



*The International Center for Research on the
Management of Technology*

**Technology Strategy in Defense
Industry Acquisitions: A Comparative
Assessment of Two Giants**

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August 1997

WP # 164-97

Sloan WP # 3982

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**Technology Strategy in Defense Industry Acquisitions:
A Comparative Assessment of Two Giants**

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Between 1993 and 1996 twenty one significant acquisitions and mergers have occurred in the United States defense industry, with more underway.¹ This dramatic consolidation has had a profound effect on the technology and corporate strategies of the few emerging defense giants. Using a comparative case study approach, this paper provides detailed analyses of the recent defense-related acquisitions and mergers of two industry leaders – Raytheon and Lockheed Martin. For the past five years both have aggressively pursued deliberate growth strategies of repeated acquisitions and mergers, substantially increasing their corporate size and enhancing their technological capabilities.

Because the corporate players are still changing and not all proposed acquisitions have been completed or approved by the U.S. Federal Trade Commission, both Raytheon and Lockheed Martin closely guard their corporate and technology strategies. Nonetheless, an extensive review of both the popular and business press, combined with aggressive efforts to interview personally and communicate with company representatives, have yielded a wealth of insights. Specifically, the paper probes the following five key technology issues for each firm:

- the motivation and rationale behind the acquisitions;
- the impact of the acquisitions upon the company’s portfolio of technology competencies;
- the penetration of new markets and access to new technology areas provided by the acquisitions;
- the organizational considerations that promote technology transfer within the integrated firm; and
- the subsequent effects of the acquisitions on core research and development.

The paper is organized into four principal sections. The first section reviews the major forces that are influencing the U.S. defense industry and shaping its recent drive toward consolidation. The second and third sections discuss the five key technology issues listed above for Raytheon and Lockheed Martin, respectively. The fourth section compares and contrasts the technology strategies of Raytheon and Lockheed Martin, and offers general conclusions regarding technology strategies for the overall defense industry.

1.0 An Overview of Defense Industry Consolidation.

The end of the Cold War and the dissolution of the Soviet Union have had a major impact on the U.S. Department of Defense (DoD) and the industry that supports it. Since the early 1990s, both the DoD procurement and R&D budgets have been decreasing. Indeed since the height of the defense buildup in the mid 1980s, when the Strategic Defense Initiative (the U.S. program aimed at developing a national “shield” against ballistic missile attack) reached its peak, the procurement budget has dropped by more than 70 percent after inflation and U.S. defense employment has shrunk by 45 percent.² Today, the DoD budget stands at \$240

¹ Jeff Cole. “War of Attrition: Defense Consolidation Rushes Toward an Era of Only 3 or 4 Giants”. *The Wall Street Journal*, 6 December 96, A1.

² D. Fuqua. “Restructuring Pays the Bill”. *Defense News*, 16 September 96.

billion and is likely to continue to decrease. As a percentage of Gross National Product, U.S. defense spending is at an all time low of about 2.5 percent.

In a 1993 speech to defense company executives at a dinner dubbed “The Last Supper” by Lockheed Martin CEO Norman Augustine, former U.S. Secretary of Defense William Perry stressed the need for consolidation. He stated that the Pentagon simply cannot continue to pay huge sums to sustain the unused excess capacity that had emerged in the defense industry.³ In response to DoD suggestions many companies decided to shed defense-related activities and concentrate instead on civilian and consumer markets. In contrast a few companies decided to stay in defense and to grow. However, this move to grow by acquiring suppliers (and/or competitors) is not typical in today’s environment, in which U.S. industry has been in the process of streamlining, downsizing, and outsourcing with suppliers for parts and services.

The companies remaining in the U.S. defense industry argue that they need to be large in order to remain flexible, win contracts, and have enough money to support the acquisition or development of technologies that will keep them competitive in the future. The Pentagon can cut budgets and programs faster than small companies can react, and the impact of specific cutbacks on a small firm’s revenue can be sudden and severe. However, a large company can more easily adjust to change by reallocating its resources through a plan of diversification that can absorb a cutback or cancellation of a program.⁴ The more diversified a company’s base, the less likely that any single government cutback will impair profitability. A few major defense companies, like Raytheon and Lockheed Martin, the subjects of our analyses, have therefore adopted the pursuit of “massive critical mass (!)” as a means of establishing a sustainable competitive advantage. Smaller companies are selling off their defense-related capabilities and technologies to larger companies that are seeking horizontal and vertical integration in the manufacturing of their own product lines. Acquiring a core supplier, who might otherwise vanish for lack of sufficient sales volume, is one way of assuring the availability of critical components and access to critical technologies. In the current environment of the defense industry, alliances, joint ventures, and direct contracting cannot by themselves necessarily ensure that the supply of important components and technologies will endure.

While this approach of acquisition stems from a corporate strategy for survival, it creates unique opportunities to expand portfolios of technology competencies. Larger companies, by marrying complementary technologies through mergers and acquisitions, will compete more effectively in multiple markets and can service a wide range of needs in the U.S. and abroad. For example, combining radar technology with an acquired missile technology, or integrating newly acquired electronics into the design and manufacturing of an aircraft or weapons system, potentially enables more efficient use of resources. It also spawns families of products with commonalities at the component level. Within the

³ J. Cole. “Defense Consolidation Rushes Toward an Era of Only 3 or 4 Giants”. *The Wall Street Journal*, 6 December 1996.

⁴ A. L. Velocci, Jr. “Competitive Advantages of Scale Could Elude Aerospace Giants”. *Aviation Week and Space Technology*, 10 February 1997.

constraints of export rules large U.S. companies can be attractive to foreign countries that wish to strengthen their own defense positions but lack either the internal capability of doing so, or the managerial skills to integrate a system from a multitude of independent contractors. Many foreign governments seek out and rely on U.S. companies that can provide “systems of systems”, that is, complete turnkey packages of hardware and services that are not otherwise available. This need applies not just to military systems but also to some civilian applications (air traffic control, maritime navigation, telecommunications). Wisely acquired and properly integrated the technologies and capabilities can stimulate markets and generate new business opportunities.

The size and financial strength of U.S. defense companies pose an increasingly formidable challenge to the divided and frequently unprofitable European defense industry, which is subsidized directly by the participating governments.⁵ Consolidation of U.S. defense companies potentially makes them more profitable and competitive because of economies of scale and the advantages gained from merging technologies. However, these apparent gains will have to contend with limited defense markets in the future. There will certainly be fewer DoD procurements. Since defense dollars are becoming more scarce and are extended over longer periods, development cycles will likewise be longer. DoD will need contractors with the financial stability and willingness to endure extended periods of low returns. A large diverse company will capture more of these new programs than will a small highly focused company. Likewise, the larger firm is better able to develop and test new technologies and production techniques while keeping the necessary engineering and manufacturing talent engaged.

The DoD would like to encourage and control an orderly downsizing and restructuring of the defense industry. To that end the government is likely to allow the merging companies to recover their acquisition costs if there are demonstrable savings to the government. The corporate challenge for these companies is to reshape themselves while preserving competitiveness, reducing costs, maintaining quality, and creating value for their shareholders. It is partly through the strategic balance and use of technology that this challenge can be met.

2.0 Raytheon: A Description of the Corporation.

The Raytheon Company was founded in 1922 by Laurence Marshall and Charles Smith. The company was originally called the American Appliance Company and intended to produce refrigeration equipment. However, the founders became interested in vacuum tubes and never fully developed their refrigeration technologies. Instead, the company found a more lucrative niche in electronic devices and in 1925 changed its name to the more impressive and modern sounding title of Raytheon Incorporated. Vannevar Bush, former chairman of MIT, was an early mover in Raytheon’s shift with his founding participation in Submarine Signal Company, a key component of the initial Raytheon. (The founders might not be surprised to learn that after 75 years Raytheon has recently sold off much of its appliance

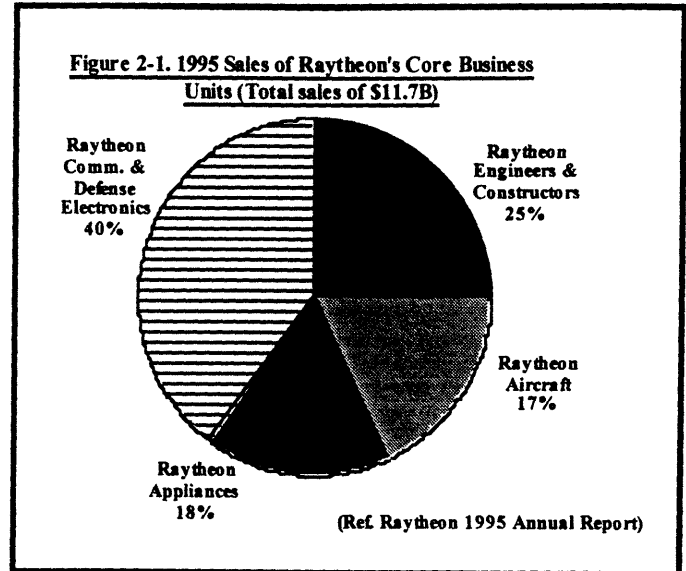
⁵ P. Finnegan. “U.S. Firms Broaden Defense Advantage”. *Defense News*, 29 July 1996.

division for \$750 million in order to help finance its defense acquisitions.)

