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## **Current trends in applied mechatronics in elementary education in the Czech Republic**

### **Introduction**

In school education, working with a construction kit fosters the development of creative activities, competitiveness and team work and helps settle problems. When working with school age children, more sophisticated systems and construction kits must be used to achieve the educational goal required [Honzíková 2005]. At the present time of advanced technologies and the Internet, we must draw pupils' attention with a new and modern teaching style and give them an opportunity to apply new knowledge and technologies. Development especially in the area of communication media, automation and robotics advances by leaps and bounds. Devices and technologies, which 10 years ago were only used in specialized institutions or at universities, become available to common users, including children – however, in a completely different form. In a form that is comprehensible more easily to this target group and that is popular with it, such as games, programmes, construction kits or personal electronics.

All this process can be compared to the development and application of interactive and multimedia teaching. The children of today are able to work with computers, communicate with each other electronically, take their bearings in the global world of the Internet and can retrieve information. It is hard to draw the attention of these children with a usual teaching style that was common in our younger days [Krotký 2009].

### **1. Systems of the Merkur construction kit**

The origins of this construction kit date back to 1925, when Mr Jaroslav Vancl founded a company with the name Inventor. The Merkur metal construction kit comprised beams of various lengths and shapes, which were being connected with classic screws. In this form the construction kit preserved, with both minor and essential construction adjustments, up to 1993 – it was very much sought after and popular. The idea and production were temporarily interrupted by the privatization of the manufacturing plant after the change of the political regime in the Czech Republic.

In 1996 the production resumed and the construction kit underwent a few other changes and extensions. It is surely worth mentioning that in 1996 and

1997 the Merkur construction kits were awarded the title „Toy of the Year”. Various electric installations, motors, gears and other things were added to the construction kit sets. The construction kit is very variable and can successfully be used as a construction element in other construction kits and sets too. This is evidenced by the prototype of an appliance for the production of first contact lenses by the Czech inventor Otto Wichterle<sup>1</sup> or amateur robotic structures mentioned hereinafter. In view of its substance, this construction kit is not suitable for the smallest children, however, the greater creative enjoyment it provides to the older ones.

At the present time you can observe very positive trends in this aspect, such as introducing or reintroducing construction activities to the programmes of schools and other educational institutions.

## **2. Construction creativity in the area of out-of-school pedagogy**

Out-of-school pedagogy, respectively hobby groups at schools, has a long tradition in the Czech Republic. In towns there are independent entities going into this kind of pedagogy. In Plzeň, for example, these entities include the Children and Youth Free Time Centre (SVČ) and the Young Technician Centre (SMT).

Roughly 5–10 years ago, a drop in the number of children attending courses focused on manual technical activities could be watched. This problem above all concerned modeller’s and electrotechnical courses. At the same time, however, the number of children attending computer and Internet courses was increasing.

At the present time, the trend is quite opposite. Classic computer courses have almost no attendees and children’s parents are again interested in courses with the elements of technical and construction creativity. We are of the opinion that the outflow of children from computer courses is caused by the fact that computer technologies lost its appeal and became common in everyday life. One of the possibilities of maintaining children in these courses is increase in the specialization of a course, such as specialization in programming, web designing etc. Another possibility is specialization and interconnection with construction creativity and subsequent practical application. The child thus creates not only an immaterial virtual work, but he/she implements something that he/she can present himself/herself with, compete with and thus apply a broad spectrum of his/her knowledge and skills. Another important positive factor is the possibility of working in a team. In an implementation team, each member is in charge of something else and at the same time all the members share in the creation of the whole.

In the case of the above-mentioned Young Technician Centre (SMT), courses of applied robotics, Merkur construction kit club or Junior TV were incorporated in the programme. All these courses are social and team courses.

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<sup>1</sup> [http://en.wikipedia.org/wiki/Otto\\_Wichterle](http://en.wikipedia.org/wiki/Otto_Wichterle)

The children are no longer sitting alone at their computers – they are in a setting, which is not competitive, but cooperative<sup>2</sup>.

### 3. Construction creativity at primary schools

Next to out-of-school activities, construction creativity is supported at primary schools too. Basic features are also contained in the contents of the General Educational Programme for the System of Primary Education (RVP ZŠ). To be more specific, at junior schools construction creativity is included in the educational programme „Man and World of Work”, which was transformed into the subject technical education. Overlaps to computer technology subjects or physics are of special importance. In the end, however, approach to this affair is up to every specific school. A few factors play an important role here. Besides financial and material requirements, the area must be covered with quality personnel. And it is just the issue of personnel that involves a problem. At present there is a general lack of teachers of technical and science subjects, especially of competent and flexible ones, who are able to adapt teaching and its forms to current trends and needs of society.

Within the regional city of Plzeň, in the area of construction and technical creativity 2 primary schools in particular excel: the 22nd and the 28th primary schools<sup>3</sup>. Their activities are annually crowned with participation in the international competition of programmable Lego models, „First Lego League”<sup>4</sup>. Pupil teams can meet other pupils from all the Czech Republic and abroad, who go into similar construction and software problems.

