Strategies for Workforce Flexibility and Capability: The New Job Families at Boeing St. Louis

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MIT's Labor Aerospace Research Agenda (LARA)

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Executive Summary

The IDS (Integrated Defense Systems) Boeing 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.

In 2001, Boeing St Louis and the IAM (International Association of Machinists and Aerospace Workers) sought to promote flexibility and increase competitiveness by grouping the existing 51 job classifications into 9 new job families or labor grades. Importantly, workers retained their seniority rights within the previous classifications, which continue to govern layoff/recall, overtime, vacation, and shift issues. However, the contract now allows for them to perform tasks in other classifications within the same or a lower labor grade. The heart of this case study centers on understanding how this agreement has been implemented, the degree to which the compressed classifications have resulted in improved outcomes for the employer and employees, and the policy implications of the effort.

Under a 1996 labor-management agreement there was a substantial increase in training across the facility, a large proportion of which involved cross-training. This heightened level of training has continued under a 2001 agreement. Overall, the amount of training in this facility has more than doubled, with even greater increases in some work areas. During this overall time period, there has been a substantial increase in quality and productivity outcomes. In some cases, such as in the quality outcomes, the rate of improvement has leveled off, but this is still a notable accomplishment given the significant increase in front-line operator verification of quality, the sale of a key part of the business associated with fabrication, layoffs and other factors. There are administrative challenges in maintaining consistent progress on a wall-to-wall basis in the facility. Still, the core model of increased flexibility, combined with just-in-time training and protection of core seniority rights is proving to be a far more sustainable model then the initial efforts at this location.

The experience of the IAM and demonstrates that it is possible for labor and management to reach a strategic agreement, linking increased flexibility in operations with increased investment in people. Realizing the full benefits of such an agreement is a complex challenge, involving fundamental shifts in the way front-line operations are run, as well as culture changes in support functions such as training, quality, finance, and production control. The development of a just-in-time capability to deliver training and on-line skills coaching mechanisms has elevated training to a strategic status – as a key part of the way business objectives are met. This is possible since training has been restructured to be integral to the lean model of manufacturing that places a higher value on continued flow in operations and front-line capability (particularly with respect to quality). Equally important has been the High Performance Work Organization (HPWO) model advanced by the IAM,

which is a form of team-based operations that is consistent with the union's concerns for fairness and attention to other workforce interests.

There are important policy implications that derive from the IAM/ experience, including implications for apprenticeship policy and the U.S. Department of Labor's O*Net, which is a newly updated Standard Occupation Classification system. On the one hand, the nine job families do not have a specified set of component tasks in ways that would match traditional apprenticeship models. Instead, the case points toward a model of targeted skill acquisition where individual workers each accumulate different mixes of skills over time. Combined with a just-in-time delivery system, it is a model that is responsive to evolving skill requirements on the part of the employer while keeping training costs low. It is also a model that meets a desire for continually expanding capability on the part of employees. This, however, raises the issue of certification, in order to ensure portability of the acquired skills across firms. At present, such portability is not a feature of this case, but a "skills passport" or other mechanism to document acquired skills would be an appropriate complement to the innovations observed in this case. A broader policy challenge would involve the development of a general architecture of new skill standards that can be used in flexible delivery models such as the one featured in the operations.

I. Introduction

Over $210 billion is spent every year on workplace training in the U.S. alone, and yet, not enough is known about how the institutional arrangements for the delivery of training are evolving to ensure that these investments deliver value to the different stakeholders involved.[1] This case examines the effect of a high profile shift in institutional training arrangements at . Through collective bargaining, the parties agreed to a compression of job classifications into job families in order to foster organizational flexibility and multi-skilling. This push for flexibility and investment in skills is linked to the implementation of lean production practices and related operational innovations to render the facility more competitive. Our aim is to assess the short and long-term impact of these strategic changes.

Motivating this research are current efforts of the U.S. Department of Labor (DoL) in the area of employment and training, including the recent revision and transformation of the Dictionary of Occupational Titles (DOT)into what is now termed O*NET (Occupational Information Network). The revision replaced thousands of little-used or obsolete jobs from the listing and instead offers a set of some 1,100 occupations, based on the 2000 Standard Occupational Classification (SOC) system used for all government data on occupations. Each O*NET occupation has detailed information on required knowledge skills and abilities. The clustering of well established, apprenticeable job classifications into new, combined job families by Boeing mirrors the change in detail effected by the transition from the DOT to O*NET classification. Thus, DoL was interested to document the specific elements of this initiative to help guide future policy around employment and training, particularly with regard to business demand for skills.

A Brief Description of O*NET

With the goal of providing a more accurate picture of the turn-of-the-century U.S. labor market, the Department of Labor replaced in 1998 its 50 year-old *Dictionary of Occupational Titles (DOT)* with an electronic *Occupational Information Network (O*NET).*

The new system is "driven by skills rather than tasks" with a focus on those skills that are attainable through conventional schooling and are thus transferable between jobs. It contains far fewer entries than did the last revision of the DOT (1991), since many of the listed titles no longer exist as independent vocations. Over 12,700 job titles have been replaced with approximately 1,100 occupations. Consequently, O*NET essentially bundled multiple, narrow jobs into single titles, while providing far more finely-grained detail on the skills and training required both to secure employment and to perform satisfactorily once employed.

Historically, the mass production system featured dozens of job classifications that were written into U.S. contracts and incorporated into operations. Management drove this process, under the logic of Taylorism, where work was segmented into narrowly specified jobs in order to increase efficiency and consistency.[2] These narrow classifications were initially resisted by unions as a threat to craft autonomy, but later embraced by the labor movement as a way to protect against the arbitrary rule of the front-line supervisor, as a

[1] See Anthony P. Carnevale, Leila J. Gainer and Janice Villet (1990). *Training in America: The Organization and Strategic Role of Training,* San Francisco: Jossey-Bass; and Galvin, T. (2001, March), "Training Top 50," *Training*, pp. 57-79 for data on training investments.

[2] Frederick W. Taylor, *The Principles of Scientific Management* (New York: Harper Bros., 1911)

way to link the attainment of higher seniority with increased choice over job assignments, and as a way to constrain management from unilaterally reducing the size of the workforce. Today, these narrow classifications can serve as a barrier to the cross-utilization of workers, reducing flexibility in operations and even constraining the employment options of the worker. 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 non-union settings. For example, in a 1996 national random sample survey of union and management negotiators of collective bargaining agreements, approximately 30% reported new language on work rule flexibility, while a second national survey conducted three years later in 1999 found over 39% of agreements contained new language on work rule flexibility.[3]

Not enough is known, however, about the impact of agreements to increase such flexibility – especially in the aerospace industry where work often involves high levels of skill and depth of craftsmanship. In the case of Boeing St. Louis, union and management agreed in 2001 to group the existing 51 job classifications into 9 new job families or labor grades. Workers would maintain their old classifications for purposes of layoff/recall, overtime distribution, vacation scheduling and shift bumps. However, they could now perform tasks in other classifications within the same or a lower labor grade. All employees would be expected, furthermore, to perform general duties such as moving parts, clean up, on-the-job-training and cross training, and quality control. The agreement also included job security language and complemented a joint union-management High Performance Work Organization (HPWO) team-based work system in place since 1996.

This agreement has the potential to serve as a model for others seeking to achieve efficiencies for the company together with enhanced skills and employability for the workforce.
Management reports that increased ability to cross-utilize workers has led to gains in productivity, scheduling, and cost savings. Substantial investments in skills training have been provided, using a remarkable just-in-time training delivery system that targets the specific needs of each work area. The individuals who have volunteered for cross training report that they enjoy the greater variety of tasks and the opportunity to learn new things. Many believe that having more skills can be helpful although virtually all those interviewed stressed that the labor market in St. Louis precludes greater external job opportunities. At the same time, there is a measure of uneasiness expressed by some employees about having enough training to do the work in other classifications. Also, there are fears that the new tasks will, in the end, eliminate jobs. An unexpected, complicating factor is a growing gap between those who take on new tasks, who tend to be younger, and those workers with more seniority who are not seeking as many training opportunities.

From a theory perspective, this case is a great example of effective job redesign as described by Hackman and Oldham.[4] As prescribed in this classic work, the new job family plan offers what the authors termed "skill variety" and provides greater "task identity." Building aircraft has always been high in "task significance," while the HPWO process increases "autonomy," and the variety of inspection options as well as performance

[3] Joel Cutcher-Gershenfeld and Thomas Kochan: "Taking Stock: Collective Bargaining at the Beginning of the 21st Century" (Working Paper Under Review, 2002).
[4] Hackman and Oldham, Job Redesign (1975).

metrics provide important "feedback." These are all classic elements recommended in job redesign. Moreover, there is no doubt that this workforce feels they make a meaningful contribution to the defense of the country. They take great responsibility for their efforts and are very conscious of the costs of any failure in an aircraft they produce.

Hackman and Oldham predict that if these conditions are met, then the workers will be motivated and feel great job satisfaction. One lesson from this research, however, is that workforce motivation is not only driven by internal job design features. While there were certainly many workers who valued the investments in training and the work arrangements, there were also many with overriding concerns about job security. These concerns were fueled by a lay off involving 260 employees that was announced shortly before our visit to the plant in June 2003. An additional key part of the context for this case was Boeing's competition for the role of prime contractor for the Joint Strike Fighter (JSF), the newest U. S. military aircraft. If Boeing had won this contract, which went to Lockheed Martin, the St. Louis facility would have had a favorable long-term employment horizon, validating the risks that union and management leaders took in establishing the new, flexible arrangements and facilitating their implementation. While the innovations featured in this case may still leave the facility more competitive than it would have otherwise been, the loss of this business opportunity further heightened job security concerns. These complicating circumstances may temper some of the enthusiasm in the workforce, but it is important to note that the continued operation of the job family system at , does suggest that the model is sustainable even in a cyclical context such as the aerospace industry.

II. Research Design and Methods

The team working on this study is from the MIT Labor Aerospace Research Agenda (LARA) and the research was sponsored by the U.S. Department of Labor (DoL). LARA is an ongoing research project investigating the impact of instability and investments in intellectual capital for the aerospace workforce.[5] The team has conducted over 50 interviews during the course of two trips to the Boeing facility in St. Louis, Missouri. On the first trip, we interviewed the plant manager, the IAM District Lodge 837 president, and 14 other company executives across the functional areas of finance, quality, production operations, supply chain, labor relations, HPWO coordination, and training. On the second visit, team members did 39 interviews with hourly workers, coaches/trainers, and union representatives. These individuals worked on four teams in four separate departments, which were selected in consultation with the company to be representative of a range of stages in team development and a mix of products.

Since the timing for training and the mix of pre-existing skills varies across the four departments, tracking these departments over time represents something of a "naturally occurring experiment." In addition to the individual interviews, 34 of those interviewed

[5] The Labor Aerospace Research Agenda (LARA) is a research program at the Massachusetts Institute of Technology. It is affiliated with the Lean Aerospace Initiative (LAI), a much larger consortium of industry, labor, government and academic scholars who are studying different aspects of the U.S. and global aerospace industries. LAI and LARA are supported by funds from the MANTECH division of the U.S. Air Force. Both LARA and LAI are based in MIT's Center for Technology, Productivity and Industrial Development. Other LARA work is available at <http://web.mit.edu/ctpid/lara/>.

completed a short survey to investigate their perceptions and attitudes. While the small sample size reduces the statistical power of these data, they offer a corroborating capture of the workers' view of the process and complement the qualitative data obtained through interviews.

The company also provided archival data on overall facility performance and quality metrics, health and safety, grievances, and training records, as well as results from company-wide employee surveys before and after the new job family system was implemented. Archival data was also provided on the four departments, which we have labeled A, B, C, and D and which are involved in three of the major products built at this site. One of the departments – Department A – featured a team that was on the brink of becoming level 4, the highest HPWO level. A second, Department B, was at level 3 and the remaining two (Departments C and D) were at level 2. The hourly workers and shop stewards we interviewed came from these teams and/or represented their work area. Monthly training and performance data were provided for the four departments that closely correspond with the work teams[6] starting in January 2001 as well as before, in the case of training records. These four vignettes will enable us to gain a more in-depth view of the dynamics of implementation and related outcomes.

[See Appendix for copies of the hourly interview questions and the survey instrument]

III. Setting the Stage

Boeing's St. Louis plant is headquarters of the company's Integrated Defense Systems Division and employed 15,000 people in May 2001. At that time, 3,100 of these workers were members of the International Association of Machinists and Aerospace Workers (IAM) Lodge No. 837. This is down from the plant's peak employment of 12,000 union machinists in 1990. The plant assembles the following aircraft models: the F-18 Super Hornet, the F-15 Eagle, the C-17 Globemaster III, the T-45 Goshawk, and the AV-8B Harrier II. In addition to producing multiple products, there is variation within each product. As one senior manager at the facility noted, "no two planes are alike – this is not mass production." The plant also houses a "phantom works" site that carries out R&D on advanced space and communications, military aircraft, and missiles. The facility is located directly adjacent to the Lambert Field Airport and one can often see fighter planes and hear the roar of their jet engines during the time one spends there.

The work at this location demands high levels of skills and capabilities. These workers are well trained and proud of the work that they do. Many come into the job with A & P certifications (Airframe and Power Plant Mechanic)[7] and/or intensive military experience

[6] The correspondence between teams and departments is exact in one of the teams. Two other teams are in departments that also include workers in second or third-shift teams. The fourth team includes people in two departments on the same shift. We have used the department as the unit of analysis because most of the performance metrics we are interested in are available at the department rather than the team level. These data correspond to all individuals interviewed and some that were not.

[7] For in-depth information on the A&P certification see the U.S. Department of Labor site at http://umet-vets.dol.gov/airframe-mechanic.htm .

and training. Workers report that their military training occurred on planes similar to the ones they build on the job. For example, one worker told us about his four years in the Navy where he worked as a structural mechanic, in sheet metal and on hydraulics. So they come to the job with years of hands-on experience and a thorough understanding of product performance, maintenance issues, and operational factors. Older workers may have received extensive in-house initial training in their core skills. It is unclear whether this was through apprenticeship training since it has been more than two decades since formal apprenticeships have been utilized in this facility. On average, workers at the facility have a minimum of 15 to 18 years of experience in their jobs.

