Commercialization of Defense Technology:

The Key Success Factors

By

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Note: *This page is an excerpt from a Chapter* in the book **Regional Resilience and Defense Conversion: Research in Urban Economics, Volume II**, pg. 31-53, copyright and published in December, 1997 by JAI Press (now Elsevier). For a copy of the book contact Elsevier

Summary

Commercializing defense technology is a worthwhile activity for defense companies. There are many examples of successful projects that produced innovative solutions for customers in commercial markets. There are also many examples of projects that were not successful.

As a result of two national surveys (one in 1988 and another in 1991) as well as twenty five years of experience in working with the managements of defense firms as they wrestled with commercialization projects, we concluded that there are a set of **Key Success Factors**. To be successful in commercializing technology, defense firms must have:

1. a *commercializable* technology base; there needs to be some inherent opportunities upon which the firm can build a commercial operation; for example, a B-2 bomber does not have a commercial market, but some of the materials used in its construction may have commercial applications.

2. strong top management support; without it there is little chance a commercial project will succeed due to the many internal barriers that will develop; the message may be overt or subtle, but top management's views about commercializing technology become well known throughout the organization;

3. a well balanced (in skills) task force; a deep understanding of commercial skills in product design and development, manufacturing engineering, manufacturing, marketing/sales and distribution are required along with the knowledge of the commercializable technology; sometimes parts of this understanding come from a sister division, or it could also come from a Strategic Partner;

4. the resources, or access to the resources, internal or external, to *implement* the development, manufacture and distribute a *differentiated* commercial product; having the means to access and serve commercial markets will take a significant investment in time and funds if the company is now serving primarily defense markets.

With these capabilities, *25% of the respondents to our surveys of the U.S. defense industry indicated that they produced successful commercial products*. This implies that 75% were not successful because they did not meet one or more of the Key Success Factors.

Some people take this result to imply that most defense companies can convert to non-defense businesses when the cycle of government spending declines. *We show in this paper, **however**, that large scale conversion of defense companies to non-defense businesses **is not likely**.*

Introduction

The U.S. defense industry is cyclical and always has been. It is dependent on the performance of the economy, but only as a second order effect. Its primary driver is the degree of the Federal government's perception of the risks faced by the country. During war time, government spending on defense is no object. During the Cold War, however, the defense budget was much more restrained and went through cycles depending upon the party in power. With the end of the Cold War, many in Congress wanted to reap the "Peace Dividend". The Defense Industry, as a result, suffered a major decline in funding the effects of which are still being felt.

As a result of these characteristics, the Defense Industry has always had to deal with surges and declines in government spending and the impact that these changes had on its core businesses. During downturns in spending, such as the early seventies when the Viet Nam war was winding down and at the end of the Cold War in the late eighties and early nineties, companies considered how they could lessen the risk of dependence on the Federal budget. Various strategies evolved including moving into non-defense businesses. As a result of these experiences, many lessons have been learned by the industry on what works and what does not work.

Many factions, inside and outside of the government, also saw the end of the Cold War as an opportunity to "convert" the defense industry to non-defense products. The

focus of this chapter is the commercialization of defense technology and its role in defense industry "conversion".

After many years of working with defense companies of all sizes, and conducting two national surveys of the Defense Industry on the subject of commercialization and conversion, *we concluded that it is **not** possible for a company of significant size that is primarily in the defense business to convert to primarily non defense businesses.* There are, of course, exceptions to the rule. Some s*maller* companies (under $50 million in annual revenues) have been able to make the conversion where their technology base had significant commercial applications. Galileo Electroptics, based in Sturbridge, Massachusetts, is an example. Some large companies (more than $100 million in annual revenues) that started to make the conversion in the late sixties have become almost all non-defense after thirty years of *acquisitions* of non-defense businesses and *divestments or abandonments of their defense businesses*. E.G. & G., based in Wellesley, Massachusetts, is an example of this type of firm. In 1970, E.G.& G was about $200 million in revenue and almost 100% involved in defense markets. The company was a major provider of products and services for the U.S. nuclear weapon programs. With the downturn in defense spending during the early seventies, the management started a program to diversify into commercial businesses. They made a few unsuccessful attempts at commercializing their technology. For example, in their defense work they developed a fast rise time oscilloscope for use in nuclear weapons research. It was technically superior to the commercial products then available from Tektronix. With an internal project, they tried to design a commercial version. After significant effort, the E.G.&G commercial oscilloscope was very difficult to operate and was never sold in any significant quantities.