Over the years Raytheon prospered and became an innovative leader in the electronics field. During World War II Raytheon helped pioneer radar and then produced over half a million magnetrons used in the war effort. After the war Raytheon's focus continued to be on defense electronics and the company became an acknowledged world leader in missile guidance systems. In 1964 the company leaders sought to mediate the inherent instability of government contract work and Raytheon embarked on a major commercial diversification program.

Over the next 30 years Raytheon progressively grew

and acquired operations in a variety of commercial market areas. The diversification plan reached a company milestone in 1993 when, for the first time, annual commercial sales exceeded government and defense sales. At present, Raytheon's four principal business areas are: Raytheon Commercial and Defense Electronics, Raytheon Engineers and Constructors, Raytheon Aircraft, and Raytheon Appliances. Figure 2-1 illustrates the recent financial size of each of these areas.



Raytheon's strategy of business diversification is a distinguishing company feature, supported by the current CEO Dennis J. Picard. In addition to providing a stabilizing influence to fluctuations in government spending, the commercial market offers a viable opportunity to leverage technologies and products originally developed for the defense market. In the 1995 annual report Picard stated that Raytheon will remain a diversified company by "continuing to apply defense technologies in commercial markets on a selective basis where there is a good match between our technology and commercial market opportunity". But by 1997 the opportunities had shifted sufficiently that the appliance selloff is now occurring.

Although Raytheon had followed a strategy of diversification for the past 30 years, in the decade of the 1990s the company has aggressively pursued defense consolidation. Following Secretary Perry's advice at the "Last Supper" Raytheon completed a major internal reorganization to create its primary electronics division, Raytheon Electronic Systems (RES). The company has had five significant acquisitions related to defense electronics. The most recent is the proposed mega-merger with Hughes Aircraft that dramatically increases Raytheon's size and financial clout. The pertinent details of Raytheon's recent acquisitions are summarized in Table 2-1.

2.1 Raytheon: Technology Strategy.

Table 2-1. Raytheon's Recent Acquisitions.

Company Name	Date Completed	Acquisition Price	Annual Revenue	# of Employees	Headquarters Location
1. Xyplex	Sept. 94	\$172M	\$100M	Unknown	Littleton, MA
2. E-Systems	May 1995	\$2.2B	\$2B	16,700	Greenville, TX
3. Chrysler Technologies (two subsidiaries Chrysler Technologies Airborne Systems (CTAS) & Chrysler Electospace Systems Inc. (CESI))	14 June 96	\$455	\$500M	2,800	CTAS in Waco, TX; CESI in Richardson, TX
4. Texas Instruments Defense Systems and Electronics (DS&E)	approx. June 97	\$2.95B	\$1.7B	12,000	Lewisville, TX
5. Hughes Aircraft (the defense operation of Hughes Electronics)	approx. Aug. 97	\$9.5B	\$6.3B	40,000	Los Angeles, CA
Projected Size of Raytheon Corp.	approx. Aug 97	\$11B in debt	\$21B	135,000	Lexington, MA

The motivation behind Raytheon's acquisitions is logical and straightforward: National and global business environments cannot absorb the excess capacity in the industry and thereby compel consolidation. Our analyses of the impacts of the acquisitions on Raytheon's and Lockheed Martin's technology strategies search for answers to four sets of questions.

- a) Each company's portfolio of technology competencies is closely analyzed to determine whether the acquisitions add new competencies or simply complement existing ones.
- b) Through the use of the Roberts/Berry familiarity matrix we seek the extent to which the acquisitions reflect forays into new technologies and new markets.⁶
- c) What are the key organizational challenges determining the company's ability to capitalize on the substantial technology potential offered by the acquired firms?
- d) How do the acquisitions affect core research and development efforts?

Raytheon's portfolio of defense industry technologies is summarized in Table 2-2. The first column lists Raytheon's cumulative technology portfolio following its five acquisitions. As reflected by the size of the list Raytheon possesses resources in an extremely broad range of technologies. Prior to the acquisitions the vast majority of Raytheon's defense expertise resided in the Raytheon Electronics Systems Division (RES). For this reason RES is used as the baseline in the second column of Table 2-2 for measuring Raytheon's pre-acquisition portfolio of technology competencies. The remaining columns depict the technologies brought into Raytheon from each of its acquired firms.

An examination of Table 2-2 yields several interesting observations. First the acquisition of the five firms resulted in a substantial 40 percent growth in Raytheon's portfolio of identified technological competencies. The hatched cells in Table 2-2 indicate new Raytheon competencies directly obtained from its recent acquisitions. The bottom row of Table 2-2 shows the number of new competencies provided from each acquired firm (note that some new competencies were obtained from more than one acquired firm). As the table shows E-Systems contributed the greatest number of new competencies at six, underscoring the exceptional value of the E-Systems acquisition from a technology portfolio

⁶ Edward B. Roberts and Charles A. Berry. "Entering New Businesses: Selecting Strategies for Success". *Sloan Management Review*, Spring 1985, 437-451.

Table 2-2. Portfolio of Technology Competencies for Raytheon and Acquired Companies.

Raytheon's Total Technology Portfolio After All Acquisitions	Raytheon Electronic Systems	E-Systems	Chrysler Tech.	TI DS&E	Hughes Aircraft	Xyplex
1. Ground Launched Missiles	XXX			XXX	XXX	
2. Air Launched Missiles	XXX			XXX	XXX	
3. Ship Launched Missiles	XXX				XXX	
4. Fiber-Optic Guided Missiles	XXX					
5. Anti-Radiation Missiles				XXX		
6. Ground Based Radars	XXX				XXX	
7. Airborne Radar Systems				XXX	XXX	
8. Weather Radar Systems	XXX					
9. Air Traffic Control Systems	XXX					
10. Early Warning Systems	XXX					
11. Satellite Surveillance		XXX				
12. Ship Radar and Fire Control	XXX					
13. Shipboard Weapons Systems	XXX				XXX	
14. Torpedo Systems					XXX	
15. Sonar & Mine Detection	XXX					
16. Marine Electronics Products	XXX					
17. Electronic Counter Measures	XXX	XXX		XXX		
18. Satellite Communications	XXX		XXX		XXX	
19. Secure Telecommunications	XXX	XXX	XXX		XXX	
20. Computer Network Systems	XXX	XXX				XXX
21. Computer Manufacture	XXX					
22. Computer System Mgmt		XXX				
23. Computer Data Management		XXX				
24. C4I Systems	XXX	XXX	XXX			
25. Training Systems & Services	XXX				XXX	
26. Training Simulators					XXX	
27. Transportation Management	XXX	XXX				
28. Aircraft Refurbishment		XXX	XXX			
29. Unmanned Vehicles		XXX				
30. Space Mission Aircraft		XXX				
31. Night Vision Systems				XXX		
32. Infrared & Electro-Optics				XXX	XXX	
33. Microelectronics	XXX			XXX		
34. Microwave ICs					XXX	
35. Gallium-Arsenide ICs				XXX		
# of New Competencies	N/A	6	1	5	5	0

perspective. This value was described by CEO Picard in press releases immediately after the acquisition, and was similarly acknowledged by Raytheon executives during our research interviews.

Another interesting observation from Table 2-2 is that approximately 50 percent of the technology competencies from the acquired firms overlap existing Raytheon capabilities. The light-shaded cells in Table 2-2 in the Raytheon Electronic Systems column highlight Raytheon's pre-existing competencies that were duplicated by competencies present in the acquired firms. This observation does not mean that the overlapping areas lack added value. On the contrary these complementing competencies, if properly managed, reinforce the learning curves and experience of the technical staff.

They also suggest the additions of manufacturing facilities and experienced staff at lower costs.