IV. The Job Family Agreement

The change in job classifications at Boeing St. Louis is the result of labor-management negotiations. While initial job classification changes and the introduction of a high performance work organization occurred in 1996, the contract that went into effect in 2001 contained the most comprehensive classification compressions. An interesting precedent of the new job families was the Assembly Mechanic—All Around classification created in 1996. The *"All-Arounds"* were to master the skills of all four main assembly classifications: Sheet Metal Assembler and Riveter (SMAR), Mechanic—Aircraft Production (MAP), Mechanic—Electrical and Radio (MER), and Sub-Assembler—Precision (SAP). Volunteers from these classifications were selected for extensive cross training and paid an extra 75 cents/hour; 25 cents for each of the three additional skill sets they were now to perform. The program, however, ran into two types of obstacles: For one thing, the training took too long and created manpower redistribution issues. Only 100 of the originally proposed 600 *"All Arounds"* were certified. The union disliked the program and set restrictions upon it. In particular, one contract rule instructed that for every 20 workers being laid off in the four feeder classifications, there would be one *"AllAround"* laid off. This proved fatal to the initiative. Because this was a less populated classification, people with high seniority who had volunteered for the new position began to be laid off and many requested transfer back to their old classifications, bringing the program to an end. Management learned from this earlier attempt at increasing job flexibility that training would need to be more targeted and workers reassured that their seniority would be maintained. The site manager, who negotiated the 2001 contract, emphasized this latter aspect when explaining the new job family concept: "People still have their classification, their heritage, and seniority."

The 2001 agreement grouped an overall total of 51 existing job classifications into 9 job families or labor grades. Workers kept their old classifications for purposes of layoff/recall, overtime distribution, vacation scheduling and shift bumps. However, they could now perform tasks in other classifications within the same or a lower labor grade. All employees would be expected, furthermore, to perform general duties such as moving parts, clean up, on-the-job-training and cross training, and quality control. Part of the rationale for the new work rules was the reduction of unnecessary down time while workers waited for members of another craft to come to do a task that was not part of their skill base. An important concurrent development was the introduction of lean practices such as operator verification for quality and point-of-use logistics for just-in-time material delivery. The contract also made clear that all related training decisions would reside with management.

Table 1: Job Families with Associated Classifications

Job Family/Labor Grade (From highest to lowest)	Classifications
Tooling	Inspector—Metrology Inspector--Tool & Die Tool & Die Maker Machinist--All Around Builder Mock-Up & Tooling Machinist—General Welder--Tooling Heat Treater—Tool Room
Flight	Inspector—Aircraft Mechanic--Electrical & Electronics Mechanic—Flight Mechanic—Electro-Optic
Maintenance a	Mechanic—Machine Repair Maintenance Mechanic--All Around Pipefitter--Maintenance Mechanic--Automotive Painter—Maintenance
Assembly	Inspector—Assembly Subassembler--Precision Mechanic--Aircraft Production Mechanic--Electrical & Radio Sheet Metal Assembler & Riveter
Process	Sheet Metal Fabricator Painter--Sign Mechanic--Tube & Cable Painter--Spray Plater--Precision Operator--Chemical Processor Operator--Nameplate Processing Machine & Hand Sewer
Support	Production Material Coordinator Crater & Packer Material Handler—Specialist
Utility	Worker—Utility
Munitions	Mechanic—Munitions
Maintenance b	Garage Attendant Housekeeper Maintenance Worker

Source: Adapted from Articles of Agreement between the Boeing Company and District Lodge No. 837, IAM
Note: Additional classifications in the contract, but not populated include: Grinder--Precision Tool & Cutter, Heat Treater—Dural, Maintenance Worker--Furniture Mover, Maintenance Worker—Laborer, Maintenance Worker--Machine & Equipment Operator Maintenance Worker--Sweeper—Janitor, Operator--Hydraulic Press & Hammer, Parts Finisher--Machine Shop, Sand Blaster, Template Maker

At the core of the 2001 contract is a linkage between employment security and flexibility. At the time was trying to win the government award for the Joint Strike Fighter. This was in the back of everyone's mind. The company saw job flexibility as essential in order to rationalize production and become more competitive for this and other future bids.[8] The union insisted that the workers' concern over stability would also need to be addressed.

[8] In fact, Lockheed Martin, which won the JSF contract, also emphasized flexible work arrangements in its manufacturing operations.

Both parties agreed to include job security language, guaranteeing no lay offs during the life of the contract unless there was diminishing product demand.

V. A Strategic Training Plan

Management learned from the 1996 experience that changing job classifications required careful consideration of the training needs for employees who made the switch. Such tactical considerations drove another strategy for implementing the 2001 agreement. This time there was a more integrated set of activities that involved shop supervisors. Training was reevaluated and a new training delivery process developed. Training would be "pull-based" – targeted according to need rather than given to all workers regardless of whether they might use it. This delivery scheme provides short-term savings and quick turn around. As one Production Manager commented, "We couldn't train everyone in everything at once, so each area had to set its priorities."

In order to determine the facilities' training needs, shop supervisors were asked to analyze their areas using the following criteria:

- Flexibility and continuous flow of planned work
- Reducing delays and set-up time caused by the movement of employees from one job assignment to another
- Enabling employees to complete entire zones of the aircraft vs. smaller jobs or tasks
- Enhancing employee skills and developing new ones
- Promoting accountability and first time quality
- Promoting standardized work.[9]

After they finished the work environment assessment, the shop supervisors were asked to "review current employee job assignments, evaluate individual employee skills, determine new employee skills needed, and then create a cross-training matrix."[10] In most cases, the training matrix for each department is still maintained by the supervisor. In the case of some more advanced teams (these are at what is termed Level 4), it is the team that maintains the matrix.

The process of needs assessment is ongoing. As the Manager of Training commented, "Supervisors sometimes are happy and sometimes they request modifications in the training. These are vocal, active, engaged customers." He also noted that the trainers often discover additional training needs while they are delivering a particular skill.

Not all supervisors initially embraced the system of just-in-time training with equal enthusiasm. At the outset, one member of the training department commented, "we could judge the commitment of the supervisor by the quality of the people they were sending for training." This reflects a key underlying cultural challenge with respect to training across classifications. Even with the smaller modules and just-in-time delivery model, there was still the need to shift the mindsets of supervisors away from seeing the training as time off the job that interferes with operations and toward being an essential investment in building

[9] From materials provided by the facility
[10] From materials provided by the facility

capability. This same individual commented that many workers, too, were skeptical that their new skills wouldn't be used or that they would end up taking away someone's job. He concluded, however, by noting that "After three years, we are still doing this. People are beginning to believe that it is not just a fad."

One Production Manager noted that this system involves "holding meetings every Monday to calibrate. We want to avoid having people completely shift jobs and we want to target the training in places where value will be added. The union is asked a lot about the training plans. We did not promise to train everyone in everything and our training budgets certainly did not increase. We are averaging around 37 hours per person per year." He went on to note that the hardest part of the change has been the shift in mindsets. "Some people on the floor couldn't wait for this, while others were resistant. Most difficult has been allowing people to make mistakes as they learn. We have to build this into the way we plan."

Cross training is the critical type of training for this study, but is only one of several types of training that employees receive. Workers have a regimen of common training in areas such as health and safety, operator verification, or team skills that appear to be mandated for everyone. Additionally, there is training that is required by the government procurement contract for certain programs. For example, the flight ramp workers are required to have re-certification training for a variety of program-related skills such as pyrotechnics and ejector seat maintenance.

Another component of the in-house training opportunities is the Advanced Craftsmanship Learning Center (ACLC), which was established in 1997. The ACLC is a training center that helps people learn to perform tasks related to a specific program or product. The centers are staffed by full and part-time coaches drawn from the workforce who generally do their work one-on-one with individual workers. The driving force behind the development of the ACLC is the reduction and prevention of defects. The coaches are selected for their skill and expertise but must also have some interpersonal skills and develop credibility among their peers to be successful. As the Manager of Training commented, "The Facility Manager said to the supervisors, 'Give me your best and your brightest.' We didn't want just anyone who was available." The ACLC uses defects data and information from inspectors to identify employees in need of training. It also assists with the on-the-job training phase that follows cross-training courses.

There is formal contract language on apprenticeships, but it has not been utilized for over twenty-five years. does maintain a 200-hour course of training for Sheet Metal Assemblers and Riveters (SMAR), which serves a small percentage of the workforce that has been transferred from fabrication sub-shops to general assembly. These workers are mostly older SMARs who formerly performed narrowly defined jobs and now need to increase skill levels. The shop supervisor decides whether to send them for additional training or for ACLC coaching.

The company's efforts to target cross training carefully and offer it on an as-needed basis rely on the shop supervisor to determine the specific skills or tasks. Additionally, HPWO level four teams may also request training for their area. The supervisor calls for volunteers or approaches individual workers to request that they volunteer for the training. The skill or

task is likely to cut across the traditional boundaries of the core crafts. A sheet metal worker might be trained to attach a set of electrical connections that are the next step in the completion of a set of tasks. This work was formerly done by an electrician while the sheet metal worker waited until the electrician could come and finish that one set of connections. Now, the sheet metal worker is sent to training to learn this specific set of tasks. When he or she returns from training, a coach or other worker skilled in this task will do on-the-job training as needed to ensure that the work is done properly. Workers can be sent back for retraining if necessary. The training for many of these tasks is standardized and summarized in data sheets.

During the first six months under the agreement (from August 2001 through December 2001), it was planned that cross training was to be provided to 787 "students" in the assembly job family, totaling 6,470 hours. The parties met and slightly exceeded these objectives, with 821 people training for a total of 7,558 hours.[11] This pace of training has been maintained in the two years since the agreement. Most importantly, these training hours were not achieved by taking large groups of workers off the line for lengthy blocks of time. This was nearly all just-in-time delivery of short modules focused on specific skills.

In 2002, cross training was extended to the flight family as well, totaling 18,143 hours. About one fifth of this time was allocated to retrain inspectors on production tasks since their role was gradually being replaced through increased use of operator verification. The majority of the inspectors were cross-trained as SMARs, the largest classification in the assembly family. This is a primary reason why 32% of total cross training in 2002 was SMAR training, followed by MER (26%), MEE (14%), MAP (10%), SAP (8%), Flight Mechanic (5%) and Common training (5%) (see appendix for a full listing of acronyms and definitions) .

The experience with cross training varied across the workforce. At one end of the spectrum, some people reported very little or no change in their daily job. Others were cross-trained to do incidental work outside their classification, like the MAP who said: "I have been trained to do electrical and sheet metal, but I'm still doing basically mechanical work." Yet others reported being more broadly multi-skilled, like the former *"All Arounds"* who were now able to perform a variety of tasks they had trained for in the past. Interestingly, there were also some individuals that reported working full-time in another classification, like the SMAR who noted: "I'm doing mechanical work now. Pretty much all I do now, hardly any more sheet metal."

In order to more fully understand the details of the skill building process, we obtained training records for four departments within the facility. As mentioned earlier, these departments represent different programs and stages of production, have different sizes and shift mixes, and vary on how advanced they are at mastering HPWO. We thus consider them "naturally occurring experiments," in which to examine in detail the training process that accompanied the compression of job classifications since 2001 and its relation to performance outcomes. We have labeled these as Departments A, B, C, and D for the purposes of this study.

[11] Note that some workers attended multiple sessions.

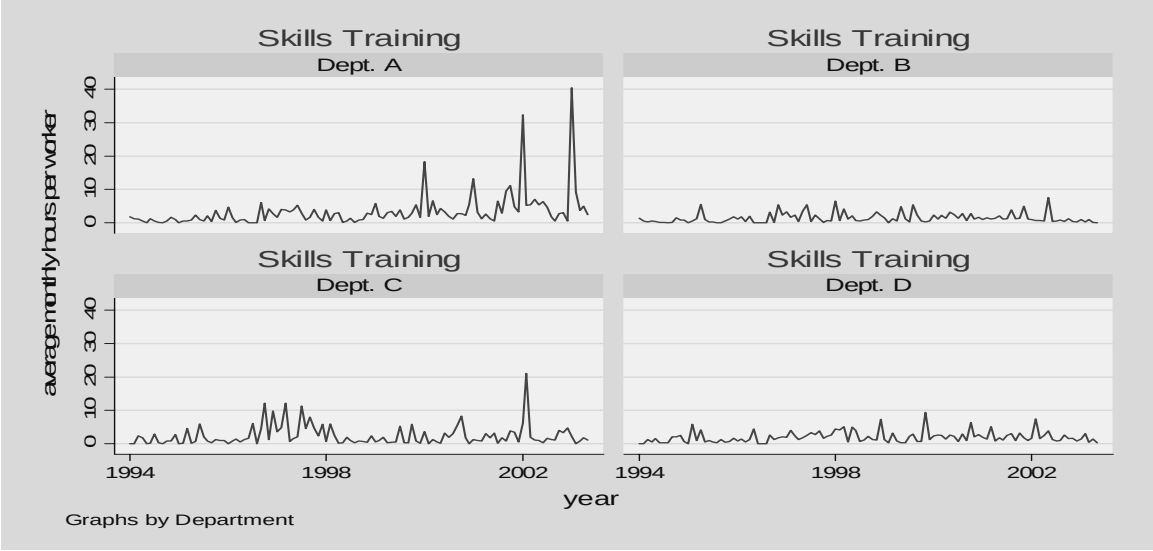
Table 2
Profile of Departments Selected for Training Data Analysis

Department	HPWO Level	Shift	Current Number of Members	Composition
A	Level 3-4	1 and 3	27	17 Flt Mech, 6 MEE, 3 Insp A/C, 1 Painter
B	Level 3	1, 2, and 3	34	27 SMAR, 2 Iassy, 2 MAP, 2 SAP, 1 utility worker
C	Level 2	1	11	7 SMAR, 2 MAP, 2 MER
D	Level 2	1 and 2	21	9 MAP, 7 SMAR, 4 MER, 1 Iassy

The training records we had access to go back over twenty years. They represent all the formal training courses received by the *current* members of the department since 1981. This means that the records of people who were in the past laid off, retired, transferred to another department, etc., are not included (there are only a few individuals whose training records ended at some point but have not been expunged). Conversely, people who have transferred in from other departments have brought with them all their past training records. We thus have a complete picture of the training courses received by these four sets of employees – although not of the departments *per se* – over a long period of time. This gives us a remarkable window into how training has changed over the years at . We divided this data into three periods: 1) before the 1996 contract, 2) between 1996 and 2001, and 3) after the 2001 contract. Both these contracts introduced major changes in job classifications. The following chart shows the annual average training hours per worker in each of these groups.

