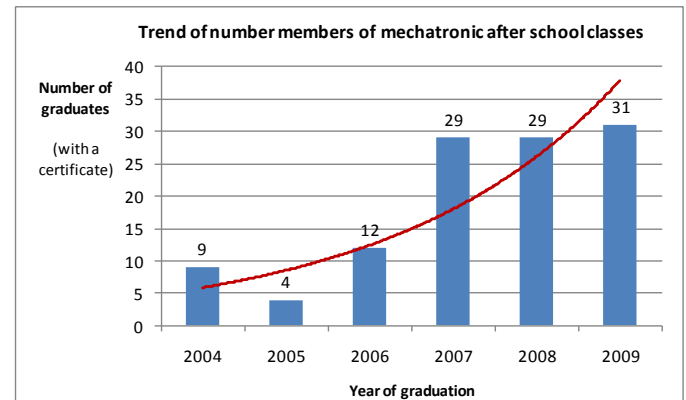


Figure 5. Trend of number graduates

Fig.5 illustrates increase number members of mechatronic after school classes which were nominated by their teachers for certificate receiving.

¹ Information: <http://www.trencianskyrobotickyden.sk/>

² Information: <http://www.robotika.sk/maine.php>

³ Photos: http://mk.tnuni.sk/?page_id=54&album=1&gallery=9

⁴ Information: http://mk.tnuni.sk/?page_id=16

⁵ Photos http://mk.tnuni.sk/?page_id=54&album=1&gallery=14

VII. FEEDBACK

At the present the first graduates are students of technical faculties of Slovak University of Technology in Bratislava, Masaryk university in Brno, ADuT and other universities.

Here are some of the observations and views of former members of mini - questionnaire MC - "mechatronic after school classes":

Jakub Káčer, completed MC: NQC programming language I. and II. Student Central Technical College in Nové Mesto nad Váhom.

Jaroslav Dzurilla, completed MC: Introduction to Programming (ANSI C) Object - Oriented Programming Visual Studio. NET - C #, Programming in Linux. The faculty of mechatronics Alexander Dubček university of Trenčín.

Michal Bystrický, completed MC: Introduction to Programming (ANSI C) Object - Oriented Programming Visual Studio. NET - C #, Programming in LINUX OS. Student Faculty of Informatics and Information (FIIT) Technologies Slovak University of Technology in Bratislava (STU).

1st How many years have you been a member of "mechatronic after school classes" and where did you study?

.. Two years. (Jakub Káčer)

.. Three years. I am a student at university in the field of mechatronics - 3rd grade. (Jaroslav Dzurilla)

.. Three years. I still FIIT, I'm going into the third grade (Michal Bystrický)

2nd To what extent has it affected you in deciding where the high schools, universities? (Rate scale of 0-5, 0-no effect on me, 5 – completely influenced me)

.. I would give three points. Total impact on me. (Jakub Káčer)

.. Partly influenced me. So I put three points. (Jaroslav Dzurilla)

.. I always knew that I would study IT, therefore I will give 0 points. (Michal Bystrický)3. Pomohlo Ti niečo z krúžku pri štúdiu na SŠ, VŠ ?

3rd Did something of "mechatronic after school classes" help to you in the study of the high schools, universities?

.. helpful and fairly. (Jakub Káčer)

.. I went through the MC in the "image" and I learned interesting things for me which I would otherwise not receive in high school. (Jaroslav Dzurilla)

.. yes definitely, I'd probably pick a "sense of programming" (programming thinking). (Michal Bystrický)

4th What was for you to "mechatronic after school classes" too difficult, and what you did not understand what you were bored?

.. nothing has bored, everything was great .. (Jakub Káčer)

.. hm ... I do not know at what level it is there now ... but I liked it ... (Jaroslav Dzurilla)

.. Rather, I enjoyed procedural programming. Object - oriented programming power of explanation by elementary school students. I remember I was struggling with the ring Constructors and destructors. (Michal Bystrický)

5th What change would you on the "mechatronic after school classes"?

.. Of course I would be more happy if they were available and modern versions of Lego dacta ... (Jakub Káčer)

.. I think that the results depend on the MC as an individual approach to students and teacher. (Jaroslav Dzurilla)

.. missing my leader, which showed us the way - work, work and more time to work on yourself. I think it must change to build better quality people from schools. Set a goal and go for it and actually implement it. To teach people to look in the API and Google. Regarding hardware, I would certainly start to work on the principle of what and how it works. Not Lego, but the board, and mini-solder the solder components.

I am studying the embedded systems and missing me a lot of the principles, I got behind the electronics, electrical engineering, logic circuits, and I do not know everything, but I would not know the real solder and construct a 486, and it is a mistake.

And this greeting students of Faculty of Electrical Engineering and Information Technology (FEI) STU, who have this on examination ☺). (Michal Bystrický)

VIII. CONCLUSION

We can write that the word "mechatronics" has become well-known in Trenčín and its vicinity. Our experiences from groups realizing confirmed that schoolchild motivation was rose and positive attitude was created to technical sciences, primarily to mechatronics.

It can seem our goal is complete and we can end – but not! After short pause we must receive new power, new inspiration, find new enthusiasm and continue in this and similar activities. Although the graduates of mechatronics groups will be not students of ADuT, with the highest probability they will be students of some of technical faculties, not only on Slovakia and this is our primary goal.

This activity is very hard from time and organization point of view. In spite of this costs that are put into it will be turned back in form of potential students of universities technical faculties. In the future we will greet integration this kind of activity into boring town conception for work with children and youth.

We want to thank to Faculty of electrical and computer engineering of Slovak technical university in Bratislava for *ISTROBOT* match realizing. It was for us big inspiration and motivation, it supported us in thought that our steps walk on right way. We thank to members of Tatra Team too who lead groups at the present for schoolchildren in laboratories of secondary school directly. And thank for this conference too that is taking statute of *Open university* conference in the right time.

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