Job Task Analysis of the Aviation Maintenance Technician Phase II

Larin K. Adam
Edward J. Czepiel
Douglas J. Henry
Gilbert K. Krulee
Geoffrey C. Murray
Brandi M. Williamson

The Transportation Center
Northwestern University
1936 Sheridan Road
Evanston IL 60208

March 1997
Final Report

LIST OF ABBREVIATIONS

A&P -- Aircraft and Powerplant Certificate
AMT -- Aviation Maintenance Technician
ATA -- Air Transport Association
FAA -- Federal Aviation Administration
FAR -- Federal Aviation Regulation
FCC -- Federal Communications Commission
FSDO -- Flight Standards District Office
JTA -- Job Task Analysis
NATA -- National Air Transport Association
NBAA -- National Business Aircraft Association
RAA -- Regional Airline Association

LIST OF FIGURES

Figure 1. Number of Facilities For Each Industry Segment in Phase I

Figure 2. Percentage of Surveys Collected from Each Industry Segment in Phase I

Figure 3. Frequency Count of Years Experience for All Respondents in Phase I

Figure 4. Task List Generation Matrix

Figure 5. Comparison of Industry Classification Schemes

Figure 6. Percentage of Facilities Surveyed by Industry Segment

Figure 7. Percentage of Surveys from Each Industry Segment

Figure 8. Blue Ribbon Estimates of Technicians In Each Industry Segment

Figure 9. Blue Ribbon Estimates Adjusted for Comparison with JTA

Figure 10. Job Classification of Respondents--All Industry Segments Combined

Figure 11. Job Classification of Respondents by Industry Segment

Figure 12. Average Years Experience By Industry Segment

Figure 13. Frequency Count of Years Experience for All Respondents

Figure 14. Sources of Experience for All Respondents

Figure 15. Sources of Experience By Industry Segment

LIST OF TABLES

Table 1-a. Industry Segment Abbreviations in Phase I

Table 1-b. Visit Committee Members

Table 2. Subject Areas

Table 3. Industry Segment Abbreviations

Table 4. Sample Subject Area Grid

Table 5. Example of Data Tables for Frequency and Percent Response

Table 6. Definition of the Rating Scales

EXECUTIVE SUMMARY

The Transportation Center at Northwestern University is under grant from the Federal Aviation Administration (FAA) to perform a job task analysis (JTA) of the aviation maintenance technician (AMT). The objective of this research is to update a similar analysis, the Allen Study, performed in 1974 by The University of California, Los Angeles. The Allen Study was used as regulatory support for Federal Aviation Regulation (FAR) Part 147, which outlines the curriculum requirements for AMT schools. Similarly, the results of the JTA will provide an updated description of the tasks an AMT performs and will be used to make appropriate changes to the FARs.

The JTA project is being performed in three phases. In Phase I, which was completed in June 1994, the research team developed and validated a research and survey methodology for a sample of aircraft maintenance tasks. As a result of Phase I, the research team identified an efficient and unobtrusive method to administer surveys.

The objective of Phase II was to conduct a full-scale survey of the major tasks technicians perform. A list of 303 tasks was constructed that provided a broad coverage of tasks that an AMT performs. The survey questionnaire and the interview process were revised to reflect the expanded task list. A total of 2,434 surveys were collected from 84 facilities across all segments of the industry. The data from the surveys were input into a database to facilitate a flexible analysis.

The data analysis detailed in this report provides information about the facilities that participated in the study. The results from the background section of the survey reports demographic information about the respondents. The results from the task analysis are listed by industry segment to demonstrate the similarities and differences between the individual segments.

Phase III will concentrate on analyzing the data collected in the context of a revised FAR Part 147. A committee of representatives from both the industry and AMT schools will assist in this effort. Phase III is expected to be completed in the third quarter of 1997.

1. INTRODUCTION

1.1 Background

The Federal Aviation Administration (FAA) is responsible for the training and certification requirements of Aviation Maintenance Technicians (AMTs). These standards are currently summarized in two Federal Aviation Regulations (FARs), specifically FAR Part 65, which governs the certification of AMTs and FAR Part 147, which outlines the curriculum for AMT schools. In principle, these regulations build upon a realistic understanding of the job responsibilities of an AMT.