These numbers reflect *formal* training courses only and do not include on-the-job training and coach (ACLC) training. They therefore represent just a fraction of the total training efforts at the facility. The following set of charts provides a profile of the skills training delivered in each of the four departments:

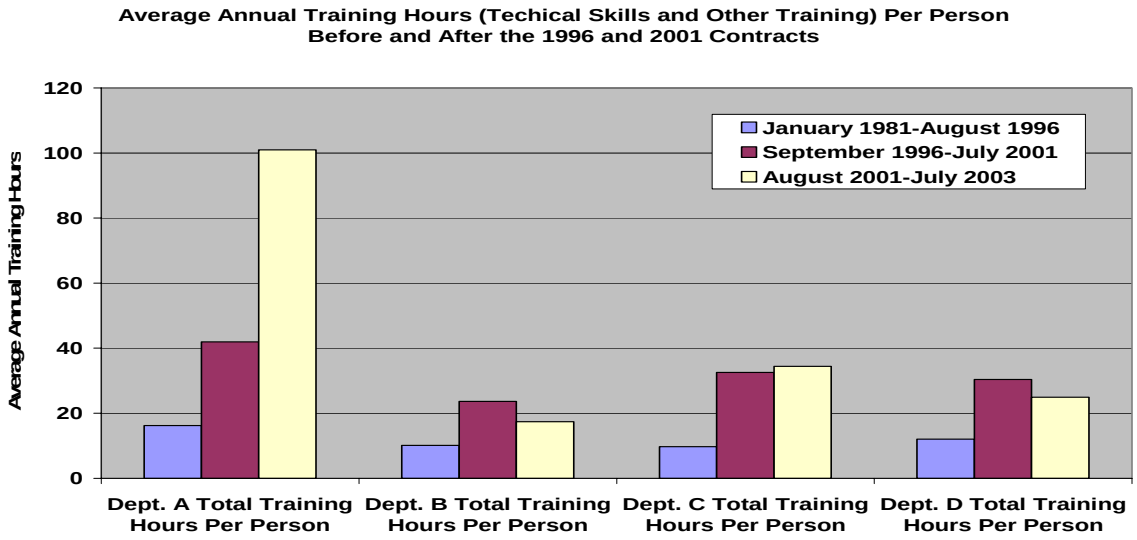
Chart 1
Skills Training in Four Departments: 1993-2003
Average Monthly Hours Per Worker



As these charts illustrate, the profiles of the departments vary considerably – with one (Department "A") showing a pattern of significantly increasing investment in training, another (Department "C") showing two different peak periods, and the last two (Departments "B" and "D") showing a steady level of training activity. In the case of Department A, this training is largely linked to military procurement contracts, which require flight ramp workers to be frequently recertified in certain critical skills. The two peaks in Department C reflect spikes in cross training efforts following the 1996 and 2001 agreements. This department engages in final assembly, an area where there is more scope for effective cross-utilization of workers than in previous stages of production. Indeed, Department C includes a high proportion of former *"All-Arounds,"* in contrast to Departments B and D, the other two assembly teams.

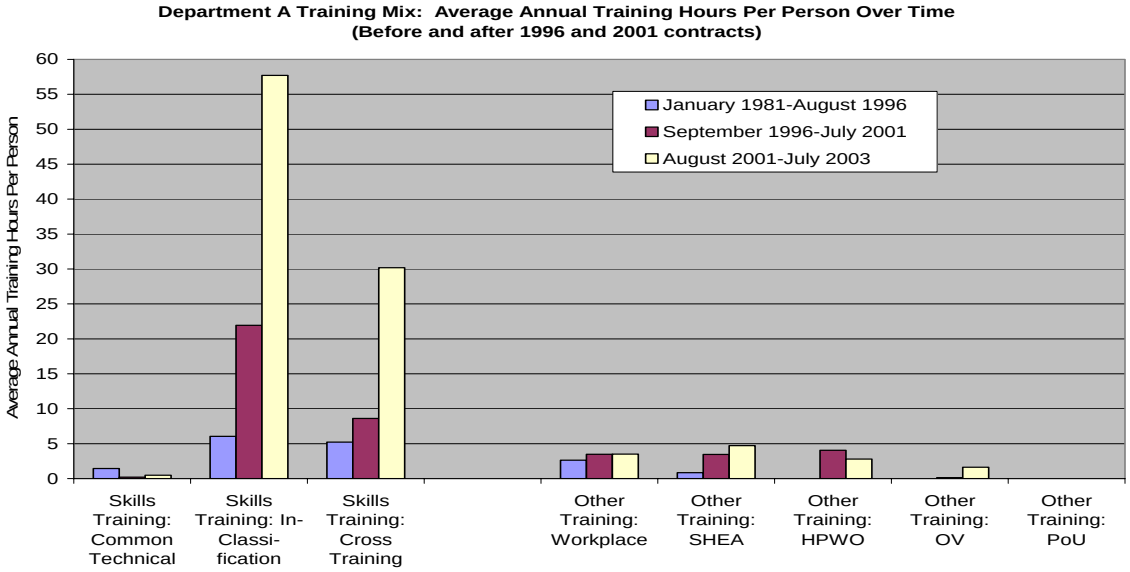
Chart 2 provides a summary of all training (technical skills and other training) for these same four departments, presented in summary form as a bar chart for the three time periods before and after the 1996 and 2001 contracts. Presented this way, we see that the last two contracts have brought at least a doubling of the amount of training provided in all four departments. The increase in Department A has been most dramatic under the most recent contract, with Department C also showing a further increase. Since 2001, there has been a slight fall off in Departments B and D.

Chart 2



The following four charts provide a break-out by types of training in each of the departments. In Department A there was substantial investment in training within classification. This department is largely made up of flight mechanics, one of the most skilled classifications in the facility, and they are subject to periodic mandated training of this type. There was also a substantial increase in cross training under the new contract.

Chart 3



In Department B, the amount of training was much less, but the cross training has increased substantially – first under the 1996 contract and then maintaining the level of training under the 2001 agreement.

Chart 4

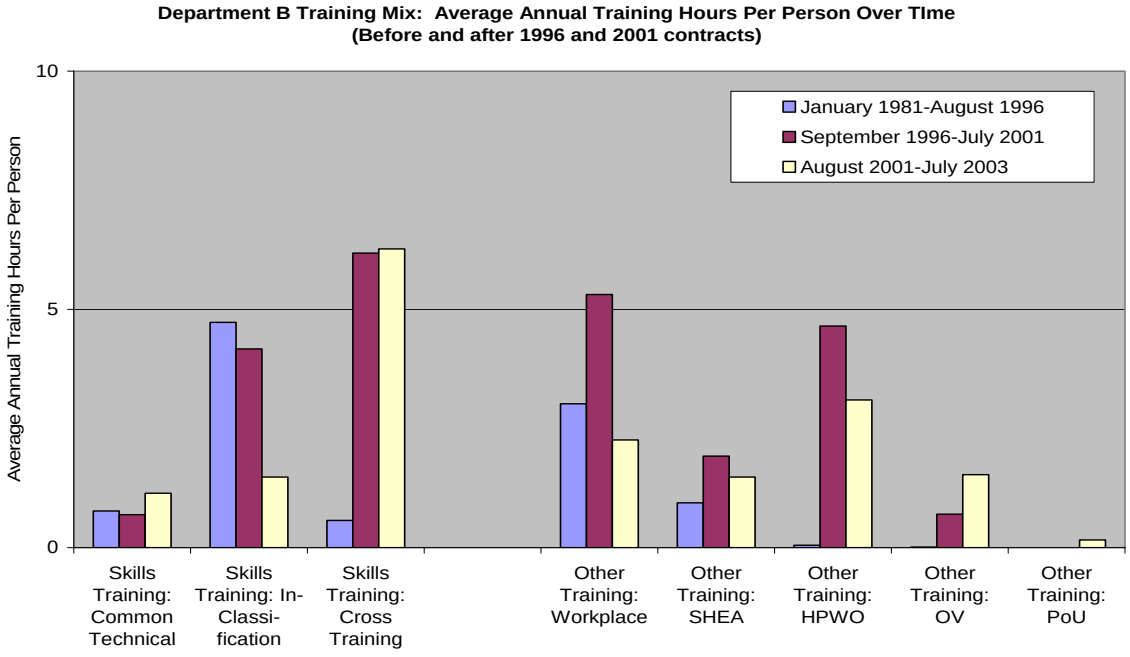
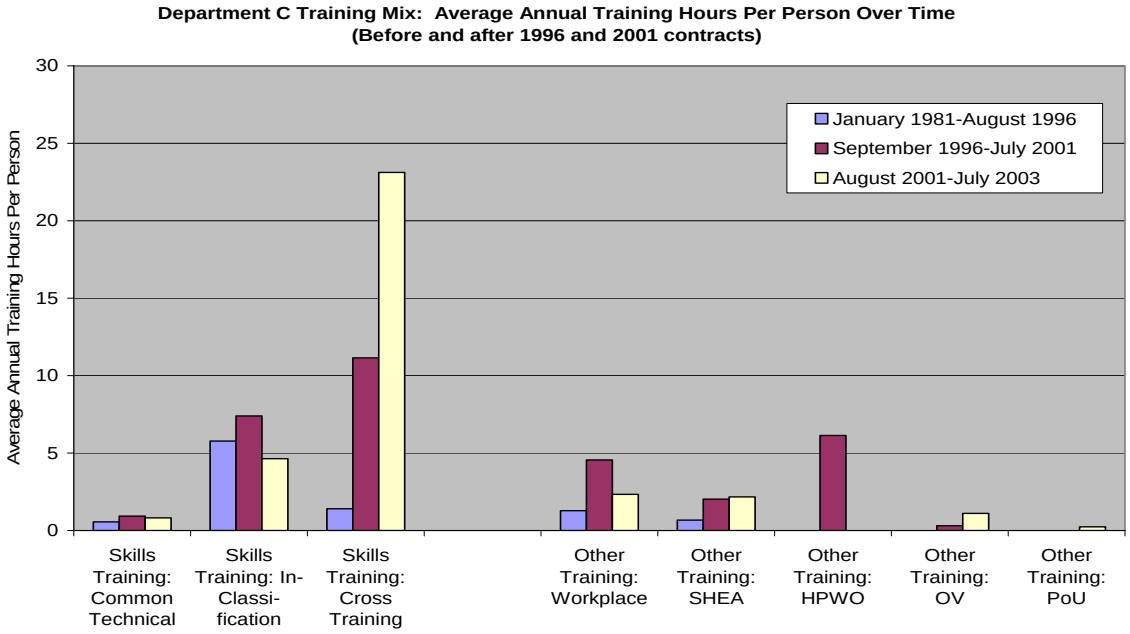
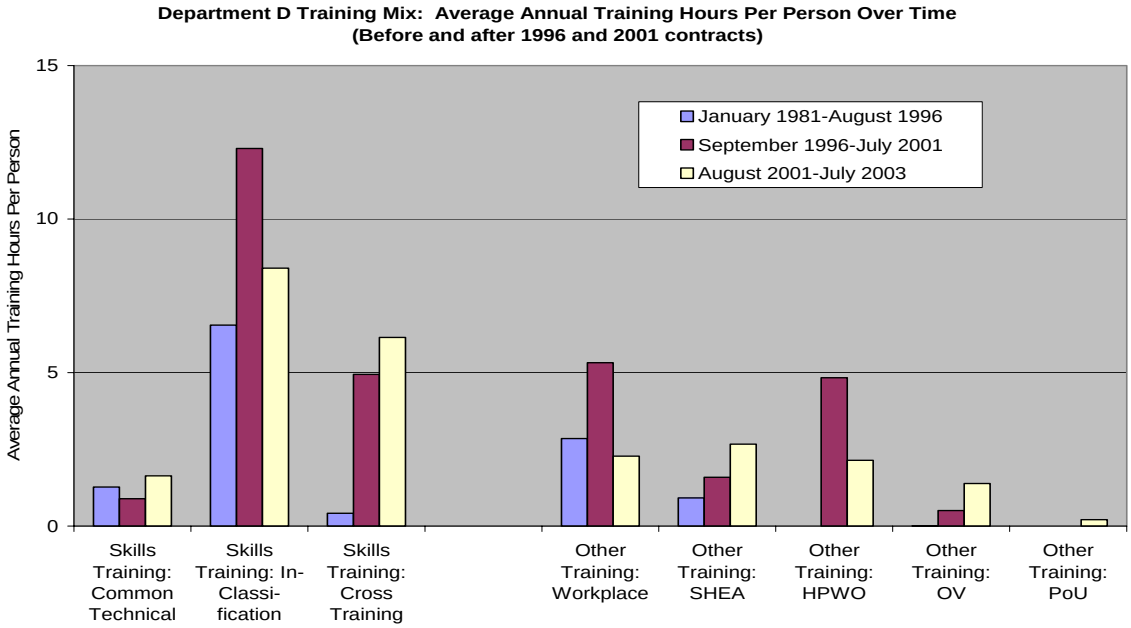


Chart 5



Departments C and D also saw increases in skills training, though the profiles are different. Department C saw a substantial increase in training under the 1996 contract and then a further doubling under the 2001 agreement. Department D experienced a similarly substantial jump following the 1996 agreement and then a maintenance of that level of training since then. Department D also experienced substantial in-classification training throughout the past decade.

Chart 6



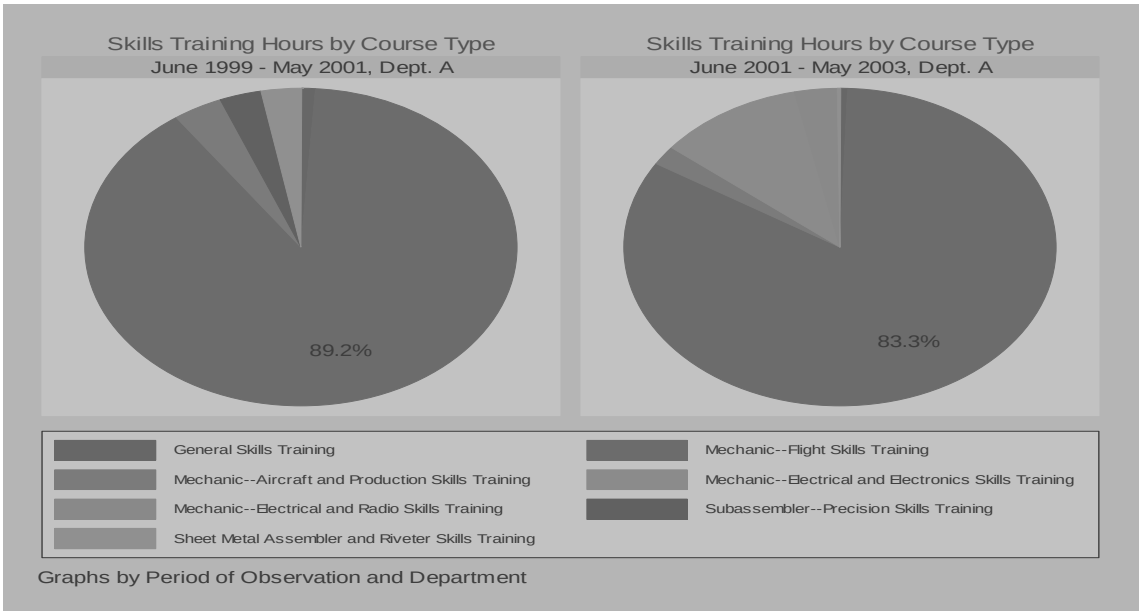
As the above charts indicate, we have sorted the training into two basic types: skills training and other training. Skills training includes, in turn, three subtypes: common technical training, training specific to a job classification, and cross training. Cross training happens when a course specific to a job classification is taken by someone in a different classification. We only have information on the employee's *current* classification but can assume it to be constant since we know, from interviews, that changes in classification have been relatively rare. Other training combines courses on workplace processes and policies (e.g., computer software, foreign object debris prevention) with others such as SHEA (health, safety and the environment) and HPWO (teams). We also identified OV (operator verification and collateral inspection) and PoU (point-of-use logistics) courses, because these initiatives also impinge on the flexible utilization of the workforce.