In general the acquisitions fill many technology gaps for Raytheon. One Raytheon Program Manager in Ground-Based Radar commented that the acquisition of Texas Instrument DS&E was critical to establishing Raytheon's competence in microelectronics.⁷ The DS&E facility is a leader in Gallium-Arsenide integrated circuits, particularly those used in aircraft radar systems. Raytheon seeks not only to increase the use of these electronic devices in its own products but also to become a primary supplier to other defense industry firms. In fact Northrop Grumman, a competitor to Raytheon that lost the bid for Texas Instruments DS&E, especially coveted TI's integrated circuit facilities and aggressively lobbied government officials and the Federal Trade Commission to block this part of the acquisition on anti-trust grounds.

Raytheon gained another critical technological competency in electro-optical devices through the acquisitions of both Hughes and TI DS&E. According to a Raytheon Division Chief for National Missile Defense (NMD), Raytheon has traditionally been rather weak in electro-optics, which are needed for on-board infrared missile seekers and other remote sensing equipment. Use of these electro-optic technologies will improve the accuracy of the heat-seeking interceptors that will be developed for the NMD program, and will enhance the homing devices for Raytheon's existing family of missile weaponry.

One final observation from Table 2-2 is that all 17 of Raytheon's new competencies could have been gained by acquiring just three of the firms: E-Systems, Texas Instruments DS&E, and Hughes Aircraft. This result clearly underscores the significant technological and strategic value of these three acquisitions to Raytheon. The other acquisitions, however, also add value because they have created market opportunities and have provided marketing and distribution channels, as indicated below.

We next analyze Raytheon's electronics acquisitions by placing each one into the Familiarity Matrix, providing a uniform framework for assessing the acquisitions in terms of their initial market and technology-relatedness to Raytheon.⁸ In general "market familiarity" is a measure of Raytheon's understanding of the customer base and business patterns in the markets served by the acquired companies. Acquisitions that replicate Raytheon's own market experiences are regarded as in Raytheon's "base" market. Those that involve some degree of market change, but with important aspects of market "sameness", are considered to be in a "new (but) familiar" market zone. Acquisitions whose market characteristics are largely different from Raytheon's are seen as "new (and) unfamiliar". A similar assessment is carried out with respect to the technical similarities between Raytheon and its acquisitions, with the extent of "technology familiarity" reflecting Raytheon's understanding of the core technologies imbedded in each of the acquired companies, based on Raytheon's own internal technical capabilities.

⁷ Personal interview with Raytheon program manager, 25 April 97.

⁸ Roberts and Berry, *ibid.*

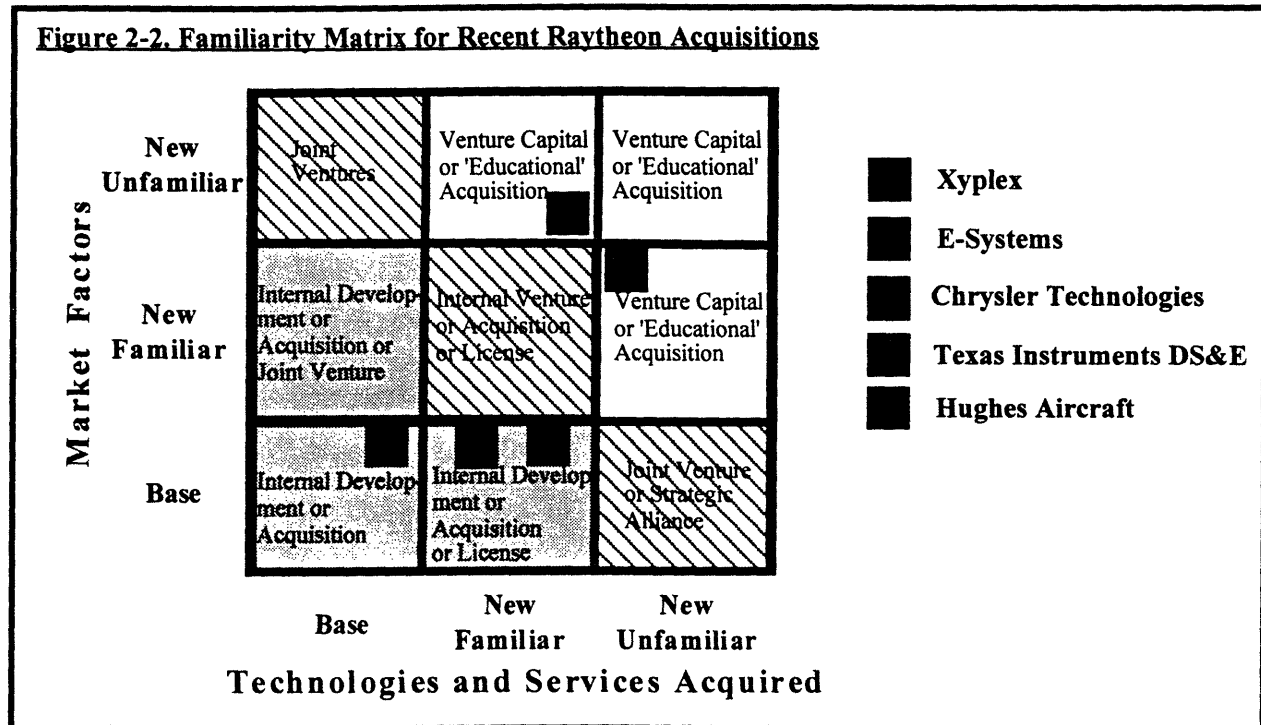
The Familiarity Matrix is constructed with the two axes of technical and market familiarity of the acquisitions relative to Raytheon, using the three measures of base, new familiar, and new unfamiliar on each axis. Figure 2-2 depicts our assessments of Raytheon's five acquisitions on this grid, now divided by different shading into three overall zones to indicate regions of roughly similar "familiarity". Within the lower left "base-familiar" zone, acquisitions are assumed to be capable of adding depth to Raytheon's existing skills and knowledge, with only incremental broadening. Empirical studies of acquisition strategies show that such "related acquisitions" tend to become successful additions to the firm.⁹ In contrast, if they were located in the upper right "new familiar-new unfamiliar" zone, any acquisitions would be essentially unrelated to Raytheon's core knowledge. While such acquisitions might have the potential of dramatically adding new skills and new market opportunities to the acquiring firm, the research literature indicates that such "unrelated acquisitions" usually fail and are frequently divested. The diagonal "marginal" zone suggests a middle ground in regard both to potential gains and likely risk of failure of the acquisitions. (The alternative strategies shown in each of the nine blocks of Figure 2-2 reflect the Roberts and Berry arguments for the most "appropriate" organizational options for efforts aimed at new business development that are characterized by the indicated degree of market and technical newness. For example, at the extreme bottom left, both internal development and external acquisitions are seen as equally proper means for Raytheon to use to develop a product or business that has both its base market and base technology. In contrast Figure 2-2 suggests that Raytheon not be more aggressive than investing venture capital into a business opportunity that would reside in the upper right corner of the grid.)

From these perspectives Chrysler Technologies, Texas Instruments DS&E, and Hughes Aircraft all appear to reside in relatively familiar market and technology territory for Raytheon. These firms largely deal in defense electronics and serve common government and commercial markets. Reflecting their contribution of five new technology competencies each, both Texas Instruments DS&E and Hughes land in the New Familiar technology category, while Chrysler is placed in the base technologies box.

E-Systems is a particularly interesting acquisition. Our analysis of competencies found that E-Systems added six entirely new technical capabilities ranging from satellite surveillance, to computer systems management, to unmanned vehicles. As a result E-Systems is categorized as New Unfamiliar Technology from Raytheon's perspective. On the other axis E-Systems serves a customer base in the government intelligence and surveillance communities. Although these are new markets for Raytheon, the fundamental nature of selling to the government provides some essential familiarity and so brings E-Systems into the New Familiar Market region. Thus, based on both market and technology factors, the E-Systems acquisition afforded significant value to Raytheon. The company gained access to valuable new technologies as well as entry into new government markets. The Roberts/Berry arguments

⁹ The most recent addition to this evidence stream is P. Healy et al., "Which Takeovers Are Profitable? Strategic or Financial?"

highlight the diversity of the E-Systems technologies relative to Raytheon's base capabilities and suggest that Raytheon is itself ill-equipped to integrate E-Systems rapidly into its own core activity. It would appear that Raytheon needs to provide a high degree of independence to the E-Systems management until greater joint learning has taken place.