Currently, the licensing structure outlined in FAR Part 65 is in the process of being revised and will become FAR Part 66. The existing Airframe and Powerplant (A&P) certificate will be replaced by the Aviation Maintenance Technician (AMT) certificate. An additional endorsement to the certificate, a transport rating (-T), will allow the

holder to return Part 25 or Part 29 transport category aircraft to service. A change in the licensing structure implies that the training requirements in Part 147 must be revised as well.

The current version of FAR Part 147 is based upon data collected as part of the Allen Study, which was completed in 1974. The Allen study noted that rapid technological changes within the aviation industry require that the AMT schools update their instructional program. Technological advances are still continuing at a rapid rate and will continue to do so.

Like the Allen Study, the Job Task Analysis (JTA) of the Aviation Maintenance Technician study will provide information about tasks that are performed by AMTs throughout the entire aviation industry. This study is helping to set the stage for a possible round of curriculum revisions that can be incorporated into the efforts of those schools that are responsible for the training of AMTs.

1.2 Objectives and Scope

The objective of this study is to provide a task analysis of the occupation of the AMT. The project consists of three phases. The objective of Phase I was to develop and validate survey methods. During Phase II the full-scale survey was performed on a complete set of tasks. Phase III will concentrate on a more in-depth analysis of the data collected, particularly within the context of a revised FAR Part 147.

The objectives of Phase II are to:

- Develop a list of tasks that broadly define the occupation of the AMT
- Administer the survey to a representative sample of facilities covering all segments of the aviation industry
- Analyze the data collected in order to identify tasks that are no longer relevant, tasks that continue to be important, and tasks that are indicators of the impact of technological change on the industry over the past twenty years
- Analyze the data in order to identify similarities and differences that are characteristic of each segment in the industry

Additional analysis will be performed in Phase III. The objectives for this phase of the project are to:

- Organize the data to facilitate revisions to AMT school curricula.
- Review the data with representatives from AMT schools and discuss the implications for curriculum reform.
- Review the data with industry representatives and discuss the implications for training within the industry.

There is currently an increasing emphasis on research in the area of human factors. Thus it is apparent that the environment in which AMTs work could be modified in order to simplify the responsibilities of AMTs. These developments have important implications for the training of AMTs and ultimately for their certification. The results of this study may be relevant to developments in the area of human factors, but any discussion of these issues is beyond the scope of this study.

1.3 Overview of the Report

This report details the activities associated with Phase II of this project. The first section reviews the activities

completed as part of Phase I. The Task List and Survey Procedure Development section discusses how the data collation methods were adapted and carried out in Phase II. Analysis Overview details the results of the survey, including the background section of the survey and the task analysis. Plans for Phase III provides an overview of the additional analysis that will be completed during this part of the study. The final section, Summary and Conclusions, highlights the major details from Phase II.

2. PHASE I REVIEW

2.1 Objective and Purpose

Most job task analyses focus on a specific occupation, or examine a position within a single organization. The objective of this study is to complete a job task analysis for the position of AMT across the entire aviation industry. Because the aviation industry varies greatly in terms of work environment and type of aircraft, the occupation of AMT can be defined in equally as broad terms. For this reason, traditional job task analyses methods needed to be revised to accommodate this expanded scope.

The objective of Phase I was to design and validate a survey method to perform the task analysis. This section will briefly discuss these activities. During this initial phase of the study, three survey methods were designed and tested: a written survey questionnaire, an interview schedule, and observations recorded on videotape. Procedures for administering the three data collection methods were developed and implemented. A more thorough discussion of these activities is included in *Job Task Analysis of the Aviation Maintenance Technician--Phase I Report.*

2.2 Overview of Survey Methods

The primary form of data collection for the quantitative portion of the task analysis was the survey questionnaire. The questionnaire used in Phase I included four sections: Background Information, Documentation, Task Inventory, and Specialized Services.

In the Background Information section, the respondents were requested to provide information pertaining to their work area and organization, certificates and licenses and duration held, areas of relevant aviation maintenance experience, and source and type of primary training. The Documentation section asked respondents to evaluate how often a given list of references were used during the course of their work and if they were responsible for returning aircraft to service.

