

Computers in engineering

Dynamic simulation makes a connection

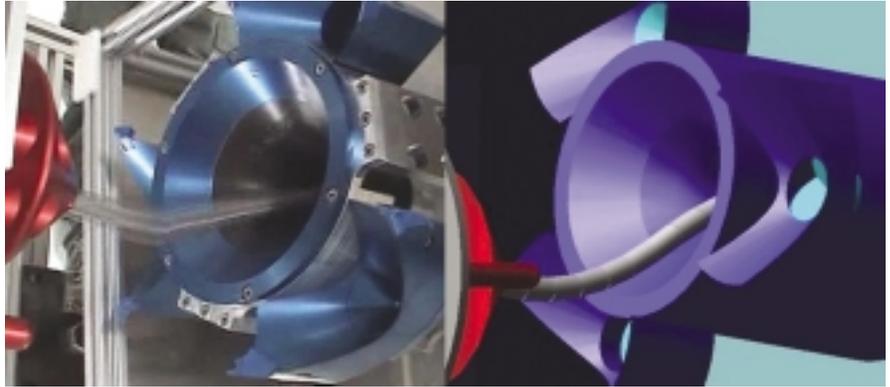
One of the most significant challenges facing an engineer during the development of any mechanism destined for space is the difficulty in testing prototypes under micro-gravity conditions. **Michigan Aerospace Corp.** developed the Autonomous Satellite Docking System (ASDS) to allow a servicing vehicle to perform a "soft" capture operation on a satellite, imparting a minimum of force during the capture cycle with a maximum of misalignment tolerance between the spacecraft. Capture is made using a flexible soft-dock cable that is extended from the docking spacecraft into a conical receptacle located on the target spacecraft.

The effect of Earth's gravity invariably causes reactions in the cable that would not be present in space. To properly emulate the behavior of the cable in outer space, Michigan Aerospace performed dynamic computer simulations of the effects of micro-gravity.

Dynamic simulation models interactions between individual components in a mechanism with a set of reaction formulas acting on rigid-body representations of the system components. Under the **DARPA** (Defense Advanced Research Projects Agency) Orbital Express program, the ASDS mechanism was initially modeled and simulated under micro-gravity conditions using MSC.ADAMS from **MSC.Software**. The virtual prototype achieved docking at various approach angles.

To validate the model, the ASDS mechanism was prototyped and tested in the air-bearing floor facility at **Marshall Space Flight Center** in Huntsville, AL. Once a good correlation between the simulation results and the actual data was shown, the model was used to predict future performance of the ASDS mechanism on several potential spacecraft for the Orbital Express program.

Following this research, under a separate program administered by the



Good correlation was achieved between simulation and test, as seen in this comparison of KC-135 flight experiment video and MSC.ADAMS simulation.

U.S. Air Force (USAF) Research Laboratory Space Vehicles Directorate in conjunction with **Microcosm, Inc.**, the dynamic simulations were updated and applied to the problem of capturing and docking with much smaller micro-satellites. The scalability of the ASDS mechanism was not certain because of the lower masses involved, so simulations were run for a range of micro-satellites. The results showed the ASDS system was applicable to multiple sizes of space assets.

Under the USAF / Microcosm contract, a prototype of a smaller Autonomous Micro-satellite Docking System (AMDS) was constructed and flown on a KC-135 micro-gravity flight through the USAF's Reduced Gravity Office in Houston, TX. In this airborne test laboratory the effects of micro-gravity are replicated for on-board experimentation. The aircraft containing the test equipment performs an inverted parabolic flight trajectory that produces approximately 25 s of zero-g. Other flight paths can replicate Lunar, Martian, or negative gravity for short periods.

The KC-135 flight test proved repeatedly that the AMDS mechanism—and on a broader scale, the ASDS system concept—would work in a micro-gravity environment. The results of the flight testing were compared to predicted results from the



The AMDS experiment was run in the KC-135 airborne test laboratory that replicates the effects of micro-gravity for on-board experimentation.

MSC.ADAMS computer model with a high degree of correlation.

As a further validation of the dynamic computer model, RecurDyn software, from **Function Bay, Inc.**, was used to perform the same simulation. Because RecurDyn uses a different calculation method to solve for dynamic behavior, it provided a good external reference to verify that the assumptions used in the model were valid. SolidWorks, from **Dassault Systemes**, was used to develop the models of the production mechanism, and the solid bodies were exported directly to RecurDyn. The new solver ran in about one third of the time for nearly identical results.

