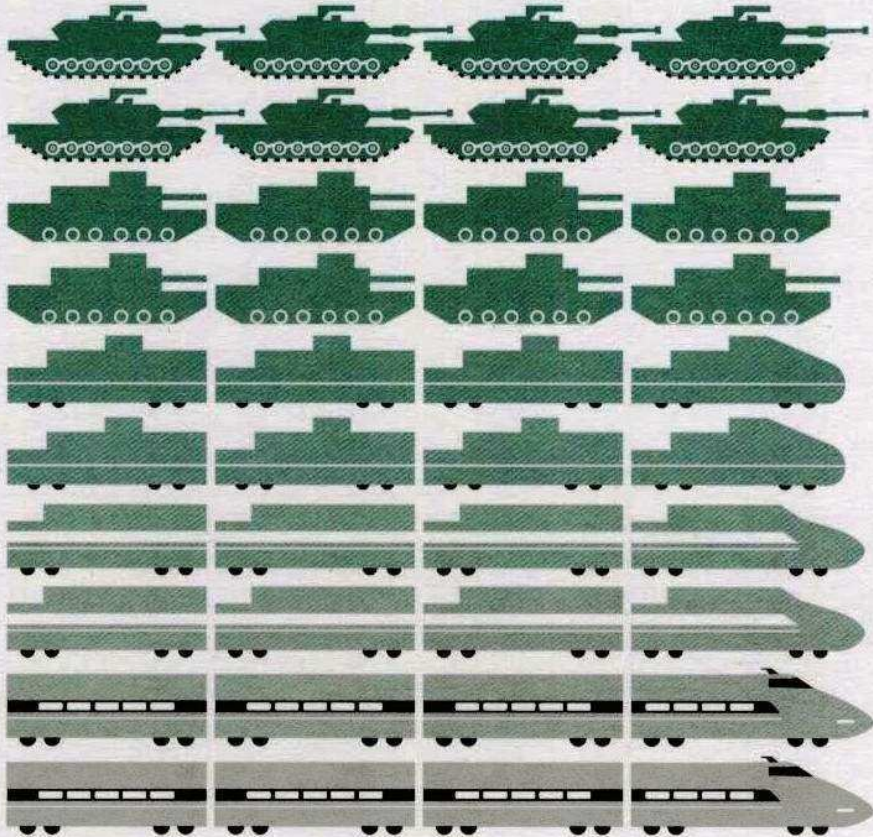


Aerospace/Defense Diversification

Avoiding Pitfalls on
the Perilous Path



A Viewpoint

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The decline in superpower tensions has brought about dramatic changes in the worldwide aerospace/defense industry. With an expected real rate of decline in the U.S. defense budget of 5 percent or higher, and similar if not greater declines elsewhere in the world, aerospace/defense firms will find it increasingly difficult to sustain revenues and shareholder values. In the near term, this decline pressures management teams to downsize and restructure. This will be a painful process, as it means dismantling technological and capital resources assembled over decades.

For the long term, interest in diversifying away from defense and into commercial markets will grow. The high growth rates of many high-tech commercial markets will be almost irresistible in comparison to shrinking defense markets. History, however, shows that business diversification will not be easy.

At the end of World War II, the Korean War, the Vietnam War, and during other spending downturns, scores of aerospace/defense firms attempted the difficult and painful transition to commercial businesses. Some succeeded, many failed — with the failures far outnumbering the successes. Countless resources were wasted in the process.

Among the many markets aerospace/defense firms entered in the effort to diversify were public transportation equipment, industrial and consumer electronics, factory automation, information systems and services, sporting goods, health-care software, systems integration, computer services, civil construction, general aviation, appliances, and other commercial markets. There is much to be learned from this rich history.

Although the success rate was not high, some aerospace/defense firms did succeed in making the transition, building major commercial market positions and adding to shareholder value. Rosemount's success in

sensors, Raytheon's early success in microwave ovens (the Amana brand), and GE's and Pratt & Whitney's successes in commercial jet-engine markets are among the success stories. Such diversification allowed these companies to realize better returns on the significant defense investment.

The rationale for diversification into commercial markets is more than economic. Aerospace firms are, by nature, technology-based businesses, employing one out of every five scientists and engineers in the U.S.

Firms at all levels of the defense industry, from component manufacturers to systems integrators, possess extraordinary engineering and manufacturing resources. In looking toward commercial markets, most firms can identify high-growth, technology-based opportunities where their capabilities may apply. Such potentially attractive high-technology markets encompass medical diagnostic equipment, information management, communications, software/data-base management, sensors, digital data acquisition/storage/dissemination, wireless communications, and many others.

Many aerospace/defense firms may have the financial resources to consider high-growth, technology-based commercial markets. Even during a downturn, well-managed aerospace/defense firms that downsize quickly and rationalize capacity will sustain strong

financial returns. As a result, they will be able to generate substantial cash flows to support important commercial diversification programs. Diversification should, nonetheless, be weighed against other options, such as investing in the core business or distributing the funds to shareholders.

While the failure rate of previous efforts is sobering, the purpose of this *Viewpoint* is not to argue against commercial diversification by aerospace/defense firms. Rather, it is to learn from earlier efforts and apply the lessons to today's business environment and markets. The goal is better-planned diversification strategies and greater success in commercial markets.

Key Lessons from History

We feel there are seven problems typically hampering commercial diversification in aerospace/defense firms:

1. Technology tunnel vision
2. Swimming with lead weights
3. Forgetting to refuel
4. Driving without a map
5. "I can do that" syndrome
6. Daniel in the lion's den
7. Sprinter's mentality in a marathon world

These issues can be traced along the typical process required to complete a successful diversification (see Exhibit 1).

1. Technology Tunnel Vision

The aerospace/defense industry demands a high level of technology performance. In most military space applications, the customer seeks extreme leading-edge technology. The industry responds by producing extraordinary functionality. However, such functionality only sometimes applies readily to commercial markets. The offerings may

Exhibit 1 (below) diagrams the commercial diversification process as it traditionally unfolds in seven stages. To complete the process successfully, aerospace/defense firms must avoid the error common to each stage.

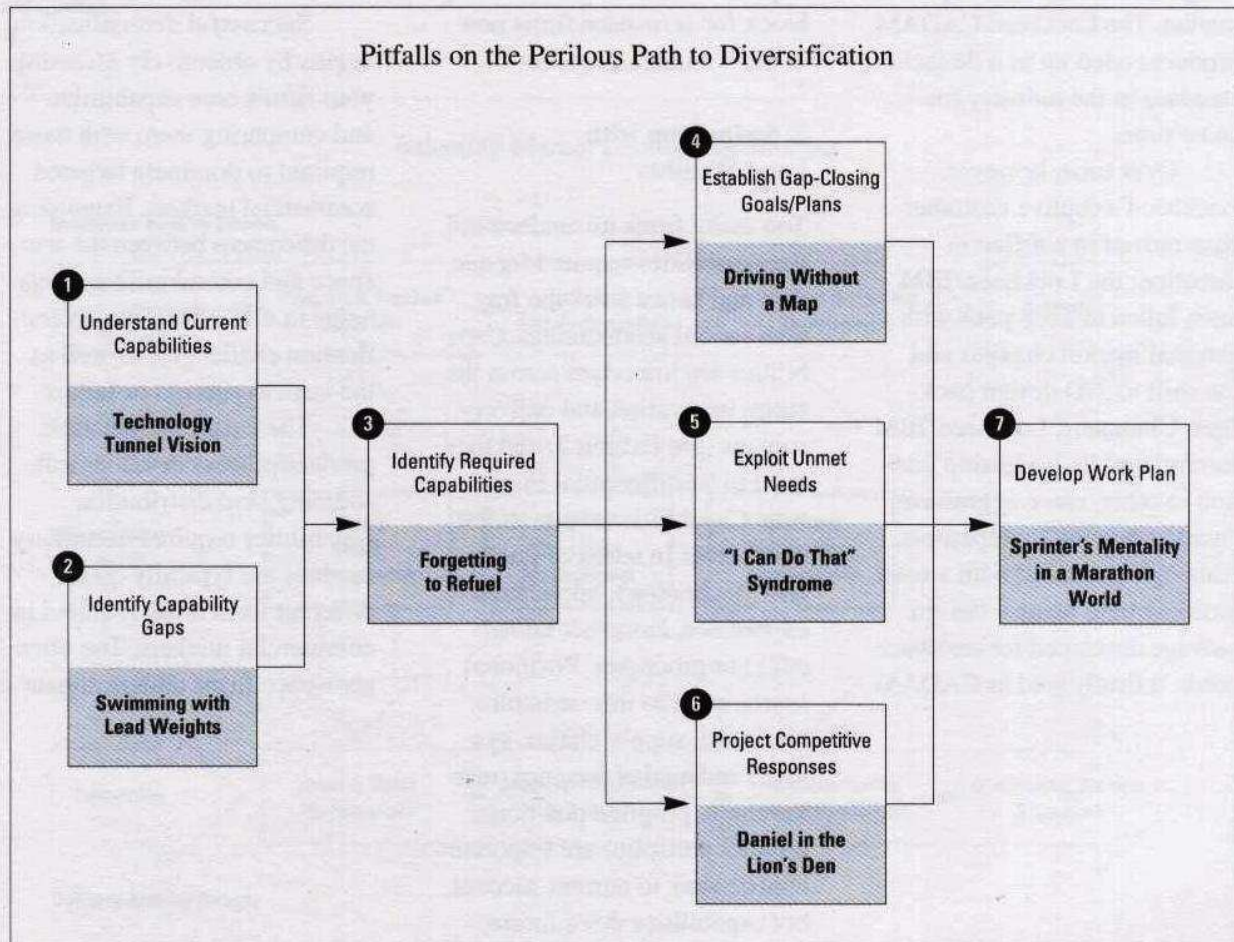
be either too elegant and expensive, or no better than those already available to commercial competitors.

