Final Report

Labor Aerospace Research Agenda (LARA)

June 1998 – April 15, 2005
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EXECUTIVE SUMMARY

The Labor Aerospace Research Agenda (LARA) began in June 1998 with a focus on the people who are at the heart of new work systems -- establishing stability and then driving continuous improvement. LARA was designed to further our understanding of this critical social dimension of what are termed lean principles and practices in the aerospace industry.

Funding has been provided via the Manufacturing Technology Division of the U.S. Air Force Research Laboratory and other sources. LARA is based at the Center for Technology, Policy and Industrial Development (CTPID) at MIT. The research and dissemination has been conducted in coordination with the Lean Aerospace Initiative (LAI).

LARA is committed to advancing policy, practice, and theory with respect to the labor and employment relations challenges facing all stakeholders in the 21st century aerospace industry. The specific research agenda was established with primary input from leading labor unions in the aerospace industry and with additional input from management, government and academic stakeholders as appropriate.

LARA's key accomplishments have been pursued with the express goal of optimizing on the value proposition for labor as a stakeholder. The specific interests and concerns of labor in the LAI consortium have been addressed by LARA. At our inception, labor leaders told us that research was also needed on the challenges that were undercutting the long-term viability of the industry, including instability in markets, funding, technology, organizations and supply chains. This research on instability has produced practical insights into what can and cannot be done at the facility level to mitigate the effects of instability on people and organizations. Simultaneously, it has advanced core theory around the concept of "instability" in complex engineered systems, as part of a growing a body of scholarship within MIT's Engineering Systems Division.

In Phase I of funding, 1998-September 2000, LARA focused on the impact of instability on employment and new work practices in the aerospace industry. Specifically, we examined three potential sources of instability -- changes in technology, changes in markets, and changes in organizations.

During Phase II, October 2000 – October 2002, the key theme of LARA research expanded to include "intellectual capital" and institutional infrastructure with a special focus on the workforce – recruiting, training, involving, and retaining talent at all levels. The research on instability continued during this phase.

Phase III encompasses October 2003 – April 15, 2005. During this phase of LARA research on instability, intellectual capital and institutional infrastructure continued, with the additional dimension of helping to organize a national Aerospace Industry Council through the Labor and Employment Relations Association (LERA). The overall research findings suggest that there are many innovative ways that individuals, facilities, and organizations attempt to mitigate the impact of instability. Still, the existing innovations are insufficient to effectively address the many sources of instability in this industry, which has direct

measurable implications for individual employment and careers, as well as for organizational performance.

Analysis of survey findings have yielded further insights into instability and employment in this industry. For example, we found a strong connection between employment outcomes and lean transformation initiatives. Specifically, we found that some U.S. aerospace facilities are taking a narrow, technical approach to lean, just focusing on minimal in-process inventory, reduced cycle times, and preventative maintenance. Others are taking what might be called a "high road" approach to lean that also emphasizes job rotation and flexibility, worker responsibility, group process training, and trust between management and employees. Further, we find that facilities emphasizing the narrow technical approach alone report experiencing job loss, while facilities emphasizing both the social and the technical dimensions report job growth. One might be called an "emaciated" approach to lean (just focused on eliminating waste), while the other seems to be genuinely creating value.

Based on the findings from our surveys, we continued our research and broadened the focus to explore industry-level institution building. We further expanded the research agenda to include a number of related workforce challenges, including what we termed “the demographic cliff,” the global employment dynamics in the industry, and the absence of industry-level coordinating mechanisms for building needed knowledge and skills. In this phase LARA continued its role impacting public policy by giving input to the Commission on the Future of the U.S. Aerospace Industry, the U.S. Department of Labor, and the LERA Aerospace Industry Council.

In the course of these efforts over the three phases of funding, LARA has supported some or all of the work of seven master’s students, two doctoral students, and one post-doc. In addition to this academic contribution, the project has provided insight to the practitioners who have contributed to the case study research through our action research approach. This feedback has also taken place through numerous workshops and presentations to groups such as LAI or the Aerospace Industries Association (AIA).

Summing up seven years of research on the aerospace workforce, we conclude that there are numerous innovations to be found, but that they are inadequately harnessed relative to the challenges facing this industry. Innovations that we have observed in avionics, airframe and propulsion operations include:

- Team-based work systems driving continuous improvement in operations
- Just-in-time delivery of modular training skills in aerospace production operations
- Cross-functional integration of engineering design and production operations
- Rapid-cycle work redesign initiatives improving product and process flow
- Worker self-inspection and statistical tracking of quality driving dramatic gains in quality performance
- Utilization of Activity-Based Costing (ABC), new pay systems, and other innovative financial arrangements
- Constructive management of sub-contracted work and restructured ownership arrangements
- Proactive handling of new technology

- Front-line union and management change agents driving continuous improvement efforts on the basis of deep expertise in the substance of new work systems and the processes of systems change
- Union-management partnerships focused on implementing and sustaining high performance work systems

Despite the importance value created through these and other innovations, we have also observed many "disconnects" at the work group, facility, organizational, and industry levels, including:

- Work teams that have become cynical after repeated "hope/heartbreak" cycles associated with successive improvement initiatives
- Inadequate mechanisms to manage leadership transitions – within management and within unions
- Incomplete accounting for investments in workforce skills and capabilities, resulting in strategic decisions that do not fully take into account the value of such investments
- Mistrust and substantive disagreements between labor and management, resulting in employers not fully valuing union contributions to improvement efforts and unions not fully embracing improvement efforts
- Barriers to the portability of workforce benefits and the transferability of workforce skills, resulting periodic regional shortages and surpluses
- Opportunities to address gaps in skill development (such as the investment need to facilitate transitions between the military to the commercial sectors of this industry) undercut by unrelated political and structural barriers
- Substantial gaps in the "pipeline" of skills for the development of the next generation of production, technical and engineering workers, as well as gaps in the perceived appeal of aerospace as an industry of choice for people to enter
- Inadequate mechanisms to understand and address the global flow of work and skills in the aerospace industry, including ambiguity about the implications of the emerging corporate strategies centered on being "systems integrators" rather than aerospace designers and manufacturers
- Gaps in available forums and dedicated participants engaged in strategic labor-management dialogue on workforce matters at the facility, regional and industry levels

Around the world, the aerospace industry is a source of national pride and prestige, as well as an important engine for growth and development. The LARA project developed the moto, "Right Skills, Right Place, Right Time," but today's realities fall well short of this vision. Despite noteworthy innovations, the persistent gaps and disconnects suggest that the continued status of aerospace as a leading industry in the US economy is at risk.

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Introduction and Historical Context

The Labor Aerospace Research Agenda (LARA) began in June 1998 with the belief that people are at the heart of new work systems -- establishing stability and then driving continuous improvement. LARA was designed to further our understanding of this critical social dimension of what are termed lean principles in the aerospace industry.

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LARA's key accomplishments have been pursued with the express goal of optimizing on the value proposition for labor as a stakeholder. The specific interests and concerns of labor in the LAI consortium have been addressed by LARA. When LARA was first funded in 1998, the preponderance of LAI members were from industry (management) and government, with a defined agenda that centered on deepening understanding of ways to assess and enable lean enterprise transformation. Labor leaders, while deeply committed to ensuring the long-term viability of the industry, were also under pressure from local leaders and members to distance themselves from narrowly focused lean initiatives. Efforts to eliminate waste were seen as accelerating layoffs rather than increasing capability and growing operations through the improved delivery of value to customers. It was also clear that there was a real need to deepen mutual understanding about lean transformation across labor, management and government as stakeholders. To keep labor engaged, LARA has held periodic strategic planning sessions and other meetings that have included national union officers and staff, including Bob Thayer (IAM), Steve Sleigh (IAM), Tom Kennedy (IAM), Paul Alemedia (AFL-CIO), Linda Ewing (UAW), Brad Markell (UAW), Gerry Lazarowitz (UAW), Greg Junemann (IFPTE), Faraz Kahn (IFPTE), Charles Bofferding (SPEEA/IPTE), Bobby Roberts (IBEW), and numerous local and regional union leaders. LARA team members frequently communicate with our labor contacts for input on research, policy recommendations, and opportunities in the field.

At our inception, labor leaders told us that research was also needed on the challenges that were undercutting the long-term viability of the industry, including instability in markets, funding, technology, organizations and supply chains. This research on instability has produced practical insights into what can and cannot be done at the facility level to mitigate the effects of instability on people and organizations. Simultaneously, it has advanced core

theory around the concept of "instability" in complex engineered systems, as part of a growing a body of scholarship within MIT's Engineering Systems Division.

LARA Phase 1

In Phase I of funding (1998-September 2000), LARA focused on the impact of instability on employment and new work practices in the aerospace industry. Specifically, we examined three potential sources of instability -- changes in technology, changes in markets, and changes in organizations. To better understand these issues, we conducted six case studies in a mix of airframe, engine and avionics facilities -- spanning military and commercial sectors of the industry as well as unionized and non-unionized sites. As well, we completed our first national random sample facility survey, with data collected from 194 separate aerospace facilities. In addition, over 400 individual surveys were completed and form the basis for ongoing dissertation research. The collective bargaining analysis, activity based costing analysis, an aerospace historical chronology, and global supply chain/strategic alliance exploration all were completed during Phase I.

LARA Phase 2

During Phase II, October 2000 – October 2002, the key theme of LARA research was "intellectual capital" and institutional infrastructure with a special focus on the workforce – recruiting, training, involving, and retaining talent at all levels. This was a natural follow on to the ongoing instability research. The second national facility survey was conducted during this phase of funding. Products include a panel study follow up to the national facility survey, case studies, the collective bargaining guide, a global supply chain/strategic alliance chart as well as conference presentations, briefings, articles, the LARA website and other knowledge deployment.

A big plus for knowledge deployment is the development and posting of the LARA web site: http://web.mit.edu/ctpid/lara/. The web site serves as a place to post our research findings. A letter was sent to all survey participants announcing that survey data is posted on the web site and information on LARA products such as the case studies and a white paper for a recent presidential commission on the future of the aerospace workforce is also on the web site.

LARA Phase 3

Phase III encompasses October 2003 – April 15, 2005. During this phase of LARA research, analysis of the data from the facility surveys continued. The findings suggest that there are many innovative ways that individuals, facilities, and organizations attempt to mitigate the impact of instability. Still, the existing innovations are insufficient to effectively address the many sources of instability in this industry, which has direct measurable implications for individual employment and careers, as well as for organizational performance. Based on the findings from our surveys, we continued our research on instability and broadened the focus to explore industry-level institution building and issues centered on what is termed investment in intellectual capital.

We further expanded the research agenda to include a number of related workforce challenges, including what we termed “the demographic cliff,” the global employment dynamics in the industry, and the absence of industry-level coordinating mechanisms for building needed knowledge and skills.

In this phase that LARA continued its role impacting public policy by giving input to the Commission on the Future of the U.S. Aerospace Industry, the U.S. Department of Labor, and the LERA Aerospace Industry Council.

In the course of these efforts over the three phases of funding, LARA has supported some or all of the work of seven master’s students, two doctoral students, and one post-doc. In addition to this academic contribution, the project has provided insight to the practitioners who have contributed to the case study research through our action research approach. This feedback has also taken place through numerous workshops and presentations to groups such as LAI or the Aerospace Industries Association (AIA).

SECTION 2: DESCRIPTION OF EFFORT AND RESULTS

The LARA research team gathered data in many ways including interviews, surveys, searching archives, as well as onsite observation and study visits. These are detailed below with each project. What might not ordinarily be considered data gathering are the extensive meetings the LARA group convened with stakeholders that enriched and informed the already collected data. With the data, the LARA research has impacted policy and practice in these two broad ways:

1. Advancing Knowledge on Instability, Lean Initiatives, Employment, and Skills in the Aerospace Industry.

2. Impacting Public Policy on New Work Systems and Employment Issues in the Aerospace Industry.

Meetings with Stakeholders

During each phase of the LARA project, meetings were held at MIT or in settings closer to the participants. For example, the LARA team held several working sessions in Detroit at the UAW headquarters. UAW officers and representatives joined the meetings in person while others were able to call in via conference phone to contribute to the meeting agenda. Meetings to report on project progress or to calibrate the various stakeholders were also held in conjunction with gatherings of other organizations such as the Industrial Relations Research Association (now the Labor employment Relations Association). These meetings provided important opportunities for researchers to calibrate with industry, labor, or government representatives and other experts. For example, Rob Scott of the Economic Policy Institute attended several LARA meetings or participated in panel discussions to brief participants on the latest statistics on offsets or other economic measures.
Beyond regular update and feedback meetings, LARA researchers and representatives from the various industry groups met for dedicated, high level meetings. Examples of these meetings follow:

In January 2000, LARA held a high performance teams meeting in Washington, D.C. with approximately 65 participants from industry, labor, government and universities. The session featured presentations on instability, HPWO and other innovations and included a policy dialogue. Recommendations from this workshop included:

- Fostering partnerships with the workforce
- Identifying/addressing sources of instability that impact the workforce & innovation
- Supporting a broad definition of “lean” aimed at industry revitalization
- Briefing LAI executives
- Briefing for DOD, Congressional officials and others
- Exploring Industry-level and other initiatives

"Enhancing the Effectiveness of our National Workforce:" Workshop Recommendations

- Highlight the importance of partnership with the workforce as a central ingredient in any lean implementation initiative
- Highlight the importance, in unionized operations, of partnership with unions as a central ingredient in any lean implementation initiative
- Identify and address sources of instability at facility, enterprise, industry and national policy levels that threaten to undermine or limit the implementation of lean principles

- Advance a definition of "lean" that emphasizes the re-vitalization of the aerospace industry, not just a narrow vision centered on cost cutting
- Explore facility, regional, enterprise and industry-level initiatives designed to enhance the effectiveness of our national workforce in the aerospace industry

- Present workshop findings and facilitate further dialogue among LAI executives on these issues

- Convene briefings for Department of Defense, Congressional officials and other key leaders to fully explore the roles of government – as employer, customer and regulator – with respect to work force capability and sources of instability

On March 12, 2001 LARA hosted a session entitled "Building 21st Century Aerospace Workforce Capability." The aim of this session was to assemble relevant research and field evidence on 21st Workforce Capability. The spirit of the session was to codify current research/experience for presentation to LAI leadership and other forums. During the session action recommendations were made for building the aerospace institutional infrastructure.

On June 15, 2004 LARA researchers met with union representatives at a stakeholders meeting. In addition to the LARA team, in attendance were: Steve Sleigh, IAM, Faraz Khan, IFPTE, John Crabill, U.S. Air Force, Man Tech Division, Laura Ginsburg, U.S. Department of Labor (by phone), Brad Markell, UAW Research Department.

