NASA'S ATTACK ON COSTS

by George M. Low

If we don't do something about the high cost of doing business in space, and do it soon, our nation's space program is in deep trouble. We are on the verge of exciting new discoveries in space science, but we cannot follow through as rapidly as we should because we can't afford it. We see before us many important space applications, but we cannot move out as rapidly as we should because we can't afford it. Most important of all, we may lose our hard-won worldwide leadership in space, if we don't find a way to do more for our money! To put it another way, we are doing less than we should do in space because things are so expensive, and because we are working under very tight budgetary constraints. There is very little we can do about the budget—it is imposed by external forces, and there are many other pressures on it; but there is a great deal we can do about costs. Doing something about the high cost of doing business in space is today's biggest challenge.

Basically, when we started out in this business 14 years ago, launch costs were overridingly important. We crammed everything we could into each launch, and optimized our satellites for low weight, low volume and high performance. Payload costs were clearly secondary considerations. This resulted in spacecraft tailor-made for each mission, with its own customized subsystems and components. Every piece was designed to the limit, with low margins and low tolerances. The net result was that most systems could be used only for the purpose for which they were originally intended, and after use in one satellite, were discarded in favor of new systems designed for the next mission. Furthermore, the low design tolerances required a tremendous number of tests and enormous volumes of paperwork to achieve absolute control. In other words, we were forced to perform very expensive developments and then used the spacecraft only once or twice before starting on the next very expensive development. We have built many one-of-a-kind items, and have demanded the utmost in performance from them. Simple statistics bear this out. Today we have 52 operating civilian spacecraft. By the end of next year we will launch 35 more, for a total of 87. These 87 represent 43 different spacecraft types—on the average each spacecraft is flown only twice!

But things are different now. Payloads have become more complex, while launch costs have come down . . . This means that we should now optimize our payloads for low cost and high reliability, and not for minimum weight and maximum performance as we did in the past. I am convinced that if we do this, we can drastically reduce the cost of doing business in space. And this, I believe, is as great a technological challenge as everything else that we have done in space. . . In the design phase, the following principles are important:

- *Don't re-invent the wheel.* Use the best that is available from other programs. In all of the commercial firms I have visited, "not invented here" is unheard of. All tear down their competitor's product, study it, analyze it, cost it and make use of the best ideas in it, as long as they do not infringe on patent rights.

- *Standardize.* This applies to parts, components, modules, subsystems and entire systems. (There are only two chassis for the entire line of Sears television sets, and even they contain many common modules.)

- *Design for low cost.* Involve production engineers in the earliest stages of design

to help eliminate those things that will be difficult to produce.

- *Design to minimize testing and paperwork.* Simply stated, this means: take advantage of reduced weight and volume constraints and use standard parts, larger margins, and larger safety factors. (In Apollo we spent millions of dollars—on tests and paper—to be sure we did not exceed the "fracture mechanics" limits on our pressure vessels. A few extra pounds in tank weights would have completely eliminated that problem, and the testing and paperwork along with it.)

- *Recognize that different systems* can accept differing degrees of risk . . . A Shuttle life support system must be more reliable than a simple experiment in the Shuttle payload bay. The cost of a system should reflect the acceptance of risk in those instances where this is possible.

- *Know your costs.* None of the things I have said has any meaning if we don't know how much each element costs. The area of accurate cost estimating is one where we have a great deal to learn. Yet it is an area which *has* been developed.

- *Trade features for cost.* This follows naturally from the previous item. Once we know how much something costs, then we can ask ourselves whether it is really worth it. Many of our so-called "requirements" really aren't that firm, and should be stated as "goals," to be re-examined in terms of cost.

- *Pay particular attention to the few very high-cost items.* In many designs some small percentage of the items amount to most of the costs. By knowing the costs, and by listing items in order of descending costs, it becomes possible to devote a great deal of attention to the high-cost items—generally with profound results.

In the implementation phase, I would emphasize the following points:

- *Know your costs before you start.* This perhaps is the most fundamental of all requirements. Without exception, the NASA programs which have been in difficulty were the ones that had insufficient definition at the outset.

- *Set firm cost targets.* A desire for the "lowest possible cost" is not a good way to approach the job. A firm and absolute cost ceiling should be established for each job.

- *Meet the established cost targets.* Don't blame cost growths above target on "external forces." Find ways to meet the targets, no matter what happens. This means that we have to become more productive in one area, if another area exhibits an "unavoidable" cost increase.

In summary, we must find ways to design for lower costs, we must know our costs, and we must set out to meet those costs. . .

In my years in the space program, and especially during the years when I had some firsthand experience as a project manager, I gained a tremendous respect for American industry . . . That industry rose to the challenge of Sputnik in 1957, and brought us to a position of world leadership in space. Today that same industry faces a new challenge—the challenge of doing more for less money.

It is up to you to apply the same skills, ingenuity and competitive spirit that allowed us to meet the challenge of 1957 to now meet the challenge of the 1970s—to preserve U.S. leadership in space through a productive program at a price the nation can afford.

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