Inclined towards Interoperability

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MSC recently asked a handful of structural engineering software experts for their thoughts on current trends, consolidation, and ease of use with their software, as well as what the future holds for their industry. The following is a compilation of their responses in which they provide some insight on what makes their industry tick.

What's new with structural engineering software, and how is it addressing design challenges?

Bates: The general trend of more power per dollar is continuing and accelerating, as it has from the very beginning of the structural software industry. Another important trend is improving integration and interoperability. In the past "integration" meant a vendor's own products exchanged data with each other; now it means that, plus exchange of data with other vendor's products as well.

Habibullah: The ability to exchange data and information between applications appears to be of major interest at present. We are currently offering several different levels of interoperability to our users, allowing them to work in whatever manner is most comfortable for them. At the top is BIM, which integrates information from all of the disciplines, and for this we offer our two-way link to Autodesk's Revit. But we also provide CIS/2 and Application Programming Interface (API) links that allow for a more focused information exchange, such as our connection to Tekla for the detailing of steel structures. In addition, our API can be used not only by third-party developers, but also by our users as a way to control input and output between our programs and their own custom applications. The API is a powerful way to communicate with other applications because of its inherent ability to maintain data integrity; it does not rely on text or neutral files (as is the case with most BIM applications) that can become obsolete or corrupted.

Krumpen: As software packages are becoming more open, this has allowed greater access to data upstream for use by other parties in the work process. More information can be displayed graphically. We can utilize filters and coloring to denote schedules, loads, capacities, shipping information, and pretty much anything else you can think of.

Tekla: We're hearing a lot about new contract and business models that might fall under the general description of integrated project delivery, and emerging BIM technology is facilitating this trend. In practice this could mean the steel fabricator or precast manufacturer receiving an engineer's model and using it for detailing and manufacture; the Washington Nationals Stadium was a good example of this. It could mean the engineer working closely with the fabricator at the early stages of a fast-track project to provide models that generate mill orders, etc. Or, it could mean the general contractor combining the structural and M/E/P models to anticipate problems in the field and to plan erection. In short, the structural engineer is providing a data-rich, usable model to the construction phase of the project.

Lawson: In general, structural engineering software these days is allowing engineers to deliver more complete solutions, cut-

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ting time off of the entire project; schedules are getting shorter and shorter.

How has structural engineering software evolved over the last few years?

Habibullah: The size of the models and the level of detail included continue to increase due to the performance enhancements offered by the software. Our current SAPFIRE analysis engine can process exceptionally large models extremely fast—orders of magnitude faster than solvers available at the beginning of the decade. Graphical displays have also greatly improved, allowing users to quickly and accurately render models in a very realistic manner, aiding not only the structural engineer in his review and verification, but also providing the owner and others on the design team a much better representation of the structure.

The use of nonlinear analysis is also becoming more common—not only for advanced technologies such as base isolators and dampers, but also for construction staging studies, where a user can see how buildings or bridges will behave as they are erected, and cable structures, where the forces in the members may be dependent upon the deflected geometry of the structure.

Bates: Structural software now is getting more design-oriented, with more direct support for building code compliance, optimization, and drawing production, either via internal features in the software itself or via links to third-party applications. Analytically, most applications still use a finite element method solution, but true sparse solvers, automatic adaptive meshing, etc. are features you can now find in programs costing $2,000 to $3,000, versus the tens of thousands you would have had to pay five years ago.

Krumpen: 3D models have changed from being just tools to create drawings to being documents in themselves. We rely on models increasingly more to coordinate vendors and within different disciplines within our own company. In many cases bid packages for work now contain a model to facilitate the vendors in making an accurate bid on the work.

Tekla: The ability to robustly integrate analysis models and physical building information models has matured greatly over the past five years. Single-source data is the cornerstone of minimizing waste in the delivery process, and the maintenance of the same data in the analysis and design process minimizes error and increases efficiency.

Are you starting to see more integration of structural engineering software with other types of software (detailing, BIM, etc.)?

Bates: Definitely. For steel, the CIS/2 standard is more important than BIM right now; BIM is still very much vendor-specific. For example, the link we develop between RISA and Revit is not the same link we would use to hook to Tekla or ArchiCAD. We have to carefully pick where we are going to spend our resources when developing links.

Krumpen: Yes, but probably at a slower pace than expected. The biggest concerns that come up with integration is how one controls ownership of information once it goes to another party, and whether all parties are properly informed when changes are made.

Tekla: The move towards BIM and an integrated workflow from conceptual design through detailing and beyond can have a number of beneficial effects outside simple productivity. One is that with the right BIM tool a young engineer can gain an appreciation of constructability and the practical implications of their design, helping them to overcome the criticism from old-timers that they unquestioningly use output from analysis and design programs.

Another, related effect is making more in-depth decisions earlier in the project that are critical to the overall decision-making process, while not sacrificing productivity. "Lean" design information in the model at early stages in the project (only seeing/querying what data is needed) is key for achieving this.

Is ease of use an ongoing battle? On that same note, what features are users asking for?

Krumpen: With the introduction of BIM—and integrating non-engineering software types such as construction, procurement, and management—ease of use becomes extremely important. It is often difficult to incorporate these new groups, especially since prior to BIM they have had limited or no interface with 3D models. So having user-friendly tools eliminates an important hurdle in getting everyone into the model. It is probably not an understatement that in order for BIM to be successful, the software tools need to be as user-friendly as possible and still provide plenty of features. Not the easiest balance to achieve.