Unfortunately, a degree of “technology arrogance” sometimes creeps into such commercial diversification planning. Too many aerospace/defense firms have mistakenly concluded that their technologies would overwhelm those available from commercial firms, permitting them to gain leadership positions quickly and easily. Often, they give too little weight to capabilities other than technology. Ironically, these companies would never dare make

this type of assumption in military markets — even though they understand those markets much better.

Experience has shown that even when an aerospace firm possessed technology superior to that available to firms already serving the commercial market, the technology alone was seldom sufficient to build a leadership position — due to higher inherent costs, an inability to develop relevant applications, or excessive performance (which commercial customers do not need).

In the early and mid-1980s, several aerospace/defense firms created first-rate, computer-aided



design/manufacturing products, most based on in-house developments designed to meet the needs of their own product engineering/manufacturing requirements. In many instances, the initial product was defined solely by the captive internal customer base, rather than by the needs of external customers. Most of these efforts failed eventually because of the focus on the special needs of aerospace/defense business.

For example, Lockheed succeeded initially in computer-aided design because it recognized its limited capabilities in sales and distribution. As a result, the company teamed with IBM to take Lockheed's first-rate product to the commercial market. The Lockheed CADAM product ended up as a de facto standard in the industry for some time.

Over time, however, Lockheed's captive customer base moved in a different direction; the Lockheed/IBM team failed to keep pace with external market changes and the shift to 3-D design packages. Ultimately, Lockheed/IBM surrendered its leadership position to other, more aggressive, "market driving" competitors. Although Lockheed built a solid business base using a design package developed for aerospace needs, it finally sold its CADAM

business to IBM in 1989 as part of an overall exit strategy from the information industry.

Meeting the high performance standards of the aerospace industry is, in itself, no guarantee of long-term commercial success. In reality, military technological know-how, in its current state of development, may be inappropriate for the commercial market and may require substantial investment and refinement. Furthermore, it is insufficient to introduce only a "first-generation product." The plans, resources, and capabilities must be in place to develop subsequent generations of products at the rapid pace demanded by most commercial markets. Typically, this requirement is a major stumbling block for aerospace firms new to the commercial game.

2. Swimming with Lead Weights

Too many firms misunderstand the capabilities required for success and hence enter the fray with serious shortcomings. Capabilities are important across the entire innovation and delivery streams (see Exhibit 2) and they need to be differential in some way. Capabilities can manifest themselves in terms of know-how (technology, application experience, customer knowledge) or processes. Positional assets, such as infrastructure (facilities, supply chains, systems) and market presence (market share, program positions, product portfolio) are important contributors to current success, but capabilities drive future

success since positional assets are inherently perishable. The capabilities must be strong and distinctive enough to enable the firm to shape and define the nature of competition in the market.

For example, within the innovation stream, this means developing the capabilities required to recognize market opportunities; to understand and define customer requirements; to design or develop and successfully commercialize technology; and to provide sales and services responsive to the market. Within the delivery stream, it includes capabilities related to manufacturing, purchasing, supply-chain management, and distribution.

Successful diversification begins by objectively assessing your firm's core capabilities and comparing them with those required to dominate targeted commercial markets. Examining the differences between the aerospace and commercial markets helps to understand the diversification challenges, as well as the keys to success or failure.

The customer interface, product/process development, sourcing, and distribution capabilities required in military markets are typically quite different from those required in commercial markets. Too often aerospace firms underestimate

the importance of the capabilities associated with understanding the commercial customer's needs, bringing products to market quickly, and managing product life cycles. Likewise, they tend to overemphasize "hard assets" (such as manufacturing and product technology), and underestimate the importance of "soft assets" (such as market insight, service and support, user-friendliness, design-to-cost skills, and pricing strategies).

Exhibit 2 (below) shows the three realms in which aerospace/defense firms must develop capabilities in order to compete in the commercial market: innovation, delivery, and management and control.

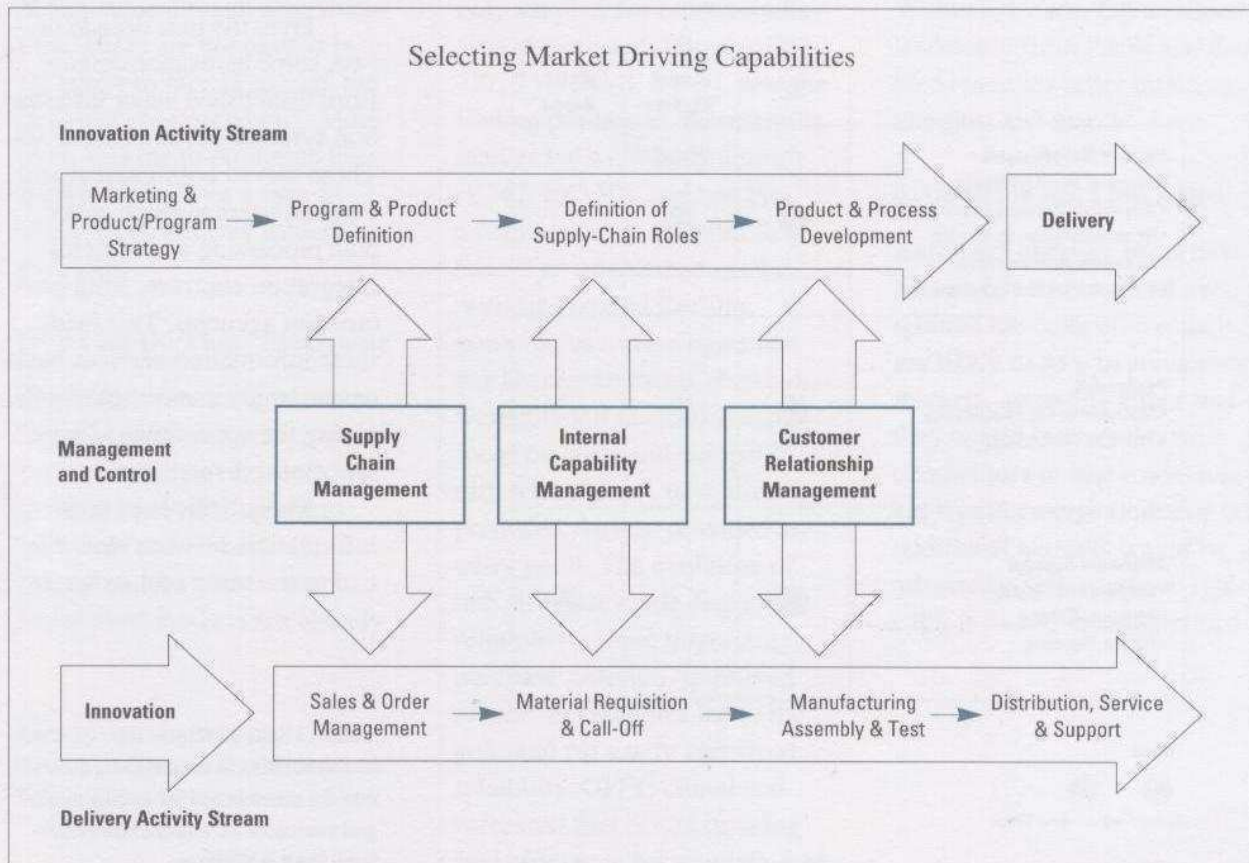
3. Forgetting to Refuel

Another common pitfall is failing to renew and replenish capabilities, and failing to direct them toward the differential requirements of the commercial market.

