NEXT GENERATION SOFTWARE: SIMULATION PROCESS MODELLING

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Introduction

Since the early days of the “invention” of the finite element method almost 60 years ago (see e.g. [[1]]), the use of engineering analysis software based on the finite element method has nowadays become standard in product development environments of all industries. However, the development of software, and thus in most cases also the application of analysis software in product engineering, is typically features and functions driven, and more or less neglects strategic aspects that deal with methodology development and integration of simulation tasks into development processes.

The dilemma is seen as a gap between software training and efficient software usage for its intended application as an efficient tool to support product development in all phases. While software vendors, quite naturally, focus on explanation of features and functions and on training examples of specific application cases, the users should be focusing on supporting the product development cycle to increase engineering efficiency. These are potentially two different things.

What we call “next generation software” is in fact the optimization of principal usage and interaction of diverse software tools to best support the requirements of the product development cycle. This paper will discuss the basic thoughts of this approach, and the benefits that can be expected from such a paradigm.

The Difference between Simulation Software and Simulation Process Modelling

What we define as “next generation software” is not meant as a replacement of existing “traditional” engineering analysis software. Actually it is complimentary to existing CAE software packages and tools and thought of as a logical extension to this.

If we look at the recent development of finite element methods (let’s say over the last 25 years), we can see the following evolutionary steps (see also [2]):

- Feature based “rich” or “high-fidelity” single physics software development
- Basic research on coupled physics
- Industrial applications for single discipline / physics
- First multiphysics applications
- System level simulation (with multidisciplinary approach)
- Simulation driven engineering
- Ultimately we see simulation process modelling as a logical but also revolutionary next step, and a key technology to, and enabler for, simulation driven engineering.

Simulation software is focusing on modelling the functional performance of products, and thus uses a bottom up approach, while simulation process modelling looks at its highest level at major phases of the product development process (see also [3]):

- Strategy Development
  - Research and defining the opportunity
- Ideation
  - Generating the next breakthrough product
- Concept and Feasibility
  - Developing a winning product value proposition
- Build & Pilot
  - Prototype your product, marketing and customer experience
- Rollout
  - Accelerate your marketing and advertising for growth

Thus simulation process modelling uses a top down approach.
Simulation process modelling will deliver methodologies and process flows that use simulation software to optimally support each major phase of the development process. For each phase a detailed simulation process is defined that varies the modelling approach in the following dimensions:

- Dimension “Detail”
- From lumped parameter (sub-)models to 3D fully detailed FEA models
- Dimension “Linearity”
- From linear to fully nonlinear models
- Dimension “Scale”
- From component to system level

These dimensions are being varied and combined for each product development phase and used as a starting point for developing each phases’ optimal simulation process. This of course requires the use of simulation software in the core. However, because of the different nature of simulations in each product development phase, different software packages might be used for different phases. While on one side the development of phase optimal simulation models is done, another focus is on interaction of different software packages covering different physics and disciplines as well, ultimately resulting in a smooth and accurate simulation process flow via the use diverse simulation applications.

The business benefits of simulation process modelling

While the benefits are very broad and typically highly short-term noticeable, we will first draw some ideas on disadvantages. The only disadvantage is that the simulation process model must have a minimum detail level but also completeness level, so that it can be executed efficiently for the virtual development of specific products or classes of products. Thus, it needs some kind of a critical mass of a potential application so that the development of such simulation process models generates a business benefit for the developer of such methods. Thus, the available range of different process models will always be more limited than the availability of simulation software, at least in the near- to mid-term time frame.

We have observed similar benefits as with the first time introduction of CAE based simulations, namely:

- Virtual systems can be used as test beds for innovations
- More freedom in design decisions
- Design changes can be evaluated without building prototypes

However, these advantages are now not only limited to component level, but affect the development of whole products as a system. We see some kind of an intensification of the following business benefits:

- Speed up development process
- Reduce development costs
- Minimize prototype expenses
- Improve product quality

A practical implementation of such a simulation process model is given in [4] and **Fehler! Verweisquelle konnte nicht gefunden werden.**. Here the author has developed a model for the virtual development of automotive audio systems. Actually the whole development process has been virtualized by means of advanced CAE methods and other numerical schemes for all disciplines involved in the product development process:

- Industrial design
- Multiphysical engineering analysis
- Digital signal processing
- Tuning (EQing)
- Psychoacoustics and subjective evaluation
- Binaural audio

By applying this model to diverse projects in automotive industry, the above mentioned business benefits could be monitored and realized.

References

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