

## EXPERIENCES WITH EDUCATION OF CAE SOFTWARE IN ACADEMIC ENVIRONMENT SUPPORTED BY MODEL TASK

TARABA, B[ohumil] & HAJDU, S[tefan]

**Abstract:** *This article describes experiences with education of computer-aided engineering (CAE) product in environment of technical university: software ANSYS. The current state and difficulty of solved tasks are characterized. The article specifies the philosophy of solving technological problems with application in the field of thermal tasks. The experiences of teaching were processed into three methods which are in published in the article. The supported model task takes account the creation and solving of the simulation model for surface laser beam heating.*

**Key words:** *methodology, teaching, academic, CAE, ANSYS*

### 1. INTRODUCTION

Technological progress is an attribute of the current era. Powerful digital computers and sophisticated software allow enter actively into the engineering knowledge process and creative activity. On the market there are for a long time established standardized commercial software which are an integral component for scientific and design development teams. Application of software engineering requires nearly full usage of knowledge acquired during the theoretical study at the university. In a variety of software it is possible to study directly the proposed solution and experiments.

The learning of students to work with CAE software aims to develop the creativity of thought and obtained knowledge to implant in new solutions and experiments preparing. Teacher's personality should meet three requirements: 1) sufficient knowledge of engineering theoretical bases, 2) extensive practical experience of working with CAE software, 3) methodical bases of teaching and experiences of work with students at the university (Kováčová et al., 2009). The result of the educational process are educated young people in the field of engineering application software type CATIA, SYSWELD, SolidWorks, ABAQUS, WHITNES, ANSYS etc., who are asked for practice. In that case answer the question of what to teach is not so difficult. Complicated, much more difficult is to answer the question of how to teach CAE software (Felder et al., 2000).

### 2. TEACHING METHODS

The content of the paper is focused on the experiences that were obtained the use of chosen CAE system ANSYS. With the success ANSYS is used in teaching subjects such as the modelling and simulation of technological processes. This paper presents three alternative methods that are suitable to use in the academic environment, classified by article authors.

#### 2.1 Application-reproductive method (ARM)

Teaching unit (exercise) is managed and moderated by teacher. The teaching unit (exercise) is managed and moderated by teacher. Teacher creates a simulation model step by step with the help of computer and data-projector (application process). Reproduce this creation process, students assign

commands into personal computer (reproductive process). Simulation model processing requires geometric and material model, loads and boundary conditions, type of solving procedure and interpretation of obtained results. Experience are: teaching the process to "start" for students with a minimum degree of knowledge of the issues; it is possible to apply it in groups of students with a basic level of computer literacy; it is suitable for the initial exercises and is designed to familiarize them with the working environment of the software.

The disadvantages are: slow progress in addressing the challenges of modeling and unbalanced levels of the student's reaction on the task modeling. The way of teaching with the use of application-reproductive method in the teaching process of the above mentioned subject is least effective procedure.

#### 2.2 Expose method

Expose method is very effective and progressive approach to increase student's knowledge in modelling and simulation of technological processes. Teacher at the beginning of a teaching unit defines a problem. The algorithm of the problem is processed so to create conditions for an independent student work on the personal computer. The following part of exercise belongs to student's activity.

The teacher becomes only an observer and if any problem occurs he remove it, or with the correct command or contribution he helps to solution of the given task. The advantages are: high efficiency of a teaching unit, students develop creative thinking and ability to follow the solution by detail. The disadvantages are: teacher must have a broad base of knowledge for the solution of the problem, he must have skills in modelling the process and be able to respond to difficult questions from the students.

#### 2.3 E-Method

Internet and the baud rate are now at high level. It is a fact that the Internet has become also a tool in teaching process (Vališová & Kasíková, 2007). Using e-learning methods in the teaching process of ANSYS is subject to the existence of the academic information system (AIS) within the university. For example, it is possible nowadays from the document server AIS to download PDF files (DOC), text files and animation.

The focus of teaching is to prepare for the learning process all necessary documents that are available for students at AIS: free distributed version of ANSYS, typologically ready set of examples with its commands attached files (ie. log files) and procedures for dealing with examples in the form of animation. E-Method provides a separate activity for students, because the teaching unit is expected solution of selected tasks and their engineering context, and not to repeat the elementary processes. Advantages: unlimited availability of information to study the MSTP, the scope for self-learning by addressing challenges in the form of log files and animations, and to contact the teacher via e-consultations. Disadvantages: difficulty in preparing the files by a team of teachers, educative software ANSYS is

computationally limited, and application of an appropriate university form of control knowledge.

### 3. MODEL TASK

The chosen model task aims to show the applicability of presented methods. Fusion welding with laser beam was chosen as a typical technological treating process of materials: laser beam with heat flow  $\phi$  [W] and velocity of movement  $w$  [m.s<sup>-1</sup>], welded material is steel sheet with thickness  $b$  [m] and the simulation model gives transient temperature fields.

#### 3.1 Method ARM

After the theoretical analysis of the task and definition of the calculated area dimensions is required the application of the method ARM, which is based on individual steps of the solution. The sequence of simulation model development: (Keypoints) → contour area (Line) → (Area) → selection of element (Shell57) → definition of the material thickness (Real constants) → definition of the material properties (Material models) → calculating the length of element → mesh generating (Mesh) → initial and boundary conditions (Define loads) → load steps creation → type of the analysis (Transient) → solving start (Solve from LS files) → evaluation of the results (General postprocessing) → temperature field contours in chosen time → temperature field animation. Step by step commands application is time-consuming. As a result is little time for assessment algorithm of task and interpretation of results.

