Solving Problems With SINDA/FLUINT

A software system utilized by NASA generated a wealth of commercialization and expansion opportunities for Cullimore & Ring Technologies (C&R), Inc., of Littleton, Colorado. SINDA/FLUINT, the NASA standard software system for thermohydraulic analysis, provides computational simulation of interacting thermal and fluid effects in designs modeled as heat transfer and fluid flow networks. It is used to design and analyze aerospace systems, such as thermal control and propulsion.

SINDA/FLUINT is an integral combination of two subprograms. The Systems Improved Numerical Differencing Analyzer (SINDA) program is a software system for solving lumped-parameter, finite difference, and finite element representations of physical problems governed by diffusion-type equations. The Fluid Integrator (FLUINT) program is an advanced, one-dimensional fluid analysis program that solves equations of arbitrary fluid flow networks. Working fluids that can be modeled in SINDA/FLUINT include single-phase gases and liquids, two-phase fluids, and mixtures of substances.

The system's code was written for NASA's Johnson Space Center by the founders of C&R while they worked at Martin Marietta (now Lockheed Martin Corporation). The technology won the NASA Space Act Award in 1991. Since Johnson could not indefinitely support the code by making necessary upgrades and software expansions, C&R was formed to take over SINDA/FLUINT, supporting NASA's use of the software. After obtaining a license from NASA and receiving Martin Marietta's consent, C&R began marketing SINDA/FLUINT as a commercial product applicable to diverse industries.

The program saves time and money by making the user's design process faster and easier, and allowing the user to gain a better understanding of complex systems. The code is completely extensible, allowing the user to choose the features, accuracy and approximation levels, and outputs. Users can also add their own customizations as needed to handle unique design tasks or to automate repetitive tasks.

C&R received multiple **Small Business Innovation Research (SBIR)** awards from Johnson to expand the system, which helped to make it the most flexible and powerful thermohydraulic analyzer currently available. To further enhance SINDA/FLUINT, C&R

This Thermal Desktop® sample screen shows a satellite model in two independent viewports. The right side of the picture contains icons of the commonly used Thermal Desktop commands.
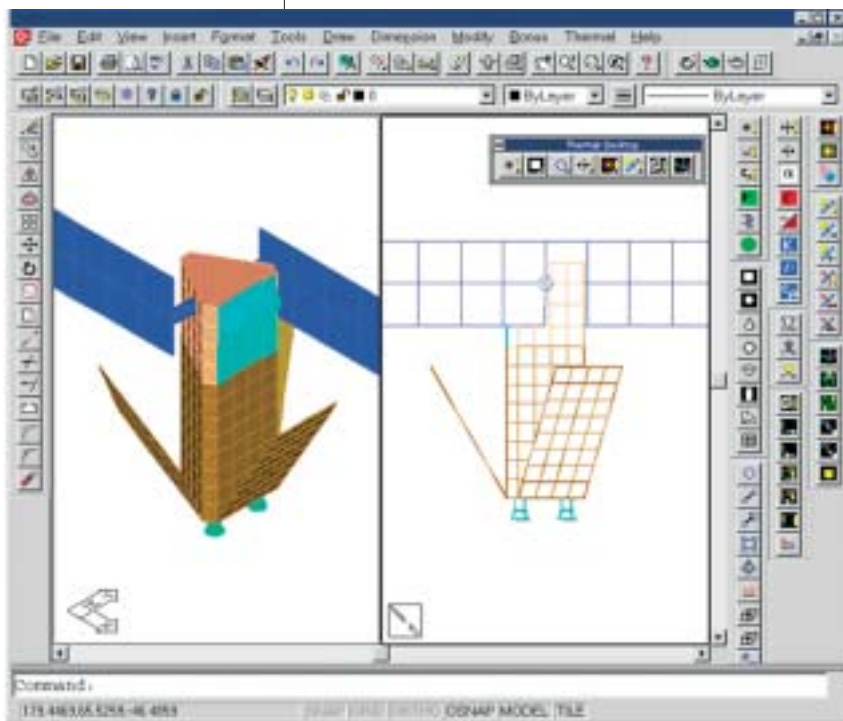
completed the development of Sinaps*Plus,*® which also originated from the founders of C&R while at Martin Marietta. Sinaps*Plus,* a sketchpad graphical user interface (GUI), provides a visual means of accessing the solution power of SINDA/FLUINT, making the system more approachable.

C&R also created a geometric GUI to work with SINDA/FLUINT, known as Thermal Desktop.® An optional computer-aided design (CAD) module of Thermal Desktop, RadCAD,® calculates radiation exchange factors for input to SINDA/FLUINT. Together, these two codes, which began as SBIR projects at NASA's Marshall Space Flight Center, solved a long-standing concurrent engineering problem. Thermal Desktop is the first tool that enables concurrent engineering for thermal analysts by providing full access to CAD-based geometry, as well as data exchange to and from structural codes without compromising traditional thermal modeling practices. Eliminating productivity bottlenecks, these two products benefit the aerospace and electronic packaging communities.

According to C&R, the funds generated from the success of the NASA-initiated products supported the development of the company's FloCAD® product, a geometric GUI for fluid network modeling (the FLUINT side of SINDA/FLUINT). This GUI provides fast, inexpensive, parametric modeling capabilities for air-, liquid-, or two-phase-cooled electronics. It also facilitates the analysis of heat pipes.

With over 4,000 users in 30 countries, applications for SINDA/FLUINT include the pharmaceutical, petrochemical, biomedical, electronics, and energy industries. The system has simulated nuclear reactors, windshield wipers, and human windpipes. SINDA/FLUINT simulates the transient liquid/vapor flows within air conditioning systems, helping the automotive industry to meet standards for fuel efficient, low-emission cars. The system was the basis of General Motor's E-Thermal vehicle-level thermal management software, which is being deployed globally. ❖

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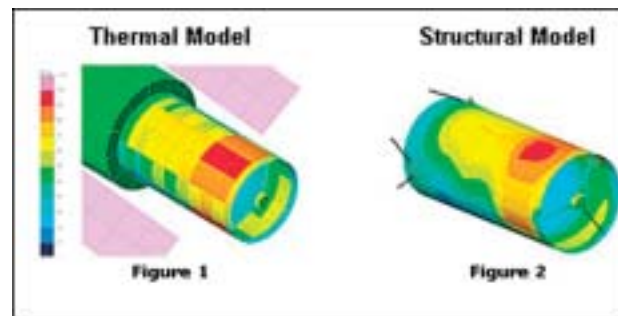
A long-standing concurrent engineering problem was solved by the integration of SINDA/FLUINT within C&R's Thermal Desktop.® Thermal engineers can work side by side with structural engineers and CAD designers for the first time, greatly enhancing both productivity and analysis accuracy.