We can see from the above charts that there has been a shift in the composition of training since the 2001 agreement. Prior to the new contract language, in 1996-2001, there was a relatively heavier focus on non-skill specific training – such as ethics training or diversity training. Following the implementation of the new language, the focus shifted toward operator verification and skills training. This suggests that the agreements in the new contract are being reflected in the actual behavior of the people in the work system. It also reflects the important fact that training budgets have not been increased to accommodate the new job family system, thus forcing some reshuffling of training funds. As one of the training managers explained: "The lean thing is to not get overhead cost up."

With respect to HPWO training, there was an increase under the 1996 agreement and more recently there has been some fall-off in the training. Since only one of the teams was on the verge of achieving the highest level of development, level 4, it is not clear why this has declined.

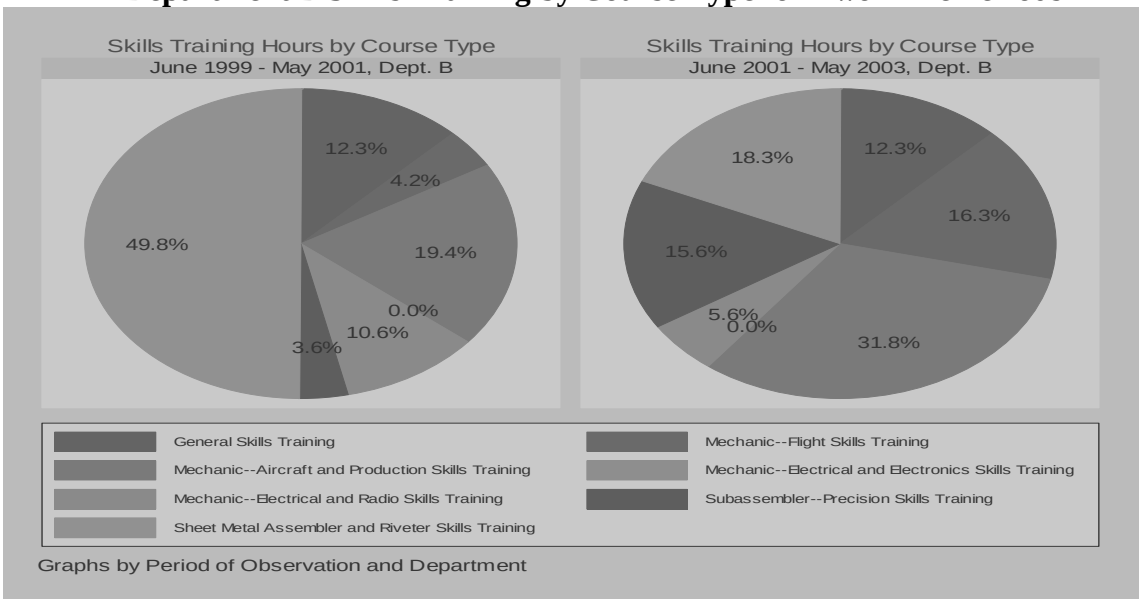
The following charts compare the content of skills training in each of the four departments in the two years before and after the 2001 agreement. In Department A, flight mechanic training accounts for between eighty and nearly ninety percent of the training, which reflects the nature of the work. Beyond that, there has been a shift toward and increased focus on electrical and electronics skills training, reflecting the growing utilization of these workers for tasks that might previously have been handled by MEEs.

Chart 7
Department A Skills Training by Course Type for Two Time Periods



In Department B, the mix of training has shifted in many ways. There has been much less training in sheet metal assembly (declining from nearly fifty percent to around eighteen percent) and increases in mechanical skills training and other categories. This experience reflects a training program that is responsive to different needs over time.

Chart 8
Department B Skills Training by Course Type for Two Time Periods



The mix of training in Department C has been more constant over time than Department B, as is indicated by Chart 9. This is also true in Department D, as reflected in Chart 10.

Chart 9
Department C Skills Training by Course Type for Two Time Periods

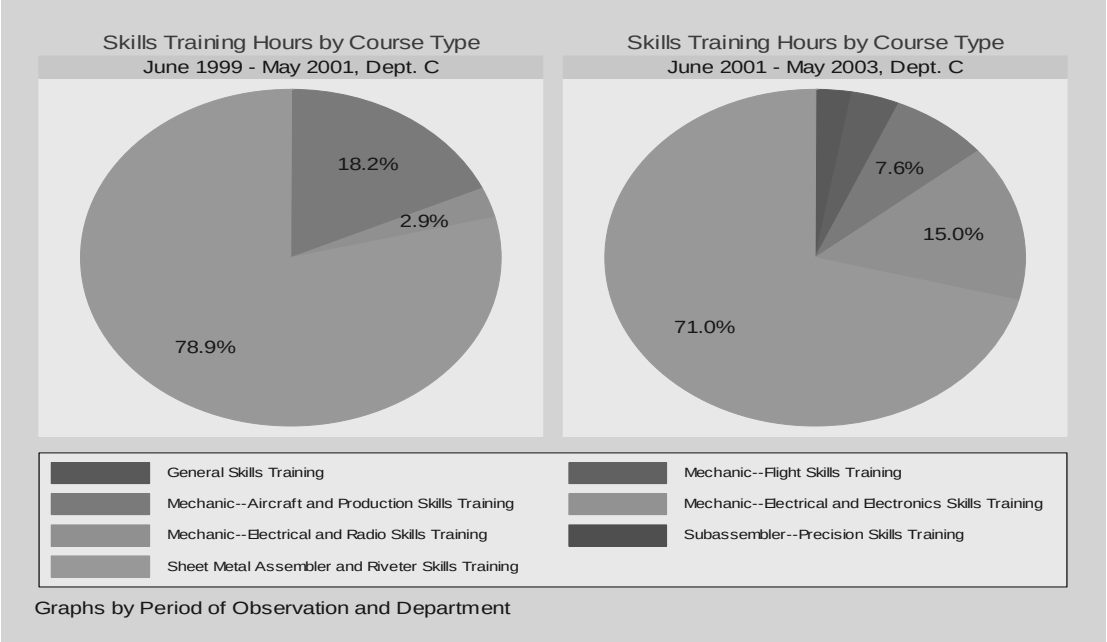
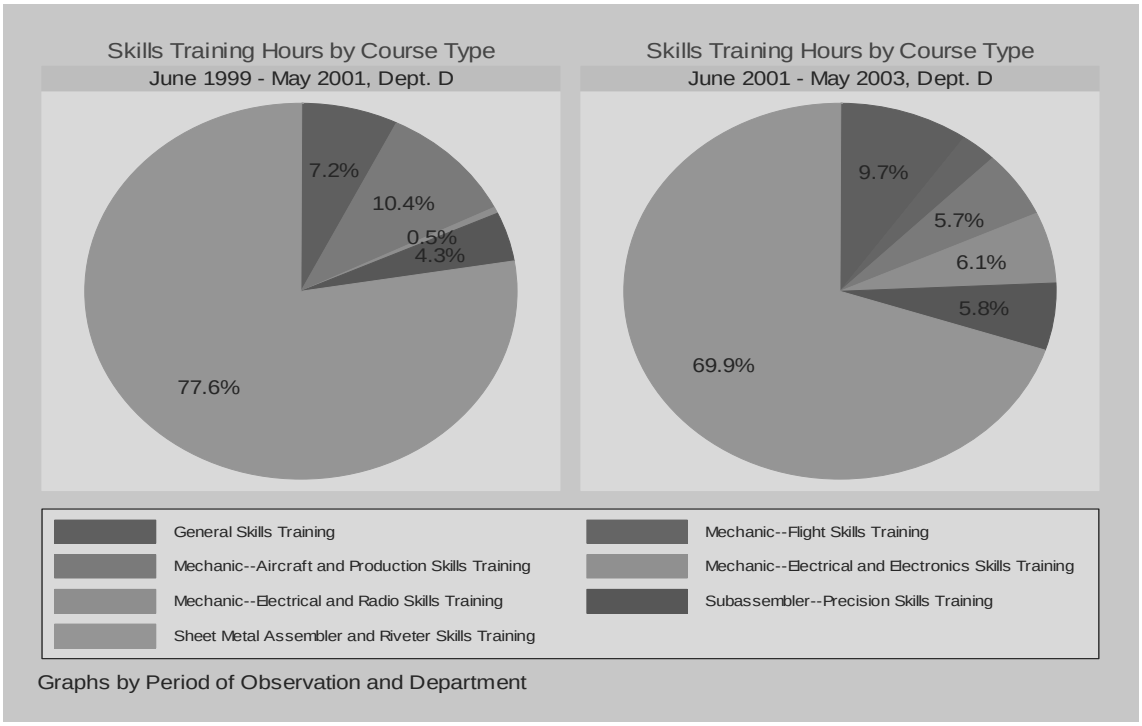


Chart 10
Department D Skills Training by Course Type for Two Time Periods



The full set of charts on the skill mix and training over time suggest that there is no one consistent pattern across departments – with some receiving two or three times as much training and with the skills mix varying in different ways in different departments. This

may be reflective of an approach to training that is responsive to different needs in different situations and it also may reflect different levels of support and motivation in different departments.

Yet another way to examine the mix of training is by job classification. The following charts present the mix of cross training received across different classifications for three different time periods (prior to 1996, between 1996 and 2001, and since 2001). As we see in Charts 11 and 13, there were some classifications, such as SMARs or MEEs where there was little or no cross-training in the period prior to 1996. Under both the 1996 and 2001 agreements there were substantial investments in cross-training for all classifications. In some cases, such as flight mechanics, there were substantial amounts of other training associated with skills certification. Since 2001, the flight mechanics have received large amounts of other training associated with skills certification. In the assembly family, the SMARs have also maintained significant levels of within-classification training. In contrast, other less numerous classifications such as SAPs, and MERs receive very little training within-classification, while cross-training to do other jobs.

Chart 11

Chart 12

Chart 13

Chart 14

Chart 15

Chart 16

VI. Concurrent Initiatives

The efforts to increase flexibility and capability can only be understood in the context of four concurrent initiatives: operator verification (OV), high performance work organization (HPWO) and direct point of use supplier delivery. Each of these initiatives is aimed at making production more effective and relates to an overall effort to create a more functionally flexible workforce and leaner system of aircraft production.

Operator Verification: Prior to the 2001 contract, a mechanic would put a completed job on a call board for an inspector to approve it. Inspectors would frequently have down time waiting for jobs to be placed on call boards, only to be bombarded with jobs at a later moment. Under OV, operators certified in a specific process can inspect their own work, preventing unnecessary bottlenecks in production. The average operator is certified in 5

processes. Those not OV qualified for a particular process still perform it and then place it on the call board as they always have—only a co-worker with collateral inspection certification (CI)) for that particular process can "buy off "that work.

Workers received 4 hours of training on the OV process. They could also move up one more step and become trained to do collateral inspection. This meant that they could inspect the work of others and certify its correctness. Although the number of dedicated, or core, inspectors has been reduced since the 2001 agreement, maintaining the highest quality is a universal concern. In addition to operator verification of their own work, the company has instituted a layered system of inspection with OV supplemented by collateral inspection or core inspectors if available. While workers can approve their own work, the highest level work – "safety of flight" tasks – are always inspected by a second worker who is either a core inspector or has collateral inspection authority to "buy off" work done by others.

This process of operator verification is consistent with the overall organizational focus on the utilization of lean manufacturing principles. It reflects the view that quality is best achieved "closest to the source," by the front-line worker. This represents a shift from the responsibility resting with a separate group of inspectors. In fact, many of those who were inspectors have returned to production work. The remaining core inspectors approve "safety of flight" work and carry both random and targeted surveillance duties, checking on specific jobs and workers that have been identified as more likely sources of defects.

IAM as an Advocate for HPWO

The International Association of Machinists and Aerospace Workers (IAM) has developed since the mid 1990s a strategy of building High Performance Work Organization (HPWO) partnerships. The aim of the strategy is to provide "a process that will help us grow the companies where IAM members work and help save and create jobs."

There are currently over 50 partnerships between the union and individual facilities or companies in the U.S. and Canada. In a HPWO partnership, the partners define a new team-based work system that draws on the insights and talents of all employees and assigns to them new roles and responsibilities. The details of the partnership agreement vary from place to place, but they all share some basic principles such as joint decision-making, continuous learning and skill building, and the sharing of information.

IAM headquarters assists locals in the 10-step process of designing, implementing and evaluating HPWO partnerships. In 1994, it invited both union and management at Boeing St. Louis to an initial training session. The company rejected the notion of full partnership but decided to start some pilots in areas that were about to be shut down. This eventually led to the conclusion of a HPWO agreement in 1996.

***HPWO*:** The 1996 agreement created a High Performance Work Organization (HPWO) in St. Louis. Under the plan, shop-floor workers were grouped into HPWO teams, with an elected team leader. Teams are encouraged to climb the HPWO steps from a Level 1 to a Level 4 team—the latter having nearly complete autonomy to craft goals and to manage and schedule their work as well as request training. Today, there are approximately 300 HPWO teams across the facility, with 25-30 that have achieved Level 4. Achieving Level 4 takes a minimum of two years and more often longer. Teams initially receive 16 hours of core HPWO training, with team leaders receiving an additional 24 hours of training.