Collective Bargaining Analysis

Collective bargaining agreements are a core factor in the employment relationships among participants in the aerospace industry. In unionized facilities, these agreements govern many aspects of day-to-day interaction as well as important processes such as promotion, job rotation, and employee development. In non-unionized firms, bargaining agreements do not physically exist, but their impact on workplace conditions is still felt. Contract language and bargaining agreements result from strategic initiatives often in response to actual or anticipated instability reflected in the cyclical nature of the industry. Therefore the LARA project undertook a study of the existing contract language in order to understand the role of collective bargaining with respect to instability in the aerospace industry.

Both the UAW and the IAM cooperated in providing bargaining agreements for sites they represent in the aerospace industry. The known universe of sites represented by all unions in the industry is approximately 500. From the contracts available, 28 were selected using criteria that tried to insure a broad view of different types of organizations, different sectors within the industry, and differing sizes of facilities.

Once the contracts for review were selected, categories of actual language were defined. These were developed initially based on categories in the contracts analyzed and then adjusted with input from the IAM and UAW. The contractual topics are organized around the following taxonomy:

1. High Performance Work Organization (HPWO) and Strategic Partnership

1a. Language establishing an HPWO or other strategic partnership
1b. Language providing strategic commitment to future of the business associated with the HPWO partnership

2. New Technology

2a. Language establishing partnership on new technology
2b. Language on training associated with new technology

3. Joint Union-Management Committees

3a. Language establishing a joint committee on safety
3b. Language establishing a joint committee on apprenticeships
3c. Language establishing a joint committee on training
3d. Language establishing a joint committee on sourcing and/or subcontracting
3e. Language establishing a joint committee on employee involvement and/or worker participation
3f. Language establishing a joint committee on other topics

4. Work Teams

4a. Language on the structure and operation of work teams
4b. Language on job rotation and cross-training within teams
4c. Language providing for hourly team leaders/coordinators
4d. Language on team leader/coordinator selection

5. Movement Across Operations

5a. Language on employee transfers to new locations within the company due to movement of operations
5b. Language on employee transfers to new locations within the company due to a reduction in force
5c. Language on employee transfers to new locations within the company for other reasons
5d. Specific guarantees on maintaining wage rates upon transfer to new locations within the company
5e. Specific guarantees on maintaining seniority upon transfer to new locations within the company

5f. Language enabling employee transfers to new locations in other companies

6. Outsourcing and Subcontracting

6a. Language requiring advance notice by the company to the union on outsourcing/subcontracting actions

6b. Language requiring the company to bargain with the union over the impact of a pending outsourcing/subcontracting action

6c. Language prohibiting or limiting layoffs due to outsourcing or subcontracting actions

6d. Language requiring the sharing of cost data associated with outsourcing/subcontracting decisions

6e. Language on the scope of work/jobs subject to notice and negotiations on outsourcing/subcontracting

7. Seniority Rights and Job Movement

7a. Language allowing for seniority preference in bidding on new jobs or when bumped from a job (within or across shifts)

7b. Language allowing for seniority preference in temporary layoff or permanent reduction in force

7b. Language establishing the scope of seniority rights

8. Job and Income Security

8a. Language allowing for volunteers in a temporary layoff or permanent reduction in force

8c. Language providing for advance notice prior to a temporary layoff or permanent reduction in force

8d. Language providing for the payment of supplementary unemployment benefits to workers on layoff

8e. Language providing for limits on layoffs during the term of the contract

8f. Language specifically limiting layoffs as a result of work reorganization (due to HPWO, teams, employee involvement, and related activities)

8g. Language allowing for early retirement as an alternative to layoffs

8h. Language allowing for preferential hiring rights of laid off employees at other locations

8i. Language allowing for limits on plant closings during the term of the agreement

8j. Language providing for training and job search assistance to laid off employees

9. New Hires

9a. Language providing for a special new hire pay rate

9b. The approximate or average spread in new hire and full rates

9c. The approximate or average grow in time from new hire to full rates

9d. Application of new hire rates when workers transfer from other locations

10. Temporary Workers

10a. Language allowing for the use of temporary workers

10b. Language on the process by which temporary workers might become permanent workers

11. Job Consolidation

11a. Evidence of compression or reduction in the number of production job classifications

11b. Evidence of compression or reduction in the number of maintenance or other support job classifications

12. Training

12a. Language on a formal apprenticeship training program

12b. Language on specific commitments around the number of apprentices to be trained during the term of the agreement

12c. Language on tuition reimbursement for work related education and training courses

12d. Language on tuition reimbursement for non work related education and training courses

12e. Language establishing in-house training/learning centers

12f. Language allowing for bargaining unit employees to serve as temporary or permanent training instructors

12g. Language establishing joint training funds

13. Hours of Work

13a. Language for overtime pay after 8 hours work

13b. Language for compressed/alternative work schedules (including 4 day work weeks with longer hours each day and other such arrangements)

14. New Pay Systems

14a. Language establishing "pay for knowledge" or "ability rated pay" systems

14b. Language providing for gainsharing or goal sharing payments

14c. Language providing for profitsharing payments

15. Flexible Work Arrangements and Work/Life Issues

15a. Language allowing for flextime

15b. Language allowing for job sharing

15c. Language allowing for telecommuting

15d. Language providing for dependent care time and information referral

Successive reviews of the contracts were made to search for examples of language in these categories. Additionally, the project highlighted language that was unique for its innovativeness and responsiveness to contemporary issues in the industry with a particular focus on those issues most related to instability. The final project contains a list of the selected contracts with demographic information about the facility and a tabulation of the numbers of contracts that contained language related to the topic categories. Further, an exemplar of language was included to illustrate a standard or innovative contractual clause.

This guide was used to further a more in depth investigation of the state of collective bargaining in aerospace. The LARA team analyzed how language is actually implemented and administered. Based on the full analysis, "A Guide to Collective Bargaining in the Face of Instability in the Aerospace Industry" was developed. As is noted in the Guide, collective bargaining serves four functions. These can be summarized with four words: Continuity, Adjustment, Innovation, and Codification. Each is a legitimate part of collective bargaining, although the dynamics are very different with these functions. The contract language in this Guide reflects this broad mix of functions. Special thanks to Michael Parker, MLIR student from Michigan State University, for taking the lead in identifying and analyzing these contracts at both the UAW and IAM headquarters.

Activity Based Costing

Activity based costing and management has not been widely used within the aerospace and defense industry. The main thrust of this research was to identify the barriers and enablers to the adoption of activity based costing and management techniques on a widespread basis among the companies that belong to the aerospace and defense industry. The research was conducted where activity based costing and management was implemented in one or more parts of a company's structure.

The case study from this research examines an application of activity based costing and management, the main goals of the implementation, the metrics for measuring the implementation's success, and the future plans after the implementation has taken place (i.e., if the implementation was a pilot program, identify future plans to cancel the project or migrate it to other areas of the organization in a effort to make it a company-wide financial management technique). Along with the above, there was substantial interaction with the persons in charge of the implementation process, through which it is hoped that information regarding the barriers and enablers to widespread usage among other companies within the aerospace and defense industry can be identified. The feasibility of activity based costing and management usage within this industry is examined and if the industry's unique operating environment would allow these companies to gain some, if not all, of the benefits gained by companies adopting activity based costing and management and operating in different industries. Rocco Paduano, MIT Sloan MBA student, worked with Joel Cutcher-Gershenfeld to complete this research for his Master thesis

Global Employment

Global employment data for the aerospace industry is not available. In order to begin the process of compiling these data, we gathered information from numerous statistical sources such as the Organisation for Economic Co-operation and Development, the Aerospace Industry Association, and U.S. Department of Labor to construct a first rough estimate of global employment numbers. Rob Scott from the Economic Policy Institute worked on this project with Betty Barrett. These initial estimates need additional refinement, but offer a reliable basis for further study.

Chart 1 provides a multi-decade look at aerospace employment and sales. We see that up until the early 1990s, employment and sales tracked one another closely. This pattern has, in fact, been characteristic of the industry over much of the past century – with cyclical ups and downs. More recently, however, employment has substantially lagged employment growth. There are many possible factors, including increased efficiency of operations, movement of work outside the US (particularly due to "offsets" in sales agreements), and even the movement of some suppliers outside of aerospace SIC 372 and 376. It might be assumed that many of these jobs might have shifted to Europe since the EU has been a leading competitive force in this industry. In fact, Chart 2 provides similar data for Europe and shows a parallel trend.

Chart 1
Sales and Employment for U.S. Aerospace Industry (SIC 372 and 376) since 1980

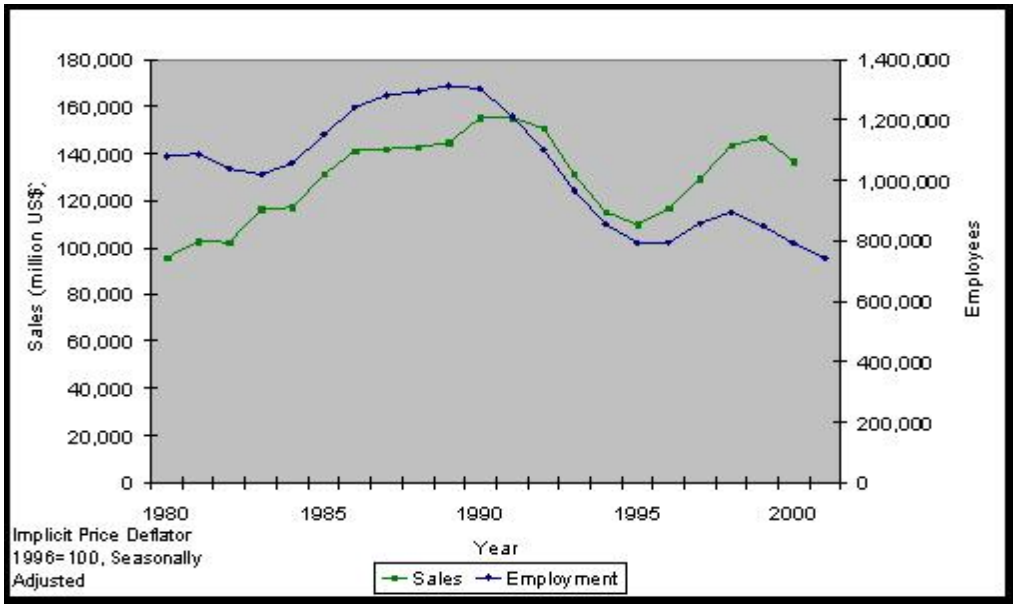
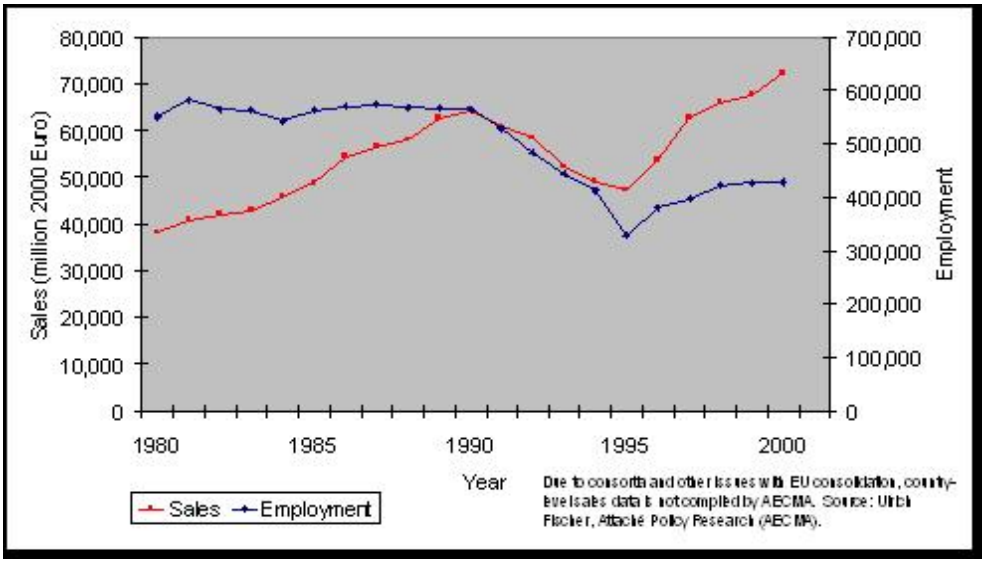


Chart 2
Sales and Employment for EU Aerospace Industry since 1980



As part of exploring global employment in aerospace, we began a global mapping project. Our first approach was to develop a map of OEM (Original Equipment Manufacturers) supplier relationships by program and a map of prime, first tier and second tier relationships organized by domestic and international sales of aerospace products, over time. These maps were designed to educate our target aerospace audience on the global challenges facing the industry. The industry is increasingly global -- through ownership, production offsets, and other suppler relationships. The global mapping project was a visual focus to help begin constructive dialogue.

As part of this project, on May 6, 2003 Marc Thompson, Templeton College, University of Oxford, visited the LARA team to discuss his research which is funded by the British government through the Department of Trade and Industry and coordinated by the Society of British Aerospace Companies. LARA researchers have maintained contact with Thompson who has become a LARA affiliated team member. He may contribute to the book manuscript currently being prepared. The LARA team also met with Maryellen Kelley, Ph.D., Advanced Technology Program, National Institute of Standards and Technology, Gaithersburg, MD (Previously with the H. John Heinz III School of Public Policy and Management, Carnegie Mellon University Pittsburgh, PA) for ideas on measuring global employment, July 2003.

The effort to actually count global aerospace employment numbers was successful in gathering data for all but three major aerospace national industries, China, Russia and India. Efforts are underway to acquire the Indian employment figure but there has been no real success in capturing the actual numbers for the other two countries. China does not yet keep the number in a format that allows for the separation of aerospace from other manufacturing workforces and the Russian numbers have been shrouded in a cloud of confusion since the breakup of the former Soviet Union. The newly formed countries that resulted from this

change are beginning to report workforce figures so it will someday be possible to capture these data as well. A chart showing the employment figures for some of the countries AND regions investigated is presented in Chart 3.