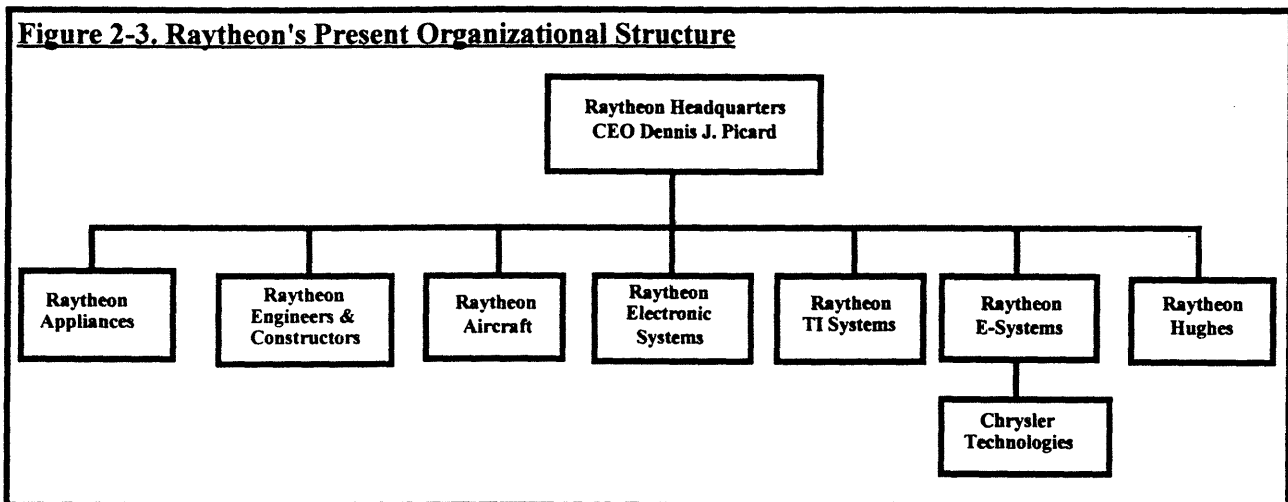
The Xyplex acquisition is even more intriguing from an acquisition strategy perspective. The purchase of Xyplex caught market analysts by surprise and represented a rather unconventional move for Raytheon. Xyplex is a designer and manufacturer of high performance computer networking systems. At the time it was acquired, analysts questioned Raytheon's rationale because Xyplex did not seem to fit into Raytheon's traditional product line or its core technology skills.¹⁰ Discussions with a senior technical director at Raytheon Electronics System Division revealed that the Xyplex purchase was actually an "educational acquisition", intended to provide Raytheon with a learning opportunity in the rapidly expanding and lucrative commercial computer networks market. Xyplex provided a foothold in the market with direct contact with established customers. Unfortunately, predictable from the Roberts/Berry analysis, the acquisition failed to achieve the desired synergy, and Xyplex was sold at a \$55 million loss 18 months later. The failure of the Xyplex acquisition illustrates the risk in expanding too rapidly beyond traditional boundaries. Although both E-Systems and Xyplex are in the "unfamiliar" zone in the Familiarity Matrix, the Xyplex acquisition would be predicted to be more hazardous as its primary unfamiliarity is on the market-side. Several studies have indicated that significant market shift is an even more difficult challenge than technological shift. (As a side note on

Sloan Management Review, Summer 1997, 45-57.

¹⁰ Jon Auerbach. "Raytheon Beefs Up on Defense". *The Boston Globe*, Business Section, 9 April 96.

Xyplex, the acquiring company, Whittaker Corporation, has also failed to achieve any significant benefit, and is now attempting to sell Xyplex.)

The key organizational challenges that will determine Raytheon's ability to unlock the technology value from its acquisitions are: a constructive consolidation of facilities, the careful management of people, and the transfer of technology throughout the enormous new company. In regard to consolidation of facilities, market analysts believe Raytheon might be able to achieve financial efficiencies of approximately 10 percent, or \$1.3B, per year.¹¹ However, achieving these savings will require dramatic organizational changes. Raytheon's present organizational structure, depicted in Figure 2-3, grants a high degree of independence and autonomy to the newly acquired companies. Under this organizational structure, each acquisition has or will become a distinct Raytheon division, reporting directly to the CEO, Dennis J. Picard. Each division is responsible for its own administration, marketing, and core product development. This structure does not enhance Raytheon's overall technology strategy because each division is also independently performing its own research and new product development. Moreover, retaining traditional company boundaries inhibits personal interaction

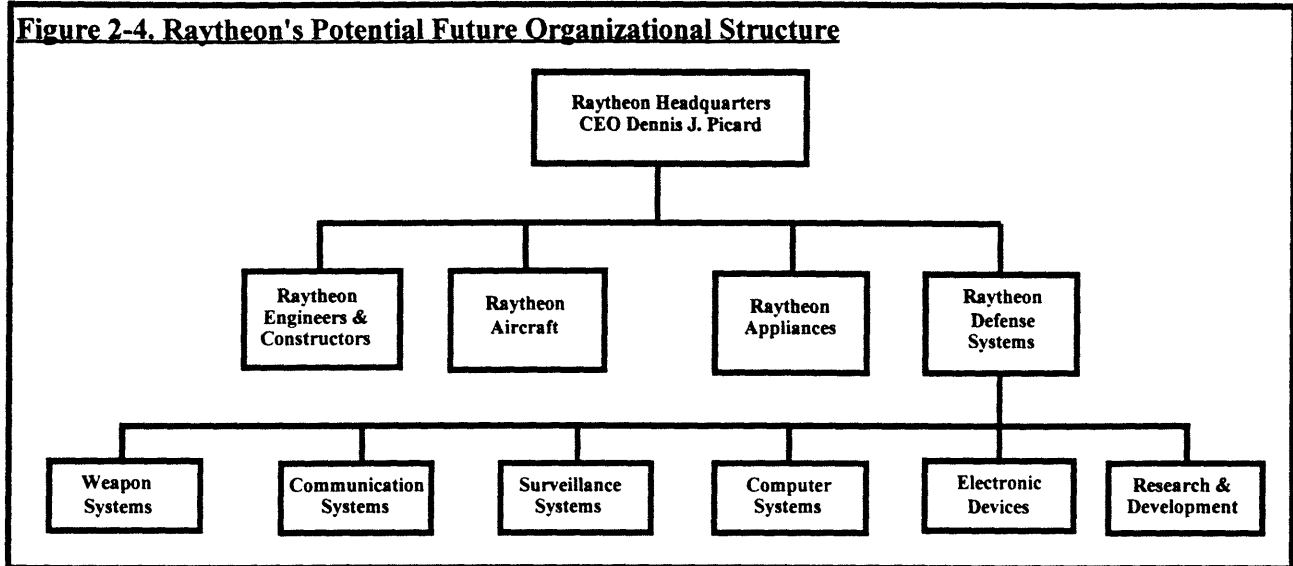


between divisions and retards the transfer of technology and expertise. Raytheon's CFO, Peter D'Angelo, has acknowledged that the company's existing structure is disadvantageous and in order to achieve the desired synergy and efficiency "major changes must occur".¹² Although Raytheon has neither publicly nor internally announced formal plans to restructure, our discussions with several Raytheon representatives suggest that there is a general understanding of the reorganization that is being considered. To promote synergy, spread technology, and reap financial savings from economies of scale, the company is expected to reorganize all defense electronics divisions into one business unit. This action will eliminate traditional company barriers and instead organize the company according to functional areas. Raytheon's potential organizational structure is depicted in Figure 2-4, with the Appliance Division significantly downsized since its recent partial divestiture.

¹¹ William Bulkeley. "U.S. Seeks More Data from Raytheon". *The Wall Street Journal*, 14 April 97, C2.

¹² Personal interview with Raytheon senior manager, 10 April 97.

Raytheon's organizational structure directly involves the second key organizational challenge – sound management of people. Each of the acquired companies has a very strong corporate culture. Many of the CEOs from these companies remained with their organizations after acquisition by Raytheon. As a result, these companies maintain their own strong identities. Raytheon faces a difficult but necessary personnel and internal marketing challenge to merge these disparate groups into a common Raytheon culture. Restructuring into a functional organization is a marshaling event that will initiate cultural change.



Another difficulty facing Raytheon is how to group individuals and program teams by function when they are dispersed across numerous facilities in more than 14 states and 3 countries. Relocating people is a difficult task. One senior engineer at Raytheon explained that talented engineering and technical people are in very high demand.¹³ The rapid growth of high technology industries in California, Texas and Massachusetts enables employees slated for relocation to remain in their local area by joining other local high-tech firms. Our interviews indicated that the market for engineers is so competitive that the RES/Hughes/TI DS&E/E-Systems divisions have a combined personnel shortage of more than 2,000 engineers. As a result, Raytheon representatives believe Raytheon will exploit the latest information technology (IT) techniques to try to achieve a “virtual” organization, rather than a traditional one that is geographically centralized.

