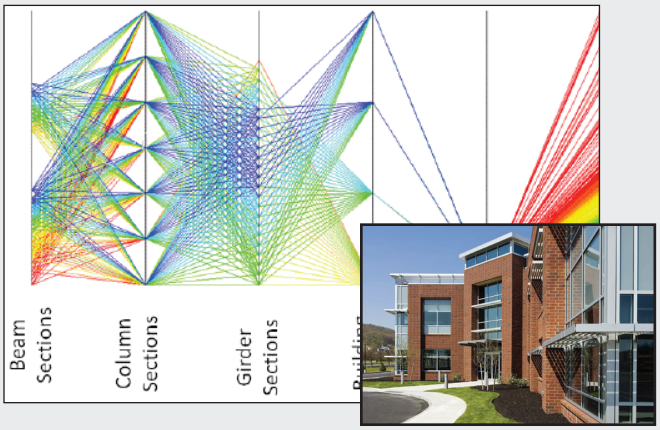
CASE STUDY

Industry: Building Design & Construction
Product: PHX ModelCenter®

Stanford Research Reveals Value of PHX ModelCenter® Trade Studies for Building Design

Challenge: Evaluate More Alternatives in Building Design



The Center for Integrated Facility Engineering (CIFE) at Stanford University identified the need to integrate CAD/CAE software from various disciplines in building design.[1] Their research found that a very limited exploration of the design space occurs at the conceptual level because existing software is "stovepiped" into a particular discipline—structural, mechanical, lighting, acoustics, etc.—and does not link or share data easily. It was estimated that an entire month is used to generate only a single design alternative. CIFE recognized that the use of MDO (multidisciplinary design optimization) and PIDO (Process Integration Design Optimization) in the aerospace and automotive industries may be applicable to building design.

Solution: PHX ModelCenter Integration of Diverse Design Codes to Visualize Alternatives

After outlining requirements for such MDO/PIDO software, CIFE selected PHX ModelCenter for its easy generation and visualization of design alternatives, including capabilities to choose optimizers and integrate CAD/CAE software. CIFE tested a practical design problem involving a classroom building in San Diego to evaluate the tradeoff between structural and energy costs. A structural optimization was done by integrating a project CAD package with Oasys GSA for finite element analysis and an in-house cost and building code-check verifier written in Visual Basic. A genetic algorithm (Darwin) was used to perform the study in PHX ModelCenter using building length and beam section as variables. Results in PHX ModelCenter's Data Visualizer clearly showed that best designs had greater building length. An energy optimization, which integrated the project CAD package with the U.S. DOE's EnergyPlus building energy simulation program for an HVAC system, followed. EnergyPlus provided the cost associated with the HVAC use over a 30-year lifespan. Optimization was done using Boeing's Design Explorer. Results confirmed designs with the highest wall area and lowest window area performed best. A multidisciplinary analysis, which combined structural and energy optimization, was then conducted. All possible variations produced 55 million designs. Darwin, with 5,600 iterations, generated a tradeoff curve representing structural cost vs. lifecycle energy cost. As capital structural cost increased, lifecycle energy costs decreased, allowing choices on how much up-front investment to make to attain a certain total energy cost.

Benefit: Easy to Use Tradeoff Curves for Building Configuration Alternatives

Using ModelCenter to implement MDO methods, the typical building design project with the usual two-to-three design cycles can be improved by several orders of magnitude.

[1]Flager, F., Welle, B., Bansal, P., Soremekun, G., Haymaker, J., "Multidisciplinary Process Integration and Design Optimization of a Classroom Building", Journal of Information Technology in Construction, Aug. 2009, http://www.itcon.org/2009/38

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