This article was written for *Aerospace Engineering* by **Anthony Hays**, Michigan Aerospace Corp.

Briefs

A U.S.-based defense contractor has agreed to a volume licensing deal for **Telelogic's** software tools. The contractor has named DOORS its corporate standard for requirements management, and is planning to use Telelogic's approach to product development by incorporating the TAU Generation2 toolset for visual modeling, simulation, and code generation.

The American Society of Mechanical Engineers (**ASME**) has published an international 3-D modeling standard. ASME Y14.41 provides a single standard that all 3-D modeling designers, engineers, and related software can follow. It establishes requirements and references documents applicable to the preparation and revision of digital product definition data. The committee members who developed this standard represent the largest automotive, aerospace, defense, and heavy-equipment manufacturers.

Spectrum Astro has selected LMS Test.Lab from **LMS International** to test and qualify high-performance satellite systems. The software and multiple LMS SCADAS III hardware systems will be deployed in the new acoustics test facility being designed and constructed by **ASRC Aerospace Corp.** in Spectrum Astro's "Factory of the Future." The equipment will be used to test satellite responses to a variety of mission loads.

FR-HITEMP Ltd., a supplier of aircraft fuel systems, has developed its next-generation of sensorless, brushless dc-motor-driven fuel pumps using the Saber simulator from **Synopsys**. The software provided multi-technology simulation for verification of the electrical, electronic, and electro-mechanical elements of the pump designs to meet new aircraft power system specifications. Engineers were able to design and simulate different pump configurations in conjunction with the power system before committing to prototypes.

Lord Corp. has been selected by **Hamilton Sundstrand** to provide Prognostics and Health Management (PHM) for the lift fan shaft monitor on the Joint Strike Fighter program. The PHM system uses diagnostic hardware and software to electronically monitor the health of rotating components to identify upcoming service issues before a repair is needed. Lord's approach integrates the PHM system with the **Rolls-Royce** LiftFan shaft, which is driven by the **Pratt & Whitney** F135 engine.

Design process automation

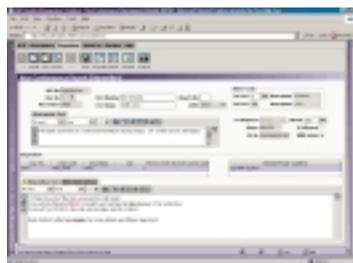
RAND Worldwide has released version 4.0 of its Automation GATEWAY programming software, which enables users of Pro/ENGINEER mechanical design software from **PTC** to directly integrate other applications and create custom interfaces. Automation GATEWAY helps to automate repetitive tasks and allow users to customize the way their models conform to design rules. Advanced users can simplify the process of integrating and modifying CAD models by creating custom applications that non-engineers can use to select and configure designs to meet different business needs.



For more information, circle 100

Managing quality

HMS Software has launched HMS-Quality Management (enterprise edition), a Web-based system for manufacturers of complex and quality-critical products. The software enables inter-enterprise collaboration so that designers, suppliers, and manufacturers can quickly discover, analyze, and



disposition nonconformance, as well as manage appropriate corrective and preventative action processes. Providing remote access to manufacturing data supports a consistent quality management process across the entire manufacturing value chain. HMS-Quality Management provides traceability, tracks the root cause of quality problems, and helps prevent future problems by identifying trends.

For more information, circle 101

Tough graphics card

Thales Computers has introduced the PMC-DGX, a graphics acceleration PCI Mezzanine Card (PMC) for driving SXGA displays in harsh environment console applications. Dual independent display capability accommodates both legacy analog and compliant digital video input flat panel displays. Based on **Asilient Technologies** 69030 HiQVideo Accelerator, performance is 1600 x 1200 64K color at 60 Hz. With 4 MB



of embedded SDRAM, the new PMC is able to support 83 MHz operation. The PMC-DGX can seamlessly replace the CPCIGx and GTX8 graphics boards.

For more information, circle 102

Software tracing

Green Hills Software, Inc., offers a hardware trace probe that brings software trace collection to processors with embedded trace ports. The Green Hills SuperTrace Probe combines a high-



speed trace engine with a large memory to give developers a broad window into embedded software execution. The SuperTrace Probe provides both a means of controlling the processor's trace logic and a channel for capturing trace data while the processor is running. The new probe also includes all the run-control features of the original Green Hills Probe. In contrast to a typical trace probe, which uses only a few megabytes of buffer to hold data, the new probe features a 1 GB trace buffer that can capture several hundred million processor cycles of execution and data trace.

For more information, circle 103