The last major organizational challenge is the installation of pervasive practices to stimulate the sharing and transfer of technology and experience throughout the company. Eliminating former company boundaries through functional restructuring is a major step toward this goal. For instance, having all missile developers together, even if it is done virtually through IT, will greatly facilitate the sharing of technology and ideas. In addition, Raytheon plans to increase the practice of personnel interchange. A senior divisional manager lamented that technical people are rarely loaned to other

¹³ Personal interview with senior engineer, Raytheon Electronic Systems Division, 8 April 97.

programs or divisions for specific technical assignments, or even to provide informational briefings on the capabilities and expertise of the home program. He felt that there will be more mobility and visibility within the proposed new Raytheon, envisioned by Mr. Picard and other top executives.

The final aspect of Raytheon's technology strategy concerns core research and development (R&D). Raytheon split up its central R&D facility in 1994. At present, each Raytheon division is responsible for its own R&D efforts, leading to a rather short term focus, according to senior technical management. Raytheon as a whole focuses 95 percent of its R&D resources on new or next generation product development. It spends only 5 percent of its technical efforts on core research. This practice is likely to sacrifice Raytheon's long term technology prowess in order to obtain short term gains. As shown in Figure 2-4, one corporate-level manager told us that Raytheon may again establish a distinct R&D entity in the upcoming reorganization. He foresees Raytheon's consolidating R&D resources and, in some cases, physically relocating researchers to centralized core research areas.

Raytheon's recent acquisitions offer many benefits for R&D. The strongest comes from the expertise and technical management skills of the Hughes Research Laboratory in Malibu, CA. Other R&D talent comes with the acquisition of Texas Instrument's Advanced Programs Division and its Advanced Technology and Components Division. The anticipated centralized R&D organization, coupled with subsequent collaboration between these facilities and Raytheon's own Advanced Device Center, will greatly enhance the company's capability in microelectronic devices.

2.2 Raytheon: Conclusions.

An examination of Raytheon's five recent acquisitions has provided some insight into the company's technology strategy. The company's recent spate of acquisitions is motivated more by business than by technology. This is not surprising in light of the perceived need to be large in order to continue to participate in the shrinking defense industry (as described in section 1.0). As a result, Raytheon's technology strategy has been dynamic and emergent, often reacting to the acquisitions as they occurred. Restructuring Raytheon along functional lines, even if it becomes a virtual organization, would promote retention of highly valued personnel and enhance internal technology transfer. In addition, a reorganization would likely re-establish a central R&D division. Because Raytheon currently lacks centralized R&D management, the company allocates only 5% of its R&D budget to research and 95% to relatively-near term development. A larger proportion devoted to research would seem more appropriate for a large technology-oriented company that has just acquired many technological resources through acquisitions.

Raytheon is still in the process of sorting through its competencies, deciding what to exploit aggressively, and what simply to maintain. Nevertheless, the acquisitions are substantially valuable to Raytheon's technology position. The acquisitions, particularly of E-Systems, Texas Instruments, and Hughes, resulted in a 40% increase in Raytheon's portfolio of technology competencies. For instance, the Texas Instruments acquisition garnered critical microelectronics technologies, and both the Texas

Instruments and the Hughes acquisitions significantly increased electro-optics expertise. From an overall perspective, Raytheon's acquisitions in defense electronics appear to be a largely horizontal integration. The company has greatly expanded its breadth of technologies and product lines and gained access to new markets.

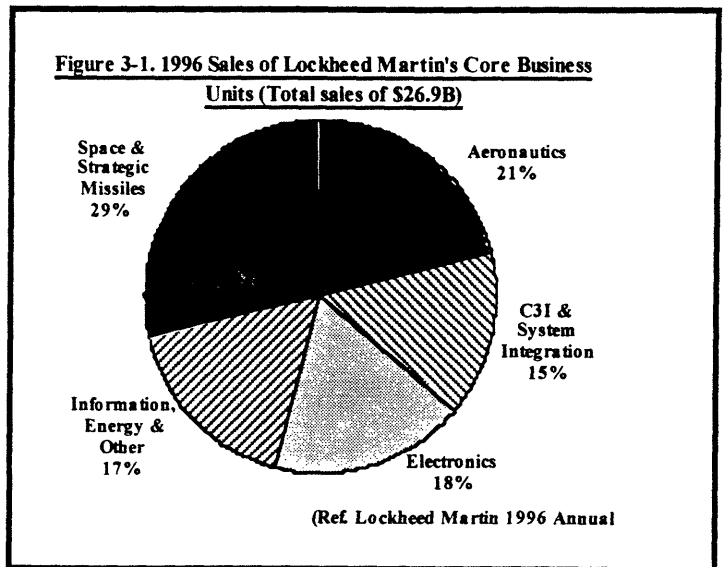
3.0 Lockheed-Martin: A Description of the Corporation.

Lockheed Martin Corporation was formed on March 15, 1995 with the merger of two of the world's premier aerospace technology companies, the Lockheed Corporation and the Martin Marietta Corporation. Lockheed became a world leader in defense and space technology, focused on special mission and high performance aircraft, missiles, and guided weapon systems for the military. Lockheed's sales prior to the merger were \$13.2 billion. Martin Marietta was the world's largest developer of space, defense, aviation, and communications equipment, systems primarily developed for the defense market. Martin Marietta's sales had reached \$9.4 billion. Now, in 1997, the merged Lockheed Martin Corporation is a highly diversified \$30 billion advanced technology company.

The roots of Lockheed Martin can be traced back to the early days of flight. In 1909 aviation pioneer Glenn Martin organized a small company around a modest airplane construction business. He built this company into a major airframe supplier to U.S. military and commercial customers. In 1913 the first Lockheed plane flew over San Francisco Bay. The Lockheed Corporation was formed in 1932 after the fledgling airplane company was extensively reorganized. The next major event for Glenn Martin's company was the 1961 merger with American-Marietta Corporation, a leading supplier of road and building construction materials. Over the years both Lockheed and Martin-Marietta prospered and became highly diversified in advanced technology.

Today Lockheed Martin is the largest contractor for the U.S. Department of Defense, the Department of Energy, and the National Aeronautics and Space Administration, with more than half its revenues from the Department of Defense. Lockheed's principal business sectors are: 1) Aeronautics, 2) Electronics, 3) Energy & Environment, 4) Information & Technology Services, 5) Space & Strategic Missiles, and 6) C3I & Systems Integration. Figure 3-1 illustrates the respective financial contribution of each of these six business areas.

Lockheed's vision statement is ambitious: "Our vision is for Lockheed Martin to be recognized



as the world's premier system engineering and technology enterprise. Our mission is to build on our aerospace heritage to meet the needs of our customers with high-quality products and services. And, in so doing, produce superior returns for our shareholders and foster growth and achievement for our employees."¹⁴ Although Lockheed has been a continuous growth company in its quest for mission fulfillment, it has taken a more aggressive approach since the 1990s. The chronology of recent mergers and acquisitions by Lockheed is detailed in Table 3-1.

In the span of approximately 18 months with the merger of Martin Marietta and the acquisition of Loral, the Lockheed Martin Corporation has risen to become the world's largest defense firm with defense sales totaling more than \$30 billion. And, most recently, in July 1997 it agreed to acquire Northrop Grumman Corporation for \$8.3 billion, subject to government approvals.

Table 3-1. Lockheed Martin's Recent Acquisitions.

Company Name	Date Completed	Acquisition Price	Annual Revenue	# of Employees
1. General Dynamic Corp.'s Military Aircraft Business	March 1993	\$1.52B	\$3B	16,200
2. Martin Marietta Corp. acquires General Electric Aerospace	April 1993	\$3.05B	\$5.4B	17,300
3. Loral Corp. acquires IBM Federal Systems	Dec. 1993	\$1.58B	\$3.1B	14,000
4. Lockheed and Martin Marietta merger	Dec. 1994	\$10B+ value	\$23B	140,000
5. Loral buys Unisys Corp.'s Defense Business	May 1995	\$862M	\$1.1B	10,700
6. Lockheed Martin acquires most of Loral	April 1996	\$9B+	\$6.7B	30,000
Projected Size Lockheed Martin	approx. Aug 97		\$30B	190,000

3.1 Lockheed Martin: Technology Strategy.

Despite Lockheed Martin's status as the world's biggest defense contractor, the company's leaders, former Lockheed CEO Daniel M. Tellep and former Martin Marietta CEO Norman R. Augustine, say the new company will derive 40 percent of its revenues from non-military markets. "We're committed to defense, and would like to hold the defense part of our business roughly constant," said Augustine in an interview with *Government Executive*. "But our growth will come principally from non-defense. The civilian government is one area we have very much in mind. One, because it's a growing market, and secondly, we know how to do business with the government."

