Univerzita Hradec Králové

Faculty of Education

Technical Design and Simulations in Education of Subjects of Natural Sciences

Karel Dvořák, Vladimír Jehlička

Abstract

Professional competences of engineering graduates of secondary schools and colleges include skills of work with tools for design. Performed research investigations show the benefit of deployment of computer applications in project oriented education of vocational subjects in order to increase knowledge, skills and to strengthen interdisciplinary relationships. A part of competencies in technical fields is also a sufficient mathematical and physical background. The submitted text presents possibilities and a potential of technical applications for the support of education of selected topics of natural science linked to technically related areas. The issue is a part of a systematic approach to the education of technical, engineering-oriented subjects. In addition, the contribution presents, besides the listed technologies also examples of deployment of tools to support education and results of the didactic experiment to assess the benefits of using this category of computer applications.

Introduction

The contribution presents possibilities of the use of tools for design and simulations for the realization of experiments in physics and demontration of geometrical tasks. Deployed applications are used for designer activities and technical preparation of production in industrial practice and at the same time in education of vocational subjects at technically oriented schools [1]. The base are the requirements on competencies of graduates, considered in a broader context. Background of mathematics and physics is essential for the solving of designer tasks.

Tools for design and simulation

It is a group of applications for creating 2D and 3D digital models of objects. Following tools are deployed for the realization of physical experiments and demonstration of geometric problems:

CAD – ***Computer Aided Design***, modeling and implementation of core analyzes.

CAE – ***Computer Aided Engineering***, processing of analyzes and simulations on 2D and 3D digital models, created in CAD.

Tools are collectively referred as **CAx** [2].

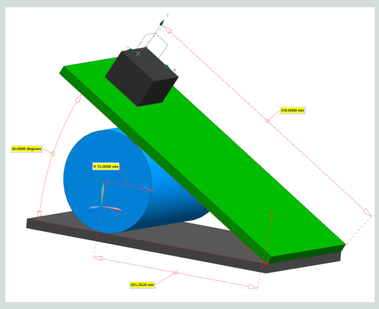
Modeling of physical tasks in virtual environments

- ❑ The ability to model and virtually demonstrate physical experiments from theoretical examples to real objects [3].
- ❑ Variability of input tasks and the ability to compare a large number of situations.
- ❑ Ability of the own creation of tasks.
- ❑ The use of realized tasks for the creation of comprehensive teaching materials.

Modeling of mathematical examples

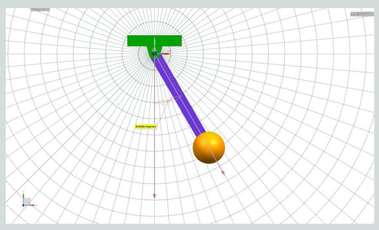
- ○ Vizualization of geometrical variables in 2D a 3D environment.
- ○ Use of designer methods in 2D a 3D environment.
- ○ Possibility of analysis of results and comparison of more versions of solutions.
- ○ Vizualization of reference geometry and sample of transformation.
- ○ Constructing of math problems in connection with designer tasks solved in practice.

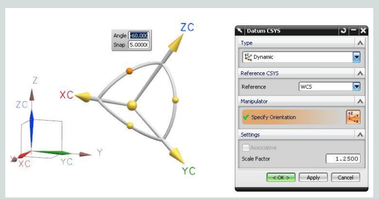
Virtual prototype examples



Model of inclined plane for the experiment to determining the coefficient of friction.

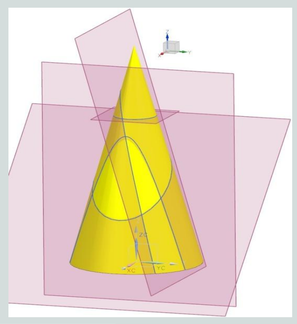
Physics pendulum model, embedded in the polar coordinate system.





Example of an interactive transformation of the coordinate system.

Illustration of an interactive design of conics on a 3D body.



