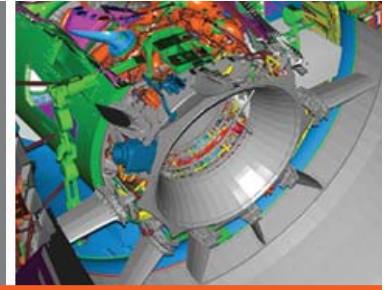
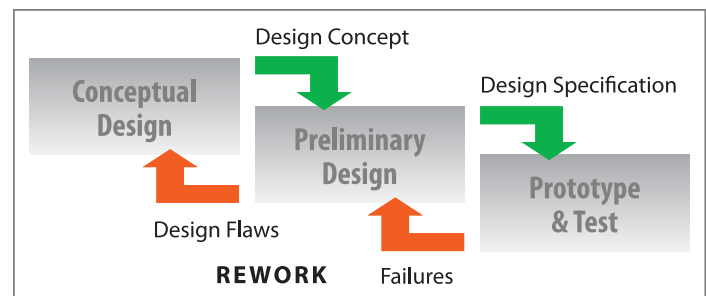
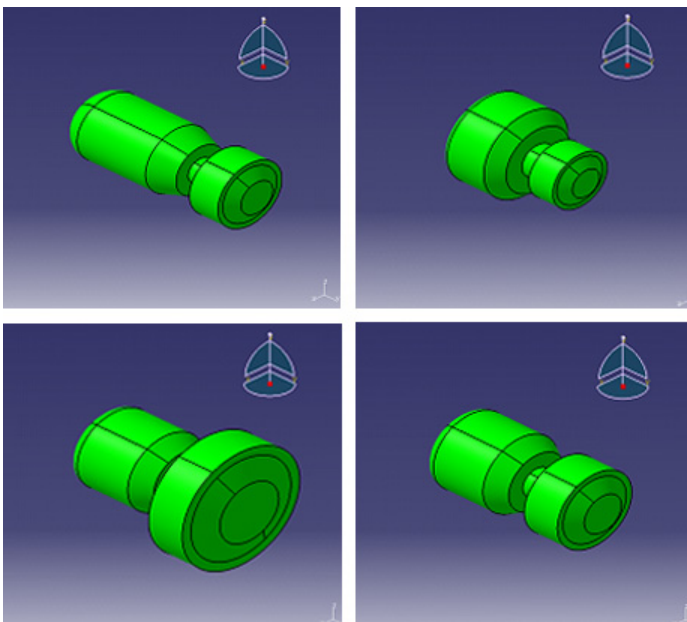


CAD Fusion:

Bridging the handoff from Conceptual to Preliminary Design



Various software tools have brought incremental improvements to the Conceptual and Preliminary stages of design. Each design stage has now evolved to a limit where further improvement requires substantial investment. The next significant and most cost-effective step for increasing design process efficiencies is to break down the walls and integrate Conceptual and Preliminary design teams in a shared, collaborative environment. **By Dr. Scott Woyak, Ph.D, Phoenix Integration**



This design process has stood the test of time from the days of drafting boards and slide rules to today with high performance computers. Existing gains in faster, better, cheaper have all occurred as the result of incremental improvements within each design stage. Conceptual Design has improved through the use of mathematical tools such as Excel, Matlab, and Mathcad. This in turn has been followed by the application of systems engineering and design optimization environments such as PHX ModelCenter.

Preliminary Design has improved as 3D CAD tools (e.g. Catia, NX, Pro/E) have gradually replaced manual drawings. Second generation improvements have occurred through successful management of CAD data with PDM tools (Enovia, Teamcenter, Windchill). The prototyping process has also seen improvement through the adoption of virtual prototyping methods. Finite Element tools such as Nastran, Ansys, and Abaqus are used to predict product weak points and failures so that design errors can be caught before costly physical prototypes need to be created. Together these enhancements have reduced product design efforts by orders of magnitude.

While the aforementioned solutions have all led to design process improvements, their benefits are coming to an end. The individual design stages have been evolved to a level of efficiency that requires great investments to be improved upon. To generate additional returns, we must look at breaking down the walls between stages and fusing processes.

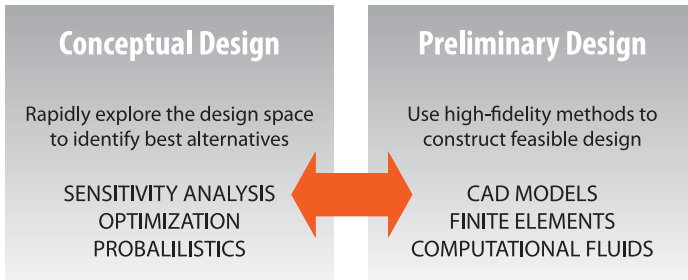
The Problem

The engineering goals of faster, better, cheaper are never ending. The past 50 years have seen tremendous advancement with the introduction of computers into the design process. The fundamental divisions of labor for design, however, still largely remain unchanged: Conceptual Design followed by Preliminary Design followed by Prototyping and Test. Breaking down the barriers and fusing these design stages together is necessary for continual improvement.

