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THREE CLICKS AWAY FROM THE SOLUTION

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How many of you can convert 73˚Celsius into Fahrenheit? No, you are not allowed to use a unit converter.

It's difficult, is it not?

Those in their 40s and above had to learn the formula to convert Celsius to Fahrenheit. The younger generation do not need to know those formulae for conversion. If you search on google, you will get a large number of converters to do that for you

Our present and future looks exactly like this. All thanks to computer technology and Internet. A few people, who have the knowledge, build software tools and web based services. Millions of people use the tools without having full knowledge of the subject.

Nowadays, there are many webservices which provide free engineering solutions. However, these tools are mostly based on analytical solutions. The world is changing with new innovations entering the markets on a daily basis. **Many new engineering challenges cannot be solved by conventional analytical formulas anymore.** The complexity involved in these challenges require discretization of the problem (in space and/or in time) such that the governing (differential) equations can numerically be applied and subsequently solved. For most of these challenges **a digital model of the real physical situation has to be developed and simulated for different scenarios.** For instance, one can assess digitally what will happen to the tallest skyscraper when subjected to an earthquake load with a certain magnitude, or we can find a suitable method to manufacture car wheel rims with advanced high strength steels to reduce the overall car weight.

These kinds of question cannot be answered by a designer who does not have good knowledge of the subject. To answer the example questions mentioned above, one may need to be an expert in finite elements, nonlinear structural mechanics, nonlinear solid mechanics, metal forming, material science etc. Large companies have sufficient resources to hire highly skilled PhDs and software tools to answer these questions. They also have the possibilities to hire consultants to answer such kind of questions. But small and medium enterprises (SME) do not have enough resources to get the knowledge and tools in-house or to hire expensive consultants. The question is

How can we provide solutions to the SMEs, for their highly complex engineering challenges, at a low cost?

Another constraint linked to this issue is that the required knowledge is mostly accumulated at universities. The focus at Universities is mainly on fundamental research which leads to scientific output and related achievements. Application of this scientific research is not a major concern of most Universities. Therefore, it is not very easy for an SME to utilize the knowledge at the Universities, especially if the question is not scientifically challenging.

Automated Simulation Platform

Most of the world's renowned commercial finite element software give the possibility to write programming scripts for building up FEA models, running the simulation and post processing the simulation results. This gives the opportunity to build up a digital platform for simulations where users can give inputs, run the simulation automatically and read the results. Running a high-end nonlinear simulation becomes as easy as converting Celsius to Fahrenheit. Okay, so that was indeed a bit of exaggeration, but the required knowledge

RUNNING A HIGH-END NONLINEAR SIMULATION BECOMES AS EASY AS CONVERTING CELSIUS TO FAHRENHEIT

to run a high-end simulation can definitely be reduced significantly for instance to the level of design engineers, who more or less know how to work with CAD and have some process knowledge of the physical systems which need to be simulated. The SMEs may not need a highly skilled PhD to run the simulations. Neither does costly software need be purchased. The simulations can run on the server (or in a cloud) with licensed software owned by the digital simulation platform owner. The idea sounds very interesting and can definitely help the SMEs to find their answers in a cost-effective manner. But there is a saying "What comes easy, won't last, what lasts, won't come easy." So, there are definitely many challenges in realizing the idea of digital simulation platforms. To name some of them:

- Making the FEA models as generic as possible while keeping the level of automation to a maximum. If the model cannot be made too generic, different models can be made in one group to cover a wide range of applications.
- Making the FEA models robust. Simulations can easily suffer from convergence problems for example.
- Writing scripts to generate results. Different users may want to look at different results. Storing all results from a simulation may become problematic.
- Different objectives to run simulations. Some users may just want to perform a single simulation of a physical process and look at the results. Some users may want to check feasibility of a new physical process (or change in existing physical process). While some users may like to optimize their physical processes using simulations. This requires development of envelop scripts to define the architecture of data flow depending upon the objective of the user.
- Users may not have all required input data to run a simulation. For example they may not have specific material data. This may require building up of a data base to provide suggestions to users.

- Defining the business model can also be challenging.

Despite these challenges, it is still possible to develop useful and worthwhile digital simulation platforms. As software becomes more mature and the number of users and uses increase, it can become straightforward and normal to simulate all models prior to building.

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HOT DIE FORMING PROCESS DESIGN AND SIMULATION FOR SHEET METAL APPLICATIONS

HoDforming GmbH is the successor of the North Rhine-Westphalian company Amborn-Engineering which has been founded in 2000. The company focusses on high temperature forming (HoDforming = Hot Die forming) of metal sheets and hollow bodies for **research, development, production and distribution of processes and products for the shaping of metals** for the use in nearly **every field such as automotive, aviation and medical technology.**

HoDforming has proven their innovative technology in hollow part forming. But most of automotive structural parts are made from sheet steel material. The hot die forming for sheet metal parts is much more complex compared to hollow part forming. Understanding, designing and determining the hot die forming process parameters is a challenging task.

Fraunhofer Project Center at the University of Twente developed a **simulation model for sheet metal hot die forming.** This model was first used to check the **feasibility of the process, process design and optimized process parameters.** The automated platform consists on a front-end with user defined input, which is then sent to the server. The back end converts the input data into a simulation script and starts the simulation. Once the simulation is complete, the results can be downloaded by the user to their own computer.

HoDforming is now developing their machine and dies based on the results this project has generated. The simulations are completely automated and the only user interaction necessary is the insertion of the input geometry and extraction of the result file. Hence, this case study shows that **automated simulations can be easy to use and almost no advanced engineering knowledge is required.**