Workshop Highlights 3

OTA's workshop on the lower industrial tiers of the space transportation industry was held on March 2, 1995. Workshop participants are listed in the front of this report. Unlike chapters 1 and 2, this chapter reflects only the discussion at the workshop.

The complement of firms represented was fairly diverse. It included seven manufacturing and three service firms, ranging in size from a few millions of dollars in annual sales to over a half–billion. Firms were selected from a cross section of the industry, including avionics, propulsion, structures, materials, instrumentation, and fuels. And they were selected for their work on the full–range of current space launch vehicles and long–range ballistic missiles, as well as many retired systems. The firms characterized themselves as occupying predominantly the second and third tiers.[1]

CURRENT STATUS AND CRITICAL SECTORS

The single most striking characteristic of the discussion at the workshop was the general pessimism of the participants, based on the view that the defense and space markets were shrinking and that this trend was unlikely to reverse itself.

One participant said that his firm has dwindled from 500 employees to 240 over the last three years, and is having difficulty getting its suppliers to build the obsolete components that are re-

"... the United States has not yet adequate/y defined its goals in the space launch field.. ."

[1] According to preliminary input–output analysis, OTA estimates that the second and third tiers account for more than 35 percent of the value added in space transportation systems. OTA conducted telephone interviews with representatives of the fourth and lower tiers, which account for less than 10 percent of value added, to augment the discussion in chapters 1 and 2.

quired to support existing launch vehicle designs, because of *their* pessimism about the future of the market.

Another agreed, and said that as a result, his firm's facilities are obsolete and the know–how to maintain and operate them is dissipating as retirements and downsizing continue. He reflected skepticism that current launch vehicle development studies would result in anything being built, and emphasized that preservation of the industry's skill base could not be achieved by studies, but only by the actual construction of new or evolved launch vehicles.

Another participant said that his firm would be closing its plant for the manufacture of large solid rocket motor nozzles at the end of March 1995, because its business base had evaporated. The result, he said, would be to leave only one surviving firm in his market niche.

Another participant described his firm as heavily diversified, with as much sales volume in the non–aerospace market as in aerospace. He described the company's military and other government business as shrinking rapidly, and its remaining base primarily in the aircraft field rather than the missile and space business.

When asked to identify elements of the lower–tier industrial base that are being particularly hard hit, one participant said that solid propulsion is especially vulnerable. Makers of long–range ballistic missiles and tactical missiles have little work. If that trend continues, they will become increasingly dependent on their related launch vehicle business both for work and for maintaining critical missile capabilities.[2]

Solid rocket motors are currently used in several expendable launch vehicles or ELVs (e.g., Delta, Titan, Lockheed Launch Vehicle, and Taurus), and are a major component of the Space Shuttle. The Lockheed Launch Vehicle and the Taurus use a motor derived from the Peacekeeper intercontinental ballistic missile. DOD and NASA space transportation development plans, however, could all but eliminate the need for solid rocket propulsion in launch vehicles, if the Evolved Expendable Launch Vehicle (EELV) program and reusable launch vehicle (RLV) programs are successful and rely exclusively on liquid–fueled engines.[3]

Continuing on this theme, one participant noted that some firms producing inputs to the solid rocket business are also leaving the business. For example, he said, there is only one maker of rayon for carbon–carbon composite structures. Aerospace forgings are almost impossible to get now in any size, he continued. There are only a handful of shops in the country big enough to handle the equipment, and some of them are leaving the aerospace business.

As for restarting a program after a hiatus, he said, once a plant closes, its specialized facilities are lost to the industry. In his view, it is almost too late to reverse the trend. NASA's current proposal for the X–33 RLV foresees a delay of 4 to 5 years before serious production can begin on anything beyond the initial demonstration vehicle, and many subcontractors will be out of the business by that time.

One of the most serious problems faced by lower–tier companies is the loss of experienced people and a lack of hiring of young engineers and technicians. All the firms that commented on this issue said that they have not hired anyone in several years. Young engineers are staying away from aerospace, they said, because of its declining employment and uncertain future. One mentioned that his firm had previously drawn on a pool of young engineers who came to the firm under

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[2] All current U.S. long–range ballistic missiles have solid rocket motors. If solid rocket motor capabilities were lost, the government could conceivably design new weapon systems based on new RLV technology and liquid–fueled engines. This possibility is not now being seriously considered.