Chart 3
Worldwide Aerospace Employment in Selected Countries (1990-2001)

Year	Selected Countries/Regions				
	US [1]	EU [2]	Canada [3] [4]	Japan [5]	Brazil [6]
1990	1,302,000	564,595	65,700	39,100	-
1991	1,214,000	528,636	65,600	40,300	-
1992	1,100,000	483,828	61,300	40,200	-
1993	966,000	443,770	53,400	39,600	-
1994	855,000	413,329	54,000	35,000	-
1995	796,000	329,041	57,600	38,300	7,600
1996	796,000	382,012	61,000	35,700	6,500
1997	859,000	395,487	64,000	34,200	8,000
1998	896,000	422,484	73,000	34,100	10,500
1999	847,000	426,730	83,600	34,000	12,000
2000	791,000	429,107	91,500	32,148	14,000
2001	742,000	435,500	95,000	-	15,000

1. Source: Bureau of Labor Statistics, "Employment and Earnings" and Aerospace Industries Association (AIA) estimates from
www.aia-aerospace.org/stats/aero_stats/aero_stats.cfm
Refers to sum of SIC codes 372 and 376, and "all other aerospace related employment"
2. Source: European Association of Aerospace Industries (AECMA)
3. Numbers for 1980-83 refer to SIC 3211: Aircraft and Aircraft Parts (source: Industry Canada)
Post-1983 numbers source: "Canada's Aerospace Industry--A Global Leader." Presentation to journalists by Ron Kane, vice president, policy
and research, for Aerospace Industries Association of Canada (AIAC). July 2002.
4. The Canadian category, Aircraft and Aircraft Parts Industry (SIC 3211), includes US SIC codes 3724, 3728, 3769, 3721, 3761, 3764.
5. Source: Society of Japanese Aerospace Companies (SJAC) numbers reported in The European Aerospace Industry--Trading Position and
Figures 1997; 1988-2000 from SJAC website "Historical Development of the Japanese Aerospace Industry" at www.sjac.or.jp/english/01_b.htm
6. Source: Brazilian Aerospace Industries Association (AIAB)

This work helped prepare LARA to offer real insight into upcoming gaps in knowledge and skills that will develop as the aerospace workforce ages and retires. For example, it is not possible to train the number of machinists that the Bureau of Labor Statistics predicts is needed by 2008 in the timeframe available to the industry at current training and certification levels. No industry or national level initiative exists currently to address these gaps although they are now becoming recognized more widely.

LARA researchers met with David DeLong, author of the recently released book, Lost Knowledge, to discuss his research and incorporate his findings into project information for dissemination to the wider industry community. DeLong's work supported the LARA findings of upcoming shortages in aerospace workforce skills. The bottom line here is that as actual workforce/employment numbers fall, the remaining members of the workforce are

aging and will retire in increasing numbers in the next 7 to 10 years. This retirement wave could leave the industry without sufficient numbers of people with certain required skills.

An off shoot of this decline in employment is the fact that the current workforce has less need for certification and training programs such as the Airframe and Powerplant Licenses which have traditionally been offered through community colleges. The shrinking demand for training has combined with budgetary belt tightening to a decrease in the number of schools that continue to offer such training. This means that when the industry requires more people with this type of training, the programs will need to be reconstituted or rebuilt making the training even more costly.

LARA has also looked at the current state of apprenticeship programs in the U.S. aerospace industry. Rarely have there been so few people actively in training in these programs. The national facility survey reports that approximately 15% of the facilities indicated the existence of a DoL apprenticeship program, with the vast majority, 11%, having no current apprentices and no recent graduates. Only about 1.5% of aerospace facilities reported having more than 5 current apprentices or recent graduates, with the balance (about 2.5%) having less than that. About 8% of the facilities (including many of the same facilities with DoL apprenticeship) indicated that they had current apprentices or recent graduates in non-DoL apprenticeship programs. Again, however, the majority (over 5%) had fewer than 5 employees in these programs. On average, the reported capacity of the apprenticeship programs in the facilities where they still exist is over 20 workers. Thus, there is every indication that apprenticeship is no longer the training mode of choice in the U.S. aerospace industry. Other strategic choices dominate. For example, one prominent engine manufacturer purchased an entire Polish machine shop with several thousand machinists while laying off machinists in this country. This choice precludes the high costs and the long term nature of training needed to certify U.S. machinists. A question remains whether this is a successful choice over the long term.

Chart 4 represents one look at the demographic profile of the industry that helps to illustrate to full dimensions of the challenge.

Chart 4
Aerospace Age Distribution

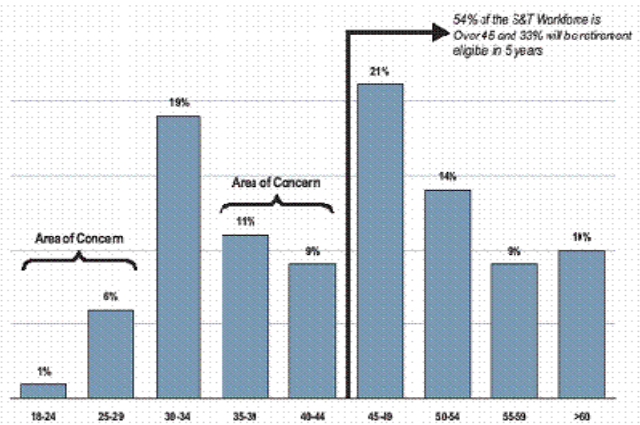


Figure 5. Average Space Industry Science & Engineering Workforce Age Distribution
Source: Booz Allen & Hamilton (1999)

As is evident from this chart, the more skilled, high-seniority majority in this workforce is heading for retirement and there are likely to be significant gaps in the skills associated with numerous apprenticable trades and other areas of specialty skils.

Boeing St. Louis [US Department of Labor (Grant: ES-12740-03-60)]

The LARA team was asked by the Employment and Training Agency of the Department of Labor (DoL) to document a change in how job descriptions and job content were being created at the Boeing Airplane Company in St. Louis, Missouri. The impetus for this sponsorship was the completion of a newly revised version of the Dictionary of Occupational Titles which the DoL had just completed and which consisted of detailed job content, skill requirements and training criteria for approximately 1400 of the most common occupations in the United States. Just as this revision was nearly complete, the DoL learned of the work that Boeing Company and the International Association of Machinists Local in St Louis were doing to reformulate and consolidate the previous 51 job classifications into nine job families or labor grades. LARA was asked to visit the site and document the events taking place as well as the implications of those events for job descriptions, work systems, and training initiatives. This case is integrated into the body of LARA research and adds to the overall outcomes of this project by extending our knowledge of U.S. aerospace workforce and employment relations issues.

Beyond the actual case study, this research has lead to three additional academic papers or presentations. Of particular importance to industry scholars are the detailed training data that were received from the company. Fifteen years of training data for four teams of individuals was made available for LARA analysis. These data provide in depth view of the types of training and changes in type as well as amount of training that these people received over 15 years. Analysis will allow a scholarly review of the evolution of this training over time and in conjunction with strategic initiatives within the firm. What follows is an overview of the case and its implications.

The IAM/Boeing operations in St. Louis are at the frontier of fostering workforce flexibility and new investment in skills – all in a constrained economic context marked by past labor management conflict and continuing organizational instability. Today, pioneering systems for just-in-time delivery of training combine with high performance work systems and front-line quality inspection. This experience points the way toward a model of skill development that meets employer needs for continuous adaptation and employee interest in lifelong learning, and which has important implications for public policy in the areas of training and apprenticeships.

Under the mass production system, dozens of job classifications were written into contracts and incorporated into operations – corresponding to the increasing segmentation of work. Today, these same classifications can serve as a barrier to the cross-utilization of workers, reducing flexibility in operations and constraining career opportunities.

In a number of industries, there is a growing trend toward the negotiation of increased flexibility in collective bargaining agreements, as well as increased use of combined classifications in nonunion operations. Not enough is known about the impact and operation of agreements to increase such flexibility – especially in the aerospace industry where so much of the work involves the use of highly specialized skills.

National Facility Surveys

A central component of the LARA project is three national random sample aerospace facility surveys. The surveys were targeted to senior operations managers in a random national sample of aerospace companies. The first survey was conducted in 1999-2000. The second began in the summer of 2002, with phone follow up continuing into early 2003. The third began in the winter of 2005. The surveys examine a wide range of topics related to the larger themes of instability and new work systems across a broad range of aerospace industry participants.

To accomplish these three surveys, project team members identified a sample drawn from a national aerospace directory and supplemented with data from the Lean Aerospace Initiative and other sources. The surveys were not only designed and printed professionally, but a web-based version was available for the first two surveys allowing participants to complete and submit an electronic survey. A first mailing targeted over 2500 facilities. Follow-up cards, telephone calls to over 900 non-respondents and a second mailing resulted in a final sample of 192 valid responses in the first administration of the survey. The approximate response rates (taking into account bad addresses and companies no longer in aerospace) were: 18% for airframes and engines; 10% for avionics, space and other sectors.

The second and third administrations of the survey targeted largely the same 2500 recipients with a small percentage removed from the list because the addresses were incorrect or the business was no longer in the industry. In the second round the mailing and follow up phone calls resulted in 362 responses. In this round, over 200 were returned as “not in the aerospace industry” or returned to sender as bad addresses.

The third survey gave the LARA researchers an opportunity to revise the questions to include more specific questions about skills gaps and business strategies. The business strategies questions were drawn from a vetted survey administered by Scholars at Oxford University to study the British aerospace industry. This inclusion may allow for at least a minimal piece of comparative analysis in the United Kingdom and the United States.

Initial returns from the third round of the National Aerospace Industry Survey allow us to make preliminary comparisons along select dimensions. As displayed in Chart 5, the breakdown of the primary product markets served by respondents has remained fairly stable across the three cross-sections. One dynamic implied by these data is a shift from the enumerated product categories, e.g., airframes, engines, munitions, to smaller, niche markets aggregated into the residual category. With so many technologies potentially lumped into a single category, it is clear that further analysis of Round III data must account for this proliferation of new markets served and the implications this might have for industry challenges. For example, average establishment size has fallen with each subsequent round of surveying, from 604 workers within each facility in 1999 to just 214 by 2005. Although this may result from the self-selection of respondents, it is also possible that facilities have trimmed employment rolls without strategically redirecting their product market or business strategies. However, when considered in conjunction with the increased use of so-called "High-Performance Work Teams" (HPWTs), smaller plants may well be producing smaller batches of more specialized products. Unfortunately, this simple theory is belied by the apparent slowing of the diffusion of HPWTs as well as early signs of a reduction in annual training hours for the production workforce. The data on apprenticeship programs does not reflect what appears from a preliminary inspection to be a reduction in actual numbers of people in those programs.

The median data on the age of the workforce provides a provocative view that demands deeper investigation. The lack of change may reflect the actual state of workforce age in the industry or may reflect the situation in the smaller firms more represented in these first returns. In earlier rounds of the survey, the "demographic cliff" was evident among large firms, but not small ones. This same factor may be reflected in the retirement eligibility data as well.

Chart 5: Comparative Results from Three Rounds of National Aerospace Industry Survey[1]

	Round I	Round II	Round III
Primary Product			
airframes and mech. systems	27.4%	24.1%	21.2%
propulsion/engines	9.6%	13.0%	7.7%
missiles or munitions	1.5%	2.8%	1.9%
avionics and elec. systems	20.3%	16.7%	17.3%
spacecraft or launch systems	2.5%	2.5%	1.9%
other	38.6%	40.8%	50.0%
No. of Workers	605	556	214
Training Hours per Worker per Year			
production	37.5	36.9	28.5
manager	32.0	29.2	31.3
professional/ technical	39.1	42.2	38.0
% Workforce in HPWTs[2]	under 25%	25% - 50%	25% - 50%
Apprenticeship Program	-[3]	20%	20%
Median Age of Workforce			
professional/ managerial	-[3]	46-55	46-55
technical/ production	-[3]	36-45	36-45
Retirement Eligibility	-[3]	under 10%	under 10%
n	198	363	105[1]

Table prepared by Adam Seth Litwin

1 Data analysis and collection for Round III is ongoing.

2 High-Performance Work Teams

3 Round I did not include this question.

While we stress that the analysis of Round III is only just getting underway, this first glimpse offers a sense of the richness of these data for making sense of trends in the industry. Next steps include fuller exploration of the longitudinal nature of the dataset. The six-year time period and the repeated sampling of the same facilities enhance the richness of results. For example, how are employers altering their employment models in response to intensified product market competition? Alternatively, which firms are more likely to leverage their existing workforces to generate value in other, unexploited markets? Furthermore, what institutional barriers prevent those employers who are eager to train their workforces from making these investments? Answers to these and other questions await the full analysis of these data, which is now underway.

Topics covered in the three survey administrations include:

- An organizational profile
- An overview of the frequency of specific types of instability
- A recounting of management practices used to mitigate the effects of instability
- Analysis of the impact of types of instability
- An overview of work practices in the facility
- Analysis of contextual factors that impact the facility
- Identification of the learning environment in the facility
- A trend of the employment outcomes over three years
- An overview of the facility's economic performance over three years
- Trends in the populations of employment groups or classification
- A review of firms' knowledge management techniques and their perceived values
- Indicators of the extent of global involvement among U.S. firms
- Identification of the firm's strategic motivation

Facility Profile from the Survey:
Average number of employees: 558
Average year began operations: 1976
Average percentage sales to largest customer: 30%
Average number of major government programs: 5.4
Average number of major commercial programs: 8.9
Unionization among respondents: 15%

Respondent Profile:
Average years of experience in aerospace: 24
Average age range: 46-55 years
Average education level: undergraduate degree with some graduate education

Guiding the analysis of the data is a conceptual model, which is presented in Chart 6. This model reflects the view that key outcomes for aerospace stakeholders (employment, economic performance, and organizational learning) are impacted by the various forms of instability. The impact of instability is mediated by new work practices and moderated by various mitigation strategies.