In a second interview, when asked about Lockheed Martin's business strategy for the short term (the next year or so) and the longer term, Augustine replied, "This Corporation has two elements to the strategy that we've been following for a number of years -- and it's still the proper strategy for the foreseeable future. The first element has been to build on our defense business, to put ourselves in a very

¹⁴ Lockheed Martin 1996 Annual Report.

solid position in terms of market share. We've accomplished that and now we'll seek to benefit from that, particularly as the defense procurement budget begins to turn back up. Our successes in winning new business this past year suggest the soundness of this approach. The second element of our strategy has been to grow into closely related non-defense areas. Now I emphasize *closely related*. By that I mean things that are high tech, large systems with large customers (like governments or large corporations). And this will be our principle thrust in the next few years -- in areas such as telecommunications, information systems, training and simulation, infrastructure support, environmental management, technical services and so on. We have a whole host of capabilities that we can grow into solid businesses.”¹⁵

Lockheed Martin's portfolio of defense industry technologies is summarized in Table 3-2. The first column lists Lockheed Martin's cumulative technology portfolio after the recent acquisitions. As reflected by the list, Lockheed possesses an intensive technology base in its core areas. Each merger and acquisition has strengthened and completed existing capabilities to fulfill its vision of becoming a premier system engineering and technology enterprise. The remaining columns depict the technologies brought into Lockheed from the acquired firms.

Table 3-2 clearly indicates that Lockheed Martin is systematically adding to its core competencies in major platform systems with additional capabilities in electronics, information systems, and systems integration. Following a strategy of acquiring and investing in firms, Lockheed Martin is enhancing its capability to provide service to the defense industry and to other government businesses--- a growth-by-acquisition strategy. Currently Lockheed is focusing on what it does best, defense and government-related business.

The acquisitions and mergers resulted in a 185 percent increase in the number of key competencies included in Lockheed's technology portfolio. Each acquisition has enabled Lockheed to obtain new competencies in primary business areas. Very little existing technology was replicated by these acquisitions (about 15%). The shading in Table 3-2 highlights the new competencies that were added (hatched) as well as the few technologies that were replicated (shaded). Overall, the mergers and acquisitions have dramatically strengthened Lockheed Martin in preparation for competition in the consolidating defense industry.

¹⁵ www.lmco.com - News Release.

Table 3-2. Portfolio of Technology Competencies for Lockheed and Acquired Companies.

Lockheed's Total Technology Portfolio After All Acquisitions	Lockheed	Martin Marietta & GE	General Dynamics	Loral Corp.	Unisys	IBM
1. HighPerformanceAircraft	XXX					
2. Strategic Missiles	XXX					
3. Space Missiles	XXX			XXX		
4. Guided Weapons	XXX					
5. FiberOptic Guided Missiles	XXX					
6. Communication Equipment		XXX				
7. Military Aircraft	XXX					
8. Aerospace		XXX				
9. DefenseElectronics		XXX	XXX	XXX		
10. Space Systems			XXX	XXX		
11. Armored Vehicles			XXX			
12. Artillery				XXX		
13. Satellite Surveillance				XXX		
14. Professional Services				XXX		
15. Tactical Systems				XXX		
16. Systems Integration				XXX		
17. Military Digital Computers					XXX	
18. Military Software					XXX	
19. Computer-Aided Design	XXX					XXX
20. Computer-Aided Mfg.						XXX
# of New Competencies	N/A	3	3	7	2	1

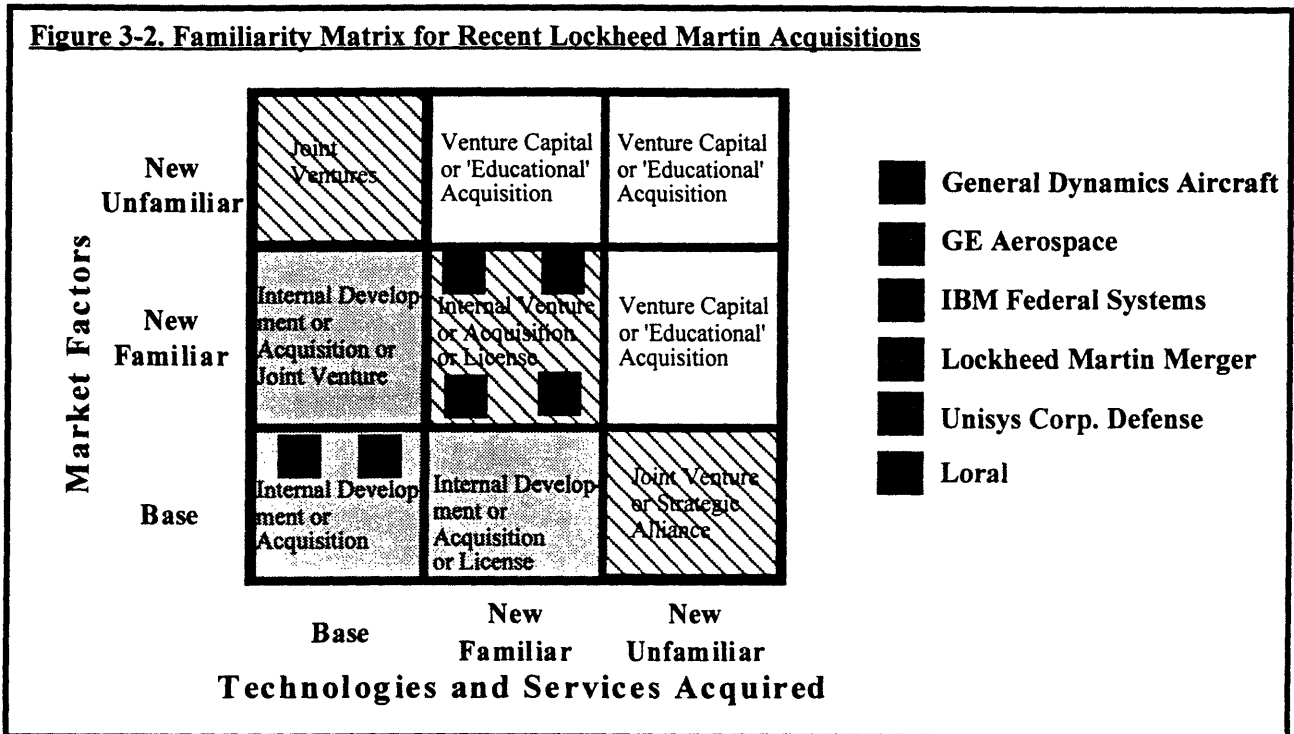
Based on the complementary nature of Martin Marietta's defense electronics business and of Loral's electronics and system integration businesses, Lockheed Martin is achieving a high degree of vertical integration. What made the merger of Lockheed and Martin Marietta attractive in the first place was the compatibility of their product lines. While Lockheed had long been a dominant military aircraft manufacturer, Martin Marietta had concentrated on defense electronics. Lockheed has also positioned itself to compete effectively in other non-defense government business areas, such as space exploration with the new X-33 spacecraft, and the effort with the Federal Bureau of Investigation to implement that agency's Automatic Fingerprint Identification Segment technology.

We again use the Familiarity Matrix to locate each of Lockheed Martin's recent acquisitions in terms of new market and technology penetration. Figure 3-2 graphically depicts our assessments for each of Lockheed's recent acquisitions. When Lockheed Martin purchased Loral, a leading supplier of advanced electronic systems, components, and services to U.S. and foreign governments for defense and non-defense, a new business sector was established for the transition. Loral provided Lockheed with additional capabilities of electronics, systems integration, and information systems.

For example, General Dynamics Space Systems boosted Lockheed's capability in the intermediate-lift space launch vehicle market with the Atlas series of launch vehicles. The acquisition of General Electric Aerospace strategically complemented Lockheed Martin's existing aerospace capabilities and resulted in the creation of valuable affiliated corporations. General Dynamics Space Systems fits well into Lockheed's existing Space & Strategic Missiles sector and General Dynamics

military aircraft business fell under the Aeronautics sector.

