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General Dynamics Land Systems Achieves Early Simulation in a Unified Performance-Engineering Workspace Based on Abstract Modeling

Executive Summary

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By Bruce Jenkins, Principal Analyst, Ora Research LLC

How to bring simulation earlier in the product design process has been discussed for years but few have been able to overcome the technical and work-process barriers to doing so. General Dynamics Land Systems (GDLS) has launched a process where automation through templates with abstract modeling technology creates a seamless modeling/simulation process. By eliminating manual steps and allowing engineering and analysis processes to be built around an abstract model, this new process condenses project timelines – in a project piloting the new technology, extracting data from a CAD model and using it to populate an analysis database was slashed from an all-day job to just two hours. Even more, the new process makes it feasible to begin analysis early in design, while alternative geometries and product configurations are still being evaluated.

Explains Mike Patterson, technical lead for the System Simulation and Test group at GDLS, and leader of the new initiative, "You may execute four or five different analyses for one specific product configuration – power consumption, structural, thermal and so on. The issue is that there's not a lot of traceability from the specific Pro/ENGINEER data set to a given analysis run, nor is there a lot of traceability between different analyses – we know we used a given product configuration, but there's not a documented flow of which configuration was used. Models change rapidly, and mistakes are made. The aim of this whole project was to alleviate that pain: showing what configuration we came from, showing that the root-source data for all the analyses was the same, and then being able to respond rapidly when the configuration changes."

"Early in the design phase," Patterson explains, "lots of things change on a daily basis. One thing we want to be able to do with an automated process is capture those design changes without being locked into a specific configuration. One of the benefits of abstract modeling is that we are not locked into a specific configuration as defined by an early design, so we can react more quickly to design changes."

Patterson emphasizes how this rapid-response capability promises to transform the role of simulation and analysis in product development, radically increasing the value it offers to a program. "We want to change analysis from a reactive process occurring late in development, to a proactive process used early and throughout design."

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Selecting a Solution

Before the project began, the Comet technology had been presented and demonstrated to GDLS by Comet Solutions, Inc. Comet uses what the company calls its Abstract Engineering Model (AEM) to let engineers import and parametrically manipulate CAD geometry, specify additional data for engineering analysis, specify and execute engineering analysis processes, launch multiple CAE tools from within the Performance Engineering Workspace, and assimilate the simulation results. The Comet project keeps track of all the analysis iterations and CAD information, providing a clear project data pedigree for each stage of the design process. Evaluation of design alternatives can be conducted, with a clear history of each iteration and result.

"We looked at what MSC was doing with SimDesigner and SimExpert," Patterson continues. "Their approach focused on taking a CAD model and analyzing it. But it seemed to us that it could not do much from an assembly viewpoint: it could react to a change in the geometry of an individual part, but if a change occurred at the assembly level, you had to manually revise your process, and point it to the change. By contrast, Comet's approach is: 'We know you're going to have road wheels; you take the geometry and you're good to go.' So we selected Comet as the gateway to our CAD data, our mass properties data, and now all these other capabilities – meshing, calling processes, etc." In sum, Patterson says, "We're going to fit Comet into our overall processes. It's not the only tool we're going to use: we're looking at a combined Comet/SimManager/iSight approach."

Implementing the Solution

GDLS designed its initial implementation of the Comet technology to provide an automated method of generating a VCAT vehicle configuration, quickly defining the vehicle configuration, and guaranteeing that data pedigree between the analysis models and the Pro/ENGINEER database is maintained. The objective was to create a process in the Comet GUI that could be executed as simply as possible. This would be achieved by developing a simulation template within Comet that would create an Abstract Model and process map within the Comet GUI when executed.

Comet Solutions, through their Engineering Services, developed a Comet project that incorporated the scripts and processes needed to read the Pro/ENGINEER assembly and create the XML vehicle file for use in VCAT. Created to aid in executing the developed process, this project allows easy configuration of the Comet session for generating the XML vehicle file, which a user can typically execute in under 10 minutes.