Habibullah: Ease of use is very important, and is always a major focus with any development work that we undertake. If the user interface environment is logical and consistent, which we feel ours is, you can continue to add features and capabilities that enhance the productivity of the software without negatively impacting the ease of use. Our user environment also uses a cascading approach in that users doing simpler tasks are not necessarily exposed to the more sophisticated options. However, we do realize that a graphical user interface may not be the best solution for all of our users, so we continue to develop and improve other ways of creating models and extracting results.

One item that users recently asked for was for our software to support the ANSI/AISC 360-05 code (the 2005 AISC *Specification for Structural Steel Buildings*) utilizing the direct analysis method, which we just released. This upgrade completely automates the inclusion of second-order p-delta effects, member stiffness reductions, and the application of notional load combinations in the design of steel members. Other items that we currently have under development include a database-driven bridge modeling tool, enhanced report generation capabilities, and the ability to input a user-defined element formulation.

Bates: Ease of use has always been one of RISA's strongest selling points; we're much more accustomed to hearing compliments versus complaints, so we don't hear demands for a more user-friendly interface. For us, the real battle is continually adding new features without cluttering up the interface.

Lawson: According to a recent customer survey we conducted, the two most important attributes of a structural engineer software package are its design capabilities and ease of use. As you add more and more features, it stll needs to be easy to use. That said, we provide extensive training and documentation online and at customer sites. All of our project managers are S.E.s, so the people providing the training really know engineering.

Tekla: The challenge our interface designers enjoy is meeting the expectations of users who want software that is easier to use and continually includes more and more powerful features. Tekla has engaged the services of Georgia Tech to conduct extensive research into usability. The first fruits of that work will be seen in version 14, due this spring.

Do you think that certain features of your structural engineering software are underutilized? What is being done to promote these features?

Habibullah: Our software appeals to a very wide range of users and industries, and thus there will always be some options in the programs that are of little interest to a particular class of user. However, one area that we would like to see utilized more is the link between our structural engineering software and other BIM and detailing packages. In order to rectify this, we are trying to work closer with our development partners in order to promote these connections in a mutually beneficial manner.

Krumpen: The limiting factor in not taking advantage is the impact of the new features to the work process. We are often proceeding in incremental steps to avoid getting in over our heads. Doing too many new things at once can often cloud real process issues, so we try new things with some caution. Typically, we create a technology plan, an informal "what we want to do in the near future" list. When a new project comes up, we assess if it is appropriate to make these introductions or not.

Lawson: Some features are underutilized, but it's tough to find time to learn them during the workday. Again, that's where our training comes in.

Bates: We've tailored our products to a wide range of design challenges based primarily on user feedback, so most every feature in the software is there because a number of our clients consider it to be important.

Tekla: Sometimes, users may not realize that software offers them new ways of addressing old problems. In the case of Tekla Structures, a couple of examples come to mind:

1. The ability to model selectively both rebar and embedments at steel-concrete intersections. This enables the engineer to anticipate and avoid interferences and has the potential to eliminate expensive field fixes for one of the more common issues facing construction teams.
2. Model-based shop drawing review. The traditional process of checking shop drawings remains a significant part of the structural engineer's scope of work. Even though 3D modeling technology has improved the creation of shop drawings, the workload to review shop drawings is just as extensive as years before.

To introduce our users to new work processes we developed best practice documents that are based on the real world experience of P.E.s, detailers, and fabricators.

What effects has consolidation had on the structural software industry?

Habibullah: Interestingly enough, the consolidation in the industry brought about by large CAD companies buying smaller structural software providers appears to be (somewhat surprisingly to us) a benefit to our business. What we are finding is that a significant number of firms who previously used the acquired engineering programs are migrating to our products.

Bates: As any industry matures, consolidation is a fact of life. The cost of entry is much higher now than it was 20 years ago when I started RISA. Anyone wanting to break into the U.S. structural software market now will find it to be very difficult. It's probably more cost-effective to acquire an existing player as opposed to trying to build from scratch.

Lawson: Our goal with acquisitions is to fill in the "white space" in our expertise in an effort to provide an overall structural software solution to our customers. For example, we just acquired a bridge software program, and as such have gained several bridge experts.

Krumpen: Much like with any industry, there are multiple players at the beginning, and some will flourish while others die. This is just how it works; may the best idea win. What worries me is the concept of software packages becoming "closed systems," where in order to fully integrate your project, one must procure all the software from one entity or only work with firms that use the same software. I think this will limit the construction industry, especially smaller firms, at a crucial time when true integration is gaining momentum.

What do you see for the future of structural engineering software?

Habibullah: A primary focus in our near-term development effort is the creation of a comprehensive software package for the structural engineer that allows them to produce analysis models, designs, and production drawings from a single integrated application. This application will be able to share information with other BIM software for the purpose of coordinating and verifying data with other disciplines, but the production of all models and drawings as they relate to the structural engineer will be handled in this single structural engineering package.

Bates: We'll continue to see steady improvements and more integration in software, but I don't see any "inflection points" in the near term. The role of structural software is to automate, as much as possible, the structural engineer's workflow. The market itself will only accept change at a certain rate. Engineers are not interested in revamping their workflow every three to five years.

Krumpen: On-the-fly cost assessment of structures is one change we'll see. Any change made to a structure will give the user a clearer understanding of the financial impacts to the fabricator, erector, and owner. Changes, RFIs, and managing documents will be more automated, with the databases warning all parties when critical information is lacking. Integration with analysis and detailing packages will become more seamless—hopefully to the point that one would wonder why there were ever two models to begin with. Offices will become virtual, with software linking geographically disparate partners in a one-model environment.

Tekla: In 2008, Tekla will introduce a construction management product that will provide anyone involved in construction and erection management with a visual tool to combine and manipulate data from sources such as Excel and Primavera together with models from Tekla Structures and other BIM products. MSC