The management of E.G. & G then determined that the easiest and fastest way to diversify was *to acquire* commercial companies. (This was a common conclusion reached by many defense firms). They started a major program to buy a mix of commercial, technically based businesses. Today, E.G. & G. is about $1.5 billion in revenue. By divesting or shutting down various defense activities, the company now receives less than 30% of its total revenue from defense sales.

*There are no examples of large businesses converting to non defense "quickly" (less than 10 years) **or** through the commercialization of their defense technologies.* ***Commercializing defense technology, on the other hand, is a viable economic alternative for most defense companies.*** While not the way to save companies from a significant decline in defense spending, it does mitigate the effects of the decline. This commercialized defense technology aids the economy in many ways and is well worthwhile for companies and Federal and State governments to support. Lessons have been learned over the years about the Key Success Factors for commercialization. *We cover that topic as the focus of this chapter.*

Results of the defense industry surveys

For companies considering a serious effort to diversify their defense business, three key questions arise:

1. What is the success rate for companies who diversify by commercializing their defense technologies?

2. For those companies that were successful, how did they do it?

3. For those companies that were not successful - what went wrong?

The answers to these questions emerged from our surveys and corroborated our experience in working with defense firms on their commercialization efforts.

Commercialization Success Rates

First, we looked at the success rates for companies that tried to commercialize their defense technologies. Our survey in 1991 had 148 respondents with combined defense sales of $115 billion, a significant share of the total market. 71% of the respondents said that they *studied the possibility* of commercializing their defense technology and 29% did not consider the idea. Of the group that studied commercialization:

73% did bring a commercial product to market

27% did not commercialize their technology

For the products that did go to market:

48% were said to be an overall success by the respondents

52% were not an overall success - although many were partial successes

Putting the results in the context of the total sample of 148 respondents:

52% did try to develop a commercial product based on their defense technology;

25% did commercialize a product and said that the effort *was an overall success;*

27% commercialized a product and said the effort was not an overall success, with many terming the effort a partial success.

The Key Success Factors for Commercializing Defense Technology

In our surveys of the U.S. defense industry, we asked our respondents their opinion about the Key Success Factors. These were the skills, resources, company

characteristics, etc. that contributed in a positive way to the overall success of the project. There were four capabilities that emerged that a company must have to be successful:

1. *a commercializable technology base*

2. *strong top management support*

3. *a well balanced (in skills) task force*

4. *the resources, internal or external, to develop a differentiated product.*

We will look at each of these factors in detail to explain what they mean.

Commercializable Technology Base

The first requirement of success is to have a commercializable technology base. It is obvious that total, dedicated defense systems such as the Sea Wolf submarine or an F-22 fighter aircraft by themselves do not have commercial applications. The companies that manufacture them, General Dynamics and Lockheed-Martin, would have to look elsewhere to find commercializable technologies. For example, some of the components and subsystems used on the Sea Wolf and F-22 can be used in commercial equipment with either a technical and/or cost advantage compared to existing products. The first requirement of success is to have a commercializable technology base. It is obvious that total, dedicated defense systems such as the Sea Wolf submarine or an F-22 fighter aircraft by themselves do not have commercial applications. The companies that manufacture them, General Dynamics and Lockheed-Martin, would have to look elsewhere to find commercializable technologies. For example, some of the components and subsystems used on the Sea Wolf and F-22 can be used in commercial equipment with either a technical and/or cost advantage compared to existing products.

One example of a company that produces products for both the Sea wolf submarine and the F-22 fighter is G&H Technology (G&H) of Camarillo, California. G&H was able to take these applications and turn them into useful commercial products. The background of the development is instructive.