Benefits and Payback

Technical benefits of the new performance-engineering workspace, according to Patterson, include:

- Earlier use of digital simulation and analysis in product development than was feasible before
- Ability to set up and execute more analysis runs and design iterations in a given time
- Fewer people required to set up and execute an analysis run
- Heightened confidence in analysis results due to better-documented data pedigree

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"Management's assumption," Patterson notes, is often that "once we automate a process, then we can cut people and costs. But in practice, we analysts say, 'Oh, we can run it a thousand times now – we can do more sensitivity analysis and so on.' We want to become more robust in our design – that's one of our main goals. Reducing sensitivity to variables is a goal. We want to be able to predict performance numbers early on in the program, and have confidence that those numbers are valid. We want to show deltas between different configurations."

Patterson notes one area where greater insight gained from performing analysis early in design can substantially reduce program costs – namely, reducing physical prototype fabrication and testing.

Next Steps

The company is convinced that the specific achievements in this pilot project can be broadened to a generic approach to improving performance engineering across all its programs.

Pro/E-ADAMS Round-Trip Automation – Says Patterson, "In the initial project, we primarily translated data to another data set" – a scope of work that only touched the surface of all that Comet can do. "That was only a pilot for what we're doing this year, which is implementing analysis in ADAMS from that Pro/ENGINEER data set. We'll be looking at the full stream – going from the Pro/E model to getting some right quality metrics, such as absorb power for a vehicle driving down a course (measured in watts, representing the energy being absorbed by the driver driving down the course – a U.S. military standard); taking accelerations, putting them through a filter, and recording the outputs as a power measure. We want to automate that whole process."

Patterson foresees dramatic time and labor savings as a result. "Today, developing a detailed model in ADAMS (not counting simulation time) probably takes 20 to 30 hours of an engineer's time. We want to cut that down to 3 or 4 hours at most when working in the Comet Workspace. Ideally we want to identify the Pro/E model, then take no more than half a day to set up the model and drive it down the course in ADAMS."

Looking ahead, "another thing we really want to focus on," Patterson reports, "is the ability to implement DFSS processes, and to perform DOEs and optimizations."

Automated Preprocessing for Thermal Analysis – Already Jing Pang, GDLS's Thermal Architect, has launched a project to implement abstract modeling technology in the company's thermal analysis processes. The conventional workflow required from 3 to as long as 10 weeks to prepare a NASTRAN file for input to the MuSES thermal analysis code. Because preprocessing takes so long, Pang notes, thermal analysis simply can't keep pace with updates to the design, and thus cannot really support the design process. Another drawback is that the work of preprocessing a given design cannot be reused. Yet a third constraint is that preprocessing tasks are very tedious, yet they require the skills of highly experienced professionals.

To address all these limitations, Pang is in the midst of a project to implement Comet technology so as to compress this 3- to 10-week process to just 1 to 2 weeks. The project

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also aims to make much of the preprocessing work reusable when the design is updated, and to automate the process with rules and other aids in order to reduce the level of expertise required.

Reducing Manual Errors – How does Patterson sum up the benefits of the Comet technology? "We can reduce errors because we won't be relying on analysis models to be built by hand."

More Efficient Use of Analysts' Expertise – With the new approach, says Patterson, "we only need a few process owners; the rest will be able to follow the process because it's been automated. The experts are freed to develop the processes."

Facilitating Organizational Change – Finally, Patterson notes the value of new technology insertions in facilitating change in an organization's entrenched practices. "The best chance we have to change a process, or change the perception of how things must be done, is by implementing a new example and showing concrete results of how it changes and improves a specific process."

About GDLS

General Dynamics Land Systems designs, manufactures and supports land and amphibious combat systems for the U.S. Army, the U.S. Marine Corps and allied nations. Land Systems has a 65-year defense heritage of providing high-quality, technically superior, high-value products and services to the United States and its allies.

*This executive summary is excerpted from **General Dynamics Land Systems Achieves Early Simulation in a Unified Performance-Engineering Workspace Based on Abstract Modeling**, a white paper published by Ora Research LLC, Cambridge, Mass., www.oraresearch.com. To receive the complete white paper, contact Comet Solutions, Inc. (tel. +1 513-407-5559, kelly.vickers@cometsolutions.com) or Ora Research (tel. +1 617-875-9598, bruce.jenkins@oraresearch.com).*