One executive of an aerospace/defense prime has observed that commercial markets "are generally characterized by short market cycles, rapid change, critical time-to-market cycles, large development investments, and often strong competition. Historically, neither [we] nor other aerospace companies have had much success in commercial ventures."

The challenges of diversifying from aerospace/defense to commercial markets — whether

by internal development, strategic alliance, joint venture, or acquisition — are enormous. They arise from vast differences between the markets, including differences in customer characteristics, the nature of competition, and management processes. These differences lead to further differences in product or service performance requirements, product volume characteristics, overhead and support structures, and technology strategies. As top aerospace/defense executives contemplate commercial diversification, they must take time to understand these differences as a key step in planning, since they require management to commit to building and evolving new capabilities to close the gap.



For example, Raytheon entered the microwave oven business by applying microwave technology (as well as manufacturing assembly and testing know-how) gained from military applications. In this case, Raytheon, unlike many other defense firms, built the complementary skills needed in marketing, sales, service, and distribution by acquiring Amana.

For nearly ten years Raytheon dominated this market. As microwave technology know-how became a commodity, however, other capabilities required for success rose in importance and eliminated

Raytheon's relative advantage. New competitors such as Panasonic entered with superior product designs and the capabilities to serve the commercial appliance markets. They introduced new innovations to the product line, including carousel turntables, humidity sensors, digital displays, and so on. As a result, Raytheon/Amana has yielded leadership and is now a small player, having failed to build and sustain market driving capabilities.

This example highlights the need to recognize the fundamental differences in requirements between military and

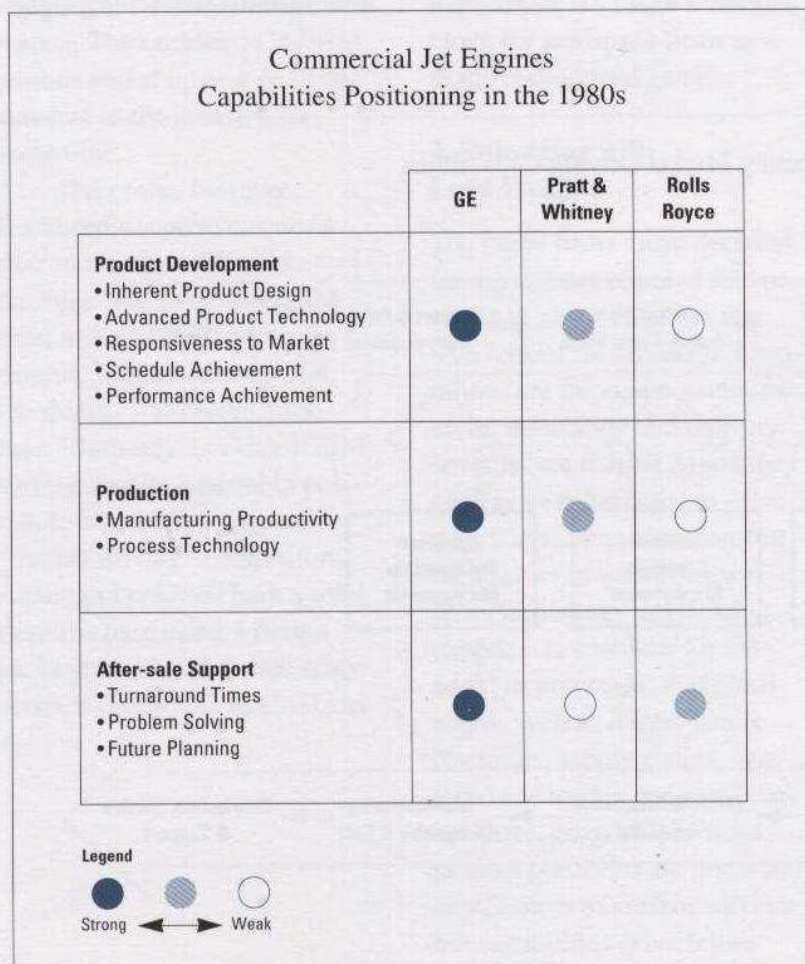
commercial markets and to build and evolve the complementary capabilities required to address targeted commercial markets.

4. Driving Without a Map

Setting the wrong objectives contributes in a real way to many of the failures of aerospace/defense firms in commercial diversification. Too often the goal is stated in terms of achieving some percent of the firm's revenues in non-aerospace markets. While such goals demonstrate the desired order of magnitude, they do not guide strategic objectives. The very same companies would not use such vague direction in the pursuit of defense markets. Rather, they would seek to lead markets by establishing strong, differentiated capabilities.

Over the past decade or two, some aerospace/defense firms established major information systems/services businesses. These served both internal and external users through major data processing and systems integration contracts from government agencies. This made these information-services businesses large almost immediately, giving the appearance of rapid, successful diversification.

Many firms kept their information-services business tied to the same cost structure,



◀ **Exhibit 3 (left) illustrates how GE used its capabilities to successfully diversify into the commercial jet-engine market and overcome an entrenched incumbent, Pratt & Whitney.**

employee policies, and benefit package in order to maintain "one culture" within the firm. Too often, they over-emphasized building volume rather than distinctive capabilities and shareholder value. Unlike competitors (such as EDS, CSC, and others) who tailored their cost structure and hiring/personnel development policies to the commercial market, the information-services activities of many of these aerospace firms were more an extension of their internal information-systems capabilities and were too expensive and unresponsive to the market.

Successful firms establish different objectives. First, they aim to dominate targeted commercial markets, rather than just participate. Second, they aim to create positive shareholder value through diversification. These are not easy. It is far easier to merely change the defense/commercial mix. Moreover, seeking to dominate the market disciplines a firm to achieve competitive leadership positions.

5. "I Can Do That" Syndrome

Too many efforts fail because aerospace/defense companies merely aspire to "me too" product/capability offerings with little or no visible incremental benefit to customers. Since most markets are already

populated with entrenched incumbents who are rarely short of capacity to meet market demand, the new entrant needs to explicitly target unmet needs and focus on bringing differential capability to those unmet needs. Otherwise, diversification is doomed to failure.

Overcoming incumbents also requires timing the entry to exploit unique discontinuities in the market which create a window for new entrants who can bring previously undervalued capabilities. GE's expansion into commercial jet engines is a good example (see Exhibit 3). They faced an entrenched and well-respected competitor, Pratt & Whitney, who held a near stranglehold on the existing market throughout the 1960s and early 1970s. P&W was the only supplier for most popular aircraft programs (Boeing 707, 727, 737, DC-8, DC-9), held the leading position in the emerging market for wide-body aircraft (B747, DC-10), and had the advantage of a large installed base. The established market positions proved fleeting, however, as technologies and market requirements changed. Deregulation made airlines focus on costs and competitive differentiation. A new aircraft producer, Airbus, provided an entry point. The evolution of hub structure made dispatch reliability a more important purchase criterion. Improved engine technologies led to the potential for vastly improved reliability. OPEC stimulated increased fuel prices (making fuel efficiency paramount), and

new wide-body aircraft provided an additional entry point for new engine types (reducing the value of the installed base of P&W engines).