Out of the military's interest in protecting their electronics from the strong electromagnetic pulse that is emitted from a nuclear weapon, G&H developed and patented a unique material that they call PULSE-GUARD® . The properties of this material are that it is a very high resistance insulator under normal conditions. When the material is subjected to a strong electric field, however, it quickly (less than one billionth of a second) turns into a conductor. This material was used in military electronic systems to protect against the fast rise time, nuclear magnetic pulses by conducting away to ground the energy from the pulse before it entered the sensitive electronics.

With the end of the Cold War, G&H searched for other applications that could use the unique material. In the defense area, protection of highly sensitive integrated circuits against electrostatic discharge (ESD) emerged as a need. The PULSE-GUARD® material was used by the Navy on the Sea Wolf submarine to protect its electronics from ESD threats.

This lead G&H to look for commercial ESD protection applications. They developed a new product that is a flexible circuit incorporating the PULSE-GUARD® material and which fits in a standard commercial connector. G&H recognized that they did not have the capability to manufacture the device at high volume and low cost; nor did it have the distribution system necessary to achieve a significant market penetration. For this reason, they chose to form a Strategic Partnership with a company that had the requisite skills. This device is now being sold broadly in the U.S. and in Europe for many commercial applications including computers, medical and telecommunications equipment.

G&H also supplies a connector used on the F-22. This connector must be protected against a lightning strike. The PULSE-GUARD® material is also planned to be used for this application. The function is the same, to conduct away the energy associated with the secondary effects of a lightning strike before it damages the electronics. The difference is in the form and amount of energy in the pulse. It is much larger and longer in time that with an ESD event. The PULSE-GUARD® material can handle the higher energy easily. This led G&H to explore similar applications in an industrial environment. For example, a PULSE-GUARD® device can be used to protect industrial equipment against secondary lightning events; or to stop the strong energy pulse associated with the starting of large industrial electric motors before the pulse can damage other equipment.

G&H's Strategic Partner for the ESD product will also exploit the high energy capabilities of the technology. Again, the manufacturing process and the distribution system are dramatically different than found in G&H.

These examples provide a related but equally important success factor. Most defense companies are focused on the skills necessary to be successful in the defense industry. These skills are usually not coincident with those that are required to be successful in commercial businesses. Not recognizing this fact is a major cause of failure in commercializing defense technology. We discuss a related issue in the section, a **Well Balanced Team**.. Most defense companies are focused on the skills necessary to be successful in the defense industry. These skills are usually not coincident with those that are required to be successful in commercial businesses. Not recognizing this fact is a major cause of failure in commercializing defense technology. We discuss a related issue in the section, a **Well Balanced** Team. These examples provide a related but equally important success factor. Most defense companies are focused on the skills necessary to be successful in the defense industry. These skills are usually not coincident with those that are required to be successful in commercial businesses. Not recognizing this fact is a major cause of

failure in commercializing defense technology. We discuss a related issue in the section, a **Well Balanced Team**.

There are many other examples of commercializable technologies that have emerged out of defense products. Advanced composite materials were developed for aircraft applications. They are now used extensively in sporting goods for light weight tennis racquets and golf clubs, in automobiles for strong but light weight components, bridges and other structures. In most cases, it is not the defense companies that are exploiting the technologies, but well positioned commercial companies.

The U.S. government spent billions of dollars putting a series of satellites into high earth orbit for use in a Global Positioning System (GPS). The primary intent was to allow the military to accurately identify the location on the surface of the earth of their targets, personnel and equipment. Associated aircraft, ship and earth based equipment was developed by such companies as Raytheon and Trimble to take the satellite signals and convert them into a position.

Over the last several years numerous commercial applications for this equipment has emerged and is being exploited by largely commercial operations. Automobiles incorporate the systems for guidance to their destinations. Truck, taxi, police and emergency vehicle fleets use the system to track and direct their operators. Yachtsmen are extensive users of related equipment to navigate the oceans and waterways.

