An expert predicts the future of Finite Element Analysis

by Paul Kurowski

Finite Element Analysis (FEA) became an engineering analysis tool in the late 1960s. Its beginnings were difficult, because each project needed a custom program. Intimate familiarity with FEA theory, programming and hardware was required.

Commercial software arrived in the 1970s, making FEA somewhat easier. Still, command-driven codes, cryptic terminology and expensive software and hardware prevented FEA from gaining popularity. Due to software and hardware limitations, analysis could not catch up with the design process and results could be used only for design validation.

That changed in early 1990s when graphic user interfaces (GUI) replaced awkward commands and powerful computers became affordable. In addition, progress in auto meshers and the onset of p-element based software made results less dependent on user's judgment. Slowly, FEA started changing from an exclusive analyst's tool to a tool that engineers could actually use to support the design in progress—not just to verify it after completion.

Wider use of FEA and other analysis tools, like computational fluid dynamics, prompted its name change. The common name for all analysis tools is now simulation—reflecting their use to simulate mechanical (or thermal) properties of a structure and to replace prototypes with simulation models existing in the virtual reality of computer models.

So what will the future bring us?

Long term forecasting is very difficult. Let's try to extrapolate present trends and look ahead five years from now.

FEA as a design tool

FEA will be well established as a design tool, rather than just a design validation tool. Using it concurrently with the design process, companies will reduce the number of prototyping iterations—ideally to one. Implementation of FEA by a design engineer will have a profound impact on the entire design process.

FEA and CAD

Pressure for higher productivity will bring us better interfacing with CAD, where FEA functions are called from inside CAD software. Improvements in CAD will facilitate dual geometry representation and efficient switching between CAD-specific geometry and FEA-specific geometry. We may even see some on-line stress calculations running in the background and updated automatically to reflect changes to the CAD model. CAD/FEA integration will expedite "design of experiment" techniques for decision making, sensitivity and optimization studies.

While improving productivity, that tight integration will make the confusion between CAD and FEA even worse, as many people already think that FEA is just another module of CAD.

Computers

We'll see faster processors, less expensive memory and storage devices with FEA expansion as a tool for product development. In the world of design engineering, the Windows NT operating system will come to dominate the simulation market with low hardware costs, compatibility with other applications and the availability of expertise being its main advantages.

FEA and Internet

The ease of data exchange offered through the Internet will make it possible to work on the same project in different geographical locations, get hotline support, get software upgrades and more. For the same reasons, it will be easier to use outside consultants for companies that wish to maintain in-house FEA expertise.

Software development

While traditional h-element software will maintain its base of customers, we will see most growth and action in p-element based software—like Pro/Mechanica, for instance. It offers easier interfacing with CAD and less dependence of results on user's judgment. Models requiring solid-element meshing with finite solid-based software will see significant growth.

Software will be tuned for working with large models and assemblies. Techniques for connecting assemblies (welds, bolts, rivets) will be developed. If we are lucky, we may even see a good brick element auto mesher. Along with FEA software development, the growing volume of engineering data—data generated by simulations—will necessitate progress and systematic implementation of product information management software.

Advanced types of analysis

Today, 90% of practical analysis is simplified to linear static. In the years to come we will see more use of what is considered today as "advanced" analysis, like non-linear (geometry and material), fatigue and dynamic for a more accurate representation of reality. We will also see more analysis using solid elements to represent reality, which will be more accurate than beam and shell idealizations. Composites will be analysed with more ease and 3-D analysis will take over most of what is now done with 2-D plane stress and strain simplifications.

Industry use of FEA

We will see most of growth in consumer products, automotive suppliers (OEM's are already in) and electronics industries. FEA will be gaining acceptance in other engineering disciplines, not just in mechanical engineering.

Education and training

With total lower cost and ease of use, more people will have access to the FEA and proportionally more people without proper qualifications will use the FEA. The need for proper personnel training will become acutely visible. Responding to that and to industry pressure for a more qualified work force, hands-on courses will become popular offerings at universities and colleges.

Testing

Will testing still be needed five years from now? Maybe we could skip prototyping altogether and just simulate everything?

It's not likely. FEA will still need proper boundary conditions and correct material properties. All of that information may not always be available, even with the most advanced software at hand. We will continue to test new products—but hopefully less and with higher success rates.

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