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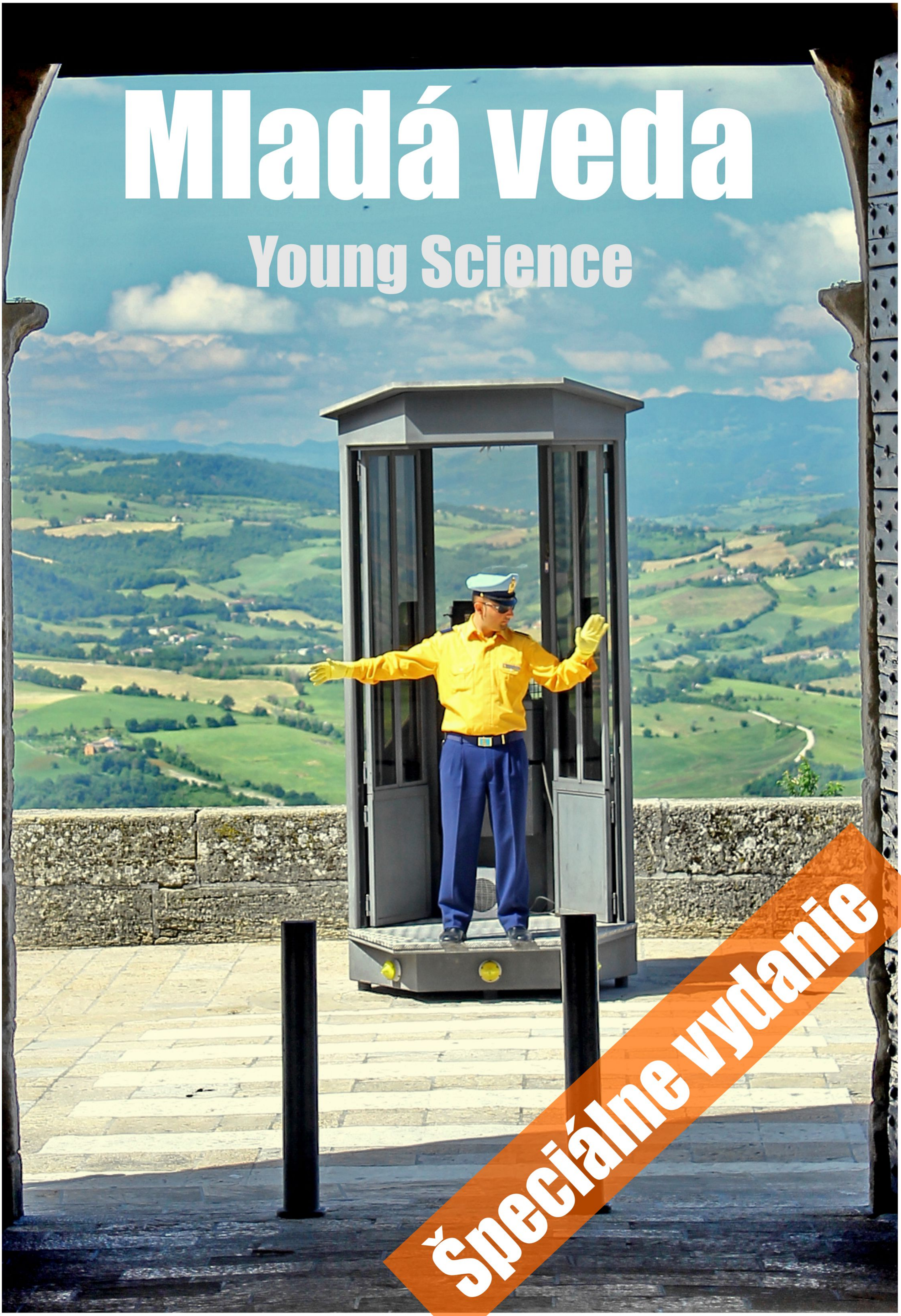

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POČÍTAČOM PODPOROVANÉ KONŠTRUOVANIE AKO JEDEN Z NÁSTROJOV PREPOJENIA TEÓRIE S PRAXOU

COMPUTER AIDED DESIGN AS ONE OF THE TOOLS OF CONNECTION BETWEEN THEORY AND PRACTICE

Martin Podařil[1]

Autor pôsobí ako odborný asistent na Katedre strojírenství Vysokej školy technickej a ekonomickej v Českých Budějovicích. Vo svojom výskume sa venuje Počítačom podporovanému konštruovaniu a výrobe, 3D meraniu a technickým materiálom.