In the Task Inventory section, the respondents were presented with a list of 23 tasks. If the respondent performed the task, he or she was requested to rate the task according to six performance measures. They included

- Frequency: how often the task is performed
- Criticality to Flight Operation: possible consequences if task is not performed correctly
- Difficulty to Learn: level of difficulty to learn the task
- Technical Knowledge: level of technical knowledge required to complete the task
- Manipulative Skill: degree of manipulative skill required to complete the task
- Industry Training: amount of industry training received related to the task

A rating scale for each of the measures had a corresponding scale ranging from one through five.

The Specialized Services section also applied to the set of tasks. This section sought to collect information about tasks that are performed by internal support shop or outside vendors. If the respondent recognized one of these tasks as a specialized service, they were presented with a list of questions concerning the reasons a task is referred to a specialized service provider, the frequency of occurrence and who actually performs the task.

The interview schedule was divided into two sections. The Background Information section was the same as the background section in the survey. The Task Performance Inquiry section was organized by the convention outlined in the Air Transportation Association's (ATA) Specification 100. First, the respondent was asked to provide tasks under the chapter that they perform frequently. This information provided a basis for the complete task list in Phase II. The respondent was then asked what knowledge and skills an AMT should possess to perform tasks proficiently. Finally, the respondent was asked what special tools or equipment an AMT should know how to use.

The observations were the least structured of the data collection methods. At a limited number of sites, permission was obtained to observe and record on videotape AMTs carrying out specific tasks. The information obtained through the use of the videotape was supplemented by comments made by the AMT while he or she was carrying out the task.

The project staff began to contact sites in the local Chicago area with the assistance of the local FAA Flight Standards District Office (FSDO) to participate in the study. The local area sites provided the staff with an opportunity to develop a visit protocol to ensure consistent administration of the survey. Each site was visited twice. The purpose of the initial visit was to explain the project purpose and develop a plan and schedule to administer the surveys. Surveys, interviews, and observations were conducted during the subsequent visit.

After the visit protocol was developed and tested locally, additional sites were identified to complete the sample. The project staff worked with the ATA and the National Air Transport Association (NATA) to identify additional facilities. Major facilities, such as an airline base or line facility, or large repair station were identified. Then as many smaller facilities in the area were contacted and visited in order to obtain a representative sample of facilities as well as to maximize the travel budget.

2.3 Overview of Results

During Phase I, the research team at Northwestern visited 34 aircraft maintenance facilities. The facilities were classified according to the FAR operating certificate under which the majority of the maintenance work was performed. The segments were defined as listed in Table 1-a.

Table 1-a. Industry Segment Abbreviations in Phase I

Figure 1 details the number of the facilities per segment. A total of 1,262 surveys were collected. Figure 2 depicts the surveys classified according to industry segment. While the largest number of facilities that participated in the survey were from the general aviation segments, the largest number of surveys were from the airline segments.