The conclusion of this section is that the first requirement for a successful commercialization program is that a defense company must have technologies in its base that have the potential for commercial applications. This is typically the starting point for companies that want to study the possibility of developing such products. The first step, therefore, in a commercial diversification program is to study the technology base and compare it to opportunities in commercial markets. As we will discuss in the **Well Balanced Team** section, at this stage it is crucial to have people on the commercialization team who both understand the technologies and others who have knowledge of commercial markets and how they operate. The conclusion of this section is that the first requirement for a successful commercialization program is that a defense company must have technologies in its base that have the potential for commercial applications. This is typically the starting point for companies that want to study the possibility of developing such products. The first step, therefore, in a commercial diversification program is to study the technology base and compare it to opportunities in commercial markets. As we will discuss in the **Well Balanced Team** section, at this stage it is crucial to have people on the commercialization team who both understand the technologies and others who have knowledge of commercial markets and how they operate. The conclusion of this section is that the first requirement for a successful commercialization program is that a defense company must have technologies in its base that have the potential for commercial applications. This is typically the starting point for companies that want to study the possibility of developing such products. The first step, therefore, in a commercial

diversification program is to study the technology base and compare it to opportunities in commercial markets. As we will discuss in the **Well Balanced Team** section, at this stage it is crucial to have people on the commercialization team who both understand the technologies and others who have knowledge of commercial markets and how they operate.

Strong Top Management Support

In most of the defense companies that responded to our survey, the search for commercial product opportunities was focused at the Division level. It was very clear to our respondents that top management at the corporate level must be completely in favor of any program to diversify or it will be doomed to failure. If top management are not behind the effort then the incentives and controls in the organization will be aimed at achieving other goals. Even worse, there will be significant barriers to success.

A corollary to having strong top management support is for the commercialization team to maintain proper and constant communications with top management. From our experience, if the commercialization team did not obtain agreement with top management at each key decision point, the probability was large that top management would disagree eventually with the direction that the program took and this could result in its *unsuccessful* conclusion.

A good example of this problem occurred during one of our early consulting engagements for commercialization. We were working with the president of a subsidiary of a large manufacturer of electronics components. The subsidiary was engaged in manufacturing high reliability relays for aerospace/defense applications. The time of the assignment was coincident with the defense spending downturn after the Viet Nam war. The objective of the engagement was to assist the client to commercialize its defense technology.

After a year of working with the commercial diversification team within our client company, we had identified a new product based on the company's core defense technologies and that had significant market potential. To commercialize the development, it was decided that the best approach was to acquire a commercial company in a similar business and then transfer the technology into that company.

We launched a search for the commercial company and found one that was privately held and willing to discuss being acquired by our client. We arranged a meeting between our client and the CEO of the target company. The purpose was to launch the negotiation. A few days before the meeting I received a call from my client. He said he brought the whole project up with the CEO of his parent company and was shot down. He had not kept the CEO fully informed at each step of the way and learned late in the game that the CEO did not want his company to even be in the business area selected by the commercialization team, let alone acquire a company

already in the field. The negotiation for the acquisition was, therefore, unnecessary and had to be cancelled.

A Well Balanced Team

It is critical to have a well balanced team to plan and implement a commercialization program. Our respondents indicated that the *organizational factor* primarily responsible for a lack of success was the absence of such a group. This group could be a skilled in-house team composed of scientists and engineers conversant with the technology and members of an existing commercial business unit within the defense company that had the experience to understand the needs of the commercial markets and how to serve them.

Related factors reported by the respondents as causes for failures were the lack of a full analysis of commercial market needs and the development of an effective market penetration strategy. Clearly, without the appropriate people who understand both the technology and market requirement, these types of mistakes are bound to be made.

If a defense company does not have in-house staff who have commercial experience, other sources of such talents can be found in consultants or Strategic Partners. As previously outlined, in the case of G&H Technology, they used both. The consultants worked with the internal team. The possibilities for commercial products were delineated and evaluated. The top priority opportunities were then studied in depth for their commercial viability. The best ideas were then rounded out with more detailed product concepts that fit particular market needs. At this point, the consultants identified an appropriate Strategic Partner to help G&H bring the products to market. The partnership was formed and the products launched successfully.