In addition to official competitions, young designers and programmers can present themselves at a traditional annual event called „Plzeň’s Days of Science and Technology”<sup>5</sup>. This event aims to popularize science and technology with the general public and pupils from various types of school. The Days of Science are organized under the auspices of the University of West Bohemia in Plzeň and technical and science departments in particular take part in them. For two days they move to the town centre along with their appliances, where the public can acquaint itself with the latest technologies and applied research. However, the goal is not only to present, but to make it possible to give a try too. The participants could, for example, try measuring various quantities in the stall of the Department of Technical Education of the College of Education, control a robot by means of sight or remote control it through a joystick, look into the microworld, examine alternative drives, etc. As many as 50 entities participate in the event annually. Primary schools, the Children and Youth Free Time Centre (SVČ) and the Young Technician Centre

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<sup>2</sup> <http://www.smtpl.cz/>

<sup>3</sup> <http://www.zs28plzen.cz/skolni-akce-5/mistrovstvi-cr-first-lego-league-2009.aspx;>  
<http://www.22zsplzen.cz/prace-zaku/vytvarne-prace/lego-roboti/>

<sup>4</sup> [http://en.wikipedia.org/wiki/FIRST\\_Lego\\_League](http://en.wikipedia.org/wiki/FIRST_Lego_League)

<sup>5</sup> <http://www.dnyvedy.cz/2009/uvod>

(SMT) present themselves too. Nevertheless, technology is not presented and shown there by university professionals only, but often by young creators from schools too.

These types of activity and results contribute to mutual exchange of experience and information and to cooperation. Students, who take an active part in this field, have much bigger chances in further education and on the labour market later on too.

#### **4. Preparation of teachers at a College of Education**

As it has already been suggested in the previous chapters, modern teaching requires competent and flexible teachers. Education of teachers in the primary form is provided for in the Czech Republic by a number of Colleges of Education. One of them is the Department of Technical Education (KAT) of the College of Education of the University of West Bohemia in Plzeň<sup>6</sup>. This department principally prepares prospective teachers of technical education at junior schools, but it also prepares students of teaching for infant schools and students of other non-teaching specializations. Study programmes and style of teaching reflect the current social requirements described in the contents of this article.

The study plans of follow-up master of art studies include a few compulsory or optional subjects, which involve construction creativity or working with a construction kit. Individual teaching contents can be found out at the websites of individual subjects in the Courseware and STAG systems<sup>7</sup>. With respect to equipment, the department itself shows a good level. Most subjects are taught not only theoretically, but practically too, and the students can test their knowledge in diverse assignments and projects.

##### **4.1. Technical background**

For teaching technical and construction disciplines we can offer the systems of Merkur, Lego Mindstorm, NXT and Technics construction kits. For more sophisticated automation applications and teaching in higher educational institutions we use modern simulation devices and software (RC2000).

Not long ago, teaching automation and applied robotics was innovated by procuring a robotic manipulator of the LynxMotion Company, which was bought from the funds of specific research. This mechanical „arm” is characterized by 6 degrees of scope and is controlled by a system of modeller’s servomechanisms and SSC-32 control unit<sup>8</sup>. The control of this device is quite practical. Communication interface is created by a PC serial port and for example the „C” programming language. For an easier user input, RIOS company software or Microsoft Robotics Studio programme are available.

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<sup>6</sup> <http://www.kat.zcu.cz>

<sup>7</sup> <http://portal.zcu.cz>

<sup>8</sup> <http://www.lynxmotion.com/Category.aspx?CategoryID=130>

An interesting construction combination is the utilization of the variability of the Merkur construction kit and the control unit of servomechanisms. In this way it is possible to enliven even mechanically more advanced construction kits and transform them into autonomous or remote-controlled robots. The SSC-32 controller or a solution with an ATmega processor can successfully be used again. One of such devices, called „Hexapod”, comes from the workshop of the Young Technician Centre in Plzeň and was presented at this year’s Days of Science and Technology in Pilsen<sup>9</sup>.

## Conclusion

Just as primary school pupils have their own competitions in the area of applied robotics, students of technical disciplines at Colleges of Education can present themselves at our place with their works. The Department of Technical Education of the College of Education of the University of West Bohemia annually holds an international competition of student scientific works called „Technologies Contest Pilsen”<sup>10</sup>. The competition has several sections and takes place under the auspices of the Municipal Council of the City of Pilsen and the University of West Bohemia in Pilsen. Last year, for example, students from the University of Primorska, Faculty of Education of Koper, participated in the competition.

Another competition was presented by the nation-wide media not long ago. It was a competition of Lego NXT robots in several disciplines. The winners of this competition are through to the international round. The competition was held by the Department of Control Technologies of the Czech University of Technology (ČVUT)<sup>11</sup>.

It is possible to say that a few-degree system of supporting and teaching technical construction creativity is beginning to work and this system interferes in other interdisciplinary subjects too. In order that this trend is sustainable in the long-term, it is necessary to continuously innovate teaching and to maintain all the time an excellent technical and didactic level.

## Literature

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<sup>9</sup> <http://www.dnyvedy.cz/2009/uvod>

<sup>10</sup> <http://www.olympiadatechniky.zcu.cz/>

<sup>11</sup> <http://hobby.idnes.cz/>

[http://en.wikipedia.org/wiki/Otto\\_Wichterle](http://en.wikipedia.org/wiki/Otto_Wichterle)  
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### **Abstract**

Working with a construction kit fosters the development of creativity and manual skills of pupils. In pre-school education, a large number of positive phenomena can be observed, such as the development of the personality of the child educated.

**Key words:** pre-school education, mechatronics.

### **Aktualne trendy włączenia elementów mechatroniki do procesu kształcenia na poziomie podstawowym w Republice Czeskiej**

#### **Streszczenie**

Pracownie szkolne z wyposażeniem w zestawy konstrukcyjne sprzyjają rozwijaniu kreatywności i manualnych umiejętności uczniów. W edukacji przedszkolnej może zostać zainicjowanych bardzo dużo pozytywnych zjawisk wspomagających rozwój indywidualny dziecka.

**Słowa kluczowe:** edukacja przedszkolna, mechatronika.