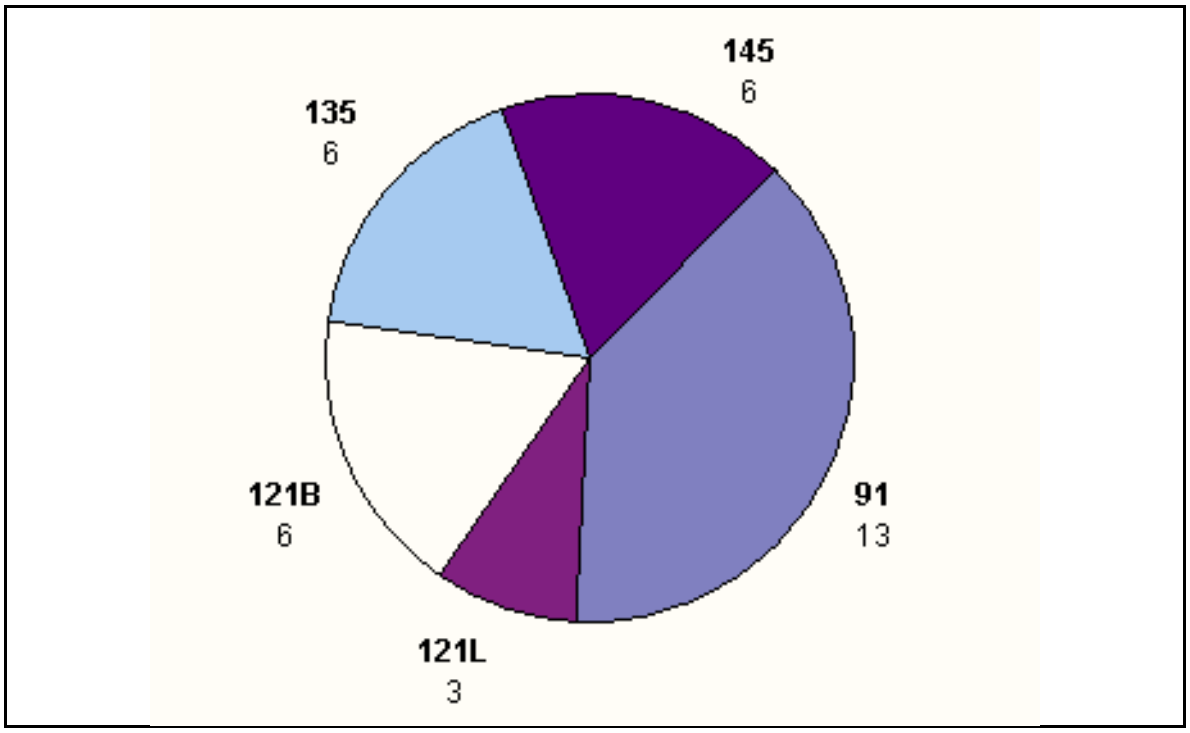

Figure 1. Number of Facilities for Each Industry Segment in Phase I

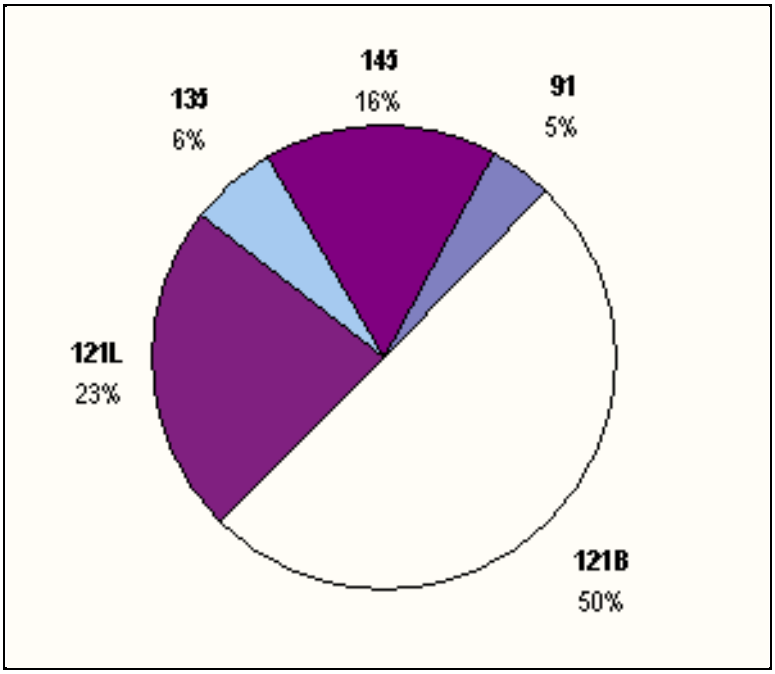

Figure 2. Percentage of Surveys Collected from Each Industry Segment in Phase I

A plot of the number of respondents versus the number of years that they have been involved in aircraft maintenance is shown in Figure 3. The distribution of respondents is bimodal, with one large group of respondents peaking at about eight years experience (1985) and another smaller group at 27 years (1966) experience. This distribution closely correlates with two major periods of expansion in the airline industry.