Ironically, P&W's established product dominance made it difficult for them to capitalize on these changes, since high development costs tend to make self-obsolescence of current engine products look unattractive financially (when isolated from competitive issues). GE exploited these changes by developing business capabilities which were relevant in the new environment in which customers would respond favorably to improved product reliability and support, achievable through less complex product design and enhanced support capabilities. The results were impressive. Within a decade, GE assumed leadership from P&W and doubled revenues (after inflation), margins, and market share.

6. Daniel in the Lion's Den

Aerospace/defense firms have also underestimated and even ignored the competition they are likely to face in commercial markets, assuming either that they would overwhelm their competitors or that a new market would emerge (and that no additional entrants would be attracted). This approach typically is rooted in assumptions

about the relative strength and scale of military and commercial firms.

Many aerospace/defense products and process technologies are unique because the military/space customer can afford to spend enormous sums on their development. After all, a major aerospace/defense program may cost hundreds of millions — even billions — of dollars, and its life may extend over a period of ten to twenty years or more. Firms make major investments and develop large resources in engineering development, testing, and manufacturing to pursue such projects.

Exhibit 4 (below) illustrates how the market driving capabilities and low unit costs of the two major ceramic-packaging companies make entry into this market enormously difficult for a newcomer — even one with advanced ceramic and process technology skills.

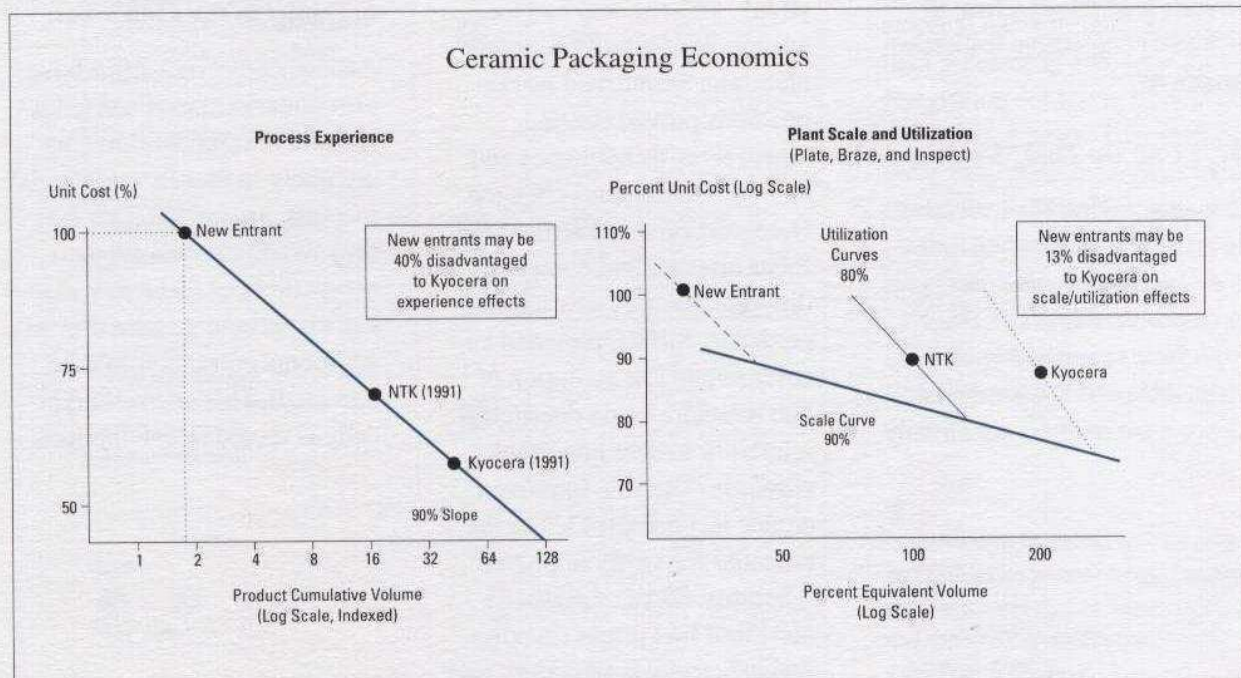
This is evident in the development of composite materials, computer architecture, semi-conductors, jet engines, avionics, and others.

In searching for commercial applications, prime and systems contractors in the aerospace/defense industry tend to look for very large markets, on a scale commensurate with the resources they already have in place. In other words, they look for commercial markets the size of the military markets they have served in the past — those with potential annual revenues of a half billion dollars or more.

Relatively few markets of this size exist, and those that are large enough typically consist of smaller segments with significantly differing characteristics. Furthermore, segments that are large enough present additional challenges.

The commercial industries where scale-sensitive technologies apply have most likely already evolved into an industrial structure dominated by a few major large-scale competitors. The commercial firms that have toiled in these markets typically are already formidable players with significant capabilities. Thus, the aerospace/defense firm contemplating entry into existing large, technology-based markets may be selecting markets with strong incumbents already advanced in engineering, manufacturing, and infrastructure. Plus, the incumbents' technology may be equivalent to, or even better than, that offered by the aerospace/defense firm. Entry by a newcomer becomes an extraordinarily daunting task in these cases.

Exhibit 4 illustrates this situation in electronic ceramic packaging. In a market with



several billions in annual revenues, employing advanced ceramic and process technology skills available to several aerospace/defense firms, the challenges of market entry are huge! Two major Japanese competitors control more than 85 percent of the worldwide market. As a result, they have unit costs far below those of potential new entrants and they have market driving capabilities in design, cycle time, and manufacturing. While this may leave some niches open, the majority of the market is intensely competitive and essentially foreclosed unless new technology comes along or one of the major players stumbles.

Likewise, Exhibit 5 shows the cost situation for suppliers of commercial aircraft structures. While military contractors may have superior technology (in composites, for instance), military producers may have much higher costs compared with commercial aircraft subcontractors.

These cost differences result from a combination of complex government regulations and low production volumes typical of aerospace/defense programs.

This creates a catch-22 for aerospace/defense firms:

- If a large market for applying aerospace technology currently exists, it is very likely dominated by strong incumbents, since the need for scale is inherent to the market and the technology.
- If an identifiable market does not exist, or is in an early growth stage, the aerospace/defense firm will need to help create it, forcing a shift in focus from technology and manufacturing — skills it may already have — toward softer skills, such as understanding commercial users' needs and gaining market access — skills it lacks.

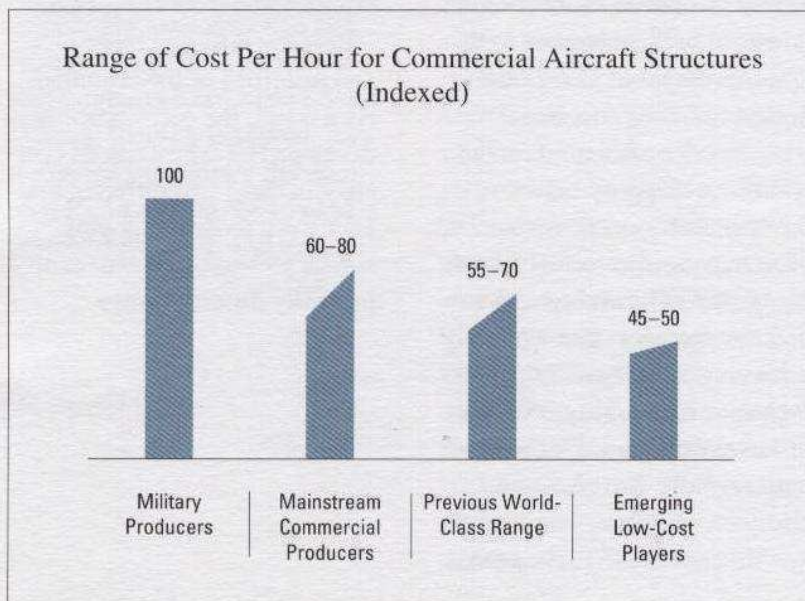
An aerospace company should realize that, by attempting to enter commercial markets by leveraging large resources in design technology and manu-

facturing, it most likely selects very tough competitors, and must make significant changes in its capabilities. Alternatively, the technology advantage of the aerospace firm must be very significant.