[3] See U.S. Congress, Office of Technology Assessment, *The National Space Transportation Policy: Issues for Congress*, OTA–ISS–620 (Washington, DC: U.S. Government Printing Office, May 1995).

work–study programs, but that the firm had stopped using these "co–ops" several years ago.

In general, participants said that fewer than half of the people in their companies involved in launch vehicles five years ago are still in the field. In time, they predicted, even though some firms might survive, they would not have retained the pool of skills unique to the industry (such as designing for the special requirements of operating in the vacuum of space), because work and training will not have continued.

Participants also commented on the dearth of investment in launch vehicle–related industrial facilities. They asserted that there has been little or no investment over the past 25 to 30 years. Materials and fabrication techniques have not been changed, they said, and space technology in some areas, such as advanced composites, is "Stone Age."

Participants identified environmental regulations as a major brake on doing business. They felt that stringent application of environmental controls was significantly raising their costs and complicating their operations. In this regard, they cited the phasing–out of ozone–depleting chemicals, Superfund–related litigation and cleanup costs, and overly stringent water–quality requirements on manufacturing facilities.

One participant noted that even though water entering his facility was more contaminated than when it left, his firm was obligated to make its runoff meet Clean Water Act standards as if the supply water had been pure to begin with.

Another participant mentioned that lower–tier firms in Southern California are finding themselves unable to obtain working capital, even with firm contracts in hand, because banks avoid funding anything in the aerospace field. Others had heard of similar cases in other parts of the country, and speculated that banks fear that any government aerospace contracts are imminently vulnerable to alteration or cancellation.

Finally, one participant cited an ongoing Air Force study that he said appears to conclude, on the basis of limited data, that 35 to 40 percent of the lower–tier firms in the space industry will cease doing government–related business within the next five years. He believes there would probably still be sources for the items that the lower–tier firms had provided, but said that the impact on the lower tiers would be far greater than on the primes. The primes, he said, would find other business to do or consolidate, but they would not go out of business.

THE IMPACT OF FUTURE VEHICLE CHOICES

Most participants expressed skepticism about the proposed EELV and X–33 RLV programs. Several strongly doubted that there was a commitment in the government to build a new vehicle after so many false starts. One argued that the EELV program was likely to be carried through, but others commented that at best the EELV program was more likely to result in an upgraded Delta or Atlas than a new family of vehicles.

Another participant said that while a follow–on RLV derived from the X–33 demonstrator would clearly be a new vehicle, he foresaw a repetition of the Space Shuttle experience, with cost growth undermining any hoped–for savings. He further doubted that the funding could be found for the level of effort required. Noting that the government was seeking substantial corporate investment in the program, he said that the prime contractors were skeptical too, and that the lower–tier firms had been burned too often. Some participants expressed concern that the EELV and X–33 RLV programs were not sized to meet the needs of the commercial market and the smaller, cheaper spacecraft that both DOD and NASA are emphasizing.

Commenting on NASA's stated plans to decide in 2000 whether to pursue a next–generation RLV or invest in refurbishing the Space Shuttle, several participants agreed that it would probably be cheaper to build a new RLV than to redesign or rebuild the current Shuttle fleet. Some doubted that NASA considers extending the life of the Shuttle to be a serious option, while others believed that the most likely outcome of developing the EELV and RLV in parallel would be a decision not to pursue the RLV, and to upgrade the Shuttle instead.

Two participants in the workshop noted that they had been approached by prime contractors to join teams bidding on the X–33 program, but that the primes had been seeking significant advance payments from subcontractors wishing to join their team. Their firms had refused to contribute, these participants said, and so other firms were chosen for those teams. Their reluctance was not due to a lack of capital, but because they did not foresee any future market. They said that their firms had contributed willingly to new project teams in the commercial aircraft industry, where they saw the future business potential.

If the X–33 RLV demonstrator succeeds and a decision is made to go forward with a full–scale RLV, some firms at the workshop believed they would benefit because of the "airplane–like" nature of many of its systems. Those firms primarily associated with ELVs saw no relevance to their future prospects, which are closely tied to the future of the EELV program.

One participant noted that although any benefit to his firm from the Space Shuttle program was far in the past, a large share of the NASA budget continued to go to that program, rather than to supporting the industrial base. He predicted that a future RLV would follow a similar pattern, resulting in a limited amount of initial business for the lower–tier firms, followed by years of little or no return while the money flowed into operations.