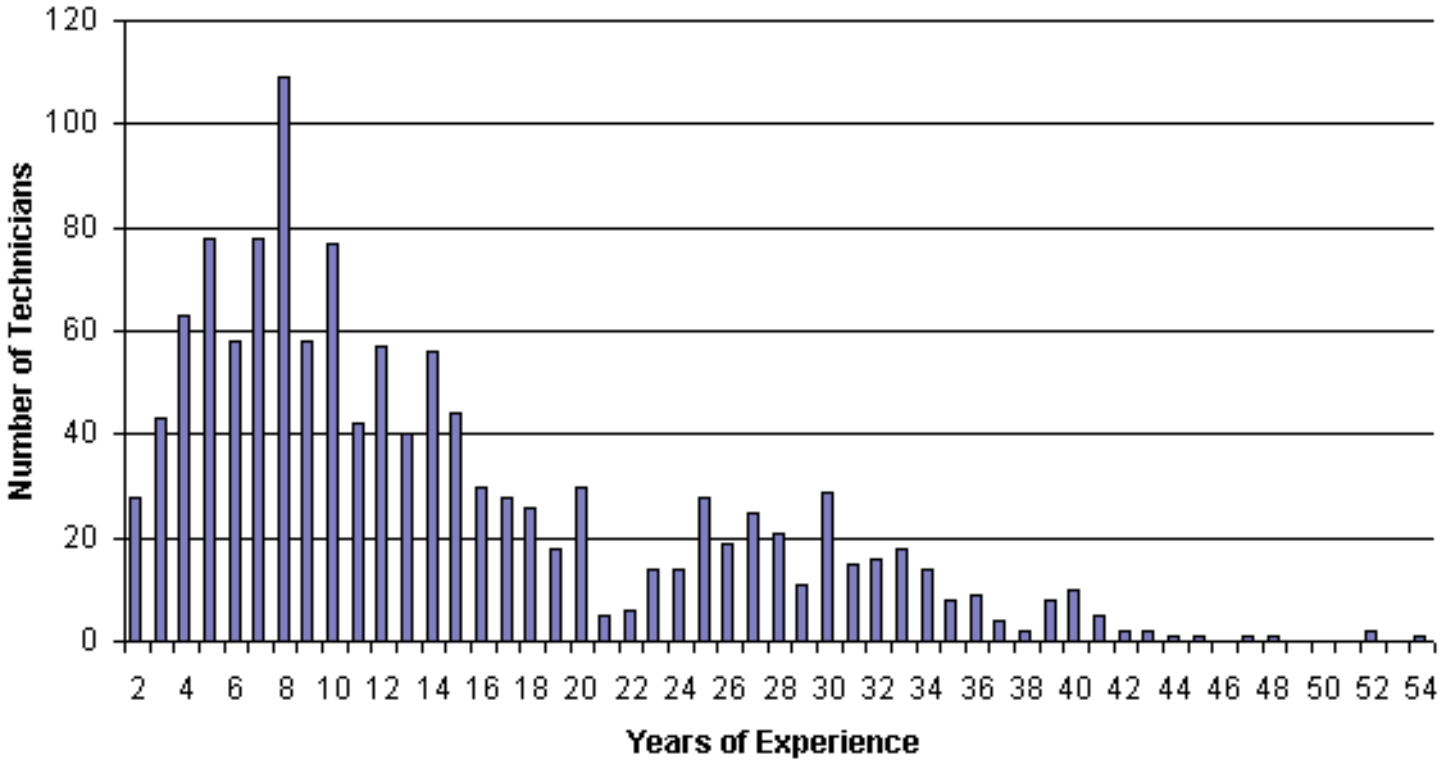

Figure 3. Frequency Count of Years Experience for All Respondents in Phase I

Specific results for the Documentation, Task Inventory, and Specialized Services sections are listed in the Job Task Analysis of the Aviation Maintenance Technician--Phase I Report. The Documentation section reported information as to which documents AMTs referenced on-the-job and under which regulation the aircraft was returned to service. The Task Inventory section listed the average for the six performance measures along with the percent response for each of the tasks. Both of these two sections worked well in the survey and few problems were encountered. The Specialized Services results were problematic since it proved difficult to ask generic questions that would apply to all segments of the industry for this section.

2.4 Visit Committee

The purpose of the visit committee is to review the survey procedures and results from an industry perspective. The membership includes representatives from all segments of the industry and are listed in Table 1-b.

Table 1-b. Visit Committee Members	

The first visit committee meeting was held in May 1994. The objectives of this meeting were to review the Phase I results and to provide suggestions for improving the presentation, content, and clarity of the associated report. The committee also offered recommendations on proceeding into Phase II of the study. The issues covered included constructing the task list and revising the survey methods accordingly.