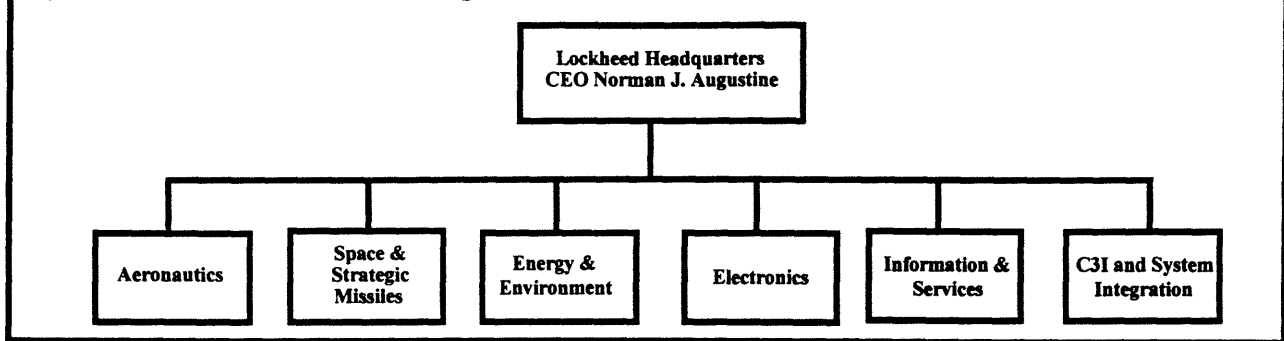
With almost every acquisition or merger, Lockheed has chosen to operate in relatively familiar markets and technology. These firms are largely focused in defense electronics and have core competencies that serve common government and large commercial markets. The majority of the acquisitions have brought new capabilities and new technologies to enhance Lockheed's core business sectors. This is reflected in the Figure 3-2 Familiarity Matrix. Some of the acquisitions and mergers add strengths to the existing "base"; the others are in the "new familiar" section as they offer new technologies and the possibility of new markets.



Even with all the mergers and acquisitions, only a few types of work need to be collocated. Relocating some assets would reap economies of scale in manufacturing, and centralize some core R&D investments. Lockheed Martin has a large number of site locations. In order to facilitate the internal sharing of information and technology, Lockheed Martin is using its own expertise in IT to network the corporation. The term "virtual enterprise" literally applies to Lockheed Martin. Through this innovative electronic organizational structure, it is showing that a company of such immense size can take advantage of its larger scale but still compete like a small company.

Lockheed Martin faces many of the same organizational challenges confronting Raytheon: merging disparate cultures, carefully managing people, and consolidating facilities. The major difference between the two is that Lockheed Martin already has an organizational structure based on functional areas of core competence. Figure 3-3 illustrates Lockheed's organizational structure. The current organization is formed around the six business sectors. Lockheed has been deliberate in the vertical integration of the acquired companies into these sectors.

Figure 3-3. Lockheed Martin's Organizational Structure



However, one exception to this principle was the absorption of Loral. To promote synergy, technology transfer, and financial savings from economies of scale, Lockheed reorganized its original five business sectors into six. When Loral was acquired, Lockheed Martin chose to create a new business sector in tactical systems, now called C3I & Systems Integration. This sector was the last “piece of the puzzle” in Lockheed’s strategy for spanning and servicing practically every major defense technology. This strategy has also allowed entry into such commercial markets as information systems.

Assembling such a diverse team from many parts is a cultural challenge. So far, this has not been a serious problem. Lockheed’s management states that they are mindful of cultural differences and take them into consideration when matching up the various elements that will make up their corporation. Management’s goal is a seamless organization in which the different business sectors operate as though they are one entity. To do this, Lockheed is creating a virtual enterprise, through which it can reduce the overall cost structure but, more importantly, speed the rate of innovation and stimulate the sharing of technology throughout the company.

3.2 Lockheed Martin: Conclusions .

Lockheed Martin has been aggressive in its quest to become the major defense contractor in the world, and to attain competitive advantage in other government and commercial markets. The most recent mergers and acquisitions have been motivated more by the pursuit of “critical mass,” but now the company is focusing on its technology strategy. Much vertical integration is apparent, and horizontal integration of companies and technologies is underway.

In February 1997 Lockheed Martin announced a strategic plan to re-engineer its non-core businesses. The reductions in these areas are being offset by employment growth in others. In fact, in its newsletter, *Lockheed Martin Today*, the company announced a shortage of technical expertise for the first time in many years. Lockheed Martin is hiring at a rate unmatched in a decade. Reflecting the rapid growth of information technology across all industries, Lockheed is looking for people with technical skills in computer science, electrical engineering, and computer engineering.

Lockheed must also address its research and development activities. A rapid pace of acquisitions can have both positive and negative effects upon R&D. Positively, through each acquisition and

merger, Lockheed Martin can take advantage of the richness of the acquired expertise and the fresh viewpoints of the technical staff. Negatively, configuring a core R&D capability can be difficult when the assets are spread across so many states. In our discussions with Lockheed executives they expressed their concerns about R&D and admit that more attention is needed in developing that area..

Overall Lockheed continues to focus on closely-related technologies that expand its core competencies in the defense and government business areas. Its acquisitions land mostly near the lower-left corner of the Familiarity Matrix. As CEO Norman Augustine stressed, it is his intent to pursue only those business opportunities that will enhance Lockheed's capabilities in familiar defense and associated government and commercial markets. His management of his firm's technology via acquisitions follows this path.

4.0 Comparison of the Two Companies and General Defense Industry Conclusions.

From our study we see that Raytheon is currently undergoing a metamorphosis; committees are meeting in the executive offices in Lexington, Massachusetts to survey the company's resources, target the markets, and determine the configuration of the new company that will best position Raytheon for the future. Lockheed Martin, on the other hand, is already functionally organized and therefore better positioned to integrate efficiently its acquired assets and more quickly capitalize on strategically valuable new technology and markets. Nonetheless, both Raytheon and Lockheed Martin stand to benefit substantially from the technologies and potential market opportunities that have come along with their acquisitions. In both cases new technologies are introduced, technology gaps are filled, existing capabilities are reinforced, and new business synergies are created. Our comparison of the two companies with respect to our five key attributes of technology strategy is synopsisized in Table 5-1.

In regard to the overall industry the study of Raytheon and Lockheed Martin have provided an interesting perspective on the role and impact of technology strategy in the emerging consolidated defense industry. In addition to consideration of external market influences a successful technology strategy must also address fundamental internal aspects within the company itself. Beyond merging technologies and fixed assets, a technology strategy also depends upon the careful integration of technical people and a restructuring of the organization so that the incoming value can be absorbed and applied in the most advantageous manner.

Raytheon and Lockheed Martin are two major defense industry companies that have resorted to the strategy of mergers and acquisitions to ensure access to critical services, technologies, and components. These actions have also helped to access for these two firms the few alternative markets toward which the enormous capacity of the industry can be redirected as world events continue to change and as defense budgets worldwide continue to decrease. From our research we see that Boeing and Northrop-Grumman have been similarly following aggressive consolidation strategies and were in fact main competitors to Raytheon and Lockheed Martin for many industry acquisition targets. The now anticipated Boeing-McDonald and Lockheed-Northrop mergers are the next mega-steps in the evolving

pattern of consolidation.

In conclusion we have learned that the corporate and technology strategies of a large defense company are highly intertwined. Corporate decisions are made to ensure survival, to solidify existing lines of business, to develop new business opportunities, and to satisfy shareholders. In the new defense industry, it appears the biggest firms will survive by adopting a technology strategy that integrates acquired capabilities into current product lines and assertively adapts defense technology strengths toward future non-defense market opportunities. Diversifying beyond the boundaries of the defense industry might afford the growth, stability and profitability that the defense markets alone can no longer support.

Table 4-1. Comparison of Technology Strategy Issues for Raytheon and Lockheed Martin.