Chart 6
Conceptual Model for Research on Instability, Employment and New Work Practices

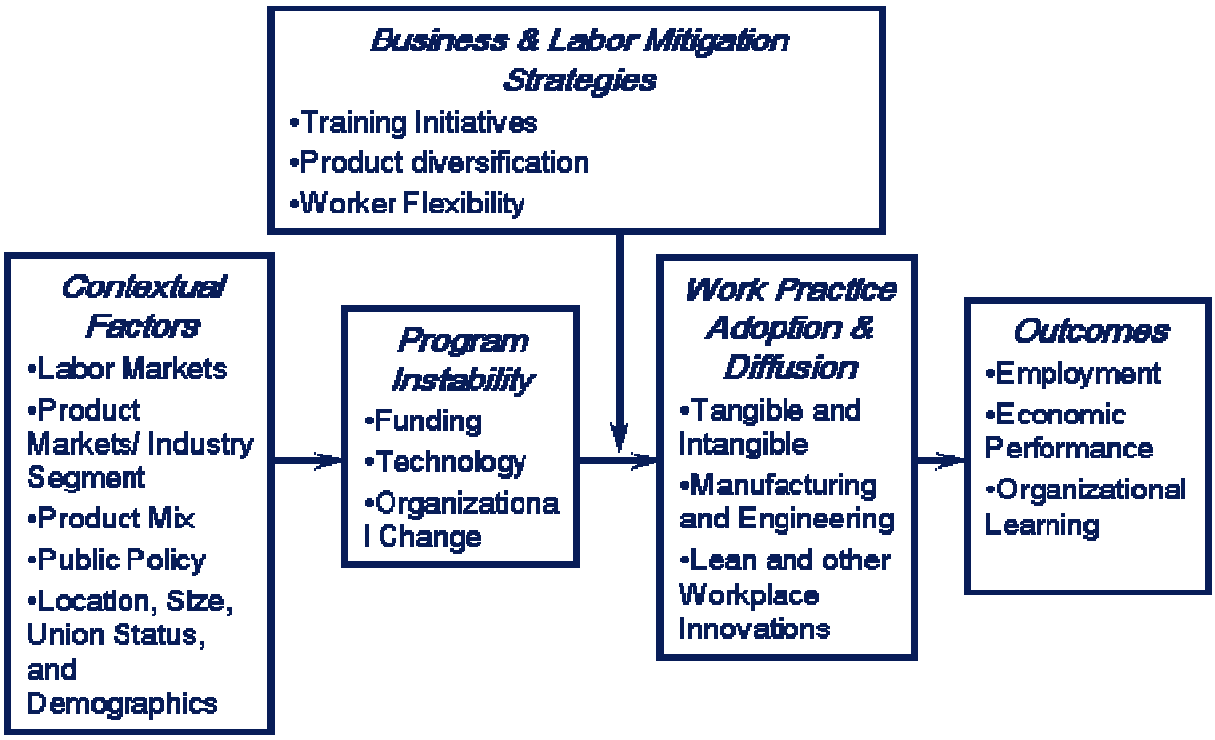
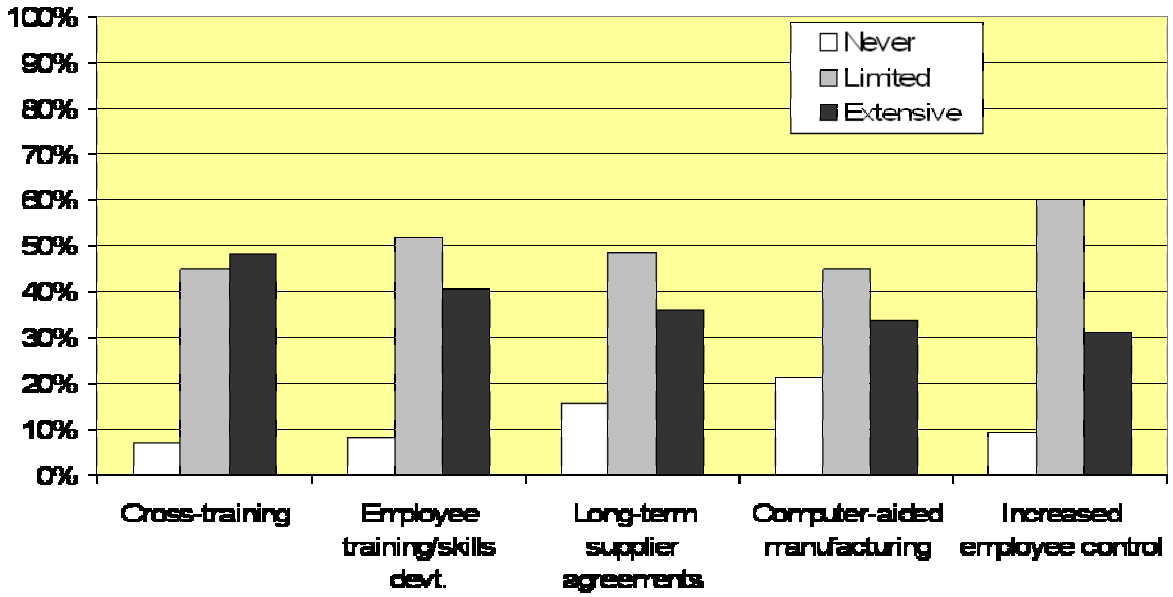


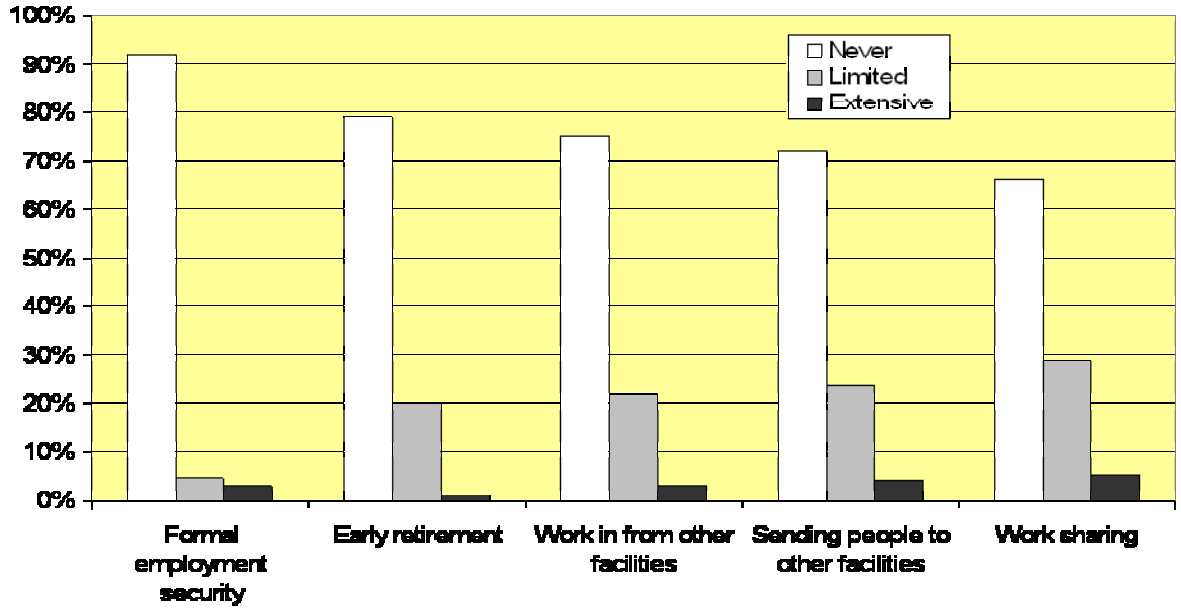
Chart 7 summarizes the five most common methods reported for the mitigation of instability: Cross training, Employee training/skills development, Long term supplier agreements, computer aided manufacturing, Increased employee control. This was presented in a briefing to the LAI Executive Board in June 2000. As is evident from the data, these methods reflect policy action domains that are within the control of facility leadership. While all helpful, none are likely to prevent continued instability in the industry.

Chart 7
Five Most Common Methods for Mitigation of Instability



By contrast, Chart 8 presents the five least common methods: Formal employment security, Early retirement, Work in from other facilities, Sending people to other facilities, Work sharing. Many of these do represent systems-level efforts that are more likely to have a larger impact, but they reveal the lack of systems-level mechanisms for dialogue and action.

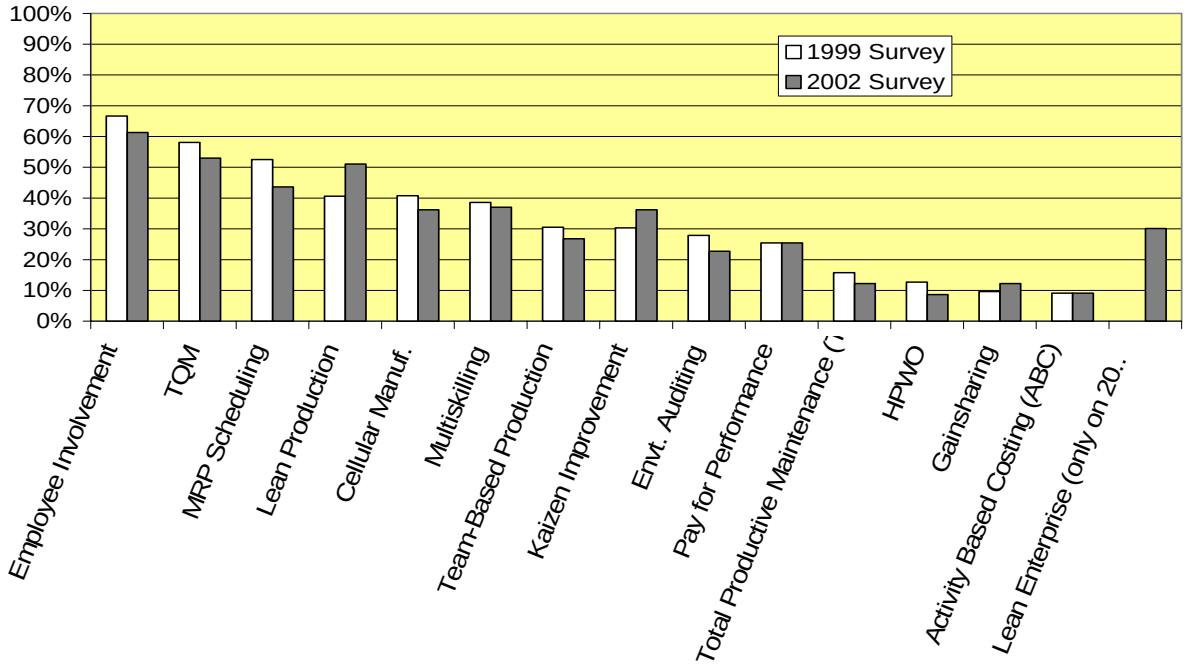
Chart 8
Five Least Common Methods for Mitigation of Instability



In exploring the impact of instability on workplace innovations and operations, we first asked respondents about the presence of various workplace initiatives. Chart 9 provides and

overview of the frequency of a broad range of initiatives, with employee involvement and TQM being the most common.

Chart 9
Reported Presence of Workplace Innovations



Charts 10, 11, and 12 represent a mapping of these various initiatives against the forms of instability. A scale was composed in which organizations facing high levels of instability were distinguished from those facing moderate or low levels of instability. In the first chart we see examples of initiatives that are not particularly impacted by the level of instability – the frequency is approximately the same regardless of the degree of instability.

Chart 10
Minimal Impact of Instability

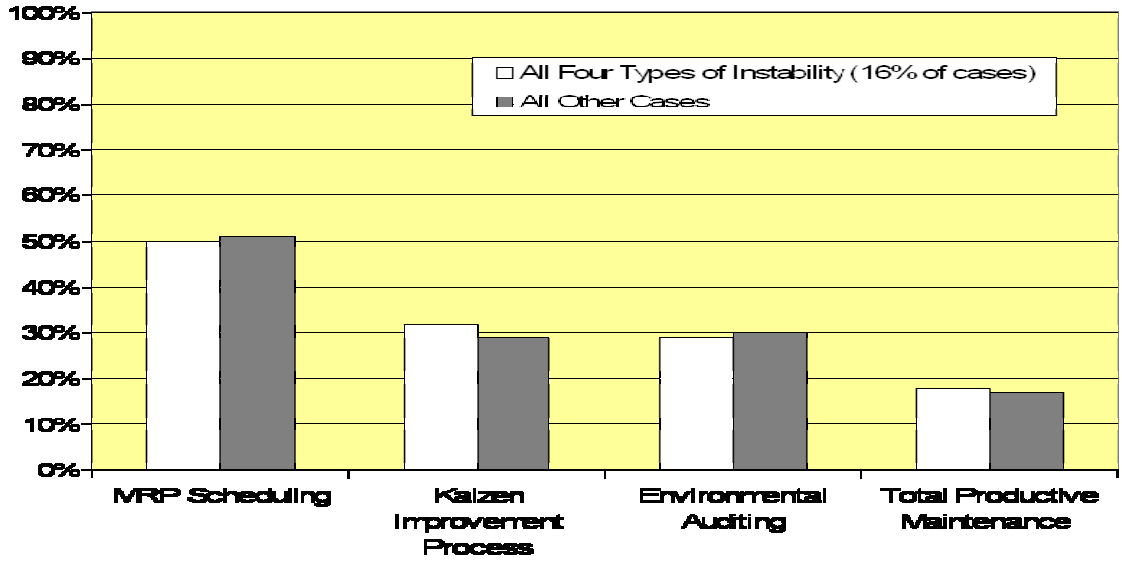
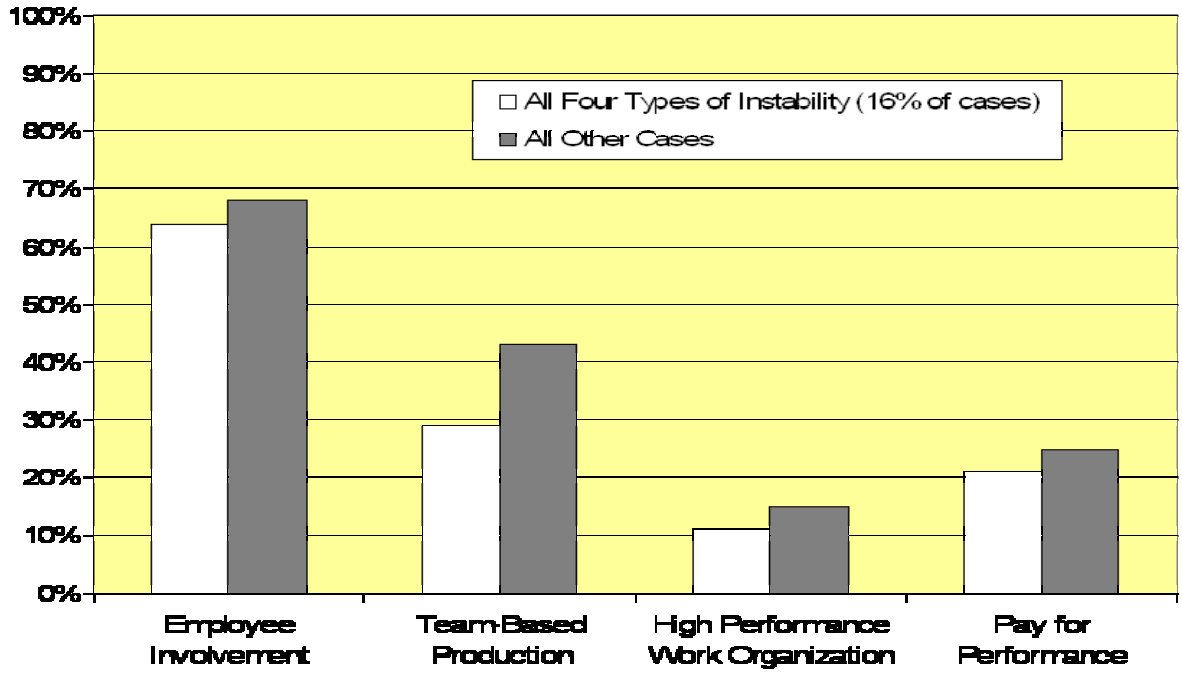