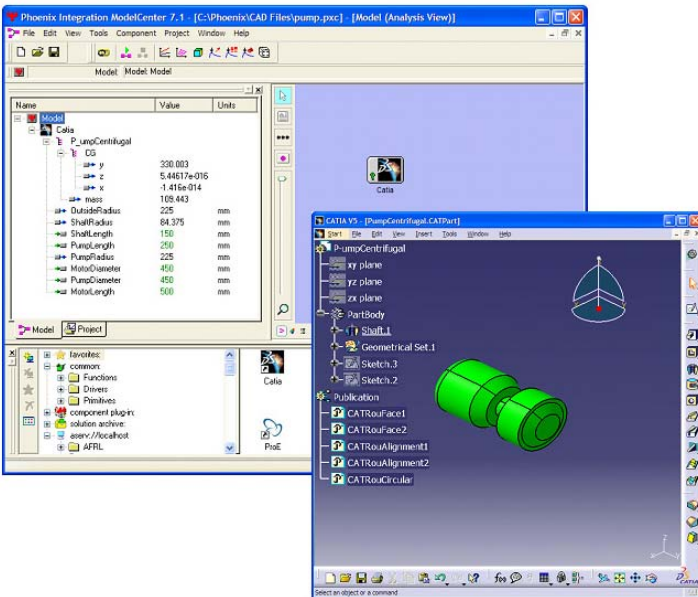
Let's examine the traditional design process. First an idea is generated. During Conceptual Design the idea is evaluated for feasibility and then optimized. The resulting concept is turned over to a Preliminary Design team to design the specific parts that together form the real system. Once completed, a prototype is built and tested. At any stage, if errors are found, the design process is thrown back to a previous stage for rework.

The Solution

Separate design stages lose meaning in a virtual world. As computers have become more powerful and less expensive, and as engineering design tools have become more reliable, the need for separate design phases has lessened. With the introduction of CAD Fusion, a series of CAD tool plug-ins for PHX ModelCenter, Phoenix Integration is merging together these separate design stages.



The result of CAD Fusion is that early stage designers can share analysis tools with downstream analysts, and downstream analysts can utilize design optimization methods typically only employed early in the design process. Benefits from CAD Fusion include:



- **REWORK IS MINIMIZED.** Visualization of CAD geometries by Conceptual designers would greatly reduce errors and rework. Preliminary designers working in CAD can recognize errors by viewing geometry. Conceptual designers, without CAD Fusion, cannot see geometry, so design errors may go unnoticed until the design is handed to Preliminary design. CAD Fusion enables the Conceptual designer to detect mistakes before the handoff to Preliminary design.

- **DESIGN HAND-OFFS ARE SIMPLIFIED.** By using the same analysis tools, early stage designers can hand off near complete analysis models to preliminary designers.
- **TEAM COMMUNICATION IS IMPROVED.** By using the same analysis tools, errors due to miscommunication of units, loads, and material properties would be minimized.
- **BETTER DESIGNS ARE CREATED.** Errors due to approximations used in simplified analysis tools lead to uncertainty in designs emerging from Conceptual Design. By increasing the fidelity level of calculations early in the process, greater knowledge of analysis results leads to better design choices.
- **SHORTENED DESIGN CYCLES.** Reducing rework and improving team dynamics all contribute to streamlining and shorting design cycles.
- **IMPROVED UTILIZATION OF ENGINEERING RESOURCES.** Eliminating the walls between design stages means eliminating countless design reviews, e-mails, documentation, data translation tasks, etc. Engineers can spend their time doing engineering.

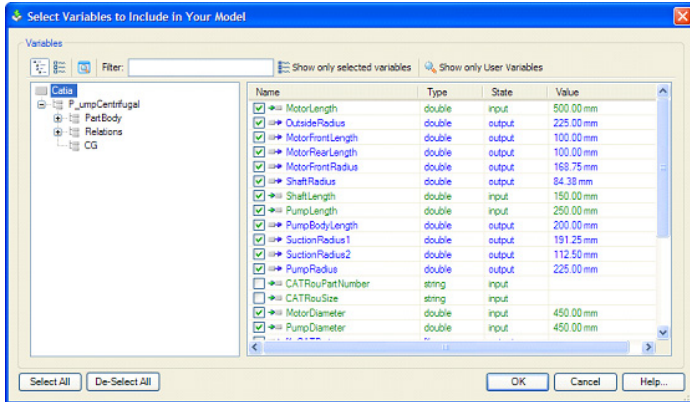
Barriers Overcome with CAD Fusion

Key barriers to adopting CAD earlier in the design process include:

- Too much programming and scripting
- Robustness of CAD tools
 - Memory leaks
 - Random bugs and crashes
- CAD licenses can be scarce
- Geometry issues
 - Invalid geometry can be generated
 - Geometry changes are not continuous
 - Mesh generation is the problem, not CAD
- Management of files instead of variables as a means of integration
- CAD/CAE tools take too long to run

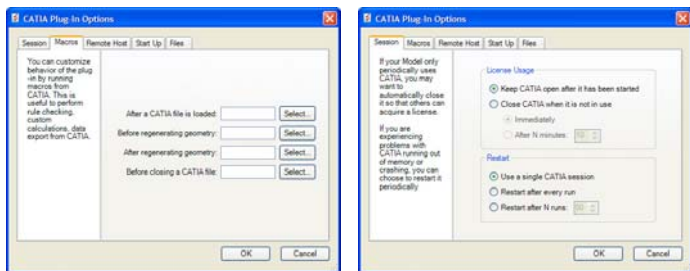
CAD Fusion enables a direct integration of ModelCenter with CAD tools, automating CAD applications without end-user programming or scripting and without intermediate translators that cause a "least common denominator syndrome. With CAD Fusion, ModelCenter users can:

- Automatically import CAD design parameters and computed values such as volumes, surface areas, weights and mass properties for use as variables in ModelCenter



- Regenerate geometry after changes to input parameters
- Invoke CAD macros and run CAD rule checking
- Extract units for CAD variables
- View 3-D CAD geometry during ModelCenter trade studies and real-time updates to geometry as variables are optimized in ModelCenter
- Export files in a variety of formats after each ModelCenter design iteration to update CAD and other linked applications

CAD Fusion increases the robustness of your CAD applications by providing workarounds for CAD tool crashes and memory leaks. CAD tools were not designed to be automated in 1,000-run loops, which cause crashes, leaks and inconsistent behavior. With CAD Fusion, PHX ModelCenter manages the CAD tool session by automatically restarting it as needed to avoid these kinds of problems.



To provide flexible management of CAD tool licenses, CAD Fusion enables users to specify how ModelCenter manages CAD sessions. Sessions can be optimized to only consume licenses when the CAD tool is in use to perform functions such as geometry regeneration. Sessions can also be run remotely if CAD licenses are only available on specific machines.

CAD Fusion solves geometry robustness and continuity issues by invoking CAD rule checking and macros. Macro scripts can be invoked to detect (and potentially fix) errors that would normally go unnoticed. PHX ModelCenter also provides response-surface-based optimization methods that are insensitive to discontinuities

common with incremental changes to geometry.

Mesh Generation is often the limiting factor for using CAD in trade studies. The problem is that CAD geometry has many artifacts that must be "cleaned" before a mesh can be generated. CAD Fusion resolves these types of issues by working directly with mesh morphing tools such as Sculptor and GMAP. These tools incrementally modify a mesh after it has been manually cleaned and generated rather than requiring a new mesh to be created at each iteration.

CAD Fusion enables file linking in addition to parameter linking. Each CAD Plug-In can export one or more files as outputs. These files can then be directly linked to downstream applications. Issues associated with long running codes can be overcome by load balancing trade studies across available resources using PHX CenterLink to perform runs in parallel or as a gateway to HPC clusters.

Summary

Engineering design is typically divided into Conceptual and Preliminary design phases. Conceptual designers build multi-disciplinary models with low-fidelity calculations that can be rapidly executed to explore a design space and establish high-level design objectives. Preliminary designers use high-fidelity CAD and CAE tools to create part designs that together meet design objectives. The hand off from one team to the other is minimal, leading to process inefficiencies, errors and reworks. CAD Fusion enables your organization to break down the walls between Conceptual and Preliminary design with a more collaborative design environment that shares a common language. The Preliminary Design team can provide early feedback to Conceptual designers, which helps to avoid errors and costly rework later in the design process. At the end of Conceptual Design, the Preliminary Design team can be handed a CAD model that already meets many of the design criteria, thus shortening the process for higher quality designs and providing the next significant innovation for improving design process efficiencies.

■ **ABOUT THE AUTHOR. Dr. Scott Woyak, Ph.D.** As CEO of Phoenix Integration, Dr. Woyak's mission is to help engineers and analysts make better decisions, more quickly. This occurs through integration and automation of simulation tools and the appropriate application of design methods. Worldwide companies are benefiting such as Boeing, Airbus, Lockheed Martin, NASA, GE and Northrop Grumman. Dr. Woyak is a graduate of Virginia Tech and holds a Ph.D. in Mechanical Engineering.

About Phoenix Integration

Phoenix Integration commands a leadership position in flexible, scalable, high-performance software solutions for engineering process integration and design optimization. Phoenix software is used worldwide for product design, simulation and modeling during engineering design phases by global organizations in the aerospace and defense industries, and commercial enterprises, including nine of the top 10 U.S. defense contractors and seven of the top 10 aerospace companies.

Toll-free: 800.500.1936 Website: www.phoenix-int.com