3. TASK LIST AND SURVEY PROCEDURES

3.1 Introduction

Since only 23 tasks were studied in Phase I, the survey procedures needed to be modified to reflect the expanded task list in Phase II. This section outlines the development of the task list and the survey procedures. The first step was to determine the list of tasks that were to be surveyed. The format and content of the survey questionnaire was then designed to accommodate the expanded task list. An interview format was developed to compliment the information collected in the survey document. A protocol was formed in order to consistently administer the survey and interview at each facility. Finally, potential sites were identified to be contacted to participate in the study.

3.2 Task List Development

An important issue in developing a task list for Phase II was the number of tasks the list included. An exhaustive list of tasks that an AMT performs would prove too long to incorporate into the survey. On the other hand, a compact list could sacrifice the level of detail necessary to distinguish between different levels of task performance. The list of tasks needed to be aggregated to a level that was neither ambiguous, nor lengthy.

The Allen Study outlined 589 tasks. However, many of the tasks were knowledge-based, such as "read and write in the English Language." The performance based tasks number closer to 400.

Figure 4 depicts the general matrix that was used to construct the task list. The top axis lists major systems and components of an aircraft. The side axis lists the generic levels of performance that occur on each system or component. These levels are grouped into three categories: service, inspect, test or check; repair, replace, modify, overhaul or calibrate; and troubleshoot. The applicable actions were then noted for each system.

Systems and Components Performance Levels	Major System	Major Components
Check, Test, Service, Inspect		
Repair, Replace, Modify, Calibrate		
Troubleshoot		

Figure 4: Task List Generation Matrix

From this point, if the task in the matrix was too general, it was desegregated either into its components or further sub-actions. For example, "rig flight controls" could be further broken down into "rig flaps," "rig rudder," etc. Or, if the task in the matrix was too specific, some tasks could be condensed into one. For example, "check tires" and "inflate tires" could be combined into one single task, "check and service tires."

The result of this process is a list of 303 tasks. The tasks were then grouped by the applicable ATA chapter code of the particular component or system. This list was further grouped into 20 subject areas. The subject areas are listed below in Table 2. The list was reviewed by the visit committee and several AMTs at facilities that participated in Phase I.

Table 2. Subject Areas

Airframe or Structure
- Cleaning and Corrosion Control
- Landing Gear
- Structures
- Fuel System
- Minor Repairs and Welding

Powerplant
- Engines
- Fuel Control and Lubrication
- Propellers

Avionics
- Navigation
- Communication

Avionics
- Autoflight
- Ignition and Starting
- Flight Controls
- Electrical Power and Aircraft Lighting
- Cabin Atmosphere Control

General
- Hydraulics and Pneumatics
- Inspections
- Fire Protection
- Anti-Icing and De-Icing
- Indicating, Recording and Warning Systems

3.3 Survey Development

The written questionnaire used in Phase I was modified to accommodate the expanded task list. The overall goal for developing the questionnaire was to take no longer than one hour to complete.

The Phase I questionnaire contained a detailed background information section. While most of this information was useful, only the information that was critical to performing the analysis of the data was retained. This included: level of current position within the company, maintenance certificates or licenses held, areas of previous work experience, and total number of years experience while working in aircraft maintenance.

The Phase I questionnaire also included a documentation section which identified common references that AMTs made on the job. Again, for the sake of brevity, this section was deleted. The Phase I data proved an adequate sample for this information.

Three performance measures were retained from the Phase I survey. These measures include frequency, criticality, and difficulty to learn. Each of these measures has a discrete scale from one to five associated with it, where one represents the minimum in that measure, and five the maximum. A fourth measure, percent response, is the number of respondents who report that they performed the task in the last calendar year.

Difficulty to learn was used as a measure versus difficulty to perform. This is an important distinction because a task

that is difficult to learn may initially be easy to perform once proficiency is achieved. Information about difficulties in learning tasks is valuable in helping schools and industry training providers determine where extra time is needed on a particular subject area or where alternative teaching methods should be employed.

The criticality variable determines how critical a task is to the safety of flight operations. Identifying critical tasks is imperative because these are areas where technicians need to have sufficient expertise even if the task is performed infrequently.

