The space industry is seeking software that will usher in a new era in optimized spacecraft systems design. But if we're smart enough to make it, will we be smart enough to use it?

In Search of Software Solutions
by Marshall Kaplan — McLean, VA

It is likely that the space industry will soon experience what some will refer to as a revolution, and others as an evolutionary process, in the way satellites and other complex systems are designed and developed. It is clear that this change is not to be denied. We now have the technology and the motivation to successfully transform a major part of this industry and move it into a new and highly productive period.

But we're not there yet. Spacecraft and launch vehicles are designed and built in a pre-Henry Ford environment, i.e., with the mentality of one-at-a-time production. Today, we typically start a spacecraft project with several preliminary design machinations, iterations and arguments about what to do and how to do it. There is a great deal of frustration and almost no meaningful optimization; lots of innovation, but little automation in the process.

We must be able to simulate the workings of the physical world to a level of complexity that is consistent with the requirements of increasing productivity in order to remain competitive. The recent evolution of computer hardware and software is making it possible to simultaneously integrate, simulate and optimize the process of systems engineering and design.

The space industry is slowly but surely adjusting to the use of these capabilities. Until recently, spacecraft engineers had their own, very narrow application software for making engineering calculations. Often, commercial software, such as Microsoft Excel, is used as the host for many custom design calculations through the use of macros. Such devices are convenient and helpful, but are extremely limited in their ability to simulate and optimize the system beyond a few subsystems.

The primitive process of systems engineering and design evolution consists of engineering design group meetings in which options and possible changes to the design are discussed. Such meetings expend great amounts of time and absorb lots of engineering manpower. Thus, large amounts of money are spent during the process of evolving a final spacecraft design. The end result of this process is a rather inefficient, non-optimized spacecraft which offers marginal performance at great cost, and only after years of hard work and frustration.

Given that we have reached a sophisticated, mature stage of computer hardware and software development, it is time to move forward with revamping the space industry to achieve a new paradigm of space systems engineering approaches which is a true reflection of our state of technology. New and growing satellite companies are in the best position to take full advantage of this situation, because they tend to be flexible in adjusting to new ways of doing business.

An Integrated Approach
The introduction of a higher level of systems engineering through an integrated software approach will give satellite suppliers a real competitive edge in winning and producing new generations of low-cost, quickly-developed, optimized spacecraft. Customer organizations will be able to better select systems requirements and improve their return on investment figures. Subsystem suppliers will better position themselves to be selected as subcontractors.

The old, established companies will have greater difficulty in achieving the new paradigm. Company size, slowness-of-response, resistance to change and heritage software are all factors which may slow the process of improving the systems engineering process.

Even though this new paradigm is surely coming, we must be leery of claims made about new and amazing software systems for satellite design. As in any time of change, there is an opportunity for profit, and with the scrupulous software suppliers come a few unscrupulous ones. The real capabilities of recently offered “integrated systems” packages vary from sophisticated, truly-integrated systems engineering packages to feeble attempts to connect two commercial applications. It is a relatively simple undertaking to make two applications talk to each other, but it is orders of magnitude more difficult to make many applications communicate.

Even though there are limited advantages to getting two or three applications working together, the impact on the systems engineering and satellite development process is minor indeed. It is only when a truly efficient integrated package is available that great advances in development processes and productivity can be realized.

Four key elements appear to be necessary in order to achieve new heights of productivity from the satellite design and optimization process. First, a fast, technically-oriented, high-level computer language is essential for processing calculations and data transfers. Second, a common database is needed in order to handle data generation and transfer by many individual applications. Third, to make the system user-friendly and efficient, a
graphical user interface should be placed on the front end of the integrated package. Finally, transparent interfacing with the many existing commercial and custom applications and tools already in use by customer organizations leads to minimal disruption during changeover to this new way of developing satellites.

This approach appears simple in concept, and its implementation is indeed not as complex as one might think. The complexity appears in the generation of "templates" for the design process. In order to create a truly automated, integrated, optimization design and simulation package all those engineering rules and relationships that engineers use in the design process must be definitively formulated into algorithms. Today, most of those rules and relationships exist only within the experience base of those engineers and project managers in the field, such rules having never been formally stated as engineering or logic expressions.

Thus, a large part of the process of achieving the new paradigm involves the tedious process of reducing experience to engineering and logic relationships, and identifying the many conditions under which decisions are made. Each user of the integrated software system must create unique templates which are representative of its experience and proprietary knowledge base.

Demand, But No Supply
Almost every satellite manufacturer, major subsystem supplier, support organization or satellite user wants a sophisticated, integrated systems engineering and design software package. In response to this demand, a number of companies are trying to sell or develop such products. In fact, NASA has long sought such software solutions and DARPA has spent tens of millions of dollars trying to develop this type of package.

A clear and strong market exists for this so-far elusive package. Market estimates run from a few hundreds to as much as tens of thousands of licenses. When properly developed and marketed, such software will drive whole companies and be thought of as enterprise software. Those organizations that can take full advantage of this software will have a significant competitive advantage in the satellite market place.

By the nature of the process, once a truly integrated systems engineering software package is available for satellite manufacturers it will become attractive to other related industries. For example, the launch vehicle industry appears to be a next logical step in expanding the universe of applications for such a process capability. Launch vehicles have been, and are, extremely expensive. By reducing the design cycle process and implementing shortened development schedules there should be significant cost reductions realized. It is even fair to assume that there will be no real reductions in launch costs without the realization of such enhancing software for simulating and optimizing future launcher systems.

Marshall H. Kaplan was recently appointed as the Chief Executive Officer of Computational Technologies, Inc. of Santa Clara, California. This company has developed the GENSAT integrated systems engineering software package for satellite design, simulation and optimization. He is senior technical adviser to Launchspace Magazine.