A Differentiated Product

Finally, to be successful, the team must come up with a differentiated product that has significant technical and/or economic advantages. An example of such a product is G&H Technologies surge suppressor, PULSE-GUARD that was used on the Sea Wolf submarine. The product has significant technical and economic advantages in several commercial applications. Competitive technologies are Metal Oxide Varistors (MOVs) and Transient Voltage Suppression (TVS) Diodes. Both types of products can stop the ESD pulse, but they only protect one line at a time, have a relatively high capacitance and are mounted on the PC board taking up valuable "real estate". PULSE-GUARD , on the other hand, is applied to all lines in the circuit instead of one at a time; has a significantly lower capacitance which is critical for high speed data applications; does not deteriorate after experiencing a number of pulses as do MOVs; and does not take up any board space which is critical in many small package applications like hand held computers.

In summary, a differentiated product is necessary to develop an effective market penetration strategy. The product can be positioned against standard products by highlighting its advantages. Premium pricing is also generally available because of the desirable features over standard technologies. With such advantages, the chances for commercial success are high. Without them, the new product would be "me too" and have difficulty in penetrating against established brands.

What Went Wrong?

For companies that did not have an overall success in our surveys, we asked what were major things that went wrong.. As one might expect, the factors that surfaced were the inverse of many of the key success factors.

The primary problem causing failure was the lack of commercial market experience on the team. As a result, the commercial markets were not properly analyzed; a well differentiated product that met market needs was not developed; an effective entry strategy was not implemented; and they did not have the ability to design and manufacture a product to commercial specifications and prices.

Another major cause of lack of success was not having top management support for the commercialization project. Many company top executives, such as those quoted elsewhere in this chapter, have been in the industry long enough to have gone through one or more down cycles. During those periods they may have experienced attempts in their companies to diversify into commercial markets and saw many of the problems. As a result, they developed strong personal views about the viability of such efforts. They may allow new efforts to be undertaken, but they don't provide their full backing to the project. As a result, the signals are read by the organization, incentives were not aligned and barriers went up.

There are numerous examples of commercialization approaches that made it to the market, but were not successful in the long run. Some well known failures include the Grumman Company's attempt to provide buses for urban applications; and Boeing/Vertol's light rail vehicle business. Both companies lost considerable amounts of money because they tried to make commercial products with aerospace/defense operations. General Dynamics made a similar mistake when it undertook a contract for the Massachusetts Water Resources Authority to manufacture a waste treatment system. They are a manufacturer of Navy vessels and were not set up to manufacture such a system economically.

The Time to Build a Non-Defense Business

In our survey, we asked our respondents how long it took them to bring a product to market. 44% took over one year to study if they could develop a commercial product and get into the business. 65% took more than another year to actually bring the product to market. A reasonable assumption, therefore, is that a defense company

that is just starting to consider a similar project should expect to take at least two years from the start of the program before they get to the market.

To envision the impact of a successful commercialization project on a company, we can consider a fictional but realistic example. Company A is $100 million in sales and is selling primarily to defense markets. With the downturn in the industry, the defense sales of Company A are declining at 10% per year. Two years ago, the company knew it would be losing defense business and launched a commercialization project. The search was successful and the commercial product entered its market two years later. It was very successful and its first year's sales were $10 million or 10% of the existing defense business. After entry, the sales grew at 30% per year for the next several years. A very successful product launch and commercialization success story.

Without the new product, Company A's sales would have declined from $100 million to $66 million in 5 years. With the very successful new product, sales declined form $110 million to $95 million in five years. This is a better result for the company and the shareholders, but it still resulted in a smaller company with fewer jobs.

Looking at the same example from a product mix point of view, in the first year, Company A's non-defense business amounted to only 9% of sales. After five years, the non-defense business grew to 30% with total company sales of $95 million. The vast majority of the company is still defense even with a highly successful commercial product.

Our Conclusion

Our conclusion *is commercialization projects can be successful in defense firms if they follow the Key Success Factors. Large scale conversion of the defense industry, however, is not likely. Implementing a combination of defense and non-defense diversification strategies, however, offers the best chance for companies to succeed when defense spending declines*. Even the Clinton administration, at their height of reaping the "the Peace Dividend", concluded that conversion is not possible. They backed off from the Technology Reinvestment Program in the 1996 budget and phased it out in 1997.