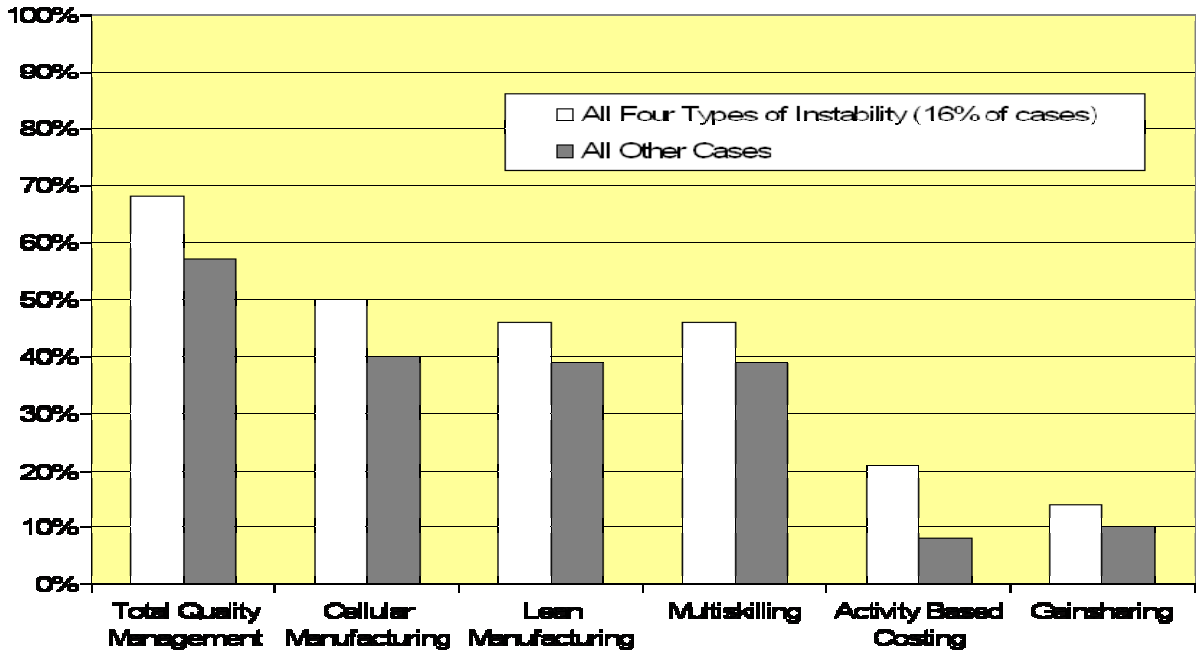
Chart 11 presents facility-level initiatives less likely to be found when instability is high.

Chart 11
Workplace Initiatives Less Likely Due to Instability



By contrast, Chart 12 features initiatives more likely to be found when instability is high.

Chart 12
Workplace Initiatives More Likely Due to Instability



This analysis provides insight into the middle part of the model – how instability affects various workplace initiatives. The final part of the model involves the impact of these initiatives on economic performance. As Chart 13 illustrates, some impact of instability can be found on quality and schedule performance, but not on reported productivity levels.

Chart 13
Instability and Productivity, Quality and Schedule/Delivery Performance

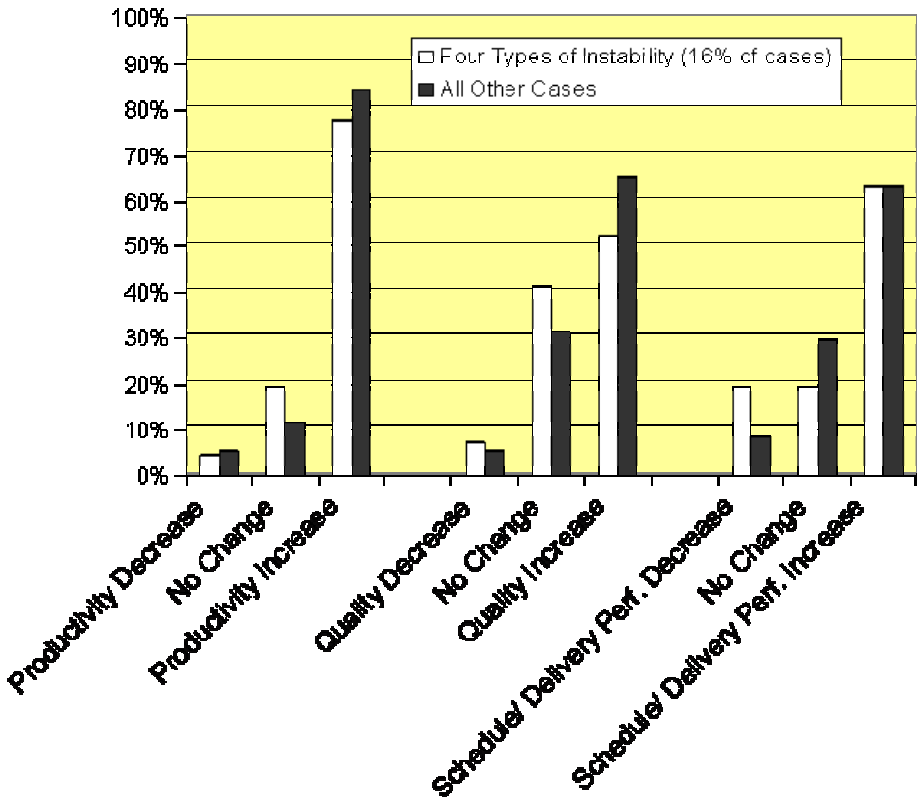
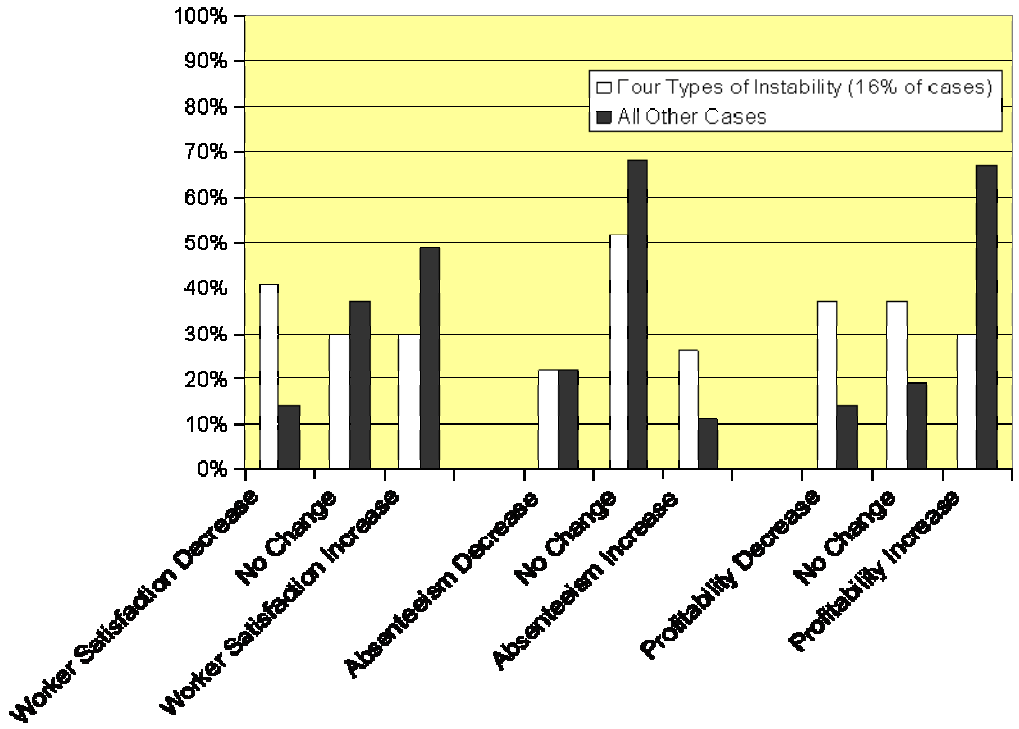


Chart 14 extends the analysis to other outcomes, with clear impacts on work satisfaction, absenteeism and profitability.

Chart 14
Instability and Worker Satisfaction, Absenteeism, and Profitability



Analysis of survey findings have yielded further insights into instability and employment in this industry. For example, we found that some U.S. aerospace facilities are taking a narrow, technical approach to lean, just focusing on minimal in-process inventory, reduced cycle times, and preventative maintenance. Others are taking what might be called a "high road" approach to lean that also emphasizes job rotation and flexibility, worker responsibility, group process training, and trust between management and employees. The LARA research further finds that facilities emphasizing the narrow technical approach alone are experiencing job loss, while facilities emphasizing both the social and the technical dimensions are experiencing job growth. One might be called an "emaciated" approach to lean (just focused on eliminating waste), while the other seems to be genuinely creating value.

Additional findings from these surveys have been coordinated with LAI research by Eric Rebentisch to advance knowledge on the concept of instability in complex systems, which was presented in two ESD symposia. Takashi Inaba is also studying these findings and using them as a core element of his PhD dissertation research. Findings from the surveys have also been presented to the LAI Executive Board and Plenary Conference as well as in other settings. The data are rich and will continue to support ongoing and substantive analysis.

One critical element of the research is a long term study of the survey data from all three survey administrations. The LARA team established a panel research project that allows times series data to be collected from the same set of respondents over the three survey rounds. Such a panel design allows long term analysis of industry changes. Long term

analysis is a key ingredient to support subsequent policy recommendations to the constituents in this project; labor, government, industry, and academia. The data has been included in briefings, reports, and scholarly articles.

One overarching aspect of instability in the industry is presented in Chart 15. As additional consolidation occurs in the industry the challenges associated with organizational instability are likely to intensify.

Chart 15: Consolidation in the Aerospace Defense Sector

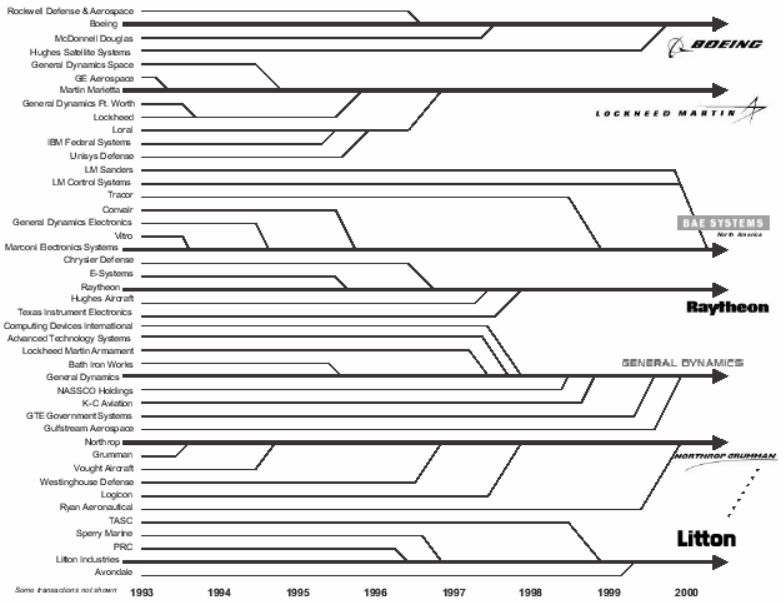


Figure 3. Defense Industrial Consolidation, 1993 to 2000 (selected transactions)

To access the survey and the results for Survey I and II, visit: http://web.mit.edu/ctpid/lara/pdfs/NatlsurveyI.pdf. Results for Survey III will be posted spring/summer 2005.

Copies of each survey round are included in the appendix. (Appendix I)

Individual Survey

Positioned as a complementary study with the facility surveys, the individual survey investigated the impact of employment instability and organizational responses to this change at the individual level. The range of topics includes work practices, technology, employment, learning, the impact of funding, and focused views from inside the participating organizations.

The survey was administered in four research sites:

- Boeing Rocketdyne in Canoga Park, California

- Boeing Commercial Airplane in Wichita, Kansas
- Rockwell Collins sister facilities in Cedar Rapids and Coralville, Iowa
- Textron in Wilmington, Massachusetts

All of these sites are unionized facilities, except the Textron plant. We collected over 400 individual surveys. Respondents were chosen by the employer using random sampling methods as much as possible. LARA team members administered the surveys at each site.

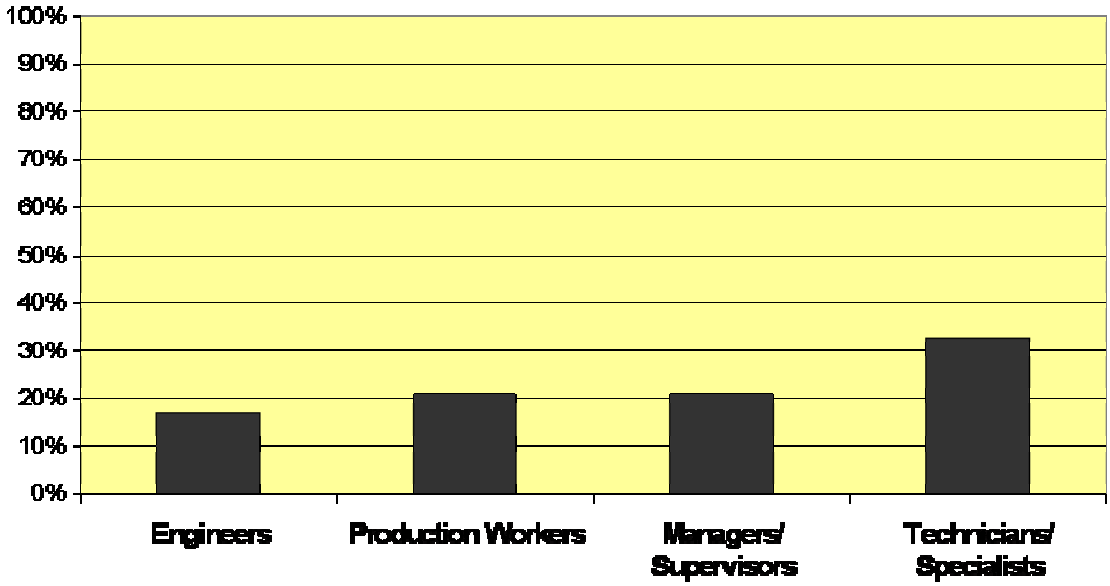
Of the data analyzed at this time the response ratio based on occupation code for employees (of those who answered this item) taking the survey is as follows:

(as of August 20, 2000).

Engineer	81	(30.3%)
Manager/supervisor	67	(25.1%)
Technical	17	(6.4%)
Production	100	(37.5%)
Other	2	(0.7%)
Total	267	(100%)

Findings from the individual surveys was cited by the National Commission on the Future of the Aerospace Industry. As you can see from Chart 16, serious questions exist about future entrants into the industry.