On approximately a quarterly basis there are special dinners in which the teams that have achieved Level 4 are honored, with both union and management leaders providing the recognition. Team members receive a monetary award at the ceremony. Since 1999, the

HPWO Performance Share Plan has also rewarded each worker at the facility according to a complex gain-sharing formula. The average payout over the last three years has been $1,200.

In general, there is a positive view of teamwork across the workforce. For example, of the 34 individuals who completed our individual survey, all but 5 respondents agreed with the statement that they preferred a teamwork environment. In our survey of workers in the four departments, the intensity of worker response on the concept of HPWO specifically was correlated with the team level, with Level 4 Team members voicing greater enthusiasm over the changes that HPWO made in their day-to-day work lives. Views on the HPWO initiative had no direct relationship with the job classifications of the workers.

***Point of Use**:* The 2001 contract also featured language on the transition to a point-of-use supplier delivery method. Workers in the support job family would be responsible for dispersing the parts from the receiving station to the point of use, although all employees would now be expected to assist with this task. Since 1997, supply chain management at the facility has improved inventory turns while reducing the ratio of production control staff to direct labor.

Lean Transformation: HPWO, in-process quality control and point-of-use logistics are all part of a larger "lean transformation," with other manifestations of lean directly impacting the organization of work at Boeing, St. Louis. Initially, the HPWO efforts and the lean initiatives were separate. As one of the site's HPWO coordinators commented, "When lean first came in, it was another organization. There was union push back. Now HPWO has become an umbrella for any change on the shop floor."

From the perspective of the operators, the most visible manifestation of lean is the shop floor itself. Each of the three shops we visited was clean, bright, and painstakingly efficient in layout. We observed perfectly organized and labeled tool cribs, each individually-outfitted for its role and place in the production process, freshly-painted and spotless floors, meticulously free of dangerous FOD (foreign object debris), such as screws, nuts, and other small objects that can get caught in engines and other mechanisms, injuring people and damaging planes. Building 101, the newly opened consolidated production facility for the C-17, especially heralds the arrival of lean production. Built to facilitate point-of-use delivery of supplies and pre-fabricated parts, the facility is part of a $140 million plan to make Boeing St. Louis the most efficient producer in the industry.[12] The production setting is designed so that FOD hits the floor instead of collecting in the part itself, while the floor color and texture enables its quick detection. Another manifestation of lean is the standardization of tools, in which a specialized toolbox is placed at each work station.

There are larger strategic issues associated with lean transformation. As the site manager explained Boeing St. Louis aims to become more of a systems integrator and less of a fabricator of airplane parts, moving up the value chain and abandoning the in-house production of low-value-added items. As the company encourages suppliers to provide subassemblies and focuses more tightly on the final assembly of aircraft, a different mix of skills and capabilities will become more important. One example of the impact of choosing

[12] *St. Louis Post Dispatch,* 4 June 2002.

an integrative strategy is the sale of the fabrication facilities in 2001 to the British firm GKN Aerospace Services. Importantly, Boeing was responsive to union concerns that GKN maintain the union status for the workforce that was transferred. There are currently 837 IAM members working at the new GKN St. Louis site.

Another enterprise-level implication of the lean approach can be found in new product development. All of the platforms produced in this facility undergo periodic re-designs, with E/F versions of the F18 being the most recent and pivotal to the future of the operation. Consistent with lean principles, the product redesign also involved detailed value stream maps and the direct involvement of production team members on the Integrated Product Teams (IPTs), which also featured the involvement of customers and suppliers. As one manager commented, "We broke down the wall between design and manufacturing. It used to be that manufacturing was not heavily involved until a few weeks before assembly. Now issues of floor layout and industrial engineering were being considered one or two years in advance."

VII. Assessing Outcomes

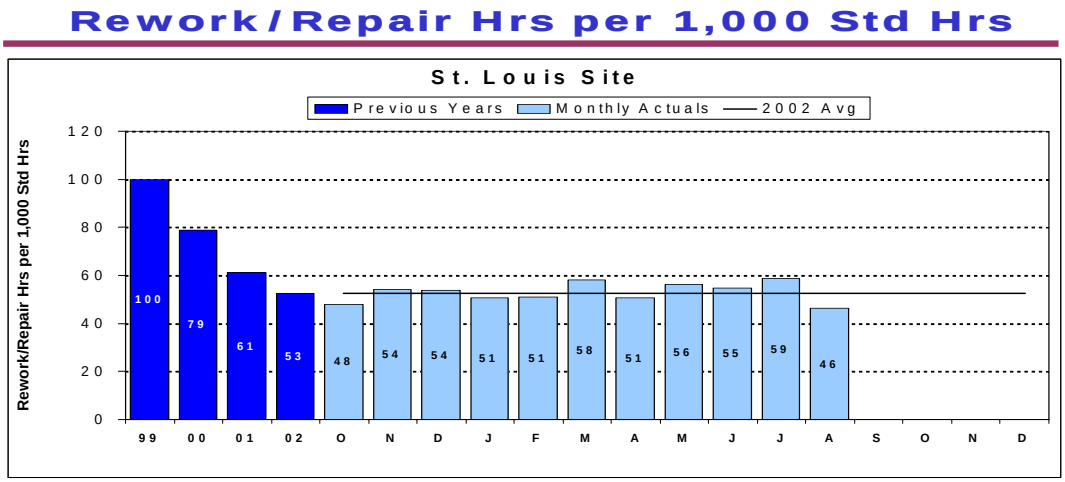
The Boeing job family initiative can be assessed on two levels of flexibility. First it can be assessed on how well it succeeds in giving the company greater flexibility in the use of its workforce. The cross training is aimed at allowing workers in specific classifications to do incidental work that is normally considered the work of other classifications. At this time no worker is required to change classifications but many inspectors are being re-assigned to production work. The job family system is an opportunity to rationalize the work of aircraft assembly by allowing one worker to be trained to perform consecutively tasks that were once done by several specialized workers. This allows the work to flow more smoothly and production to be completed more quickly. Cost reductions include a decrease in the amount of down time spent waiting while another is called in to complete a task. On a second level, flexibility could also benefit individual workers through the enlargement of their skills and capabilities, enhancing employability. Many workers believe that having more skills can be helpful. However, the value of this is diminished by the limited number of alternative job opportunities in the St. Louis labor market.

Flexibility and Organizational Outcomes: Linking facility-level output measures and the implementation of the job family agreement is not a simple task. There are many factors that influence productivity and quality data in aircraft production such as the actual orders received, changes in design, production schedules, subcontracting, or changes in work organization such as the implementation of lean manufacturing principles. Management reports that increased ability to cross-utilize workers has led to gains in productivity, scheduling and cost savings. A senior production manager commented, for instance, that "The F-18 program is ahead of schedule and a five-year goal to reduce defects by 19% was reached in just 3 years." This is all the more remarkable given that there was also a major reduction in budget costs. "Even with the added cost of all the learning we've still hit all the targets." An IAM representative stated, "We have experienced significant productivity gains as a result of the labor grade plan…under the old contract we were finishing 36 F-18's a year; now we will finish 44. That's a 22% increase in delivered aircraft with fewer

bodies." Production managers from other programs also stressed that "our rates have increased but we haven't increased manpower."

In regards to quality, company metrics show that defects per 1,000 standard hours have been at or below plan since January 2002. Defect figures have markedly improved compared to 1998 and 1999, but they are difficult to interpret because the method used to measure them changed in 2002. The next chart features rework/repair hours per 1,000 standard work hours, which were not affected by this change. We can see that rework/repair costs have declined 47% since 1999 (with 1999 figures used as a baseline). While the decline started well before the implementation of the 2001 agreement, it has leveled off to a large degree in 2002 and 2003.

Chart 17



Despite these data, many of the workers we interviewed about the new inspection approach said that they preferred having, like in the past, a "second set of eyes" checking their work. Some of the workers also voiced a desire not to take away the jobs of inspectors.. Among those doing collateral inspection, some felt this new task frequently forced them to interrupt their regular work. In most cases, the same individuals that had become multi-skilled through cross training were also those engaged in collateral inspection. They sometimes reported that other employees were not asked to take on additional tasks while they were not being paid any extra money for their efforts.

Charts 18- 21 represent a preliminary analysis of outcomes. Each chart includes monthly summaries of skills training hours, combined with monthly data on productivity (as measured by what Boeing terms the Realization Factor or the RF) and repair costs (normalized based on the expended hours that month). Increases in the RF are favorable – they represent performance that exceeds what would be expected at the staff levels and with the other inputs during a given time period. Decreases in repair costs are favorable, by contrast. These tables do point to some possible relationships between training and these performance outcomes, but further analysis will be needed to examine concurrent factors, effects of different types of training, lagged effects and other possible relationships between training investments and performance outcomes. This analysis will be continuing on the part of the MIT research team.