The Phase I questionnaire included a "Specialized Services" section that was attached to the task section. The objective of this section was to find out which tasks were contracted out to an outside vendor or third party and for what reason. This section was difficult to structure into a format suitable for a questionnaire and did not yield satisfactory results in Phase I. This section was deleted in Phase II.

3.4 Interview Development

Interviews were conducted to supplement information collected in the survey questionnaire. While the surveys gather information in a very structured format, the interviews allow for more open-ended response to the questions. The interview in Phase II was broadened to focus on issues related to the maintenance organization, the work environment, and training.

The interview schedule comprises four sections. The background information section asks questions about the experience of the respondent, including current position, total years experience working in aircraft maintenance, educational experience, and previous work experience.

The remaining three sections involve questions specific to the facility at which the respondent works. The first section focuses on questions related to task assignment and supervision. The second section deals with training within the organization; when it is delivered and for what reasons. The third section pertains to specialization of technicians and shops. This section tries to determine the reasons a specialized shop exists within an organization and if unique skills are required and/or obtained.

3.5 Site Classification and Selection

The classification scheme devised in Phase I categorized each facility according to the FAR certificate under which the facility operated. This method presented problems at many facilities that operated under multiple certificates. In some cases, it was difficult to separate under which certificate the majority of maintenance work was performed. For example, many smaller general aviation facilities operated under FAR Part 135 for their on-demand air charter work, FAR Part 145 repair station for maintenance on other aircraft, and FAR Part 121 for contracted line services for an airline. Also, regional airlines could be classified as Part 135 or Part 121.

The objective of the classification scheme is to group facilities that are similar in both organization and work environment for the AMT. For this reason, the classification scheme was revised and is depicted in Figure 5. Major airline facilities were divided into line (ML) and base (MB). The categories of regional airline (RG) and corporate (CP) facilities were added. General aviation facilities were classified as large if the facility employed more than 20 technicians and had dedicated specialized shops, such as an avionics or sheetmetal shop. Likewise, general aviation facilities were classified as small if they employed fewer than twenty technicians with no specialized shops.

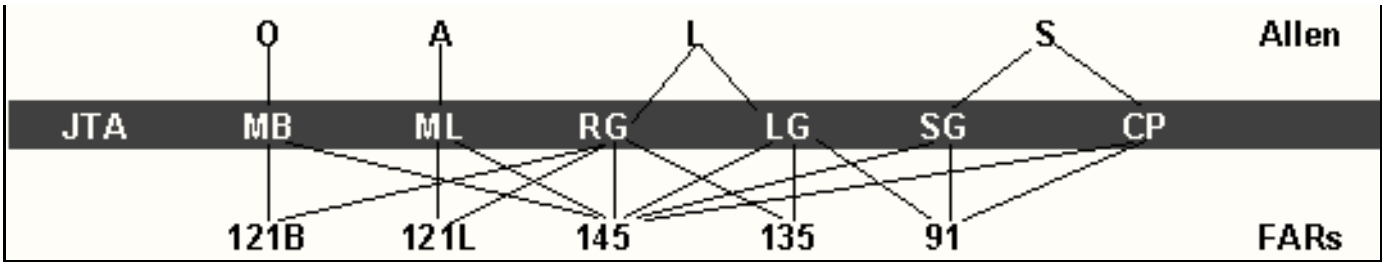

Figure 5: Comparison of Industry Classification Schemes

The Phase II classification scheme also allows an easier comparison to the Allen Study. Overhaul (O) and line (L) facilities of major airlines correspond directly. The large general aviation (L) segment in the Allen Study corresponds to the regional airline and large general aviation segments in the JTA study. The small general aviation (S) segment encompasses both the small general aviation and corporate facilities in the JTA study.

Sites to participate in the study were identified using this scheme. The facilities visited during Phase I that were still in operation formed a basis of sites to visit in Phase II. Again, the ATA and the NATA identified potential facilities for participation in the study. To broaden the sample of facilities, the National Business Aircraft Association and the Regional Airline Association also enlisted the support of their respective memberships. The local FAA FSDO also often proved an excellent source of potential sites.

A similar strategy to the one used in Phase I was employed in choosing cities to concentrate in. A large facility would be chosen, such as an airline's base or line facility or a major repair station. Then, as many smaller facilities in the vicinity would be involved in the study as possible.