Chart 16: Careers in Aerospace



"I would highly recommend that my children work in this industry"
(Agree or Strongly Agree, n=482)

Case Studies

Case studies allow readers to have a detailed look into the specifics of a site or situation. Because they make useful and accessible teaching tools for a wide variety of audiences, case studies were the research methods of choice for much of LARA's work. The goal was to provide the team and the readers with facts in a concentrated format that allows more reliable analysis of the situation. Out of this analysis we hope that people will create more knowledge of the situation and its wider industry context. Taken together these case snapshots offer an extended overview of elements of the U.S. aerospace industry in the last decade.

The series of ten LARA case studies on instability provide insight into some of the ways that facilities are coping with the impacts of budget shifts, organizational restructuring, changing economic and market forces as well as technological change. Case study sites reflect a wide spectrum of industry participants. The locations span a variety of sectors, include military and commercial sites, vary by size, and union status. The cases offer a series of lessons and observations, we hope will provide greater insight into the issues facing the aerospace industry in the global economy. But these case studies also make clear that these are system challenges that can only be partly mitigated or addressed at the facility level.

From the case studies we learned that instability could come from many factors. The following is a partial list organized under the main types of stability we identified:

- **Shifts in funding or economic forces**
  Shift from R&D to production funds
  Fluctuations in demand for primary product in facility
  Uncertainty in Congressional budget flows
  Pressures from customers to reduce costs

- **Shifts in technology**
  Changes in customer requirement
  Materials innovations
  Rapid pace of change in computer capabilities
  Environmental constraints
  Strategic change from fabrication to systems integration
  Introduction of new design methods

- **Shifts in organizational structures (such as mergers or reorganizing)**
  Acquisition/layoffs
  Mergers/restructuring
  Relocation of products among facilities
  Two-tier relationship between sister facilities
  Demographics – retirements/gaps in past hiring, skills shortages
  Turnover – management, engineering, hourly
  Knowledge management
  Base relocation and consolidation
  Changes in work organization systems

Changes in skills and capabilities

We observed a number of different mitigation strategies:

- Business Strategy
  Increase proportion of commercial business sought
  Shift in product mix to increase focus on space

- Human Resource Management/Industrial Relations
  Cross-training/flexible utilization teams
  Informal no-layoff practice
  Labor-management partnership
  Employee Involvement
  Intensified training of hourly and salaried employees
  Co-location of engineers, teams
  Two-tier wage system
  Multi-facility transfer agreements

Coupled with the information found in each case are tools to help with using the cases as teaching tools. Each case study has teaching notes and questions to guide discussion. They are all electronically available on the following web sites: http://web.mit.edu/ctpid/lara/prodpub/casestudies.html and https://dspace.mit.edu/handle/1721.1/1784/browse-title.

In addition to distribution at the individual sites, many copies have been sent to labor educators at a number of universities and unions around the country. Copies have also been distributed at other events such as LAI and AIA events. Furthermore, we are in the process of editing the cases and other relevant materials into a book manuscript. A copy of each case study, is included in Appendix II.

Below each case is briefly described and then important lessons drawn from all the cases are highlighted.

1. **Fostering Continuous Improvement in a Changing Business Context. Textron Systems, Wilmington, Massachusetts, 1998, 1999, 2000. Cutcher-Gershenfeld**.

This is a large non-union facility implementing systems change initiatives in a rapidly changing business context. Textron has been an important contributor to the U.S. defense aerospace business for five decades. The company is a prime contractor with the U.S. government and supplier for other technologies. Textron sees workplace change initiatives as key to business success. It seeks performance gains through employee training and development. Textron Systems illustrates the ever-changing challenge of aligning employment systems with business strategy in the aerospace industry. It can sustain major change initiatives and is vulnerable to the swings that come with each new business contract. A combination of training, organizational development and work restructuring activities are being implemented. Even so, they cannot fully mitigate the instability associated with the defense aerospace sector.

2. **Fostering Workplace Innovation and Labor-Management Partnership: The Challenge of Strategic Shifts in Business Operations, Pratt & Whitney (United Technologies) and IAM Local 971, West Palm Beach, Florida, 1999. Barrett.**

This case began as an effort to document locally designed and implemented joint innovations between the IAM and area management centering on establishing a team-based work system and joint training systems. While important as innovations, these efforts did not convince Pratt Corporate leaders in Connecticut managers to maintain the workforce in this location. Ultimately, neither union or local management efforts were sufficient to overcome the instability associated with broad corporate strategies around the movement of work. The case illustrates the types of dilemmas that can occur across and within large organizations as competition to survive becomes more severe. Of particular interest is the fact that in this case there was internal division among headquarters level management and union leadership and those at the facility level in both organizations. A second part of this case that highlights corporate strategy is the attempt made to shift the West Palm Facility from R&D to fabrication. This shift was extremely difficult for the highly skilled workforce to understand and accept. Thus the case contains two markers of the overall trends in the industry, outsourcing highly skilled work and implementation of new work systems.

3. **Transformation through Employee Involvement and Workplace Training: The Challenges of a Changing Business Context. Rocketdyne Propulsion and Power, Canoga Park, California, 1999. Inaba and Barrett.**

Employee involvement (EI) programs like the one at Boeing Rocketdyne are often efforts to more fully engage the workforce in the success of the firm. In this case as the company shifts its focus from military to commercial products, a new program was one tactic. Beginning after acquisition by Boeing in 1996, the facility developed a vigorous employee involvement program. EI and workforce training were the two key mechanisms to mitigate instability in the product switch over. Negotiated between the UAW union local and Rockwell International in 1990, the EI program creates an opportunity to say how work is done, which represents an important culture change. Leadership skills are just as important to success are technical skills. 120 EI groups were formed as well as six self-directed teams. Rocketdyne is still faced with organizational and cultural change challenges, through the growth and competition in the space sector. Engaging in a jointly supported participative activity can provide greater access to expertise and knowledge within the workforce in exchange for the increased employment security that can arise from increased cost effectiveness.

4. **Employing Activity Based Costing and Management Practices within the Aerospace Industry: Sustaining the Drive for Lean. Boeing Commercial Airplane Group, Wichita Division/IAM, Wichita, Kansas, 1999 and 2000. Barrett, Paduana, and others.**

Activity Based Costing and Management (ABCM) is an accounting tool that can help companies recognize true costs and make critical choices. ABCM is designed to help

firms shift their priorities from individual products to the overall manufacturing environment. BCAG is the world's largest manufacturer of commercial airplanes. It is crucial to move the corporate financial department from account role to that of business partner. The ABCM model organizes activities in terms of their relationship to final cost objects. Looking at two pilot studies, this case study shows the benefits that can be reaped from ABCM implementation. The IAM has supported the adoption of ABCM as a way to get at the true costs of production. There is caution, however, that ABCM is not a panacea.

One important element of ABCM or other nontraditional accounting practices is the freah perspective this type of change can bring to people in the industry. As an industry that "grew up" with a cost plus system during WWII and the Cold War, patterns of interaction were engrained, as were processes such as military procurement. Rethinking how to make decisions and establish procedures can be beneficial on many levels. The most critical factor, however, is making the new procedures flourish and be sufficiently robust that they replace the older systems.

5. **From Three to One: Integrating a High Performance Work Organization Process, Lean Production and Activity Based Costing Change Initiatives. Boeing Corporation, Wichita, Kansas, IAM, 2000. Kochan.**

In 1997, Boeing and IAM launched a High Performance Work Organization (HPWO) after introducing lean production initiatives in 1994 and Activity Based Costing (ABC) in 1996. Management and union leaders wanted to empower the workforce and enhance the competitiveness of the operations. After a slow and difficult path of diffusion, they need to decide how to best integrate these separate improvement programs into a single initiative. Boeing's engineering culture needs to work with the pragmatic workforce in Wichita. Workers fear losing products and projects to other Boeing facilities and have concerns about leadership turnover and follow-through. Working with the HPWO initiative helped managers recognize the advantages that could be achieved through a cooperative effort with the union. While this realization has great value, the parties need to see the value of integrating and supporting all their efforts in order to optimize the benefits.

6. **A Decade of Learning: International Association of Machinists/Boeing Joint Programs. Seattle, Washington, 2001. Kochan.**

This national joint training initiative, funded at 14 cents per payroll hour worked, represents a key institutional innovation. Negotiated under Article 20 of the contract, this program has evolved over its first decade of experience. It expands life long learning to nearly all hourly workers. Major components of the program include: Layoff and Redeployment assistance, The Health and Safety Institute; Career and Personal Development; Classroom Training; Personal Enrichment, and High Performance Work Organization (HPWO). After a decade, the joint programs have reached between 40 and 50% of bargaining unit employees. Lean initiatives at Boeing are largely separate from the National Joint Training programs. The joint training programs have attractive design

features and a steady stream of funds - so perhaps they should be more tightly linked. The program is jointly governed and staffed and thereby provides shared ownership from management, the union and the workforce. Its full potential will only be realized, however, when line managers see it as a core resource.

7. **Rockwell Collins & IBEW Locals 1362 and 1634: Investing in Knowledge, Skills, and Future Capability in an Uncertain Business Environment. Cedar Rapids, Iowa, 2003. Barrett.**

The impact of the post-September 11th economy can be more deeply appreciated by observing Rockwell Collins in Cedar Rapids, Iowa deal with the hard choices they faced. The company and its unions still maintain a commitment to knowledge retention and knowledge building, despite being faced with the need to cut costs, including laying off significant portions of the work force.. This case study chronicles the efforts of this leading producer of advanced communication and aviation electronics for the commercial market and the defense industry to balance the costs of maintaining productive effectiveness while responding to market pressures. Current market pressures include increased technical requirements and depressed demand for its products, which include: in-flight entertainment systems, aircraft communication systems, global positioning systems (GPS), flight deck displays (including collision alert systems and virtual landing aids), communications systems, and automatic flight controls. Survival depends on walking a strategic knife edge to sustain the bottom line and still maintain the innovation and flexibility needed to build products to market demand. Two plants were part of this case, which allows the case to also examine how their differing work systems can effect workforce responsiveness.

8. **Strategies for Workforce Flexibility and Capability: The New Job Families at Boeing St. Louis. 2004. Barrett, Fraile, Litwin, Cutcher-Gershenfeld.**

The Boeing Integrated Defense Systems (IDS) St. Louis plant is at the frontier of fostering workforce flexibility and new investment in skills. Pioneering systems for just-in-time delivery of training combine with high performance work systems, front-line quality inspection, and labor-management cooperation. This experience points the way toward a model of skill development that meets employer needs for continuous adaptation and employee interest in lifelong learning. At the core of this case are the joint efforts by the company and the union that have enabled the progress to date. Through targeting collective bargaining, the parties were able to reduce the number of traditional job classifications (see earlier discussion) and have developed innovative training techniques to enable workers to do work across these old task lines. Plant manager was able to maintain some level of employment security although layoffs did occur. This case also highlights the struggle to maintain trust and perceived business viability.

9. **International Association of Machinists and Boeing Joint Quality Through Training Programs. Tukwila, Washington. 2004. Long and Barrett.**

The Quality Through Training Program (QTTP), a joint management and IAM sponsored program, is playing a vital role within the Boeing Company to cope with a complicated situation: reducing the workforce, implementing lean manufacturing, and the upcoming training of a new workforce as thousands of workers prepare for retirement in the coming years. QTTP Joint Training Programs were not created with these specific uses in mind, but because the programs are already established, they provide a foundation on which to build these new roles. Internal union and management groups are now relying on the credibility and connections of the QTTP leadership to facilitate organizational problem-solving. This case study describes how the joint program has responded to new organizational needs heightened by sudden changes in the aerospace industry and has expanded its influence to previously uninvolved areas such as operations. Credibility, responsibility, and effectiveness have allowed QTTP to become a more valuable and appreciated factor in the company's success.

10. **Warner Robins Lean at the C-5: Essential Elements of Success, (2004) Barrett and Fraile.**

    Warner Robins Air Logistics Center is one of three maintenance depots for the U.S. Air Force. The ALC is situated on a large air base, with a number of other military units and activities. This case focuses on the introduction and application of lean principles to the C-5 maintenance program. The C-5 is a huge cargo plane in use in many areas around the world. It is an older model aircraft that is integral to military operations and must be maintained to continue its service. The Lean initiative has proven quite successful in cutting the time that each aircraft must be out of service. The case provides details of the activities and changes that have taken place. In addition, the case tries to describe the context within which this lean activity is taking place. There are real challenges facing the base through the Base Relocation and Closure Act (BRAC) as well as changes in the federal government employment provisions that could have serious impact on the workers At Warner Robins. The American Federation of Government Employees represents many of the workers at Warner Robins and needs to be more included in the decision-making about lean implementation. The Warner Robins case provides insight into the challenges, both threats and opportunities facing the workforce in military and defense workplaces.

Lessons Learned from Case Studies

The exercise of doing the case studies and viewing the industry through these snapshots provides in depth views of the objects of each study but also illuminates some aspects of the wider industry as analysis across studies goes forward. What follow are some of the lessons that can be drawn from the cases.

1. The U.S. aerospace industry is rapidly approaching a demographic cliff as the average age of the workforce reaches the late 50's and this large group begins to retire. Generation of institutional, program and project memory as well as layers of expertise and skills base will be exiting the industry. Responses to this dilemma are varied but in no way industry wide or unified from a policy perspective. For example, some

firms have adopted a systems integration strategy with the outcome that as they spin off their fabrication operations, they pass the responsibility for replenishing the skills base down the supply chain.

2. Skill training and enhancement efforts have been dramatically affected by the changes in the industry. Apprenticeship programs have been largely abandoned or mothballed for the time being because those workers who have not been laid off have had an opportunity to receive training for the more highly skilled trades. Thus, those jobs that demand certification and long terms of training are currently filled by older workers who may soon retire. There are few younger workers in the training pipeline to take over this work. The gap created by the retirement of skilled workers with high levels of organizational memory and the time needed to build a replacement workforce will not be easily filled even with the innovative efforts going on like knowledge management efforts at Rockwell Collins or just–in-time training at Boeing St. Louis. There is also a broad trend toward increased cross-training of workers in order to facilitate organizational flexibility. As the Boeing, St. Louis, case indicates, a substantial supporting infrastructure and a degree of strategic alignment between labor and management is needed in order to achieve full value from such cross training.

3. Companies and unions that engage in joint activities often find they must be very attentive to issues of trust or mistrust that may have developed over time in the employment relationship. The importance of creating and sustaining a trustful relationship cannot be emphasized enough. Trust building allows the parties to take risks and attempt innovative or previously not attempted changes. A dilemma arises when local facilities begin to develop more trusting relationships and these efforts are not understood, acknowledged or supported by higher-level leadership.

4. Employment relations is a critical element of a firm's success. Those companies that have been able to join forces with their workers often marshal greater responsiveness and better flows of knowledge. Firms and unions, where they exist, are often unwilling or unable to fully value the relationships they enjoy within the facilities and across organizational lines. Often this distance is based on past history of conflict that clouds the present. These patterns of disagreement often can become obstacles to new more effective relationships.