Chart 18

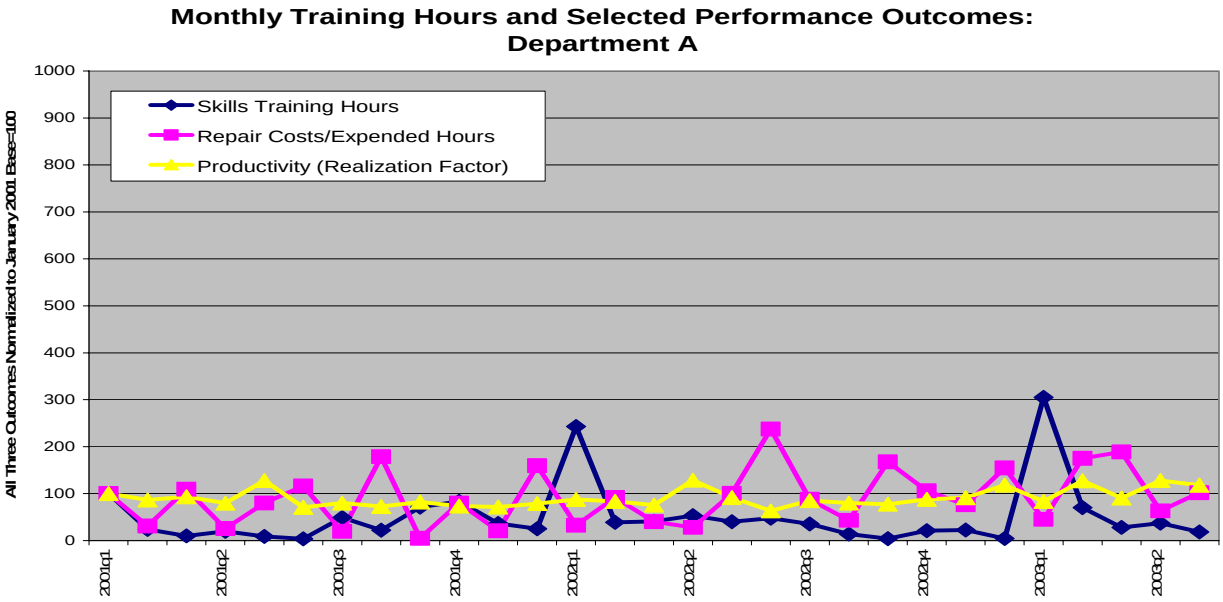


Chart 19

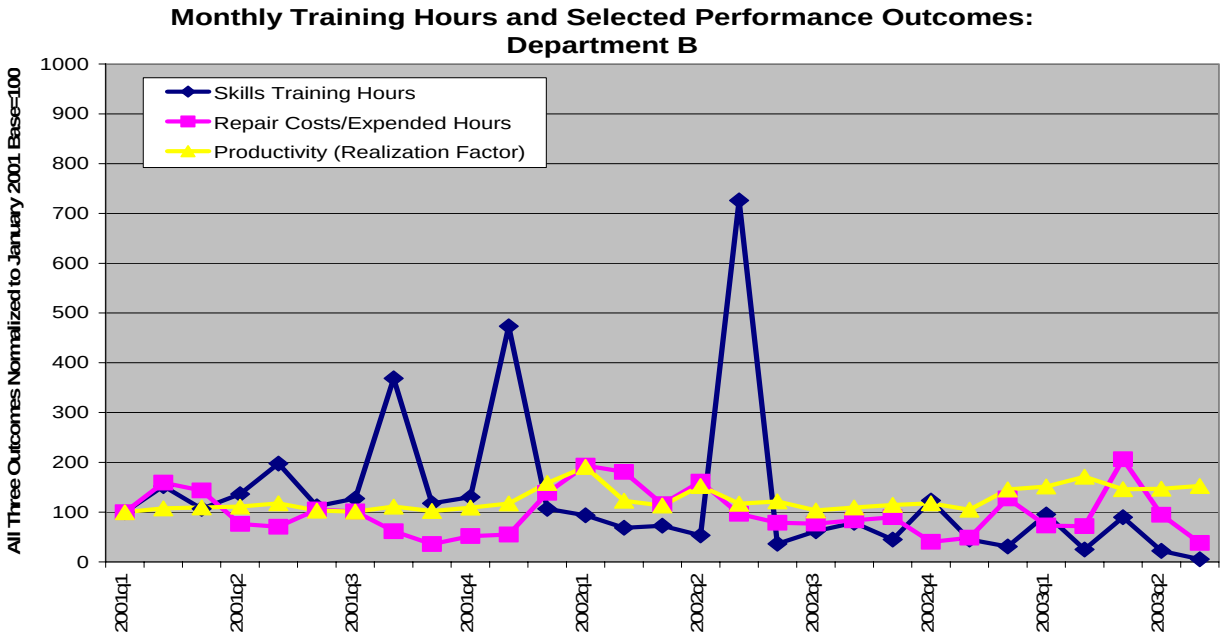


Chart 20

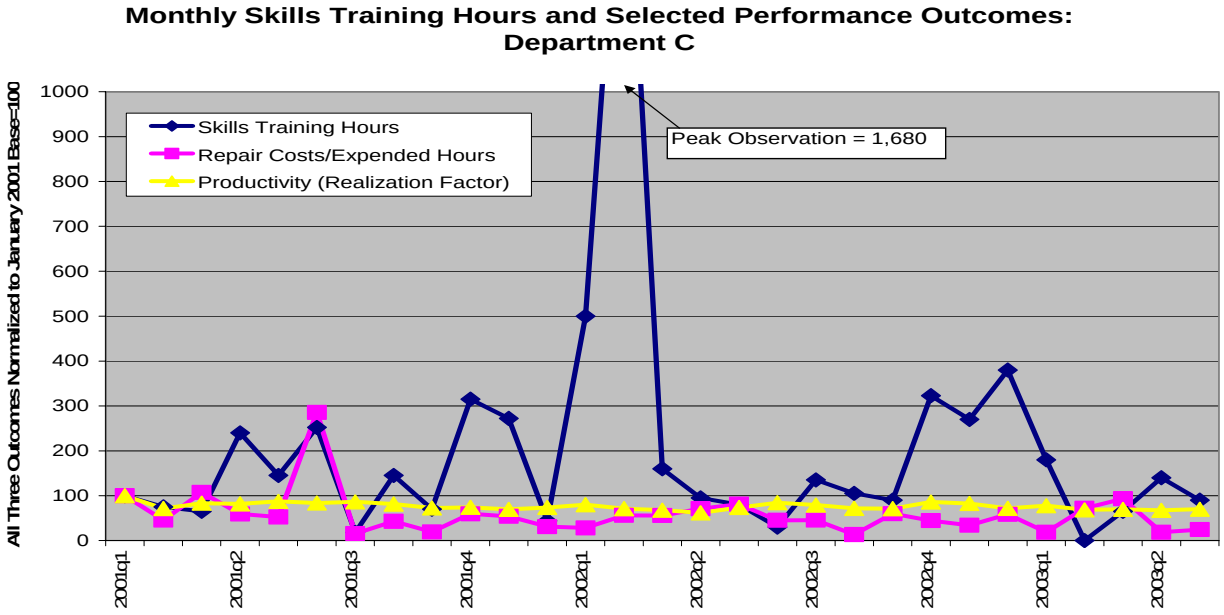
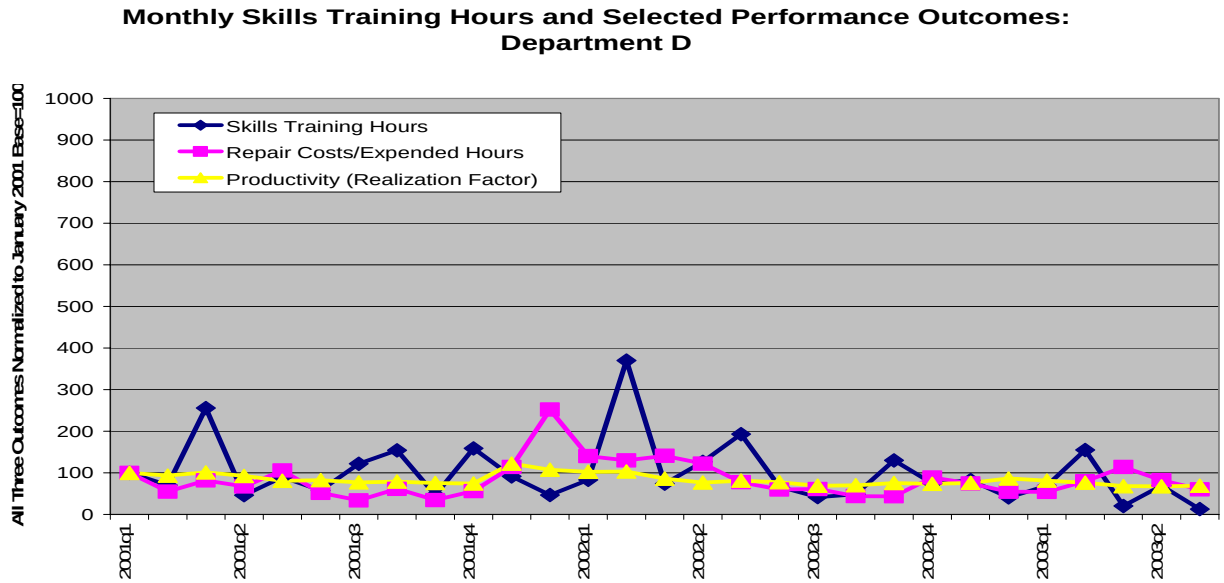


Chart 21



Flexibility and Individual Outcomes: For those workers who volunteer, training is available to allow them to do a greater percentage of the work needed to assemble an airplane. They can inspect and pass on the quality of their own work after a relatively small amount of training. Those who chose to take more training can do collateral inspection, which allows them to inspect and pass on the quality of the work of their co-workers. These are markedly different types of tasks and do allow the individual worker, who

chooses to take on the inspection duties, greater variety and responsibility in their daily routines.

This trend toward greater autonomy is also apparent in the high performance work team structure that exists in the plant. Teams take on ever more responsibility and greater shares of the tasks once performed by supervisors such as scheduling and some budgeting. As the teams progress they rise through four levels until they reach Level Four status. In this level the team still has a supervisor but his or her duties have changed so that the supervisor provides resources and facilitates the daily operations of the team. If a worker is in a Level Four team and participating in the cross trained work, he or she may be experiencing a high degree of variation and change in the work area.

A sample of 34 individuals from the four departments completed a survey that included a number of questions regarding the new work system. On the one hand, they confirmed that this set of initiatives is delivering on the organizational goal of increased flexibility. A total of 24 of the 34 respondents agreed with the statement that, "I have learned more tasks and increased my flexibility." Similarly, 24 of the respondents agreed with the statement that, "My job makes good use of my skills and abilities." On the other hand, only 11 of these respondents agreed with the statement that, "Increasing my skill level will help me maintain employment" and just 16 agreed with the statement that, "Learning new work practices will increase my employability."

It is inevitable that the impending layoff had an impact on the attitudes of these workers. In interviews they were proud of their performance and understood the importance of team-based work. They could see the logic behind the cross training in terms of the work flow and they indicated that they enjoyed being able to do different types of tasks. Unfortunately the potential for greater individual employability outside of Boeing does not seem to exist. The St. Louis labor market in which this skilled group of workers competes is either Boeing or a nearby Chrysler automobile factory. Consistent with the survey results, only a few stated during interviews that any of the new skills they acquire would result in improved employment opportunities once they have left Boeing.

VIII. Implications for Practice

In one sense, the shift to job families is a relatively simple, incremental change. In another sense, it requires significant realignment for line management, the union and all support functions in the organization. The full scope of the impact is greater, of course, as a result of the concurrent initiatives around Operator Verification (OV), High Performance Work Organization (HPWO), and Lean Enterprise Transformation.

Front-Line Workers. The front-line workers are at the heart of this movement to increased flexibility through investment in skills and training. On the one hand, they are the beneficiaries of increased investment in skills and capability, increased responsibility for quality, and the ability to suggest improvements in operations through their HPWO teams. On the other hand, the degree to which these new arrangements are valued is complex. At the outset of this case, we noted the alignment with the Hackman and Oldham job design framework, which highlights five core dimensions to a successful job redesign

initiative.[13] These are: Skill variety, Task identity, Task significance, Autonomy, and Feedback. These dimensions combine to create three critical psychological states that affect individual motivation and job satisfaction: meaningfulness, personal responsibility, and knowledge of results. If this theoretical model is applied to the situation at Boeing St. Louis, it is clear that this meets all the criteria of a successful job redesign.

Table 3: Applying the Job Design Model to the Case

Hackman and Oldham's Definitions of Core Job Dimensions	**Evidence of Core Job Dimensions in Boeing/IAM Job Family Plan**
Skill Variety -- the degree to which a job requires a variety of different activities in carrying out the work and which use different skills and talents of the person.	Workers are encouraged to volunteer to learn and perform tasks from other classifications.
Task Identity -- the degree to which the job requires completion of a "whole" and identifiable piece of work. Doing a job from beginning to end with a visible outcome.	The cross training is targeted at allowing a worker to perform a sequence of tasks rather than split up those tasks among various classifications and workers.
Task Significance -- the degree to which the job has a substantial impact on the lives or work of other people.	Building an airplane is work that requires constant attention to detail and safety of-flight issues.
Autonomy -- the degree to which the job provides substantial freedom, independence, and discretion to the individual in scheduling the work and in determining the procedures to be used in carrying it out.	The growing high performance work organization or team-based work system is increasing the levels of autonomy and decision-making authority that individual workers have. In addition the operator verification program empowers workers to inspect and pass their own work.
Feedback -- the degree to which carrying out the work activities required by the job results in the individual's obtaining direct and clear information about the effectiveness of his or her performance.	Team-based performance data are available to each worker as are the program and facility performance statistics. Workers also receive feedback from their peers through the collateral and traditional inspection programs.

What then would prevent this redesign from being classified as a great success? A key issue centers on the attitudes of the workers, who are not optimistic about the overall employment situation. For example, only 4 of the 34 participants completing the individual survey indicated that they would recommend that their children come to work in the aerospace industry, which is consistent with a larger sample of over 500 respondents asked the same question in nine other aerospace facilities where we have completed related case study research. They also report that there is decreased trust in both the union and

[13] J. R. Hackman and G. R. Oldham, "Development of the Job Diagnostic Survey", Journal of Applied Psychology, vol. 60, 1975, pp 159-170.

management leadership since the 2001 contract negotiations. It is impossible to know how different these responses would have been had there been no lay offs, had there been an upsurge in sales, or even if other comparable jobs were available in this labor market.

At the Boeing St. Louis plant and in the surrounding area the success of the job redesign may also rest on the perceived or real efficacy of the cross training in assuring that the workers have employment. For the cross training to be helpful in terms of employability, it must be thorough and there must be a place in the labor market to sell those skills. Further, because the cross training is for discrete tasks, the fit of the training with existing certification standards is a concern. As one worker commented, "My A&P license, that's my employability. Here I'm a SMAR. They won't know I was also a mechanic. I will put it in my resume but I don't think it will help me." On the other hand, another worker stated: "It will make me more employable – all these teaming skills: job family, HPWO..." But then he added: "I don't know what I would do if I'm laid off. This is the only place I have worked in."

Thus job redesign success does not rely solely on the intrinsic effect it has on the workers involved. .External factors like competition, levels of economic well-being, corporate strategy, and the culture of the organizations all play formative roles in outcomes. In this case, the company and the union were captive to a procurement decision derived from an intensely competitive governmental acquisition system. The events of September 11, 2001 greatly magnified the overall economic weaknesses that had begun to develop in both commercial and defense aerospace markets. All these elements will influence the perceived success of current efforts at the plant.

A further complicating factor is the existence of an age gap between those who take on new tasks, who tend to be younger, and those workers with more seniority who are not seeking as many training opportunities. If lay offs continue, many of the employees who are more flexible and multi-skilled, like the *"All-Arounds"*, will be leaving the workforce, taking that training and expertise. These are the very workers who exemplify the types of machinists that Boeing hopes will inhabit the new job families. At the same time, there is a portion of the current workforce that would be able to retire if they chose to do so, although past incentives for early retirement had limited success. The result is a complicated set of exchanges. For example, one worker commented: "There is a precision guy who is being laid off on Friday. He was teaching me this job that only he and another guy know – he is also being laid off. I was the one taking their job. You could feel the tension."

As the demographic cliff of an aging workforce becomes an imminent threat, the base of skills embedded in it takes on new dimensions. The company's operations assume the presence of this skill base every day. Clearly, when the minimum seniority of a group of workers is 15 to 18 years, there are many things they do not need to be told. They know what tool works best for each task, which parts are often flawed, which procedures are trickier than others, what a specific sound means when a tool has too much torque.

As these workers retire and Boeing brings in new workers, the model of targeted skill acquisition in this location will have important implications. The initial training might become less extensive, given the prospect of further training and learning opportunities throughout a career. At the same time, the flexibility that is now expected from workers,

and the fact that this facility is moving out of fabrication, suggests that future hires will need higher educational credentials (i.e., Airframe & Power Plant Mechanic licenses) and/or military experience in order to be assured the capability to utilize what could be a life-long flow of training investments.

Line Management. For front-line supervisors, this increased flexibility has enabled them to assure an improved work flow and increased quality. It has, however, required these individuals to build greater expertise in disaggregating job components in order to request targeted training support. Moreover, these individuals have had to develop their own coaching skills much more deeply. Coaching is needed in the utilization of new skills as well as with respect to the increased use of Operator Verification and the movement of HPWO teams to higher levels. For instance, Level Four teams can schedule themselves and may have control over whether workers cross crafts or not. Many of the front-line supervisors have successfully made this shift, but not all. Unfortunately, it only takes a few incidents of supervisors providing more traditional command and control leadership – focusing on "getting the product out the door" – to raise doubts in worker's minds about the organization's commitment to these initiatives. Hence, the realignment of front-line leadership skills and management style represents a key area for continued attention in this initiative.

For more senior managers, this has required a complete inversion of the typical, top-down mindset. They still hold front-line operations accountable for delivering results on cost, quality, and schedule performance, but they must also take a much more proactive role in ensuring that these operations have the tools, resources and support needed to accomplish these goals. This is because the lean approach increases performance by placing greater responsibility for performance on front-line operations. Instead of viewing training as a nice, add-on activity when time permits, for example, it has become a key enabler of work flow. In a context where training budgets are traditionally the first to be cut, this requires a shift in approach at the more senior management levels.

In motivating the shift, the site manager summarizes the message for managers as follows, "Everyone wants to go back to the good old days. Well, the good old days are tomorrow."

Union Leadership: Although the increased investment in workforce skills represents a core union priority, it has also surfaced many challenges and dilemmas for the union. As one local union leader commented: "We're all for efficiency and quality but let's get there with everyone on board." There is always a tension between the independent responsibilities of a union and its role as a strategic partner with management. In this case, the union has maintained its partnership role despite many forces pulling in opposite directions.

Currently, the workforce that is still employed is quite senior and expects to have its seniority rights protected. The ability to translate enhanced skills into secure employment is an essential element of the overall bargain that the union and management negotiated. The benefits that might have been gained by the award of the Joint Strike Fighter contract were substantial and demanded an increased level of competitiveness from Boeing. The combined loss of the JSF and the downturn in the economy after September 11, 2001 has reduced the employment security potential of this agreement. A further aspect of

employment security might have been realized if the enhanced skills of the workforce translated to greater employability in the region. But in the St Louis area this also seems to be limited by the small number of comparable employers. The benefits to the workforce of portability associated with the job family training will require a mechanism that is not just limited to the St. Louis area..

Summing up the union perspective, the local union President observed, "People were initially skeptical of the HPWO efforts as just another 'flavor of the month.' That was back in 1995 when we first started talking about this and it is still here. Today, some people are very pleased with the job families and others still have concerns. There is more that is needed to have a full partnership, but we are proud of what we have accomplished."

Human Resource Function: The Human Resource function has had to significantly adjust its operations in order to be aligned with the more flexible structure of work. First, the training function has undergone a major cultural transformation in order to shift from the scheduled "push" model of training to the just-in-time "pull" model of training. Second, the labor relations staff has had to place even greater emphasis on building and maintaining partnership relations with the union, not just negotiating collective bargaining contracts and administering the grievance procedure. This is particularly challenging considering that the number of labor relations staff has been reduced over the past decade from 18 to 5. The new contract language eliminated what was the main source of grievances in the past: the crossing of craft lines. However, people have continued to grieve over this issue in regards to overtime, which is still governed by the old job classification rules. Third, the process of performance appraisal and career planning has had to expand to take into account the efforts of supervisors and managers who are, or are not, working aggressively to support the new work system.