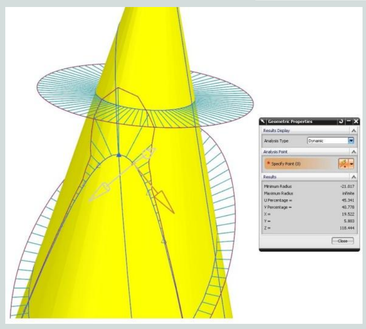
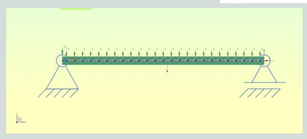
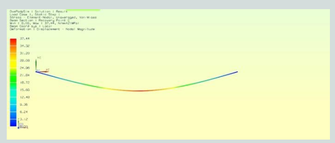


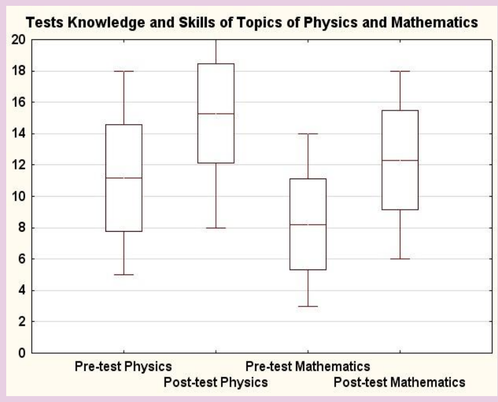
Illustration of an interactive analysis of conics on a 3D body.



Sample of modeling and simulation of complex tasks of technical mechanics.

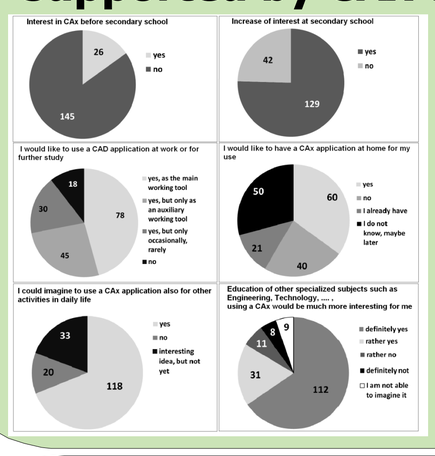


Research of the deployment of 3D modeling methods in education



- ➢ The research target: the incerase of knowledge of issue due to the virtual experiment.
- ➢ Research realized by the method of one group : pretest – experiment - posttest.
- ➢ Mixed metodology applied [4], [5].
- ➢ 84 students of technically oriented schools took part on the research.
- ➢ Physical and mathematical knowledge tested separately.

Attitudes of pupils to education supported by CAx technologies



- ❖ Part of complex, long-term research aimed at attitudes to tools for design and simulations.
- ❖ Questionnaire survey – paper or web questionnaire on www.kdvorak.cz.
- ❖ Questions selected, relevant to common attitudes to education supported by computers.
- ❖ 108 students of technically oriented schools took part on the research.

References

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Contacts

Ing. Bc. Karel Dvořák
Faculty of Education
University of Hradec Králové
Rokitanského 62, 500 03, Hradec Králové III
CZECH REPUBLIC
Karel.Dvorak@uhk.cz
http://www.kdvorak.cz

Doc. Ing. Vladimír Jehlička, CSc.
Faculty of Science
University of Hradec Králové
Rokitanského 62, 500 03, Hradec Králové III
CZECH REPUBLIC
Vladimir.Jehlicka@uhk.cz
http://lide.uhk.cz/jehlivl1

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Conclusion

Experiments of the deployment of the presented tools in education of selected topics of natural science confirms their didactic potential. It increases and strenghtens knowledge and skills and contributes to the popularization of technical disciplines. Tools for design and simulations are often commonly used at considered types of schools. The competence of teachers is usually sufficient and possibility of prepared examples and e-learning materials enable implementation in the education for teachers, specialist of other than direct technical subjects too. It should not replace the traditional approach to education, supported by printed materials and direct activities of a teacher, but it should help to achieve complex objectives in the field of technical education. The experiment results and the questionnaire survey support the hypothesis of increased knowledge, skills and motivation of students of engineering disciplines in connection with the deployment of presented tools in project oriented education of technical subjects. Based on the research findings, we can optimize educational procedures particularly in didactics of vocational subjects. Simultaneously with the preparation of educational projects, results of experiments and research experience with procedures used in education can be used to create a support system of education.