5. Over one million aerospace jobs have been lost in the last 20-30 years in the United States. While the loss of this many jobs can represent a huge economic loss to our society, it also raises questions of where these jobs went and what caused their loss? LARA research and that of others like the scholars at the Economic Policy Institute (EPI) and other universities point to global competition and the off shoring of work as two of the causes of the job loss. Jobs are, of course, lost when market demands are reduced as can be seen from the Boeing/Airbus competition for market share. Jobs have also been lost through offset agreements that often accompany large sales of aircraft. The buyers will agree to purchase a number of aircraft in return for movement of a certain percentage of the manufacture to their countries. Jobs as well

as skills and competencies have gone overseas with these agreements (Pritchard and McPherson 2004).

6. Recruitment of new workers with the most needed skills is becoming an increasing problem as young people are not attracted to an industry perceived to be unexciting as aircraft are mothballed. Recruitment is one of the three maintain areas where HR policies and procedures can make a real difference.

LARA Publications and Presentations

Case Studies

1. Fostering Continuous Improvement in a Changing Business Context. Textron Systems, Wilmington, Massachusetts, 1998, 1999, 2000. Cutcher-Gershenfeld.
2. Fostering Workplace Innovation and Labor-Management Partnership: The Challenge of Strategic Shifts in Business Operations, Pratt & Whitney (United Technologies) and IAM Local 971, West Palm Beach, Florida, 1999. Barrett.
3. Transformation through Employee Involvement and Workplace Training: The Challenges of a Changing Business Context. Rocketdyne Propulsion and Power, Canoga Park, California, 1999. Inaba and Barrett.
4. Employing Activity Based Costing and Management Practices within the Aerospace Industry: Sustaining the Drive for Lean. Boeing Commercial Airplane Group, Wichita Division/IAM, Wichita, Kansas, 1999 and 2000. Barrett, Paduana, and others.
5. From Three to One: Integrating a High Performance Work Organization Process, Lean Production and Activity Based Costing Change Initiatives. Boeing Corporation, Wichita, Kansas, IAM, 2000. Kochan.
6. A Decade of Learning: International Association of Machinists/Boeing Joint Programs. Seattle, Washington, 2001. Kochan.
7. Rockwell Collins & IBEW Locals 1362 and 1634: Investing in Knowledge, Skills, and Future Capability in an Uncertain Business Environment. Cedar Rapids, Iowa, 2003. Barrett.
8. Strategies for Workforce Flexibility and Capability: The New Job Families at Boeing St. Louis. 2004. Barrett, Fraile, Litwin, Cutcher-Gershenfeld.
9. International Association of Machinists and Boeing Joint Quality Through Training Programs. Tukwila, Washington. 2004. Long and Barrett.
10. Warner Robins Lean at the C-5: Essential Elements of Success, (2004) Barrett and Fraile.

Collective Bargaining Resource Guide

Collective Bargaining in the Face of Instability: A Resource for Workers and Employers in the U.S. Aerospace Industry (2000). See description above (p.5) Copy included in appendix.

Books and Monographs

LARA research and expertise provided key inputs to many aspects of the 2002 book on *Lean Enterprise Value: Insights from MIT's Lean Aerospace Initiative*, published by Palgrave. In particular, key contributions were made around the role of "people"

in creating value, the core principles of "lean thinking," the national and international dimensions, and the overall development of a framework oriented around value from multiple stakeholder perspectives.

"Developing a 21st Century Aerospace Workforce. Policy White Paper", Joel Cutcher-Gershenfeld, Betty Barrett, Eric Rebintisch, Thomas Kochan, and Robert Scott, submitted to Human Capital/Workforce Task Force, The U.S. Commission on the Future of the Aerospace Industry (2002). Copy included in appendix.

Scholarly Articles

Joel Cutcher-Gershenfeld, "Lean Transformation in the U.S. Aerospace Industry: Appreciating Interdependent Social and Technical Systems" Working paper, February 2003. This article was listed in June 2003 by the Social Science Research Network on its top ten download list for "MIT Sloan School of Management Working Papers Recent Hits." Abstract and download statistics available at: http://papers.ssrn.com/abstract=395449

Joel Cutcher-Gershenfeld and Eric Rebentisch, "The Impact of Instability on Complex Social and Technical Systems," (Proceedings from MIT Engineering Systems Division Internal Symposium, 2002 and External Symposium, 2004; revised and under review, *Engineering Systems Journal*)

Betty Barrett and Lydia Fraile, "Aerospace Functional Flexibility: Job Families at Boeing St. Louis" (under review) 2005

Practitioner-Oriented Articles, Copies of each in appendix

LARA Surveys the Human Impact of Aerospace Workplace Instability, John Verbos in *Impact* newsletter published by CTPID, vol. 3, no.2, Winter 2002.

Program Profile, "Labor Aerospace Research Agenda: Probing the Aerospace Employment Crisis, Patrica Proven, *Impact* newsletter published by CTPID, vol. 4, no.3, Spring 2003.

Instability in the Aerospace Industry: A Core Strategic Challenge, by Joel Cutcher-Gershenfeld, IRRA Perspectives on Work, 2003

Counting the Global Aerospace Workforce: Preliminary Findings, by Betty Barrett, Kevin Long, Lydia Fraile, and Adam Litwin, IRRA Perspectives on Work, 2003

Labor in Aerospace: The Business Perspective, by A. Bryan Davis, IRRA Perspectives on Work, 2003

Losing Altitude: Employment in the U.S. Aerospace Sector, by Steve Sleigh, Paul E. Almeida, Faraz Kahn, IRRA Perspectives on Work, 2003

Out of the Ashes: Options for Rebuilding Airline Labor Relations, by Thomas Kochan, Andrew von Nordenflycht, Robert McKersie, and Jody Hoffer Gittell, IRRA Perspectives on Work, 2003

Industry Councils: A National Impact Anticipated by Joel Cutcher-Gershenfeld, IIRA Perspectives on Work, Winter 2005

Presentations

"LARA Research Update" Presentation by Joel Cutcher-Gershenfeld to LAI Research Teams, IAM and UAW leadership, May 24, 1999.

"LARA Research Update" by Joel Cutcher-Gershenfeld for LAI Organizations and People, July 29, 1999.

"LARA Research Update" by Joel Cutcher-Gershenfeld for LAI Executive Board, November 11, 1999.

"Making Lean Work for the Workforce: Strategic Dialogue on the Implications of New Work Systems for Policy and Practice in the Aerospace Industry" Washington D.C. Workshop, January 19-20, 2000.

"The Fragile Foundation for Future Prosperity: Instability, Employment and Innovation in the Aerospace Industry," presentation by Joel Cutcher-Gershenfeld to LAI on April 26, 2000 and again by Joel Cutcher-Gershenfeld and Linda Ewig to LAI Executive Board, June 1, 2000.

"LARA Overview Briefing" by Joel Cutcher-Gershenfeld for LAI Executive Board, October 3, 2000.

"A 21st Century Success Vision for the U.S. Aerospace Enterprise," presentation by Sheila Widnall to IAM, March 5, 2001.

21st Century Workplace presentation given at the LAI Plenary and Executive by Joel Cutcher-Gershenfeld, April and May 2001.

CTPID Community Lunch presentation on LARA research given by Joel Cutcher-Gershenfeld, October 24, 2001.

"Preliminary Findings from LARA White Paper on Aerospace Workforce" Presented to LAI by Joel Cutcher-Gershenfeld on October 22, 2001.

"Genuine Learning: Aerospace Workforce Case Studies" presented by Joel Cutcher-Gershenfeld at an LAI learning event, November 6-8, 2001.

Institute for Work and Employment Research lunch discussion on LARA research given by Joel Cutcher-Gershenfeld and Betty Barrett, Case Studies distributed, December 11, 2001.

"LARA Briefing" presented by Joel Cutcher-Gershenfeld as part of LAI Rolls Royce visit, February 28, 2002.

LAI Research Seminar presentation on LARA research by Joel Cutcher-Gershenfeld, November 20, 2002.

"Building the 21st Century National Aerospace Workforce," presentation by Steve Sleigh and Joel Cutcher-Gershenfeld to Aerospace Industries Association Special Session on "Revitalization of the Workforce," March 27, 2002

Building the 21st Century Aerospace Workforce, An Industry Panel Presentation, Joel Cutcher-Gershenfeld, Industrial Relations Research Association, January 5, 2003.

"Developing the 21st Century National Aerospace Workforce" Repeat presentation by Joel Cutcher-Gershenfeld to Aerospace Industries Association, May 2003.

"Exploring the Establishment of an Aerospace Industry Studies Center," Presentation by Joel Cutcher-Gershenfeld to AIA Workforce Committee Meeting, December 4, 2003

"Building the 21st Century National Aerospace Workforce", Joel Cutcher-Gershenfeld, at The Future of Flight: The Crisis in U.S. Aviation Research and Technology, sponsored by U.S. Aviation Research and Technology and ASME, Congressional Briefing, Rayburn Office Building, May 5, 2003.

LAI Excom Goal 5 meeting. Cutcher-Gershenfeld, Barrett, and Fraile attended along with LAI representatives, Steve Sleigh, IAM, and Jim Davis, Boeing and a representative from AFGE (government employees union). Discussed research links with LAI and training union leaders, July 21, 2003. Preparation for September 18th ExCom meeting.

"Future of Labor Relations and Implications for Labor Relations Executives and Managers," presented by Thomas A. Kochan to Boeing's labor relations executives at their Education Center in St. Louis, May, 2003.

"Negotiating Functional Flexibility in Aerospace: The Case of Boeing St. Louis" Betty Barrett presented this paper (coauthored with Lydia Fraile and Joel Cutcher-Gershenfeld) at the International Industrial Relations Association World Congress 2003: Study Group 10 – Flexible Work Patterns in Berlin, Germany, September 2003.

Seminar on Case Study Field Research for LAI PhD students prepared and conducted by Betty Barrett, Lydia Fraile, and Adam Litwin, November 20, 2003.

AIA Workforce meeting, Washington, D.C., December 4, 2003.

Building the 21st Century National Aerospace Workforce: Overview for IRRA Panel Discussion – Right Skills, Right Place, Right Time, January 2004.

Valuing the 21st Century Aerospace Workforce: LARA Overview and Update, Presentation by Joel Cutcher-Gershenfeld, LAI Research Seminar, April, 2004.

Aerospace Industry Panel, Presentations by Bob Thayer, IAM; Jerry Calhoun, Boeing; and Morris Kleiner, Univ. Minnesota; with Joel Cutcher-Gershenfeld, MIT, moderator, FMCS National Labor-Management Conference and IRRA Policy Forum, June 6, 2004.

"Boeing St. Louis Case," Presented by Betty Barrett at Conference on British Aerospace Industry, Oxford University, Oxford, England, September, 2004.

Stakeholder Dialogues – Institution Building

From the beginning, LARA has seen the need as well as the opportunity to create sustainable institutional structures in the aerospace industry. While the Lean Aerospace Initiative represents a unique forum in the industry, it is not clear that it will be a permanent forum for the industry. As long as it does exist, this represents an important forum for industry-level alignment (at least in the Defense aerospace sector) on issues associated with lean enterprise transformation. As of February 2004, a new institutional initiative, the Aerospace Industry Council, has been formed. This is a still emerging forum for industry-level dialogue on labor and employment issues. Three institutional opportunities have been pursued by the LARA team:

- Aerospace Inter-Agency Task Force
  – spanning the Department of Defense, NASA, FAA, Departments of Labor, Education, Commerce and Homeland Security – to coordinate government aerospace workforce initiatives.

- Aerospace Capability Network
  - public/private partnerships spanning all key stakeholders – business, labor, government, universities, and community groups
  - Development of aerospace skill standards and certification programs
  - Dissemination of information on occupations, job availability, high performance partnerships, and new work systems
  - Grants for demonstration projects at local and regional levels.

- Industry Promotion and Development
  - Best practices in career development, employment relations, and life-long learning across the industry
  - National campaign on aerospace opportunities – primary schools, secondary schools, community colleges, and universities.

A first step toward industry-level institution building occurred in January, 2000, when leaders from labor, management, and government gathered in Washington. D.C. to explore issues of high performance work systems, instability, and employment in the aerospace industry. The conference was co-sponsored by LARA and LAI.

LARA also joined LAI in linking with related initiatives in England and Sweden in an August 2000 calibration conference.

A continuation of this institution building occurred on March-27, 2003 in Las Vegas, Nevada at an Aerospace Industries Association meeting Joel Cutcher-Gershenfeld and Steve Sleigh, IAM, Session entitled: Revitalization of Workforce. Presentation: "Building the 21st Century National Aerospace Workforce. The purpose of the meeting was to establish an ongoing multi-stakeholder initiative centered on the revitalization of the United States aerospace workforce and the competitive success of the industry. The recommendation was to establish a center for aerospace industry studies – providing a neutral forum and an ongoing research agenda.

At an Aerospace Industries Association session in December 2003, attended by Joel Cutcher-Gershenfeld and leaders from U.S. DOL, U.S. Department of Commerce, House Science Committee, Aerospace States Association, California Engineering Foundation, Texas Aerospace Cluster, IEEE, Aviation Week, Industry representatives from Boeing, Raytheon, Vought and others, dialogue focused on establishing an ongoing multi-stakeholder initiative centered on the revitalization of the U.S. Aerospace workforce and the competitive success of the industry.

Labor and Employment Relations Association (LERA) Aerospace Industry Council

As a result of the abovementioned institution building meetings and many off-line discussions, an Aerospace Industry Council has been formed. The Labor and Employment Relations Association, which is the leading professional association for addressing labor and employment matters, has a national organization composed of members in over 50 local chapters around the United States. Members include scholars, policy makers, arbitrators, mediators, union leaders and management leaders. Recently, LERA has embarked on a major initiative to establish industry councils in many sectors of society, each of which will address labor and employment issues in that sector. MIT's LARA project has played a key role in organizing an Aerospace Industry Council as part of this initiative.

The groundwork for this particular council began in 2003 on January 5 with a panel at the Industrial Relations Research Association's annual meeting. Panel title: Building the 21st Century Aerospace Workforce: An Industry Panel Presentation on Workforce/Human Capital Challenges and the Presidential Commission on the Future of the U.S. Aerospace Industry. Panel Chair: Joel Cutcher-Gershenfeld. Panel Members: Sue Allison, U.S. Department of Labor, Betty Barrett, MIT; Dan Craig, The Boeing Company; Alden Davis, Pratt and Whitney; Steve Sleigh, IAM. The panel discussed the unprecedented challenges the U.S. Aerospace industry faces, including the end of cold-war military spending, the rise of global competition, the "maturing" of many product lines into "dominant designs," the erosion of core skills (including the virtual disappearance of apprenticeships), a reduced number of new scientists and engineers, and "demographic cliff" of impending retirements, and many other developments raising core questions around ensuring an effective 21st century workforce. PowerPoint presentation included in appendix.