7. Sprinter's Mentality in a Marathon World

Some firms have sought diversification through large commercial acquisitions as a way of quickly changing the characteristics of the firm. While this approach helped in avoiding futile efforts to build commercial skills, it usually ran into significant challenges of post-merger integration. The breadth and diversity of the capabilities that these companies typically control make the task of integrating the two businesses very difficult.

A number of these acquisitions proved to be far more difficult than first imagined, producing disappointing commercial results. The purchase of Cessna by General Dynamics — and its subsequent recent sale — illustrates the challenges. A general aviation airplane builder must be sensitive to corporate business cycles and pay extraordinary attention to costs.



◀ Exhibit 5 (left) compares the cost differential between aerospace/defense firms and suppliers of commercial aircraft structures. Much of the difference results from a combination of complex governmental regulations and the low production volumes typical of military producers.

Managing in such an environment calls for skills different from those required in most aerospace/defense businesses.

On the other hand, firms committed for the long term can build commercial market leadership positions in major businesses through dogged, step-by-step efforts and thoughtful strategies, taking into account required cultural changes. GE's success in taking market share in the commercial jet-engine business from Pratt & Whitney is an excellent example.

Quick-hit strategies seldom work. More important, they can be disastrous financially, distracting management's attention away from more productive endeavors.

Diversification is a long, difficult journey, not a quick trip or sequence of exciting events characterized by large, bold acquisitions or easy entry into commercial markets. The preparation required is significant. The sense of urgency to diversify can lead to hasty planning, and even worse, buying what the investment bankers are selling, rather than making strategic, well-planned moves.

Commercial diversification requires a significant time horizon over which to build and evolve capabilities. Market selection and successful acquisitions can take three to five

years, while building a substantial commercial business can take ten, fifteen, or even twenty years. Too many failed attempts have been crafted with a belief that the task was easier and less challenging.

Understanding the Driving Factors

The failures of aerospace/defense firms to enter the commercial market are not merely the result of negligence. They are attributable to basic differences between customer requirements in the two markets — creating dramatic differences in required capabilities.

One important difference lies in the number and nature of customers in each market. Marketing in the aerospace/defense industry involves the federal government or a set of primes, subcontractors and various suppliers. Government buyers are few in number and powerful in dictating not only requirements, but also actual designs in many instances.

Another difference is the enormous disparity between the cost performance demands of military and commercial equipment. The aerospace/defense market is attuned to achieving high levels of performance and quality, with cost of lesser importance, at least until recently. Revolutionary changes occur from one weapon system generation to the next,

one satellite to the next, or one aircraft to the next, causing extremely long — ten- to twenty-year — development cycles. While engineering and manufacturing changes may be relatively frequent, significant changes in performance and technology occur infrequently.

Marketing in the aerospace/defense industry often carries an extraordinarily high risk — for example, a costly development effort leading to one winner and four or five losers. Each contract is too big to allow sufficient risk diversification. In most instances there are fewer opportunities and customers in the aerospace/defense business than in commercial markets. These create differences in the funding patterns: many aerospace/defense contractors expect and receive upfront developmental funding. In contrast, a commercial firm seldom receives any upfront funding from its customers.

Naturally, leaders in these two markets need to build organizational capabilities to reflect the different trade-offs and priorities of the customer. As a result, the core capabilities developed by organizations operating in these two different markets, even those employing similar technologies, will evolve in wildly different ways.

For example, the skills required to develop products responsive to a range of industrial and consumer market niches, with many customers with varying needs, are clearly different from those needed to bid on competitive procurements in the aerospace/defense industry. Vast differences exist between the skills required to develop a successful product line of consumer microwave ovens and those required to develop a set of advanced microwave components for extraordinarily demanding military/space applications.

Technology Development

Most aerospace/defense applications require the highest attainable performance of available technology. And the customer is willing to wait, sometimes even for years, to get it. Typically the aerospace/defense industry customer will conduct an extended development program at great cost to gain a step-function improvement in system performance. The customer can also dictate standards to which the entire industry must adhere. With national security involved, performance is naturally the dominant factor among the triad of performance, cost, and time.

While these priorities are shifting toward "highest performance at reasonable cost," the aerospace/defense customer typically is in the market infrequently and is very demanding.

This equation seldom applies in commercial markets. There, time-to-market and cost must be balanced against performance. Standards emerge from the interaction among participants of extended supply chains and the competition among alternative chains, rather than being dictated externally. And because commercial markets are driven by profit motivations rather than national security issues, industry players must develop incentives for end-users and other members of the supply chain to switch among competing architectures.

Technology breakthroughs do not ensure success in commercial markets as often as they do in aerospace/defense markets. In commercial businesses, leadership in innovation is difficult to sustain even with the advantages available through patent protection. Each new product generation, which may take less than a year and usually not longer than three years, reopens the competition. The parameters determining product/market leadership vary across markets and over time within given markets, making commercial technology management extraordinarily complex and dynamic. Plus, different combinations of market timing, cost, and quality can succeed in the same market, meaning different

firms can gain leadership positions in the same market, while deploying distinctly different capabilities.

For example, aerospace/defense firms typically produce a stream of high-performance products and services, which are embraced by customers in spite of their high inherent switching costs. A "value-based" strategy such as this is generally acceptable to military markets. However, pursuing this strategy in commercial markets would require high continuing investment. As a result, it is hard to find large commercial firms that consistently pursue this strategy successfully. (Sony attempted this until recently.) More often, this strategy is employed by small, entrepreneurial firms introducing "breakthrough" products — until success allows them to migrate to other strategies.

In an alternate competitive model, companies use an extended enterprise of suppliers, other innovators, subcontractors, and sometimes even other competitors to drive the adoption of new technology. In most cases, these are not the formal supplier/subcontractor arrangements typical of the aerospace/defense industry.

While many commercial high-technology markets are gravitating toward this type of

competition, it is all but non-existent in defense markets. The unique nature of the defense industry allows competitors to introduce revolutionary technology with little concern over the extended enterprise, since the customer has powerful influence in establishing standards. Therefore, aerospace/defense competition tends to breed value-based competition and fails to prepare industry players for the commercial world.

Product/Process Design

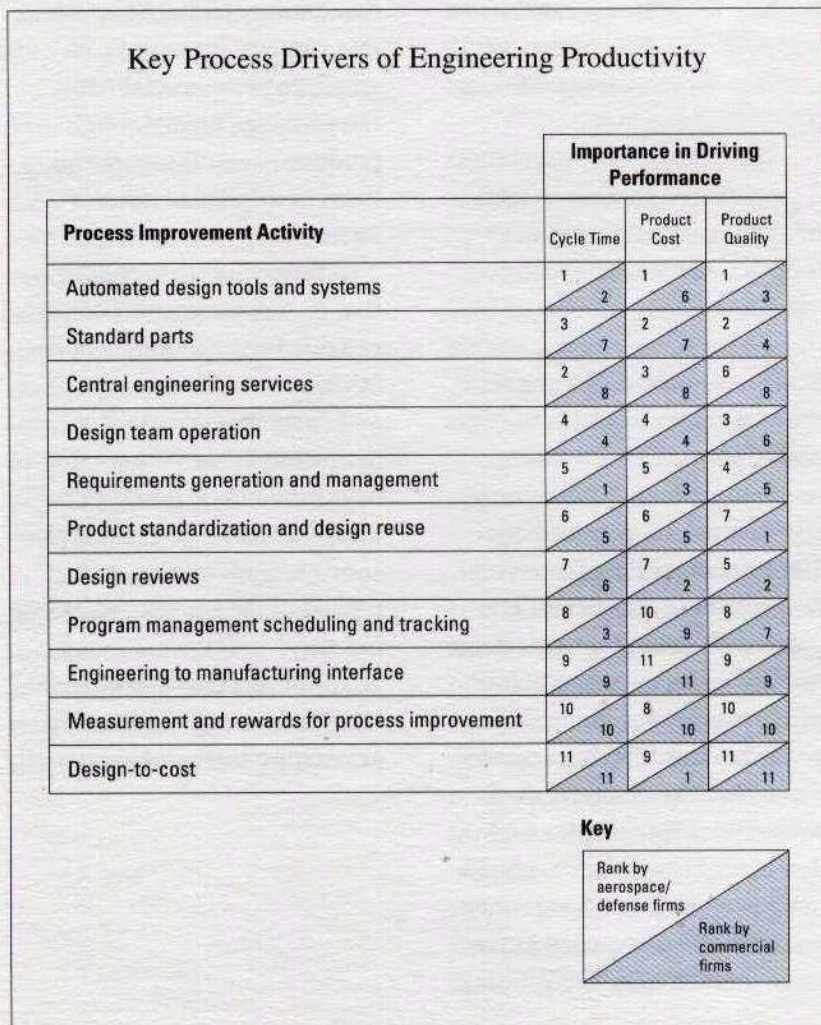
The differences in customer characteristics between aerospace/defense markets and commercial markets create significant differences in the engineering and design skills required to serve these markets.