Issue	Raytheon	Lockheed-Martin
1. Motivation and rationale of recent mergers	<ul style="list-style-type: none"> • Horizontal integration of its defense electronics and weapons systems product lines - exploitation using <i>operational acquisition</i> of additional manufacturing and experienced staff. • Diversification into commercial markets to obtain stability against the volatile defense business. • Supplying the other defense firms (primarily in its new core competency - microelectronics). 	<ul style="list-style-type: none"> • Vertical integration to guarantee suppliers in key subsystem areas. • Horizontal integration (with combined vertical) in the manner of a 'beachhead strategy'¹⁶ in the field of avionics, airframes, military and commercial aircraft, and space vehicles. • Adhering to its defense business as a core strategy - and penetrating other commercial market areas in a planned manner (recent reorg of non-core businesses in Feb. 1997).
2. Impact of Acquisition on Portfolio of Technology Competencies	<ul style="list-style-type: none"> • 40% increase in the tech. portfolio. • 50% replication of existing competencies - emphasis on additional manufacturing capabilities. • All new competencies come from 3 of the 5 acquired firms. 	<ul style="list-style-type: none"> • 185% increase in the technology portfolio. • 15% replication of existing competencies - emphasis on technological competencies and not manufacturing. • New competencies obtained from each of the 5 firms acquired
3. Penetration of New Markets	<ul style="list-style-type: none"> • Xyplex and E-Systems acquisitions yielded substantial inroads to new markets. 	<ul style="list-style-type: none"> • Insignificant entry into new markets - but significant internal supplier base now established
4. Organizational Challenges	<ul style="list-style-type: none"> • Expect to organize by function to integrate new firms efficiently. • Should use more IT and virtual organization vs. physical relocation to minimize personnel problems¹⁷. • Unification of the disparate corporate cultures, communications between divisions, loyalties to old hierarchies, and partisanship. 	<ul style="list-style-type: none"> • Already functionally organized into 6 major divisions. • More likely to use IT and "virtual enterprise"¹⁸ to enhance sharing - rather than physical relocation. • Unification of the disparate corporate cultures, communications between divisions, loyalties to old hierarchies, and partisanship
5. Impact on R&D	<ul style="list-style-type: none"> • R&D is dramatically enhanced. Currently, no central R&D plan. As a result, the company has a short term focus with 95% of R&D efforts on Devel. and only 5% on Research; potential strategic technology error. • Clear R&D benefits from several of the new acquired facilities (Hughes Research Labs, TI's Advanced Programs Division). 	<ul style="list-style-type: none"> • Small effect on core R&D. Additional development efforts added by the development ongoing in acquired firms. • Small savings by rationalization and reduction of redundant research • R&D plan needs greater definition.
Overall Assessment	Bold horizontal acquisitions, forays into the upper and right hand sides of the Roberts/Berry matrix. Lesser likelihood of success.	Conservative vertical (and some horizontal) acquisitions. Sticking to the conservative lower right hand side of the Roberts/Berry matrix. Higher likelihood of success.

¹⁶ M. Meyer and A. Lehnerd. *The Power of Product Platforms*. The Free Press, 1997.

¹⁷ Personal interview with senior executive, Hughes Corporation, 20 April 97.

¹⁸ Anthony L. Velocci, Jr. "Virtual Enterprise: A Plus for Lockheed Martin", *Aviation Week & Space Technology*, 10 February 97.

Reference Sources

Raytheon

1. Auerbach, Jon. "Raytheon Beefs Up on Defense, Makes Deal Worth \$475M for Chrysler Holdings". *The Boston Globe*, Business Section, 9 April 96.
2. Bailey, Douglas. "Raytheon hints it will soon sell \$1.5B appliance unit". *The Boston Globe*, Business Section, 25 February 97.
3. Bulkeley, William M. "U.S. Seeks More Data from Raytheon; Possibly Delaying TI, Hughes Purchases". *The Wall Street Journal*, 18 March 97, A6.
4. Bulkeley, William M. "Loss of Reimbursement Program May Threaten Raytheon Deals". *The Wall Street Journal*, 14 April 97, C2.
5. Bulkeley, William M., Jon G. Auerbach, and Jeff Cole. "Military Might: Raytheon's Picard Does It His Way, Pulling Off Deal for Hughes Assets". *The Wall Street Journal*, 17 January 97, A1.
6. Carton, Barbara. "Raytheon Considering Partial Spin-off of its Fast Growing Engineering Unit". *The Wall Street Journal*, 6 March 95, A4.
7. Cole, Jeff and William M. Bulkeley. "McDonnell Douglas and Raytheon Hold Talks on Possible Business Combination". *The Wall Street Journal*, 30 July 96, A3.
8. Cole, Jeff and John R. Wilke. "U.S. Extends Review of Raytheon Deal for TI Defense Holdings". *The Wall Street Journal*, 14 February 97, B7.
9. "E-Systems Montek Division Merging with Raytheon Aircraft". Raytheon press release, 7 June 96.
10. "GM Transactions Designed to Unlock Stockholder Value". *Hughes Electronics Herald Bulletin*, 16 January 97.
11. Lipin, Steven and Jeff Cole. "Raytheon To Acquire E-Systems for \$64 a Share or \$2.3 Billion". *The Wall Street Journal*, 3 April 95, A3.
12. Muller, Joann. "GM Shareholders Sue to Block Raytheon Buy". *The Boston Globe*, 25 February 97, D1.
13. Overview, Texas Instruments Defense Systems and Electronics Business Sale to Raytheon, Texas Instruments Internet homepage, www.ti.com/corp/docs/raytheon/c97001.htm, last updated March 1997.
14. Raytheon 1995 Annual Report, 28 February 96.
15. "Raytheon Company and Hughes Electronics' Defense Business to Merge, Creating a \$21 Billion Enterprise". Raytheon press release, 16 January 97.
16. "Raytheon Completes Chrysler Technologies Acquisition". Raytheon press release, 14 June 96.
17. Raytheon Defense and Government Electronics Overview, Raytheon Internet homepage, www.Raytheon.com/def_ovr.html, last updated February 97.
18. Raytheon Electronics Overview, Raytheon Internet homepage, www.Raytheon.com/res/res_ovr.html, last updated May 95.
19. Raytheon Internet Homepage, www.Raytheon.com.
20. "Raytheon Purchases Defense Systems & Electronics Business of Texas Instruments". Raytheon press release, 6 January 97.
21. "Raytheon to Buy Chrysler Technologies for \$455 Million". Raytheon press release, 8 April 96.
22. Rebello, Joseph, Jeff Cole, and Bob Ortega. "Raytheon Draws Doubts on Concessions, Price for E-Systems". *The Wall Street Journal*, 4 April 96, A6.
23. Sloan, Allan. "A Sexy New Loophole". *Newsweek*, 3 February 97, 37-38.
24. Zitner, Aaron. "Raytheon Loses Key Missile Deal to Rival Hughes". *The Boston Globe*, Business Section, 14 December 96.

Lockheed-Martin

25. *Government Executive*, August 1995 (vol. 27, no. 8, 76-90; ISSN 0017-2626).
26. Harrison, Joan. "The Largest Combination of Defense Contractors". *Mergers & Acquisitions*, January/February 95.
27. Hirsh, Michael. "The Norman Conquest... How Big is Too Big for the Defense Industry?" *Newsweek*, 23 December 96.
28. Lockheed Martin 1996 Annual Report.
29. "The Defiance Business. Dithering Douglas", *The Economist*, 16 November 96.
30. Velocci, Anthony L. Jr. "High Hopes Underpin Lockheed Martin Plan". *Aviation Week and Space Technology*, 3 July 95.
31. Velocci, Anthony L. Jr. "Virtual Enterprise: A Plus for Lockheed Martin". *Aviation Week & Space Technology*,

- 10 February 97.
32. Vogl, A.J. "The Latest Chapter; Interview with Lockheed Martin CEO Norman Augustine". *Across the Board*, June 96.
 33. Cole, Jeff, "War of Attrition: Defense Consolidation Rushes Toward an Era of Only 3 or 4 Giants". *The Wall Street Journal*, 6 December 96, A1.

General Background

34. Finnegan, Philip. "U.S. Firms Broaden Defense Advantage". *Defense News*, 29 July 96.
35. Finnegan, Philip. "Reshaping the U.S. Defense Industry". *Defense News*, 20 January 97, 6.
36. Fuqua, Don. "Restructuring Pays the Bill". *Defense News*, 16 September 96.
37. Gluck, F. and R.N. Foster. "Managing Technological Change: A Box of Cigars for Brad". *Harvard Business Review*, September 75.
38. *Government Executive*, August 96. Top 200 Federal Contractors Supplement, 56-76 (ISSN 0017-2626).
39. Healy, Paul M., Krishna G. Palepu and Richard S. Ruback. "Which Takeovers Are Profitable? Strategic or Financial?" *Sloan Management Review*, Summer 1997, 45-57.
40. Hoover's Handbook of American Companies. The Reference Press Inc., 1995, 726-727.
41. International Directory of Company Histories. St. James Press, Chicago and London, 1990, 85-87.
42. Meyer, M. and A. Lehnerd. The Power of Product Platforms. The Free Press, 1997.
43. Roberts, Edward B. and Charles A. Berry. "Entering New Businesses: Selecting Strategies for Success". *Sloan Management Review*, Spring 85, 437-451.
44. Womack, D., T. Jones, and D. Roos. The Machine that Changed the World. HarperPerennial Publishers, 1991.
45. Utterback, James. Mastering the Dynamics of Innovation. Harvard Business School Press, 1994.
46. Velocci, Anthony L. Jr. "Competitive Advantages of Scale Could Elude Aerospace Giants". *Aviation Week & Space Technology*, 10 February 97, 88-89.