Quality Function: The movement to operator verification represents a fundamental shift from a model of *inspecting in* quality to a model of *building in* quality. As the Manager of Quality commented, "Perhaps no organization has had to change as much as [the] quality [function]." He was referring to the shift from managing a staff of quality inspectors and supervisors to delivering quality through the front-line workforce. The mechanisms for delivering quality in this way are Operator Verification training, related cross training, and the HPWO structure. "This is not a pilot experiment," he added. "We drew a line in the sand and said from now on we will handle quality differently. Initially, it was not popular with the inspectors or the mechanics, but there is only a small group that remains flat out against what we are doing." While safety of flight quality inspection is still handled in the traditional fashion, ninety percent of workers are now doing some "buy-off" of their own work. This involved extensive pre-briefings with key customers, who were initially skeptical about this process.

Production Control and Supply Chain Management: In the Production Control organization, there has been a significant shift associated with delivering materials to the "point of use" on a "pull" basis – both within the operations and through external suppliers. As suppliers increase the amount of line-side delivery of materials, the size of the workforce in this function has been reduced. Approximately half the workforce remains, with most of the displaced workers redeployed to other parts of the operation. This has been enabled by still-experimental long-term agreements for a selected number of suppliers.

The company has also set up partnership agreements with a number of universities, including the University of Michigan, the University of Kentucky, MIT and others, in order to deliver new training in supply chain management.

Finance Function: Traditionally, the finance function has "faced upwards," providing financial reports on performance outcomes to enable senior managers to make strategic decisions. Now, however, the HPWO teams are requesting regular feedback on cost, quality and schedule performance at the team level, in a format that is easily understandable. This converts the finance function into a front-line service role, which is a significant shift. As the Manager of Finance commented, "We are not accustomed to having to get data to the floor, but it is really a small step from the direction that we were already headed, which involved managing data in smaller chunks. We are still learning how to best display data so that it will be well understood." He went on to add that, "Now that we are building this capability, the site manager recently asked us to examine the relationship between teams and performance. We had only been tracking performance down to the department level."

One unique challenge faced by the finance function in the launch of the new training system involved establishing training budgets for each department. As the Finance Manager commented, "The goal was to support as much training as possible, delivered in a timely fashion so that it would be put to use. During the first year, the supervisors estimated how much training would be needed and we had to build those hours into our budgets and our overhead calculations."

IX. Implications for Policy

The new job family system at allows greater flexibility in the work that individual employees can do, helping the company to optimize labor costs. It also offers the workforce greater variety in their daily work, opportunities for skill enrichment, and greater input in the production of each aircraft. Training at this facility has more than doubled since 1996, when ACLC coaching and cross training programs were first introduced. It has evolved in recent years, with a focus now on short training modules that are targeted to the specific needs of each team or work area and delivered on a just-in-time basis.

The long-term impact and policy implications of these innovations on skills acquisition is less clear, however. The policy implications operate on many levels. First, there are the specific policy challenges embedded in this situation, which center on the portability of skills. Then there are the larger policy challenges posed if this, more flexible model of training and operations becomes widespread and replaces more traditional training models centered on craft-specific apprenticeships.

Portability of Skills: Cross training for the new job families is for specific tasks or sets of tasks, based on the needs of each team or work area. In contrast to the former *"All Arounds,"* who got extensive training in order to master all four specializations in the assembly family, both the amount and the content of training workers receive now varies from case to case. This means that individual workers will accumulate different skill mixes

over time, which raises the question: How can these added skills be recognized in order to make them portable across firms?

In today's knowledge economy, many workplaces undergo rapid technological and organizational change that requires continuous learning. Advanced industrial countries are grappling with the issue of how to make learning outside formal educational and training institutions more visible.[14] A 1995 white paper from the European Union recommended, for instance, developing a European "personal skills card," as a new and more flexible proof of qualifications and competencies. This recommendation has not yet been implemented and there are different views on whether such a card would simply document skills or would need to be linked to specific skill standards.[15] There have been similar initiatives explored at the state and federal levels in the U.S. The Boeing St Louis case would support such policy measures. For example, issuing a "skills passport" for aerospace industry would allow for the documentation of individual skill building, which may or may not match to established industry standards. A further adjustment of industry standards to be more modular would be a valuable complement, since it would help to assure workers and customers that the targeted, just-in-time training was also sufficiently rigorous based on an external standard.

Apprenticeships: One avenue by which workers have traditionally been trained for highly skilled work is through apprenticeships. Boeing St. Louis has in the past had apprenticeship training but the program has been inactive for over twenty-five years. What will happen in the not-so-distant future when many in the current workforce retire and new workers are brought in from the street? Most likely, the new entrants will be hired into the job families rather than the old job classifications. Would the job families provide then the core for a new form of apprenticeship training?

In the short run, it is unlikely that we will see the development of a new apprenticeship structure at Boeing St Louis. This is not due to the job families *per se*, but a likely result of the way training has shifted into a "pull" just-in-time model. Given this capability, it is possible that initial in-house training may become shorter when a new worker is hired, but the intensity of training will persist throughout an individual's career. At the same time, the flexibility that is now expected from workers, and the fact that this facility is moving out of fabrication, suggests that new hires will have vocational education credentials and/or military experience that assures they are well-grounded on fundamental skills. In this regard, the experience at , surfaces the idea of a life-long learning model, with a more modular form of standards and certification.

Skill Standards and Certification: Currently there are programs in the St. Louis area that offer Airframe and Power Plant (A&P) licenses based on standards set by the Federal

[14] The following discussion is drawn from "Making Learning Visible: Identification, Assessment and Recognition of Non-Formal Learning in Europe," CEDEFOP , the European Center for the Development of Vocational Training, 2000.

[15] France is one of the most forward countries on this issue, opening up diplomas and certificates that can be obtained on the basis of assessments of non-formal learning. Germany and Austria, on the other hand, have been the most reluctant to embrace this trend, maintaining a strong focus on initial, apprenticeship training.

Aviation Administration.[16] This certification offers an overall grounding in the types of skills that mechanics need to work on aircraft and is accepted worldwide. Many of those we interviewed in St. Louis had obtained this certification prior to working at Boeing. Unfortunately, one long-standing program will not be available in the St. Louis area after December 2003: the Parks College at St. Louis University is closing the A&P program after 75 years due to the impact of the general downturn in the aerospace industry. The Director of the Aviation Maintenance Institute reported that there are currently under 20 students in the program, all of whom will be finished in August.[17] He identified two other programs that might be available to do A & P training in the area; one trains a small group of high school students and the other is at South Western Illinois College, which also has a small group of approximately 20 students enrolled. The director contrasted the situation in aerospace mechanic training as he sees it at Parks College, with a training model in automobile mechanic training. The following chart illustrates the points of comparison.

Table 4
Comparison of Aerospace and Automotive Mechanic Certification

	Airframe and Power Plant Mechanic Certification	**Automobile Mechanic Certification**
Funding	Student funded – approximately $17,000 for program tuition	Dealership support through training wage that covers costs of tuition
Standards	Set by FAA and in need of update	Factory standards updated as needed by dealers
Training Program	One year – 5 days a week, 8 hours a day	Two years – 8 weeks classroom focus and then 8 weeks hands-on paid work.
Employment Options	Student must find work after training completed	Student generally hired at dealership after training completed

It is not difficult to see why the automotive mechanic training program might be more attractive to young people choosing a career. [18] The Aviation Maintenance Institute director was also concerned that there is no pipeline of trained personnel moving along to enter the industry and that when the full impact of the looming demographic cliff is felt in aerospace, there will be no remedy for the lack of trained personnel. Moreover, the A&P certification itself is, in his view, in dire need of updating. Title 14 CFR (Code of Federal Regulations) Part 147 needs to be updated to remove what he saw as outdated but still mandated subjects.

Canada's recent efforts in aerospace training may be instructive here. The Canadian Aircraft Maintenance Council (CAMC) was established in 1991 in response to a critical

[16] For an overview of these programs see the following websites http://umet-vets.dol.gov/airframe-mechanic.htm; http://stats.bls.gov/oco/ocos179.htm

[17] Notes from telephone interview with Fred D. Dyen at Parks College of Engineering and Aviation at St. Louis University on October 7, 2003.

[18] Note that the St. Louis Community College has plans to create an Advanced Manufacturing Center at their Florissant Valley campus.

shortage of skilled personnel in the aviation maintenance industry. Four primary goals were set for the Council: "defining occupational standards for the industry; establishing training programs and core curricula, recruiting new entrants to the industry; and developing ongoing mechanisms for industry-wide resource planning.[19]" CAMC is organized as a non-profit consortium led by a staff and a Board of Directors with input from the industry. The Board of Directors is comprised of an equal number of employer and employee organizations, each with one representative on the board. The member organizations are: The Air Transport Association of Canada, the Aerospace Industry Association of Canada, the Canadian Business Aircraft Association, the International Association of Machinists and Aerospace Workers, the Canadian Federation of AME Associations, the Department of National Defense/Air Command and the National Training Association.

The organization members each represent a vital group of stakeholders in the aerospace industry. Together they have created a system that works to assure an adequate supply of skilled aviation mechanics across all segments of the Canadian industry. The Canadian system includes a tracking system that allows employers to evaluate mechanics' experience levels at the time they are hired. Each mechanic has a logbook that is filled out to reflect the types of work the mechanic has done or the competencies they have acquired in their work. CAMC also has worked to create standardized base skills through curricular and licensing consistency. These regulations apply to all aviation mechanics in Canada whether they are unionized or not.
The Council provides a forum for all stakeholders in the industry to meet and discuss issues of common interest. As the projected staffing shortages were identified, it became clear that standards for curricula and certification would make it possible for employers to hire workers with greater certainty that they possessed needed skills. CAMC was successful where a unilateral attempt by Transport Canada to accomplish many of these same activities was never able to provide the same levels of service to the industry.

CAMC is currently sponsoring the third human resources study for its membership. The study is focused on "forecasting human resource (HR) requirements" for aviation sectors for the next five, ten, and fifteen years. As with previous studies, this report will map the current state of the industry, outline the specific occupational tasks and technologies reviewed, preview technology trends, review employment practices, training, skills bases, demographics and recruitment, and make recommendations for the future. The report provides a comprehensive resource for all stakeholders. Such a knowledge resource does not appear to exist or have been undertaken on a national level in the United States but could be invaluable to the U.S. industry.

Human Capital Considerations: Economists have long recognized that, in the absence of some institutional framework, markets will fail to produce an adequate supply of skills. In his classic contribution, economics Nobel prize Gary Becker.[20] made a distinction between "general training," i.e., that which increases a worker's productivity to *many employers*,

[19] Information drawn from the Canadian Aviation Maintenance Council website at http://www.camc.ca/new/faq.html as well as through interviews with Carlos DaCosta, Board Member from the International Association of Machinists.
[20] Gary S. Becker, (1964 [1993]). Human capital: A theoretical and empirical analysis with special reference to education (3rd ed.). Chicago: University of Chicago Press.

and "specific training," i.e., that which increases productivity *only in a single firm*. Becker predicted that under spot-market conditions, employers would never pay for general training—doing so would make their workers ripe for poaching, thereby robbing firms of the returns to training investments. While workers themselves would be willing to invest in their own general "human capital," they would be likely to under-invest, as the social return on education would exceed their individual return. . In the US, policymakers long ago remedied this market failure with the state provision of education and compulsory schooling laws. A similar problem arises in regards to training that is not *firm*-specific, but rather *industry*-specific. Neither firms nor individuals could be induced to fund such skill-building in the absence of an institutional arrangement for ensuring that skills are standardized, recognized, and rewarded in a way that demonstrates their fungibility and properly appropriates the return to the investor. With help from the DoL's Employment and Training Administration and its ancestral agencies, individual industries have long recognized the training "externality" and have developed apprenticeship programs to ensure a steady supply of highly-skilled, industry-specialized workers.[21] In industries that are not organized, other mechanisms for information-sharing and for guaranteeing skill universality, including the IT industry's use of the internet, have allowed the DoL to continue to play the vital institutional role required to correct for an otherwise sub-optimal market equilibrium.

After decades of downsizing, the aerospace industry is approaching a "demographic cliff" that could easily result in a shortage of skilled personnel. In the defense sector of the industry, the average age of the production workforce is 53 and over one fourth is eligible for retirement in the next five years. Numbers in the commercial sector are similar, as are the numbers for engineers and managers. Some companies are reportedly resorting to incentives to bring back retired employees as contractors, but this is just a short-term fix.

With the potential for a skills shortage in the industry, existing apprenticeships and educational programs in aerospace need to be calibrated. This might mean, for instance, updating A&P and other licensing standards to reflect current technologies and practices. It also involves adjusting apprenticeship programs to the firms' demand for more flexible, multi-skilled workers, as well as paying attention to the interface between initial and continuous training.

Boeing, St Louis is not alone in aerospace in moving towards broader job classifications. Pratt & Whitney has reportedly tried to merge job classifications. Lockheed Martin's Dallas/Fort Worth plant, which builds the new Joint Strike Fighter, has also combined job classifications in its last contract. Similar to Boeing St Louis, the blue-collar workforce at the Dallas/Fort Worth facility shrunk from 15,000 in the 1980s to 2,300 in the year 2000. However, some 1,700 new workers have been hired in the last two years. The company is reportedly having problems finding skilled labor and has engaged with suppliers in the Forth Worth area in building a consortium to address this issue. This makes for a potentially interesting complement to the case in that the move toward flexibility is taking place in what are now emerging to be skill shortages.

[21] Slichter, S. H., Healy, J. J., & Livernash, E. R. (1960). The impact of collective bargaining on management. Washington, DC: Brookings Institution.

X. Conclusion:

The combination of flexible job classifications and just-in-time delivery of modular training at , represents an important innovation with significant policy implications. While it would be premature to abandon traditional apprenticeship models based on this one case, it is a case that points to the emergence of a set of practices for which this traditional model is less well suited. It also represents an approach to training that complements the new work systems and lean principles that are permeating the industry. Moreover, the specific sequence of events in this case is instructive about the process by which training practices evolve.