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Abstract

Using CAD applications in pre-production stage of mechanical engineering is currently already common practice in almost every company. The need of connection of students with the production sector is therefore becoming one of the necessary conditions for a subsequent application of graduates. The priority task of The Institute of Technology and Business in České Budějovice is the effort to enhance the professional literacy of students in relation to the current state of industrialized practice as well as efforts to develop their professional skills during their studies and by that to facilitate the application of students at labor market.The contribution is therefore focused on features and functionality that program Autodesk Inventor can provide to the user with the emphasis on link between study and practice. This connection will be visible on a specific example of designing and assembling of the bicycle frame and on a developing of the central front fork dampening unit.

Key words: computer aided design and manufacturing, bicycle frame, dampening unit, mechanical engineering

Abstrakt

Využívanie aplikácií počítačom podporovaného konštruovania a výroby v predvýrobnej fáze strojárstva je v súčasnosti bežnou praxou takmer v každej spoločnosti. Potreba prepojenosti

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študentov s výrobným sektorom sa preto stáva jednou z nevyhnutných podmienok pre následné uplatnenie sa absolventov. Prioritnou úlohou Vysokej školy technickej a ekonomickej v Českých Budějovicích je snaha o zvýšenie odbornej gramotnosti študentov v súvislosti so súčasným stavom industrializovanej praxe, ako aj úsilie o rozvoj odborných zručností počas štúdia a tým uľahčenie uplatnenia sa absolventov na trhu práce. Príspevok sa preto zameriava na vlastnosti a funkcionalitu, ktoré program AUTODESK Inventor poskytuje svojmu používateľovi s dôrazom na prepojenosť medzi vzdelávaním a praxou. Toto prepojenie bude viditeľné na konkrétnych príkladoch konštrukčného návrhu a vytvorenia rámu bicykla a na konštrukčnom návrhu centrálnej tlmiacej jednotky prednej vidlice.
Kľúčové slová: počítačom podporované konštruovanie a výroba, rám bicykla, tlmiaca jednotka, strojárstvo

Introduction

Computer Aided Design (CAD) incorporates all applications that are primarily used for creation and editing of geometry of products, spatial 3D models and manufacturing documentation. Many CAD systems can be extended with additional features, making them a comprehensive developed ambience. These extensions may be for specific purposes such as simulation and strength analysis. Among many advantages that CAD systems have, the most used one is the library of standardized and user-defined components that can be constantly added to the database. The main advantage of CAD applications is the big time saving that will be dedicated to graphical processing of design or editing of components.

The aim of today´s leading manufacturers engaged in development of CAD applications is to enable users the comprehensive management of product life cycle in production sector, which aims on increasing of productivity and reduction of production costs. In other words, the aim is to facilitate CAD systems and simplification of routine work of designers by modern methods and elements that expand the structure possibilities, not just of the drawing documentation, but also the possibilities of creating the geometric objects and subsequent design of other technological parameters. This system can be linked with other systems such as CAM systems or Computer Aided Manufacturing. These systems are able to generate code for control of NC machine. Among typical applications can be included: AutoCAD, Autodesk Inventor, SolidEdge, SolidWorks, CATIA.

Based on these facts, the Department of Mechanical Engineering at The Institute of Technology and Business in České Budějovice included subjects such as Computer Aided Design I and II and Computer Aided Manufacturing to the category of compulsory subjects.The need to link the students with production sector has now become one of the necessary conditions for subsequent employment of graduates. Priority task of the our institute is the effort to enhance the professional literacy of students in response to the current state of industrialized practice as well as efforts to develop their professional skills during their studies, thereby facilitating students success on the labor market.

Core

As the suitable software for the education was chosen the ambience of Autodesk Inventor (during this semester we are planning to add SolidWorks and CATIA into the educational process). This selected program, thanks to its extensions module can significantly affect the legitimacy and applicability in practice. We are speaking about modules that are used in every phase of design and technological process that means by the modelling in 3D space, through the creation of the proposed components and assemblies.

Program Autodesk Inventor is one of the bestselling CAD application for engineering of 3D design in the world. Designing in the program is based on the use of elements of parametric and adaptive modeling. These characteristics greatly facilitate the creation and modification of components. (Podařil, Kubala, 2015) The primary advantage of Inventor is the ease of use, efficient creation of highly complex components and assemblies that could mean in manufacturing sector the fast operator training and subsequent transition to modeling of components. (Fořt, Kletečka, 2007)

