Case Study

HyperWorks in Education – Lightweight Design Lecture at the IFB (Institut für Flugzeugbau), University Stuttgart

Overview

hands-on experience

Since simulation and optimization are growingly becoming more important in the everyday work life of an engineer, the IFB Stuttgart has been offering a class in lightweight design for several years, using HyperWorks to teach students all the fundamentals they need to know about FE, pre- and post-processing, and optimization tasks. This lecture enables the students to design weight optimized components in a state-of-the-art design process and allows them to gain experience in the usage of modern CAE tools.

The class consists of two parts: a theoretical part providing the students with a theoretical and methodical background of using CAE tools, and a practical part in which the students actually use the software to model and optimize a component, i. e. this year's helicopter rear rotor shaft. In the theoretical part of the lecture, the students learn about composites, classical laminate theory, finite elements and optimize and post-process the component. For all these tasks of the design study, the HyperWorks suite and in particular HyperMesh, OptiStruct, and HyperView are employed.

Usually the students neither have any hands-on experience of the software nor do they know how to solve FEM related tasks. So, the practical part starts from scratch by teaching the participants how to create a model, how to mesh it and for which applications they can use the model for (i.e. statics, dynamics, buckling, optimization). They also learn to set correct boundary conditions, loads, and sizes, and how to handle the post processing. Finally they will be able to analyze and interpret the results at the end of the project. At the end of the seminar, they conduct an entire design study and present their results in a final report with a formal presentation to the teachers and other participants of the class.

Business Profile

The IFB (Institute for Aircraft Design) of the University Stuttgart, focuses on lightweight design, aircraft design as well as aircraft production techniques and composite material. 95 employees research and teach at the institute. Research and lecture topics of the IFB's department lightweight design are numerical and analytical calculation methods, structural concepts, construction types, lightweight materials, structural test, CAD, and design. In the department airplane design, the Institute works on cutting edge lightweight design planes, which are developed and built entirely within the institute's departments. Other research topics are pilotless flying objects and high flying platforms. For more information about the IFB please visit: www.ifb.uni-stuttgart.de.

Another important department of the IFB is the Endowed Chair of Wind Energy (Stiftungslehrstuhl Windenergie - SWE). The SWE is part of the Institute of Aircraft Design at the Faculty of Aerospace Engineering and Geodesy and continues the pioneering research and teaching of Dr.-Ing. Ulrich Hütter (1910 - 1989). Research and teaching at the SWE are multidisciplinary and internationally oriented. The SWE is open to students from all faculties. Through cooperation within the university, with industry as well as other universities and research institutes the SWE actively promotes the use of wind energy and other renewable energies.

IFB



Lightweight plane concept, developed at the IFB.



Solar plane developed and built at the IFB.

"There are not many providers that offer a similar solution within one platform. There is HyperMesh, which is in my eyes one of the best pre-processors available in the market, OptiStruct with all of its optimization features and also HyperView, the very easy to use tool for post-processing tasks. We realized that thanks to its structure and architecture, HyperWorks is overall very user-friendly and easy to learn for the students, when compared to similar other available tools. On top, we are also very satisfied with the support and active participation we receive from Altair within this project."

Ronny Sachse Lightweight Design Department, IFB

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Challenge

The major challenge in introducing the students to the wide field of CAE methodology and how to use modeling, simulation, and optimization to design optimized components, is to find the right combination of theoretical lecture and practical work - given the fact that they have only three hours per week for one semester in the regular study program, leaves very little time. The lecture offers a broad overview of the use and of the possibilities engineers have with CAE applications, but to capture the entire bandwidth of CAE applications in just one seminar is a major task. At that point in their education the use of FEA tools is new to the students, and also optimization is not broadly known by then. Often, the students also find it difficult to analyze and interpret the results in a meaningful manner and to prepare the final presentation of their work. However, this knowledge is crucial for engineering students especially with regard to a successful carrier after their exam. To provide the basis for successful learning, it is important to take a step by step approach and teach the students what they need to know. Hence, it is reasonable to choose and to use a well known, user friendly CAE suite that is process oriented, industry relevant and covers a large bandwidth of application fields. The lecture covers the subject theoretically while the students have the possibility to try the newly learned topics in a practical exercise. With each fresh exercise, the professors and teachers expand the bandwidth of what is new, and teach more about the applications. During this period, the individual support of the students is very intense and deep.

Solution

The professors meet the challenge by teaching the students to use the software in a step by step manner. HyperWorks is very well fit to meet this approach, since the students find all the tools they need within one single CAE platform. They dimension the helicopter rear rotor shaft by applying the given length and inner diameter as well as loads, torques, and safety conditions to the model. With this set of boundary conditions, the students calculate the shaft itself in two steps and for two materials (aluminum and composites). In a second step they design the flanges. The design of the flanges is less analytical, first they make a pre-design and then they analyze it numerically. The flange is a good example to include the different optimization steps and mass optimization. The shaft is designed traditionally in a CAD tool and is analyzed and optimized subsequently. With the flange, the students follow an optimize the topology of the component, and then use the proposed result for the final design within the CAD tool. This might be handled in several optimization steps (topology optimization, thickness optimization, etc.).

Altair supports the university by offering one lecture on optimization and by providing as many licenses as needed for the students attending the course. In addition, the teachers will now also implement the tutorials and exercises provided by Altair into the class and will be using the newly founded Academic Support Forum, in which HyperWorks users can exchanges tips and tricks and ask questions.

HyperWorks is easy to use, and totally user-friendly, plus it provides a steep learning curve for the students covering a lot of knowledge that they will need in their future carriers. Thanks to using one platform in which all needed tools are integrated, the students do not have to work with many different tools from several providers with different user interfaces. In addition, data loss between different software tools when exporting the model from one application to another is avoided, thus facilitating the learning process.

Results/Benefits

The HyperWorks platform offers one user interface for the entire tools of the suite and one tool for each application that is covered in the seminar. The CAE suite is extremely user friendly and easy to learn. Due to its broad spectrum, the students can learn all they need to know about pre- and post-processing as well as all about the FE-solver and optimization, without getting stopped by interface problems while transferring data from one tool to another. In addition, Altair offers a special student program in which the students receive a free version of the HyperWorks Student Edition to get trained on the software within their university education. This offer also includes several training and learning programs as well as software support and online training options available on www.altairuniversity.com.



Exercize: Design Study of a helicopter rear rotor shaft.



Structural analysis of the rotor shaft.



Examples of the designed and built components.



Topology and Shape optimization of the flanges.

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