On December 4, 2003 at an AIA Workforce meeting, Joel Cutcher-Gershenfeld presented on the topic, "Exploring the Establishment of an Aerospace Industry Studies Center."

At the National Labor Management conference in June 2004 an initial meeting entitled "Towards an Aerospace Industry Council Success Vision" was held and brainstorming occurred as to what the mission of the council would be. Ideas included:

- Establish a comparative international database – across sectors and countries, including demographics
- Address the issue of instability in earnings and employment – such as continuity in health insurance coverage

- Support initiatives around training and apprenticeships, including national targets
- Collaborate across other industries that draw on similar talent and skills – especially with counter-cyclical employment opportunities
- Foster more transparent processes around how decisions are made about movement of work
- Develop international links among unions representing aerospace workers
- Address the impact of health care costs on national competitiveness
- Foster a new generation of researchers in this area
- Make visible data on projections on job growth

Additional suggestions for the Aerospace Industry Council were identified at the June 2004 National FMCS Labor-Management Conference, which included:

- This council could help influence legislation in many areas affecting labor and management – especially health care
- High performance concept in a more cooperative format – promoted by the council
- Interest in the impact of negative labor relations, and the possible impact of positive labor management relations
- An industry council could help with information exchange
- Skepticism around the impact of a council without a national platform – how to link to industry standards and to global issues?
- Helping to maintain a stable workforce
- Looking at this industry is much like the auto industry 30 years ago – Airbus is being seen as the competition, but what of the regional jets?
- International union cooperation is already taking place in this industry – build on that with employers
- Skills in this industry
- Leveraging industry buying power to stabilize health care costs
- What of the "white tail" approach as a way to stabilize – there are the issues of debt service for the idled planes

A draft Charter of LERA Aerospace Industry Council is included in the appendix.

Application to House (H.586) and Senate (S.309) Aviation Revitalization Bills

Joel Cutcher-Gershenfeld provided testimony on May 5, 2003 with ASME (American Society of Mechanical Engineers) at a congressional Briefing entitled, The Future of Flight: The Crisis in U.S. Aviation Research and Technology. At this meeting a coalition of aviation, aeronautics and aerospace organizations representing over one million scientists, engineers, and manufacturers called for a national aviation research and technology policy alongside investments in aeronautics and aviation R&D to remedy the United States' chronic decline in federal funding for aeronautics research and its impact on the workforce. Joel's presentation and others supported funding the following: Environmental Aircraft R&D initiative; Rotorcraft Aircraft R&D Initiative; Civil Supersonic Transport R&D Initiative;

University-Based Centers for Research on Aviation Training; Aviation Weather Research; Air Traffic Management R&D Initiative. The briefing was sponsored American Association of Engineering Societies, American Helicopter Society, American Institute of Aeronautics and Astronautics, American Society of Mechanical Engineers (ASME International) Institute of Electrical and Electronics Engineers, NASA Aeronautics Support Team, National Institute of Aerospace, Society of Automotive Engineers.

Joel's presentation was aimed at ensuring a pivotal impact of R&D investment in aerospace. As part of this goal, the United States needs to attract the next generation of aerospace workers – the best and the brightest and maintain knowledge and capability in the context of the demographic cliff and other challenges. The United States needs to optimize the current mix of knowledge, skills and abilities and identify future skill requirements.

Presidential Commission on the Future of the Aerospace Industry

As a result of the LARA case studies and the national facility survey, it was possible for this project to present convincing testimony on the aerospace workforce to the Presidential Commission on the Future of the Aerospace Industry. LARA Research was featured in the Final Report of the Commission on the Future of the United States Aerospace Industry issued Nov. 18, 2002.

The LARA team provided a White Paper and formal testimony that was incorporated into the report, "Anyone, Anything, Anywhere, Anytime." This report offers nine major recommendations and numerous additional recommendations for revitalization of the U.S. aerospace industry.

"Anyone, Anything, Anywhere, Anytime" highlights the massive consolidation, job losses, and revenue cuts over the past two decades and calls attention to the faltering underpinnings of the aerospace industry. The report also offers a vision catalyzing leaders in government, industry, labor, and academia to ensure this industry's future prominence. In this report, the Commission cited survey findings regarding perceived future career opportunities in the industry, data on training and apprenticeships, and case study examples on the challenges of instability. This was based on a LARA policy white paper, "Developing a 21st Century Aerospace Workforce. Policy White Paper", Joel Cutcher-Gershenfeld, Betty Barrett, Eric Rebintisch, Thomas Kochan, and Robert Scott, submitted to Human Capital/Workforce Task Force, The U.S. Commission on the Future of the Aerospace Industry (2002). (Copy in the appendix).

The LARA Policy White Paper addresses three areas of concern:

- Challenges in Attracting and Retaining a 21st Century Workforce
- Inadequate Infrastructure Enabling Wise Investment in Human Capital
- Limited Mechanisms for Diffusing Best Practices across the Aerospace Enterprise.

In response to these concerns, we recommend five specific initiatives each designed to have a transformational impact and an overall recommendation around the importance of research and development spending as a “pull” for the next generation workforce. The specific initiatives are:

- Public Policy Priority Protecting Investment in Intellectual Capital: Establishing mechanisms to mitigate instability and other threats to investment in “intellectual capital,” which could include developing longer-term procurement contracts, targeted attention to intellectual capital issues at key stages of the procurement process, requiring “intellectual capital impact statements” when funding is to be cut or re-directed in significant ways, and other related issues.

- Aerospace Capability Network: Developing a public/private partnership network organization in which all key stakeholders in the aerospace industry coordinate the establishment and dynamic evolution of a full set of relevant skill standards, future capability requirements, and relevant workforce data.

- National Training and Development Partnership: Establishing a multi-stakeholder, public/private partnership supporting strategic investment in skills and capabilities that are central to industry success and that would not otherwise receive adequate investment especially involving investment in building capability across organizations along what can be termed “mission critical” value streams.

- Regional and Local Workforce Initiatives: Demonstration grants providing targeted support for pilot local and regional innovations that effectively attract, retain and cross-utilize the aerospace workforce, as well as “best practices” with new work systems. Additional support should also be targeted at piloting mechanisms for regional and national diffusion of successful innovations. This could include matching funds from local foundations, governments and industry with implications for national policy where appropriate.

- Innovation by Government as an Employer: Establishing mechanisms to develop and diffuse innovations in strategic human resource management at government aerospace labs, depots, and bases. This is particularly important in the aerospace sector where major classes of employees are hired into the private sector after a period of time building skills and capabilities in the public sector.

LARA testimony and research on projected skills gaps and industry-government skills development were cited in Chapter 4: "National Security: Defend America and Project Power." LARA testimony and research on employment trends, skills development, and demographics were cited in Chapter 8: "Workforce: Launch the Future." Additional LARA analysis figured into the Commission's interim reports and some commissioners' dissents and comments.

In a forward to the white paper, Dr. Sheila Widnall, former Secretary of the U.S. Air Force and MIT Institute Professor commented:

> "Investing in R & D as a "pull" for the 21st Century workforce is not a new idea, but it gets to the root cause. . . How do we look at R & D from the point of view of building future capability – investing in human capital – not just completing a given project or program? This means that the definition of R & D priorities must be made with multiple stakeholders' input to anticipate future needs – taking more of a long-term, strategic approach to such investments."

Many LARA activities are commission follow on activities, including a session at the Industrial Relations Research Association meetings on January 5, 2002 entitled Facilitating Institution Building chaired by Joel Cutcher-Gershenfeld discussed the white paper and the testimony given on May 14, 2002 by Joel Cutcher-Gershenfeld at a public meeting of the Commission on the Future of the United States Aerospace Industry.

Another Commission follow on activity was a May 5, 2003 ASME International meeting at which Joel Cutcher-Gershenfeld gave a briefing on "The Future of Flight: The Crisis in U.S. Aviation Research and Technology, Washington D.C. PowerPoint presentation included in appendix.

Finally, on January 5, 2003 Joel Cutcher-Gershenfeld chaired a session entitled, "Building the 21st Century Aerospace Workforce: An Industry Panel Presentation on Workforce/Human Capital Challenges and the Presidential Commission on the Future of the U.S. Aerospace Industry at the IRRA Annual meeting in Washington, D.C.

Two key areas of future follow-on activity include: 1) A project that is about to be launched concerning "Lateral Alignment in Complex Systems" with the FAA and NASA and 2) A project to be proposed to the US Department of Defense focused on skills and capabilities as people in the military make the transition to the commercial sector (entitled M2C*plus)*, which is modeled on the successful "Helmets to Hardhats" program focused on transitions from the military to the construction industry.

SECTION 3: CONCLUSIONS

The LARA project has been guided by the motto, "right skills, right time, right place." This reflects both a concern and a commitment. The concern is that the industry is at risk. The development of skills and capabilities in the US aerospace workforce primarily takes place within short-term tactical frameworks. Long-term strategic planning and action at facility, regional, corporate and industry levels is all too rare and inadequate for the task.

Based on over a half-dozen years of research, we find that there are "islands of innovation" where parties have found creative ways to engage the workforce and build new capabilities. There are gaps, however, in the mechanisms to document and diffuse such innovation. Further, the combination of a "demographic cliff" and diminished pipelines for skill development (both among apprenticeships and in engineering programs) set the stage for deep challenges ahead. Given the increased levels of investment in aerospace in the European Union, China and other nations, the sense of urgency increases.

Summing up seven years of research on the aerospace workforce, we conclude that there are numerous innovations to be found, but that they are inadequately harnessed relative to the challenges facing this industry. Innovations that we have observed in avionics, airframe and propulsion operations include:

- Team-based work systems driving continuous improvement in operations
- Just-in-time delivery of modular training skills in aerospace production operations
- Cross-functional integration of engineering design and production operations
- Rapid-cycle work redesign initiatives improving product and process flow
- Worker self-inspection and statistical tracking of quality driving dramatic gains in quality performance
- Utilization of Activity-Based Costing (ABC), new pay systems, and other innovative financial arrangements
- Constructive management of sub-contracted work and restructured ownership arrangements
- Proactive handling of new technology
- Front-line union and management change agents driving continuous improvement efforts on the basis of deep expertise in the substance of new work systems and the processes of systems change
- Union-management partnerships focused on implementing and sustaining high performance work systems

Despite the importance value created through these and other innovations, we have also observed many "disconnects" at the work group, facility, organizational, and industry levels, including:

- Work teams that have become cynical after repeated "hope/heartbreak" cycles associated with successive improvement initiatives
- Inadequate mechanisms to manage leadership transitions – within management and within unions
- Incomplete accounting for investments in workforce skills and capabilities, resulting in strategic decisions that do not fully take into account the value of such investments

- Mistrust and substantive disagreements between labor and management, resulting in employers not fully valuing union contributions to improvement efforts and unions not fully embracing improvement efforts
- Barriers to the portability of workforce benefits and the transferability of workforce skills, resulting periodic regional shortages and surpluses
- Opportunities to address gaps in skill development (such as the investment need to facilitate transitions between the military to the commercial sectors of this industry) undercut by unrelated political and structural barriers
- Substantial gaps in the "pipeline" of skills for the development of the next generation of production, technical and engineering workers, as well as gaps in the perceived appeal of aerospace as an industry of choice for people to enter
- Inadequate mechanisms to understand and address the global flow of work and skills in the aerospace industry, including ambiguity about the implications of the emerging corporate strategies centered on being "systems integrators" rather than aerospace designers and manufacturers
- Gaps in available forums and dedicated participants engaged in strategic labor-management dialogue on workforce matters at the facility, regional and industry levels

Around the world, the aerospace industry is a source of national pride and prestige, as well as an important engine for growth and development. The LARA project developed the moto, "Right Skills, Right Place, Right Time," but today's realities fall well short of this vision. Despite noteworthy innovations, the persistent gaps and disconnects suggest that the continued status of aerospace as a leading industry in the US economy is at risk.

It is our hope that this report serves not just as a useful summary of the work completed by LARA, but also as a platform for deeper dialogue and action among the stakeholders in this industry.

LIST OF ILLUSTRATIONS

APPENDIX

I. National Facility Surveys

II. Case Studies:

1. Fostering Continuous Improvement in a Changing Business Context. Textron Systems, Wilmington, Massachusetts, 1998, 1999, 2000. Cutcher-Gershenfeld.
2. Fostering Workplace Innovation and Labor-Management Partnership: The Challenge of Strategic Shifts in Business Operations, Pratt & Whitney (United Technologies) and IAM Local 971, West Palm Beach, Florida, 1999. Barrett.
3. Transformation through Employee Involvement and Workplace Training: The Challenges of a Changing Business Context. Rocketdyne Propulsion and Power, Canoga Park, California, 1999. Inaba and Barrett.
4. Employing Activity Based Costing and Management Practices within the Aerospace Industry: Sustaining the Drive for Lean. Boeing Commercial Airplane Group, Wichita Division/IAM, Wichita, Kansas, 1999 and 2000. Barrett, Paduana, and others.
5. From Three to One: Integrating a High Performance Work Organization Process, Lean Production and Activity Based Costing Change Initiatives. Boeing Corporation, Wichita, Kansas, IAM, 2000. Kochan.
6. A Decade of Learning: International Association of Machinists/Boeing Joint Programs. Seattle, Washington, 2001. Kochan.
7. Rockwell Collins & IBEW Locals 1362 and 1634: Investing in Knowledge, Skills, and Future Capability in an Uncertain Business Environment. Cedar Rapids, Iowa, 2003. Barrett.
8. Strategies for Workforce Flexibility and Capability: The New Job Families at Boeing St. Louis. 2004. Barrett, Fraile, Litwin, Cutcher-Gershenfeld
9. International Association of Machinists and Boeing Joint Quality Through Training Programs. Tukwila, Washington. 2004. Long and Barrett.
10. Lean at the Galaxy Depot: Essential Elements of Success, (2004) Barrett and Fraile.

III. Collective Bargaining Resource Guide

IV. Scholarly Articles (2 articles included)

V. Practitioner-oriented Articles (8 articles)

VI. Commission on the Future of the U.S. Aerospace Industry
Executive Summary, Chapter 1, Chapter 8
"Developing a 21st Century Aerospace Workforce. Policy White Paper", Joel Cutcher-Gershenfeld, Betty Barrett, Eric Rebintisch, Thomas Kochan, and Robert Scott, submitted to Human Capital/Workforce Task Force, The U.S. Commission on the Future of the Aerospace Industry (2002).

VII. Draft Charter of LERA Aerospace Industry Council and LARA Briefing, May 2004