If we look closely at the use of CAD systems in educational process, we can claim them as an effective mean only if they contribute to the transformation of information into knowledge and their use will take in account the learning styles of educate. As mentioned Burgerová and Beisetzer (2003) the effective work with CAD systems contributes especially by leading of students to greater autonomy, by the development of computer competencies that student acquires by his own efforts and in particular by solving the problem, by information exchange with experts from practice and by intensification of motivation by practicing with examples with real requirements for technical documentation drawn up by using the computer. We also believe, that using of CAD systems in technical practice can help mostly by minimizing the time from the start of the design to its graphical documentation, by proposing a 3D model and subsequent analysis after creation of 2D technical documentation, by verifying the functionality of the model by using simulations, by elimination of routine activities, by minimizing the possibility of arising errors and by flexible response to comments, suggestions and proposal arising from the discussions with construction team. (Učeň, 2010)

One of the outcomes of subject was the final assignment which was oriented to the design of a fully functional model of bicycle. Students´ task was to create and design the bicycle assembly by using the knowledge acquired during the semester. The basis for design is to model the bicycle frame itself on which students practice their skills in using the program. The subsequent task was to design other components such as handlebars, saddle, wheels, pedals etc. If student had all the components designed, he was finalizing the design of a bicycle by composition of an assembly.

By designing of an assembly (Fig. 1), he had to ensure to have a perfect bonds between each components. Form and content of the assignment achieved success and for large group of students we managed to attract even greater interest in this subject.

Fig. 1 – Sample of designed bicycle assembly
Source: Author

Particularly by designing and modeling this type of the bicycle frame, student had to provisionally design the under seat pipes by rotation and thus preserve the stability of a fixed size, thus preventing the shifting of planes to unwanted positions. Once student had designed the under seat pipe, he started a new report in which it was inserted as an initial component. From location of this component, all other components unfolded, such as other pipes, axes, composition of head and not least the handle for the wheels. Most of the elements were designed to derive from the base of the shaft while it was necessary to meet the suggested geometry. It referred the set of bonds that have been prepared to link up to each other according to the specification of changes to the original part. As long as the assembly will not meet the standards of a particular strain, it would be very simple to change the size of all of the components included in assembly. In essence, this would mean, that by changing of one dimension could be ensured that all used pipes would change to desired thickness. Finally, in this case the corrections have been avoided, as the designer (student) was using his rich experience by the design and his estimation was ultimately quite precise and accurate.

An important factor in the designing of the frames is also suitably selected material. By analysis of the currently most widely used materials, we have determined that as a material for the production of a frame may be used steel, aluminum, titanium, magnesium, scandium and carbon. (Shigley et al., 2010) From the above mentioned materials according to our needs was chosen the aluminum as the most appropriate material. This decision was mainly due to its characteristics such as low weight and high rigidity. The density of aluminum is 2700 kg/m3, which is about one-third of the density of steel, the tensile strength of the aluminum alloy is up to 700MPa, a value similar to that one of low carbon steel. (Dorf, 2003) The disadvantage may be its higher price and low elasticity. (Cyrus et al., 2009) These drawbacks ultimately proved to be less significant in comparison to the frame, for example of carbon fiber or titanium.

Within this subsequent task, the research team devoted inter alia to the front fork suspension (Fig. 2). The suspension is provided by two hydraulic and one pneumatic chamber. The lower hydraulic chamber is a space between the upper shaft, lower shaft and sleeve. The upper hydraulic chamber is a space within the upper shaft (space under the spring during the compression and decompression of the spring area). Pneumatic chamber is a space in the bottom of the shaft, where the air can compress accurately to the measure of the slider a by this, it is possible to influence the pressure with the exact same way as the pressure in tires (assured by valve). This chamber is compressed by the movement of bottom shaft, while the upper shaft is stationary and thereby creating the pressure in the chamber.