Recently, eight aerospace/defense firms and four commercial firms participated in a project conducted by Booz-Allen & Hamilton. All the firms produce design-intensive, engineered products for electronics and/or electromechanical applications. The commercial firms included producers of consumer electron-

ics, power tools, home appliances, and medical instruments in the U.S. and Japan.

As illustrated in Exhibit 6, the techniques that best serve the commercial market tend to be quite different from those that best serve the aerospace/defense market. The commercial firms emphasized product standardization and design reuse to improve product quality. They ranked this factor first, as the most effective means to achieve product quality. The aerospace industry, on the other hand, ranked it seventh. Both use computer-aided design; aerospace firms ranked it the most effective means of reducing costs (and achieving quality and short cycle times), while commercial firms ranked computer-aided design sixth in impact on costs.

These differences suggest the need for defense firms to develop capabilities that are new to them. Throughout the engineering and manufacturing organizations there are many subtle, yet important, differences between the skills developed by aerospace/defense design/build



◀ **Exhibit 6 (left) illustrates how eight aerospace/defense firms and four commercial firms participating in a Booz-Allen & Hamilton project ranked various process-improvement activities in terms of their importance in driving engineering performance. For example, in the area of Cycle Time, Automated Design Tools and Systems was ranked first in importance by aerospace companies and second by non-aerospace companies.**

teams and those of commercial firms. While these differences vary by product line, it would be expected that the training, attitude, and experiences of engineers would be quite different in the two environments.

Market Access and Customer Interface

To illustrate the different requirements the two markets place on market access capabilities, one can cite the instance of an aerospace/defense firm that developed a truly advanced, three-dimensional computer-design tool for in-house use. Recognizing the potential that this product might have in commercial markets, the firm conducted a thorough competitive study. It found that its product was far more advanced than any other available in the commercial market. The firm concluded that, if introduced within two years, the product could be a major commercial success.

The company began a two-year development effort to create one of the world's best 3-D design systems. The development effort consumed many millions of dollars and extended over a three-year period, "only" a year longer than originally envisioned. Little attention was paid to the external market during this period. Of the roughly 75 people assigned to the project,

only two were assigned to market- or customer-related tasks. Virtually no one monitored competitors' activities.

When the company once again consulted potential commercial customers, it learned that other competitors had already introduced less capable, but workable, products. The competitors had developed an installed user base, which was already generating revenues and, more important, customer loyalty. In addition, two of the competitors were about to introduce second-generation products with capabilities similar to the company's more advanced product.

The aerospace/defense firm had missed out on changes in the market and the competitive structure of the industry. It had missed the importance of introducing a simpler product at an earlier date as a means of building customer access, capturing a position in the commercial market, and establishing the architecture.

Aerospace/defense firms are conditioned to long development cycles leading to production runs once the product is deemed acceptable. On the other hand, commercial firms need to continuously serve their customer base by introducing new products at regular and reasonably short intervals, while building and sustaining their revenues throughout that time period.

Success in commercial markets requires building and sustaining a presence in order

to learn the market, update the information periodically, and use that information to tailor the development program to fit evolving requirements. Unfortunately, the aerospace/defense industry does not demand this skill, which suggests that industry players have a substantial need for new learning and new experience.

Operations

Differences in customer characteristics lead to different measures of success in military and commercial businesses, and thus significant operational differences — for instance, in the areas of volume and product complexity.

The aerospace/defense industry has relatively low production volumes, frequent changes, and high levels of complexity in product mix. For example, advanced military satellites, advanced development aircraft, and some command/control systems are practically one of a kind. Even in the few relatively "high-volume" markets — such as munitions and military semiconductor components — production volumes seldom approach those achieved in commercial markets.

Printed circuit boards (PCBs), used in both commercial and military applications, are an example of complexity differences. Annual production

runs for commercial PCBs may be in the range of millions of units. In contrast, military annual production runs of PCBs may only number in the thousands or less. A single military plant may produce a thousand or more board designs, whereas in the commercial world a given plant may produce only a handful of production designs. These differences pose significant implications for operations and cost performance (see Exhibit 7). Finally, aerospace/defense products often undergo a constant stream of refinements, often making every unit unique. Commercial product designs, in contrast, are typically frozen for production, and refinements are handled as block upgrades.

Differences in volumes, product mix, and product complexity translate into significant differences in operations strategies between commercial and aerospace/defense businesses. Materials and inventory management techniques suited to one production environment are usually ill-suited for the other. Likewise, material-flows on the plant floor, selection of equipment and tooling, part supply policies, and inspection techniques can all take very different forms in the two environments. Consequently, underlying management processes and systems also vary dramatically. Substantial changes and worker retraining are usually needed to adapt aerospace/defense production facilities to commercial use.

Guidelines for Successful Diversification

To diversify successfully, an aerospace/defense firm must identify opportunities that pass four key "screening criteria":

- Does the opportunity build on a set of market driving capabilities?
- Can the necessary complementary skills be attained?
- Will the resultant organization be strong enough?
- Will the venture create shareholder value?

Leveraging Market Driving Capabilities

The capability most aerospace/defense firms can bring to commercial markets is technology. Firms seeking to diversify in the commercial markets will have few, if any, capabilities in such areas as customer access, distribution, and service. Even manufacturing assets may be geared to requirements quite different from those demanded by commercial markets.

To succeed in commercial markets, the technology possessed by the aerospace/defense firm must meet a tough standard. Namely, it should be "revolutionary" when applied to commercial markets and have the potential for satisfying targeted, currently unmet needs. The core technology should be able to achieve market leadership — as in the successful diversification cases of computing, nuclear energy, and jet-

engine technologies. "Me too" technology or simply an alternative technical solution to those already available commercially will probably doom the effort to failure.

Some aerospace/defense firms may bring capabilities other than technology, such as managing large, complex projects (e.g., the space shuttle); maintaining complex equipment (e.g., jet-engine service and repair); managing large, complex information systems (e.g., Lockheed's vehicle citation processing); as well as managing large manpower bases of skilled and semi-skilled staff and technicians (e.g., Raytheon in the engineering construction business or Lockheed in the airport management business). The majority of firms, however, should pick commercial opportunities based primarily on technology fit, rather than on the scale or complexity of the projects to be managed.

Developing Complementary Capabilities

Managers of aerospace/defense firms should target no less than world-class performance in those capabilities that lie outside

their technological expertise. Otherwise, even potentially revolutionary technology will not reach the market in time or in a form to be profitable.

The ability of management to construct an efficient and timely method to acquire the set of complementary capabilities required to pursue commercial markets should thus be a key "screening criterion" in evaluating potential diversification opportunities. All forms of "acquisition" should be examined, including joint ventures, licenses, strategic alliances, minority investments, and outright acquisitions.

Structuring a Strong Organization

Aerospace/defense and commercial businesses do not mix well. Virtually every aerospace/

defense firm that serves both markets has concluded that separate and distinct organizations are needed. To succeed in the long run, a firm must move toward separation of the defense and commercial businesses. Significant differences in accounting procedures, cycle times, cost/performance trade-offs, and other factors point clearly toward the need to build separate organizations, cultures, and management procedures.