RELATIONS WITH THE GOVERNMENT, PRIMES, AND MAJOR SUBCONTRACTORS

Relations with both the prime contractors and the government are a major concern for workshop participants. One flatly described the prime contractors as his firm's main competitors, because of their tendency toward greater vertical integration. Others agreed, adding that the accounting systems of the primes tended to obscure the true cost of substituting in–house manufacturing for subcontracting.

For example, one described a situation in which his firm lost a contract after producing a few units because the prime wished to produce the units in house, and could make doing so appear less expensive by not including overhead in the cost figure. Two others noted experiences in which primes first took work in house, then re–dispersed it to subcontractors once it became clear that in–house production was not economical. Another pointed out that because subcontractors were downsizing and losing skilled personnel, prime contractors increasingly risked having no alternative to doing the work themselves, even if they lacked the subcontractors' past experience and ability to do it well.

Several of the participants complained about being asked by prime contractors to contribute to front–end costs as a condition of teaming on new business. One said that since his firm had diversified, and its launch business was no longer a large–enough share of the total, the company would not invest in this way. He predicted that this practice would cause some of the most–skilled lower–tier firms, subcontractors that had built quality products since the 1950s, to disengage from the space market, forcing the primes to build complete systems more and more in house or to resort to new, inexperienced subcontractors.[4]

Another participant commented on the potential difficulties brought on by consolidation among the prime contractors, increasingly obliging lower–tier firms to deal with only one or two potential customers. He said that the prime contractors were applying intense pressure to the lower–tier firms to reduce costs. He emphasized the difficulty that both prime contractors and lower–tier firms—accustomed to working with government requirements—would have in adapting to the commercial marketplace.

[4] A reliance on so–called "build–to–print" companies, in particular, can in the long–run be a false economy, if full–service subcontractors with design capabilities are driven from the market. See *Building Future Security,* OTA–ISC–530 (Washington, DC: U.S. Government Printing Office, June 1992), p. 94.

Turning to the government, one participant said that he believed that the government procurement culture and its counterpart, the corporate culture accustomed to doing business with the government, together represented the biggest obstacle to sustaining the lower tiers of the space launch vehicle industry.[5]

All participants were strongly critical of government procurement practices, and frustrated by the dissonance between claims of substantial reforms and the requests for proposal to which they, through the prime contractor, had to respond.

They felt strongly that the effects of procurement reforms are not being felt at the lower tiers. All complained about the cost and complexity of conforming with government accounting and technical oversight requirements. One participant argued that firms might be dissuaded from entering the commercial market place or implementing cost–saving methods for that market, because of government "lowest–price" requirements that would oblige them to reduce their prices to the government if they offered their goods or services on the commercial market at less than the government contract price.

There was some debate about the behavior of the prime contractors in the area of requirements. Most participants felt that prime contractor behavior tended to mimic or even reinforce the government's intrusive controls and inspections. At least one participant disagreed, arguing that some prime contractors (those with both commercial and government business) are capable of significantly greater flexibility and commercial behavior when not under government procurement strictures.

One participant felt that the government's application of the Commercial Space Launch Act[6] could inadvertently pose a severe competitive threat to his firm. On the one hand, he complained that the government was making too much use of dedicated payload processing facilities, in lieu of those commercially available. On the other, as the government downsizes, he foresaw the possibility of a government decision to privatize these payload processing facilities at minimal cost, in effect setting up a competitor who would not have to invest substantially in order to enter the market.

Another felt that particularly in the area of program support and software development, the government was already a strong competitor, taking business from the lower–tier firms. Since the government was also downsizing, and beginning to cut deeply into its infrastructure, he believed that the same forces leading to more vertical integration by the primes—the desire to protect their employment and skill bases—would also lead the government to pull more of the lower–tier work in house (e.g., into the defense, energy, and NASA laboratories and centers).

RESEARCH AND DEVELOPMENT

There was a general consensus that lower–tier companies were not spending on R&D unique to launch vehicles, because of a lack of confidence in the future of that market. One participant said that his firm ceased such expenditures three years ago. Instead, he said the firm is spending for R&D in areas with future business potential. Another firm would only be willing to spend on R&D related to launch vehicles if the resulting technology would have a direct, specific application to its much larger, more stable commercial aircraft business.