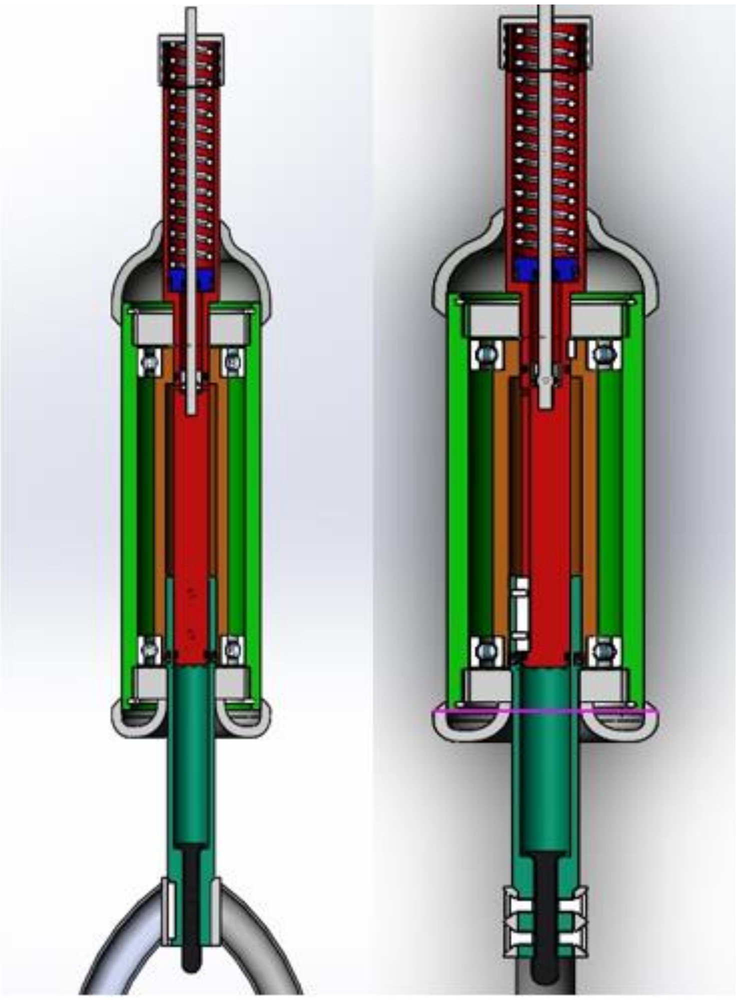

Fig.2 – Sectional view of central front fork dampening unit
Source: Author

The suspension can transmit torque and performs reciprocated movement of the bottom shaft to the top. Torque is provided by assembly that includes pen, sliding pen and by two ball bearings. Pen is placed between the upper shaft and sleeve. The sliding pen is assured within the bottom shaft and moving between the upper and bottom shaft, being in the oil bath. The assembly of the upper shaft, bottom shaft and the housing are not capable of carrying the torque. Therefore, the housing includes the ball bearings from both sides. The bearings defines the gap between the head and the housing and is secured on each side by sealing rings and lock nuts. Reciprocation is carried only by bottom shaft. This movement ensures the mounting in the hull and the upper shaft. The shaft itself is secured from below by the stop lock nut and hydraulic oil, so that the shaft could not exceed a range of functionality, depending on the compressibility of the spring and the air in lower chamber.

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Conclusion

To summarize the key outcomes of multiple ongoing projects, we can state that we are holders of fourteen European industrial patterns dedicated to the bicycle frames. Also we have constructed and designed fully functional prototype of bicycle. (Fig. 3)

Fig.3 – Prototype of a bicycle model
Source: Author

The anticipated outcomes yet to come is the creation of portal that would provide the theoretical and practical support for students. It will include so called electronic textbook and exercise book, which would contain short tutorials on handouts and it will provide the practical support for students on our institute, later on at other universities through helpdesk or "costumer" support.

Today´s using of CAD 3D modelling is a must for every mechanical engineer. This requirement has changed the approach to the problem of computer aided subjects at almost all schools involved in teaching mechanical engineering. It is important to pay attention on the increased possibility to link the knowledge acquired at lessons and the practice.

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References

1. BURGEROVÁ, Jana a Peter BEISETZER, 2003. Didaktické využitie profesionálneho technologického softvéru. In: Slovenské školstvo v kontexte európskej integrácie. Nitra: PdF UKF, ISBN 80-8050-599-3
2. CYRUS, P., A., SLABÝ, a K., LEPKOVÁ, 2009. Využití CAD systemů při řešení projektových konstrukčních úloh v předmětu části strojů, In: Media4u Magazine, XI, s. 22 – 24
3. DORF, R. C., 2003. Handbook of Engineering Tables, CRC Press, ISBN 978-0-8493-1587-9
4. FOŘT, P. a J., KLETEČKA, 2007. Autodesk Inventor – Funkční navrhování v průmyselné praxi. 2. Vydanie. Brno: Computer press, a. s., 318 s. ISBN 978-80-251-1773-6
5. PODAŘIL, Martin a Andrej KUBALA. Základy práce v programu autodesk inventor. 1. vyd. České Budějovice: Vysoká škola technická a ekonomická v Českých Budějovicích, 2015. ISBN 978-80-7468-102-8.
6. SHIGLEY, J. E., MISCHKE, CH. R. a R. G.,BUDYNAS,2010. Konstruování strojních součástí. Vyd. 1. Brno : Vysoké učení technické v Brně, nakladatelství VUTIUM, 1300 s. ISBN 978-80-214-2629-03.
7. UČEŇ, O., 2010. Modelování v Autodesk Inventoru. 1. vyd. Ostrava : VŠB-TU Ostrava, ISBN 978-80-248-2333-1. (CD).