The early experience with the "All-Arounds" and other initial efforts to increase flexibility suggest that business operations and worker interests are hard to address with a training model that involves multiple weeks off the job and splits between workers who are or are not in the flexible utilization category. The experience since the 2001 agreement points to an alternative model where training is organized in small modular sessions, delivered within a few days of the identified need, and distributed across the full workforce.

This new model of training does not operate in isolation. It depends on the larger, lean model of manufacturing that places a higher value on continued flow in operations and front-line capability (particularly with respect to quality). The HPWO team system is a key complementary enabler – with teams playing important roles in the training process and the team culture providing a complementary climate.

While this just-in-time approach to training is well matched to the new work system, its decentralized nature is both a strength and a weakness. Training is now much better matched to specific front-line circumstances in each work area, but it is also harder to document in ways that are transportable. This gets to a core policy implication. If employers increasingly move to this sort of a training model, it poses a great challenge to traditional mechanisms for skills certification that are centered on the focused accumulation of a defined body of knowledge within a set period of time. Instead, the body of knowledge being accumulated by the workforce at Boeing St. Louis varies with each worker and will likely continue throughout their careers. A key challenge for the future will involve developing more systematic ways to document and value these investments in skills and capabilities.

A key questions concerns just how representative the case is. Recent survey research on aerospace manufacturing facilities suggests that approximately one third to one half of these facilities feature the use of team-based work systems and/or lean principles and practices.[22] This would be the set of facilities in which the innovations featured here might be applicable.

The implementation of the innovative practices featured in this case has been complicated by the difficult economic climate in which the parties operate – including the unsuccessful

[22] Joel Cutcher-Gershenfeld. "Lean Transformation Across the U.S. Aerospace Industry: Exploring the Interdependence of Social and Technical Systems" (MIT Sloan and ESD working paper, 2003).

bid for a major new product and the overall decline in demand for existing products. The accomplishments of the parties are that much greater given that they have occurred in this context of deep employment security fears and economic constraints. With continued organizational and economic instability, however, it is also clear that there will be more challenges yet to come

In many ways, the experiences of the IAM and Boeing St. Louis are illustrative of a fundamental tension found across the manufacturing sector. On the one hand, this case illustrates how investment in human capital can be done in effective ways that add value to the enterprise and increase individual capability. On the other hand, this case also illustrates how these investments are vulnerable to competing pressures to outsource work and restructure enterprises. This points to a larger challenge for policy and practice, which centers on the degree to which investments in human capability are valued as vehicles for economic development and societal stability.

Labor and management in this location can rightfully be proud of having found an effective way to balance worker's interests in continued seniority protections and management's interest in increased flexibility and flow of operations. They can also be proud of having developed innovative models for the delivery of training on a just-in-time basis with on-the-job coaching. They have accomplished this through joint, labor-management efforts, building on the foundation of HPWO teams and lean production principles. The model developed by and the IAM has proven more sustainable than the earlier efforts in this location, though the road ahead is marked by continued competitive challenges. It is because of the success to date of this more flexible model of skill development that policy analysis is called for – so that national training policy properly anticipates and complements such initiatives.

Appendix
Interviewers' Protocol: IAM/Boeing St. Louis

Questions are listed in Bold – Key points of information needed are listed as sub items

Introduction:

Thank you for participating in this interview especially in what we know must a stressful time. It is part of a research project that is being conducted by the Massachusetts Institute of Technology under funding from the U.S. Department of Labor. The project has the approval and support of Boeing and the IAM. Your participation in this interview is voluntary – if you are uncomfortable with any questions, you don't have to answer them (consent form here). Our main focus is on issues of training, skills, job classification, work systems and employment issues. We have a series of general questions, with various details that are of interest in each case. Shall we begin?

1. **Please give a brief overview of your work history in the aerospace industry**.
   Classification currently
   Length of employment
   Variety of work
   List of employers
   Skills acquisition

2. **How is your work day different with the new labor grade/job family model?**
   New tasks
   Assessment of the situation

3. **Are there any new tasks that you particularly enjoy or dislike?**
   Operator Verification?

4. **Can you describe the types of training you received to prepare you for the new labor grade/ job family model?**
   Yes/no on training
   How long did it take?
   Process of the training – who made the decision over whether you got what type of training – did you choose or did management choose

5. **How do you feel about cross-training?**
   Trying to get some indication of the attitudes about pride in craft, prestige associated with training, etc.
   Is there trade off between breadth and depth?

6. **How does this relate to your experience with HPWO and teams? What opportunities are there for you to give input into how your work is done?**
   When and where and in what areas; how to organize work; whether the teams work smoothly or not

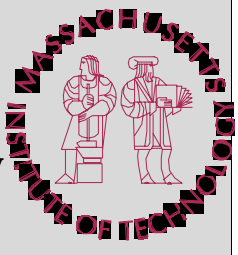
7. **Do you feel that the new labor grade/job family model offers you opportunities for advancement or increases your employment options?**
   What opportunities?

8. Is there anything else that we should be aware of to understand what's happening here?

Thank you for participating in this project.

Appendix

Survey on the Impact of Change in the Aerospace Industry



This survey measures the impact of changes in the job classification system at Boeing St. Louis on individual workers and managers. This includes changes in work practices, training and employment opportunities. This survey at your plant is being undertaken in conjunction with a research study by the Labor Aerospace Research Agenda from MIT funded by the U. S. Department of Labor. Your responses are an important contribution to this effort.

Your participation in the survey is voluntary. All responses will be kept confidential. Only aggregate results will be reported. You indicate your voluntary agreement to participate by completing and returning this questionnaire.

Filling out the complete survey should take approximately 10 minutes. The survey includes attitude questions on workplace issues and work practices. A summary of the research results will be available at the end of the study in hard copy on request at following address (DoL Boeing Survey at Building E40-211, Massachusetts Institute of Technology, 1 Amherst Street, Cambridge, MA 02139, or electronically at our web site (http://web.mit.edu/ctpid/lara/).

Part A: Individual profile

A1. a. How long have you worked in the aerospace industry? _____ Years

b. How long have you worked for this company? _____ Years

A2. What is your title or job classification?_____

A3. What is the primary program that you work on? _____

A4. What is the name of your team or department? _____

A5. How long have you worked on this team? _____

Part B: Instability

B1. In the past three years, how often has <u>your work</u> been impacted by each of the following:

	Never	Sometimes	Frequently
a. My work has been affected by changes in budget allocations for government contracts	0	1	2
b. My work has been affected by changes in internal company budgets	0	1	2
c. My work has been affected by changes in product demand	0	1	2
d. My work has been affected by changes in customer requirements, technical design or materials	0	1	2
e. My work has been affected by changes in equipment or other technology	0	1	2
f. My work has been affected by changes in supplier performance	0	1	2
g. My work has been affected by subcontracting of work previously done "in house"	0	1	2
h. My work has been affected by the "in-sourcing" of work (bringing it back to the facility) that had previously been out sourced	0	1	2
m. My work has been affected by changes in leadership vision	0	1	2
n. My work has been affected by changes in the job classification system	0	1	2
o. Other*(Please specify)*: _____	0	1	2

B2. Which item in B1 above has *most* affected <u>your work?</u> (fill in appropriate letter) _____

Part C: Context

C.1 Please indicate the degree to which you agree or disagree with the following statements with respect to your primary work area.

		Strongly Disagree		***Neither Agree nor Disagree***		***Strongly Agree***	***Don't Know***
a.	In the current labor market my skills make it easy to find a job	1	2	3	4	5	?
b.	There is high demand for the product I make	1	2	3	4	5	?
c.	I feel more and more uncertain about my future in this industry	1	2	3	4	5	?
d.	I would highly recommend that my children work in this industry	1	2	3	4	5	?

Part D: Learning Environment

D.1 Please indicate the degree to which you agree or disagree with the following statements:

		Strongly Disagree		***Neither Agree nor Disagree***		***Strongly Agree***
a.	My employer provides opportunities to learn new skills	1	2	3	4	5
b.	My employer encourages me to try different approaches to solve problems	1	2	3	4	5
c.	My employer assigns tasks I can perform without error	1	2	3	4	5
d.	I am rewarded for using on my job, what I have learned in training	1	2	3	4	5
e.	My supervisors and coworkers help reschedule work so that I can attend training	1	2	3	4	5
f.	In my work area, supervisors are open to new ideas and suggestions	1	2	3	4	5
g.	In my work area, employees are open to new ideas and suggestions	1	2	3	4	5
h.	I can openly express my views (e.g., agreement or disagreement) to management	1	2	3	4	5
i.	I understand how my job relates to others in the organization	1	2	3	4	5
j.	I have the skills I need to perform my job quite effectively	1	2	3	4	5
k.	I am encouraged to develop the skills needed for advancement	1	2	3	4	5
l.	My employer always asks me about my training needs	1	2	3	4	5

		Strongly Disagree		Neither Agree nor Disagree		Strongly Agree
n.	I am confident in my ability to adapt to change on my job	1	2	3	4	5
o.	Employees here are responsible for demonstrating on the job what they learned in training	1	2	3	4	5
p.	I have learned more tasks and increased my flexibility	1	2	3	4	5
q.	The information necessary for my work is always available	1	2	3	4	5
r.	I have been assigned a mentor to help my learning in the organization	1	2	3	4	5
s.	I have served in a formal apprenticeship program to learn my craft	1	2	3	4	5
t.	I am paid on a "pay for knowledge" basis where I get additional increments of pay for learning new skills	1	2	3	4	5
u.	Practically everything I know about how to do my job I have learned through "on-the-job" training (OJT)	1	2	3	4	5
v.	My skill level has increased as a result of new work practices	1	2	3	4	5
w.	Increasing my skill level will help me maintain employment	1	2	3	4	5
x.	Learning new work practices will increase my employability	1	2	3	4	5

Part E: Outcomes

E1. Since the new labor grade/job family took effect, what has been the overall trend for the following outcomes:

	Significant Decrease		***No Change***		***Significant Increase***	***Don't Know***
a. Use of overtime	1	2	3	4	5	?
b. Outsourcing certain operations	1	2	3	4	5	?
c. Loss of people with critical skills	1	2	3	4	5	?
d. Apprentice training	1	2	3	4	5	?
e. Number of tasks included in my job	1	2	3	4	5	?
f. My employment options	1	2	3	4	5	?
g. Other (please specify) _____	1	2	3	4	5	?

Part F: Indicators

F1. Please indicate the degree to which you agree or disagree with the following statements:

	Strongly Disagree		Neither Agree nor Disagree		Strongly Agree
a. I really wish that I could come in, do my work and go home without all the "consulting."	1	2	3	4	5
b. Today I have the authority to make work-related decisions that my supervisor used to make.	1	2	3	4	5
c. Increasing my flexibility at work makes me more effective.	1	2	3	4	5
d. My job makes good use of my skills and abilities.	1	2	3	4	5
e. Working with other people is always troublesome.	1	2	3	4	5
f. More and more the quality of work I do depends on other people's work.	1	2	3	4	5
g. I trust my co-workers to do a good job.	1	2	3	4	5
h. Work on my team is more difficult since the change in labor grades/job families.	1	2	3	4	5
i.	1	2	3	4	5
j. Overall I am very satisfied with the labor grade/job family plan.	1	2	3	4	5

F2. Please give your overall impression of the changes in these performance indicators, since the new labor grade/job family took effect. (Circle one number for each row.)

Performance Indicators	***Significant Decrease***		***No Change***		***Significant Increase***	***Don't Know***
a. Productivity	1	2	3	4	5	?
b. Quality of product or service	1	2	3	4	5	?
c. Customer service	1	2	3	4	5	?
d. Overall worker satisfaction	1	2	3	4	5	?
g. Schedule/delivery performance	1	2	3	4	5	?
h. Profitability	1	2	3	4	5	?
i. Moving decision-making authority to lower organizational levels	1	2	3	4	5	?
j. Information flow throughout the corporation	1	2	3	4	5	?

k. Employee trust in management	1	2	3	4	5	?
l. Employee trust in co-workers	1	2	3	4	5	?
m. Employee trust in the union	1	2	3	4	5	?
n. Worker responsibility for outcomes	1	2	3	4	5	?
o. Employment security	1	2	3	4	5	?
p. Overall understanding of company goals	1	2	3	4	5	?
q. Communication with co-workers and people on other teams (if relevant)	1	2	3	4	5	?

Part G: Training, Demographics and Other Factors:

G1. How many hours of formal training have you received in the last year? (Please c*heck one)*

☐ Less than 8 hours ☐ 8-20 hours ☐ 21-40 hours ☐ 41-80 hours ☐ More than 80 hours

G2. What percentage of your training was voluntary?

☐ None ☐ Under 25% ☐ 26-50% ☐ 51-75% ☐ 76-100%

G3. What percentage of your training was on your own time?

☐ None ☐ Under 25% ☐ 26-50% ☐ 51-75% ☐ 76-100%

G4. What percentage of your training was on company time?

☐ None ☐ Under 25% ☐ 26-50% ☐ 51-75% ☐ 76-100%

G5. In the hours of formal training above, how many of the hours were related to technical skills?

☐ Less than 4 hours ☐ 5-10 hours ☐ more than 10 hours

G6. In the hours of formal training above, how many of the hours were related to people or process skills?

☐ Less than 4 hours ☐ 5-10 hours ☐ more than 10 hours`

G7. Your gender: Male ☐ Female ☐

G8. Your age range: ☐ Under 25 ☐ 26-35 ☐ 36-45 ☐ 46-55 ☐ 56-65 ☐ Over 65

G9. Your education level: *(select one)* ☐ High school ☐ Some college ☐ Two-year degree ☐ Bachelor's degree ☐ Master's degree ☐ Doctorate

Other _____

Additional Comments:

_____

_____

_____

Thank you for taking the time to complete this survey.

Glossary of Acronyms

A&P Certification	Airframe and Power Plant Mechanic Certification
ACLC	Advanced Craftsmanship Learning Center
AMAA	Assembly Mechanic – All Around
CFR	Code of Federal Regulation
CI	Collateral inspection certification
DOL	Department of Labor
FOD	Foreign object debris
HPWO	High Performance Work Organization
IAM	International Association of Machinists and Aerospace Workers
IPT	Integrated Product Teams
JSF	Joint Strike Fighter
LAI	Lean Aircraft Initiative
LARA	Labor Aerospace Research Agenda
MAP	Mechanic-Aircraft Production
MDC	McDonnell Douglas Corporation
MER	Mechanic Electrical and Radio
O*NET	Occupational Information Network
OV	Operator verification and collateral inspection
PoU	Point-of-use logistics
RF	Realization Factor
SAP	SubAssembler-Precision
SHEA	Safety, Health, and the environment
SMAR	Sheet Metal Assembler and Riveter