#### 3.2 Expose method

Assignment of task and its explanation is focused emphasis on familiarizing students with new procedures that was not used in the previous analysis. The new way of solution of the task is in this case the creation of the load steps (LS). The content of load steps is data on the time effect of the laser beam on the surface of the material. For the modeling of the laser beam movement is needed to create an adequate number of load steps. Load steps are created using this method through cycles. Students solve the task singly.

#### 3.3 E-Method

The students are prepared for application of the task without a detailed explanation after the study of the task from the stored document in AIS system. In the process of calculating is the space for consultation of the problems of task. During the exercise we have more time to calculate of multiple tasks.

#### 3.4 Simulation of model task

The simulation model of movement of the laser beam has the following data:  $\phi = 400$  W,  $w = 0.005$  m.s<sup>-1</sup> and  $b = 0.004$  m. Material properties of steel sheet: coefficient of thermal conductivity  $\lambda = 45$  W.m<sup>-1</sup>.K<sup>-1</sup>, specific heat  $c = 460$  J.kg<sup>-1</sup>.K<sup>-1</sup> and density  $\rho = 7850$  kg.m<sup>-3</sup> (Radaj, 1999). Calculated area has dimensions 50 × 30 mm, Fig. 1.

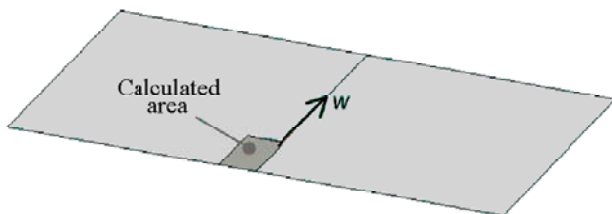


Fig. 1. Calculated area of half shell model

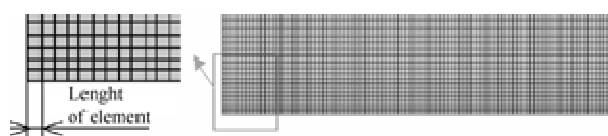


Fig. 2. Generated mesh

Generated mesh (Fig. 2) consists of shell elements with an element length 0.0005 m. Length of element represents value of laser beam displacement with a time step 0.1 s. To overcome the length of the computational area with value 0.05 m was necessary to process 100 load steps. Result of transient thermal analysis is a large amount of data available in the output files. Figure 3 shows the calculated quasistatic temperature field in time 9.0 s.

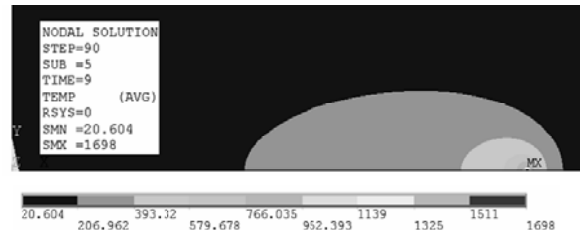


Fig. 3. Quasistatic temperature field contours [°C] in time 9.0 s

The size of the computing area is appropriate for the specified parameters of the welding. The temperature field has quasistatic character and corresponds with examined technological process. The maximum temperature reaches higher value than the melting temperature of steel.

### 4. CONCLUSION

Modeling and simulation of technological processes is very complex and difficult process. The solver must have good foundations of theoretical field solution of the task and adequate computer literacy. During the learning is the most significant aspect of the information transfer from teacher to students. Given the complexity of the CAE software teaching process is a recommended methodology: in the early stages of learning should be used initially slower ARM method. After reaching the required level of work with the software application is applied EXPOSE method. The combination EXPOSE method and E-Method provides high efficiency process. E-method is necessary for the education of talented students.

The future research will be oriented into directions: the different levels of the assigned tasks and their effect on the effectiveness of the teaching process, choose projects from the real environment with goal to solve non-linear tasks, to prepare textbooks, guides for the exercise and documents for E-Learning.

### 5. ACKNOWLEDGEMENT

The research was supported by grant VEGA 1/0721/08.

### 6. REFERENCES

- Kováčová, M. & Záhonová, V. (2009). *E-Learning on STU*, Bratislava, ISBN 978-80-227-3073-0
- Radaj, D. (1999). *Schweißprozesssimulation, Grundlagen und Anwendungen*, Verlag für Schweißen und verwandte Verfahren, DVS-Verl. Düsseldorf, ISBN 3-87155-188-0
- Vališová, A. & Kasíková, H. (2007). *Pedagogy for teachers, Pedagogika pro učitele*. Praha, Grada, ISBN 978-80-247-1734-0
- Felder R., M.; Woods D., R.; Stice, J., E.; & Rugarcia, A. (2000). *The future of engineering education. II. teaching methods work*, Chem. Engr. Education, 34(1), 26–39
- \*\*\* (2010) Ansys, *Theoretical Manual*, Available on the Internet: <http://www.pdfqueen.com/pdf/an/ansys-10-users-manual/10/> Accessed on: 2010-05-10