The primary exception to this is the commercial aircraft business, where similar demand characteristics allow many suppliers to serve both commercial aviation and military aircraft needs from the same organization.

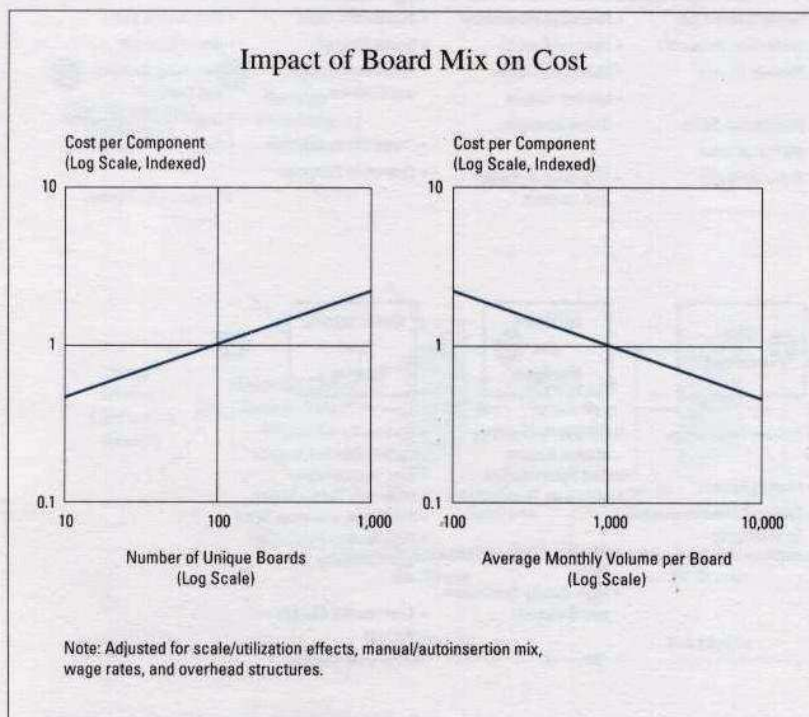
However, as a rule an organization should be structured to maintain the unique

characteristics of each business while supporting the sharing and exchange of core capabilities. Unless such a structure is politically and culturally feasible, diversification will fail to achieve its objectives.

Creating Shareholder Value

The ultimate test of commercial diversification is creating shareholder value over the long run. It is not enough to rebalance the firm's portfolio between defense and commercial activities. The move into commercial markets must build positive shareholder value.

Successfully completing a major acquisition is a challenge in today's environment, given the reduced market prices of aerospace/defense stocks and the relatively higher prices of most commercial technology-based businesses. Premiums of 25 to 50 percent over market price will need to be paid. Successful firms may sell at two or three times book value. The acquiring company should identify clearly the means for paying back the premium and contributing positively to shareholder value. As a result, alliances, joint ventures, and



◀ **Exhibit 7 (left) shows the cost implications for military plants of producing relatively low volumes of printed circuit boards.**

minority interests may dominate the initial steps of a successful diversification program.

In addition, investments in commercial markets may depress earnings and share prices during the early years of investment. While management may hope otherwise, this near-term effect may be unavoidable. The onus is on management to communicate with the investment community and to structure the

Exhibit 8 (below) charts GE's capabilities-driven approach to expansion. At each stage the company leveraged existing capabilities and built new ones based on the needs of the new business.

diversification in a fashion that clearly demonstrates the potential for creating economic value.

Management Implications

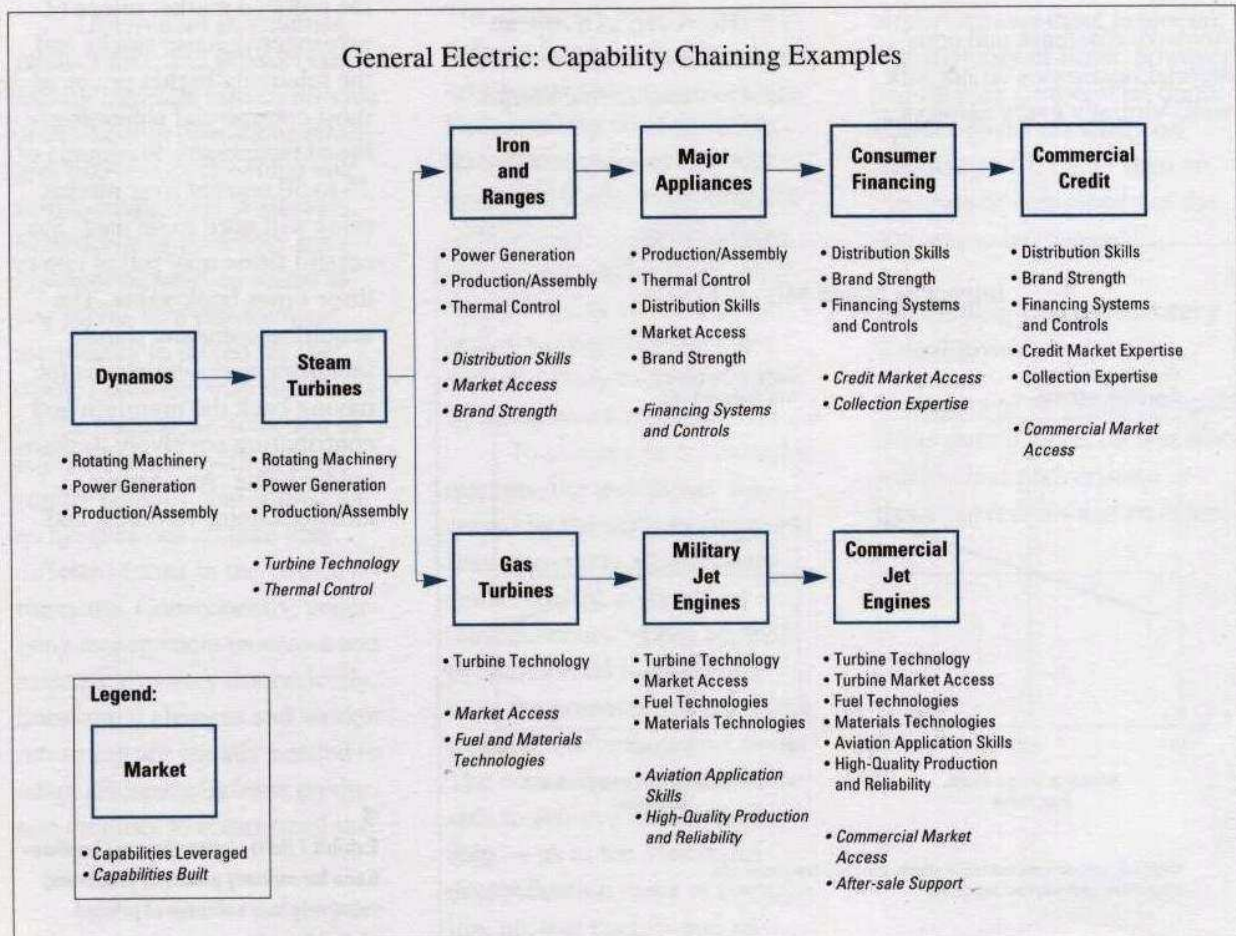
Once a set of diversification opportunities has been identified, top management of aerospace/defense firms should:

- Plan for the long term
- Commit to step changes
- Actively evolve the organization
- Lead the effort

Plan for the Long Term

Aerospace/defense firms that have successfully rebalanced their portfolios through commercial businesses include Hughes and GE in the commercial satellite business, TRW in the information-systems business, and Boeing in the commercial aircraft business. In each instance, success could not be measured in a few — even five or ten — years. The effort took many years and a number of strategic moves.

General Electric (see Exhibit 8) is an excellent example of how a capabilities-driven



approach to expansion can be effective when applied over a long time frame. At each stage, GE leveraged existing capabilities while building additional capabilities required by the new business. Focusing on capabilities rather than markets allowed GE to proceed without knowing where it would finally lead — when lamps and dynamos were the sole business, entry into the jet-engine and credit markets was not contemplated. Focusing on capabilities allowed GE to expand one step at a time, yet be remarkably successful.