One participant said that the underlying problem remained the lack of confidence in the government's committing enough resources to build a new launch vehicle. Another said his firm did only very narrow, focused R&D with immediate application to its products, and could not afford to do

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[5] For a complete discussion of these issues see U.S. Congress, Office of Technology Assessment, *Assessing the Potential for Civil–Military Integration: Technologies, Processes and Practices*, OTA–ISS–611 (Washington, DC: U.S. Government Printing Office, September, 1994)

[6] The Act was designed to facilitate the transfer of government–owned launch vehicle components, equipment, tooling, and ground facilities to the private sector. It was subsequently repealed and recodified as 49 U.S.C., Subtitle IX.

any related to launch vehicles. Still another commented that technology available off the shelf in his company is so far ahead of that used in current ELVs that there is no real need for additional R&D to support space transportation needs at this time.

Others observed that another disincentive to doing self–funded R&D was the risk that the primes would secure the rights to the resulting technologies and apply them to other programs, from which the developers would receive no residual benefit.

Several participants said government funding is fundamentally ineffective in stimulating or supporting R&D among lower–tier firms. They agreed that such funding is almost always absorbed by the prime contractors, so little reaches lower–tier firms.

One cited work done for the Advanced Launch System, entirely on his firm's own account; none of the program's funding filtered down to the subcontractors. Another commented that prime contractors typically negotiate cost–plus development contracts with the government, but try to persuade their suppliers to take on fixed–price development tasks. Participants generally agreed that many lower–tier firms are not willing to take such risks, given their bad experience with earlier, abortive launch vehicle programs.

Generally, participants felt that most lower–tier firms got little benefit from various mechanisms established by the government to assist industry R&D, such as Cooperative Research and Development Agreements or the Advanced Technology Program. They noted that doing non–product–related R&D for the government was not usually attractive to lower–tier companies, because of potential difficulties establishing subsequent technical data rights.[7] Participants doubted that OTA would find many lower–tier companies wanting to do R&D for its own sake.

There was particular dissatisfaction about working with NASA field centers and Department of Energy national laboratories on technology development projects. One participant said that projects done at NASA's Lewis Research Center, for example, which seemed to be targeted at specific problems in Shuttle design, were never incorporated in the vehicle. Another said that he believed many technology projects at laboratories were make–work. He found it hard to understand why companies should want to be involved in such activities. Still another spoke of finding his company in actual competition for focused R&D contracts with the in–house workforce at a national laboratory.

GLOBAL COMPETITION AND COOPERATION

Participants generally agreed on the need to ensure launch capability for national security missions, but disagreed about whether this required government intervention to ensure the survival of any company or group of companies.

One participant was concerned about the potential for the emergence of a single U.S. launch company, while others questioned if even one needed to survive. One mentioned the possibility of stockpiling either U.S.– or foreign–produced launch vehicles to serve defense needs, in lieu of trying to maintain production capability.

Participants agreed, however, that at best, the government was focusing on the primes, and that little attention was being given to the impact of foreign competition on the lower tiers. One participant believed that neither DOD nor NASA would intervene to save a particular company. All agreed that restoring a launch vehicle production capability after permitting a hiatus would be very expensive and difficult, and that allowing foreign firms control of the launch market would potentially lead to higher launch costs for U.S. satellite manufacturers and eventually to the erosion of the U.S. lead position in satellite manufacturing and services.

Several of the firms represented in the workshop sell limited amounts of equipment to foreign

[7] Small subcontractors also often lack the manpower and legal expertise to compete for government R&D programs.

launch vehicle programs, but all agreed that such business is minor compared to what could be expected if a new U.S. program or programs got underway.

PRESERVATION OF THE TECHNOLOGY AND INDUSTRIAL BASE

Participants in the workshop felt that the United States has not yet adequately defined its goals in the space launch field, and that reaching a consensus on these goals was a fundamental precondition to specific measures to preserve the space transportation technology and industrial base.

Participants generally agreed that if the President and Congress wished to preserve the U.S. space transportation industry, including its lower tiers, it should make a real, long–term commitment to development of at least one new launch vehicle. Most believed that no single system, whether expendable or reusable, could meet all probable requirements. All participants agreed that there was no substitute for a real development program to revive the lower–tier firms, and that only with confidence in the long–term intentions of the Congress would companies be willing to take the risks and make the long–term investments required to keep the U.S. space transportation industry viable.

Participants largely agreed on the need for the government to do more to safeguard and stimulate the technology base. Several participants strongly advocated earmarking focused (as opposed to basic) R&D funding exclusively for the private sector, instead of allowing the national laboratories to compete for it. They also urged streamlining the government's R&D management processes, so that more of the funding would actually go to do the research, and less to oversight and management. Finally, they emphasized the need for structural reform to ensure that R&D funding would flow down past the prime contractor level, and that the benefits of procurement reforms would be felt by lower–tier firms.