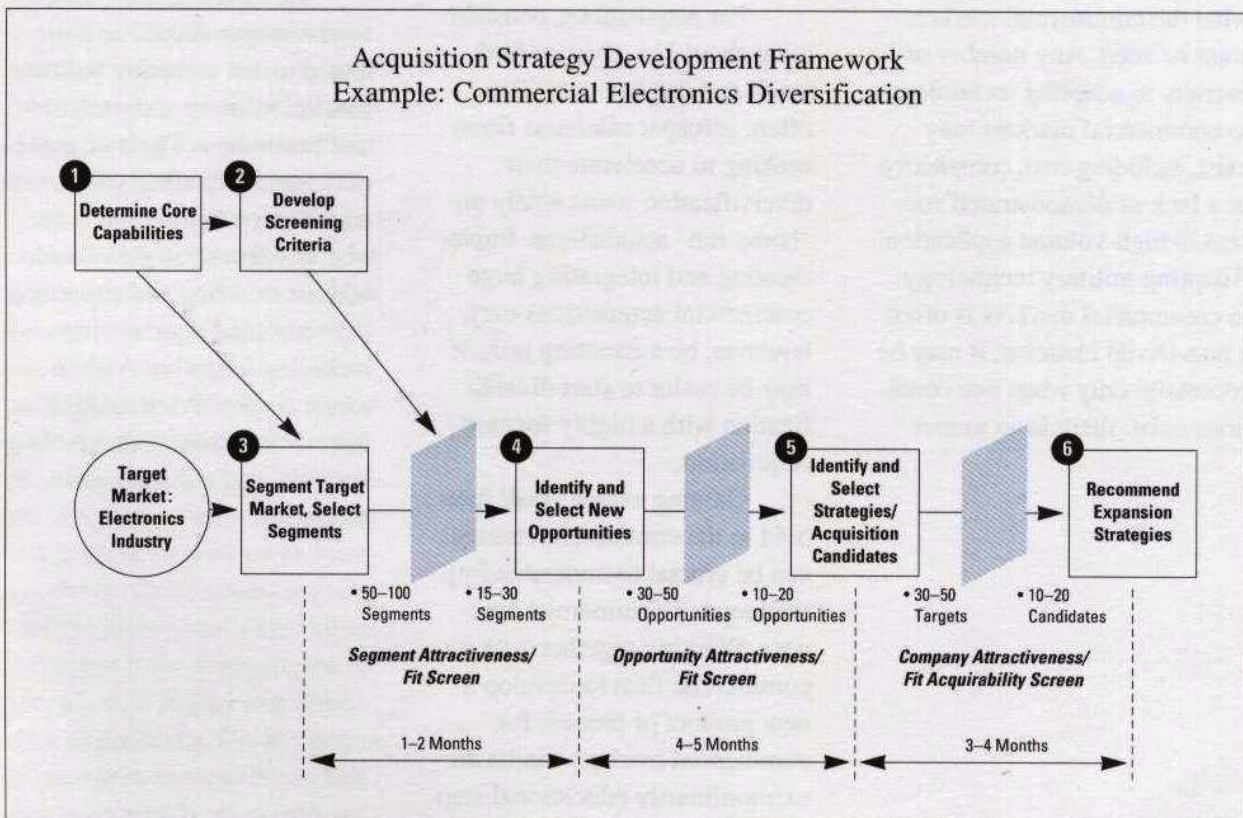
Exhibit 9 (below) shows the process for reviewing primary commercial markets for diversification potential. Completing a diversification plan can take a year or more. There are few shortcuts.

Successes such as GE's are characterized by "the chaining strategy." This approach pursues a broad market opportunity through a long-term series of gradual, incremental steps aimed at building the capabilities required to lead the market. It requires careful planning, consistency of purpose and vision, adequate funding, and the deep involvement of top management — a total commitment on the part of the firm.

Completing a plan for diversification could easily take a year. Starting from scratch, the process might look like that illustrated in Exhibit 9. The process starts with a review of the firm's core capabilities, possibly conducted parallel to a review of the commercial

markets of primary interest to management. It then proceeds through a series of industry/market screens, resulting in the identification of specific target markets. Finally, entry strategies are developed to define the approaches, the resources required, and the alliances or acquisitions necessary to enter the targeted markets. Such an effort demands considerable amounts of talent and time by top management. There are few shortcuts.

Diversification should be an ongoing process — continuously updated and reiterated to develop the required set of capabilities and to react to changing market and competitive conditions. The task will not be accomplished easily or within



a few steps. More than one false start may occur in the initial efforts to commercialize the business portfolio.

Commit to Step Changes

Invariably, an objective assessment of an aerospace/defense firm's capabilities shows major gaps when viewed from the perspective of commercial markets. Top management should realize that step changes will be required to address these deficiencies. The most successful firms will honestly and objectively rate their capabilities, assess their weaknesses, and develop strategies for strengthening them.

For example, while advanced designs and processes may well represent the leading edge in aerospace/defense technology, they are not necessarily what the commercial markets want or need. Any number of barriers to adapting technology to commercial markets may exist, including cost, complexity, or a lack of demonstrated success in high-volume application. Adapting military technology to commercial markets is often a non-trivial exercise; it may be successful only when two conditions exist: there is an unmet

need that the technology can resolve, and the potential exists to bring down the cost.

The key is to conduct the necessary market investigations to identify the new capabilities necessary to pursue the commercial opportunity, and to commit the organization to undergo the significant change required to develop or acquire them.

Actively Evolve the Organization

Identified capability gaps must be filled by some means, whether through internal development, strategic alliances, licensing, or joint ventures and/or acquisitions. In virtually all cases, the firm seeking to diversify into commercial markets must consider all options for building and strengthening the key capabilities.

For acquisitions, consideration should be given to both small and large targets. Too often, aerospace/defense firms seeking to accelerate their diversification focus solely on "home-run" acquisitions. Implementing and integrating large commercial acquisitions may, however, be a daunting task. It may be easier to start diversification with a highly focused acquisition.

Gaining even a small foothold in the commercial market can be crucial to understanding the targeted commercial business. Working together with a commercial firm to develop a new product or process for commercial markets can be an extraordinarily educational step

for the aerospace/defense firm. As understanding of the new market is gained, the firm also gains the competence and confidence for moving out against a medium or large acquisition. A major acquisition might be more appropriate as a third, fourth, or fifth step.

Firms that will succeed in commercial markets will approach every strategic alliance or acquisition opportunity as another learning experience and an integral part of a long-term "chaining" strategy.

The transition should involve bringing on board good commercial management and technical skills. Even a few key people can change the character of a firm. Empowering a few insiders and adding fresh, commercially adept talent can help build a successful business.

However, significant cultural changes should be anticipated as the company builds parallel military and commercial businesses. These changes may adversely affect employee retention on both sides. A set of consistent strategies should address building and sustaining the combined organization — including incentive systems, career tracks, overhead structures, information and reporting systems, and management processes.

Lead the Effort

Aerospace/defense firms that diversify successfully need top-down leadership. While the strategic alliances, licensing opportunities, and commercial market investigations can be pursued at all levels, major opportunities must be driven from the top to avoid duplication of effort and confusion.

Few firms have succeeded by dispersing commercialization responsibilities throughout the organization. Successful firms typically couple centralized authority and leadership with empowered "champions" throughout the organization to search out and initiate commercial market opportunities. "Everybody out for a pass" typically does not result in touchdowns.

The shrinking worldwide aerospace/defense industry will force change — massive consolidation among the survivors and increasing pressures to seek diversification opportunities in commercial markets. While most commercial diversifications have been unsuccessful, some successes have emerged — such as Hughes and GE. These firms have demonstrated that careful planning, well-crafted strategies, and long-term commitment can bring about significant and successful diversifications in commercial businesses. Other firms can achieve the same degree of success only if they learn from these experiences. The key points to remember are that diversification is invariably an enormous

undertaking; the path is rocky and long, and quite often unsuccessful; and when successful, it calls for dramatic changes in the company's capabilities and the way they are managed.

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