3.6 Visit Protocol

The visit protocol developed in Phase I was modified for use in Phase II. Again, both an initial visit and a survey visit were made to each facility. The logistical issues of participating in the study were decided upon during the initial visit and the survey was administered during the subsequent survey visit.

The purpose of the initial visit was to provide an opportunity for the JTA research team to familiarize themselves with the maintenance facility and to brief its management about the project. In addition, management at the facility determined the best manner in which to administer the survey. People who attended the initial visit varied at each site, but always included those who had a supervisory role within the organization and who would assist in coordinating the survey administration.

A site questionnaire was completed at the time of the initial visit which provided the following information: number of AMTs employed, number of non A&P certificated maintenance personnel employed, number of shifts worked and shift duration, major types of maintenance work performed at the facility, and FAA certificate/regulations under which the facility operates. This information assisted in developing a plan to administer the survey.

The number of technicians surveyed depended on the size of the facility. At smaller facilities, as many technicians as possible completed a survey. At larger facilities, a representative sample of technicians was sought, with a maximum of 250. Specifically the group would vary by years of experience, supervisory role, shift worked, and area of work (e. g., turbines, pneumatics, sheet metal, etc.).

The surveys were tailored to each site based upon the type of work performed. If a facility did not perform *any* work

on turbine engines or turbine-powered aircraft, the surveys would not include tasks relating to turbine engines. Because the list of tasks was too large to be included in a single survey that could be completed in less than an hour, different versions of the survey were created depending on the organization of the facility. If technicians worked mainly on a specific component or system of an aircraft, they would receive a survey that only included tasks from one of three categories: airframe, powerplant, or avionics. Thus, if technicians primarily performed engine overhaul work, then they received a powerplant survey. In instances where a technician worked on the entire aircraft, the technician received a general survey, which would contain only one-half the set of tasks. In this manner, the surveys were divided so that each technician was not required to evaluate the entire list of tasks. The time to complete the survey remains one-hour, yet each task could be evaluated by at least one technician at the facility.

The details of how the survey would be implemented at a site were also determined. Three options formed the basis for determining the best method of administering the survey. The primary objective was to collect the data for the study while being as unobtrusive as possible to on-going work. These options included:

Option I: Small groups gathered in a conference room. A member of the JTA staff delivered a brief presentation which provided an overview of the project and instructions on how to complete the survey. The employees completed the survey in the conference room. The JTA staff was present to monitor those taking the survey and answer any questions.

Option II: A member of the JTA staff delivered a presentation to all those employees taking the survey. The JTA staff distributed the surveys to the employees who would complete the survey as directed by on-site management. All surveys were collected by the site coordinator and returned to the JTA staff. This option allowed ample time for the respondent to complete the survey.

Option III: A member of the JTA staff set up an information table in a prominent location at the site. Employees spoke with the staff member and were given the survey and instructions. The employee completed the survey and returned it to the JTA staff member or the site coordinator. This option allowed the employee to complete the survey at a time most convenient to their individual schedule.

Arrangements for the interviews were also made at the initial visit. Fewer employees participated in the interviews than in the survey because of the logistics and the time involved. At smaller facilities, a supervisor or director of maintenance was interviewed, and time permitting, one technician. At larger facilities, the goal was to interview approximately one technician for every twenty surveys. Again, a diversity of employee backgrounds participating in the interview was sought. A mix of supervisors and technicians were interviewed. If applicable, personnel in the training department were also interviewed.

Finally, one employee at the site was designated as the site coordinator for the survey. This person served as the JTA research team's point of contact to assist in scheduling times for the administration of the survey, interviews and observations. The site coordinator was someone in a supervisory role who was familiar with the organization of the facility.

3.7 Collection of Data

A total of 2,434 surveys from 84 facilities were collected from September 1994 to December 1995. The complete list of facilities is listed in Appendix A.

After the surveys were collected, each survey was reviewed using three separate validity checks. First, each survey

was examined to verify that the Background Information section was properly completed. In particular, the certificates and licenses held had to be appropriately completed, or the survey was discarded. Second, each survey was examined to verify that the performance measures for each task were entered appropriately and that the respondent followed the survey instructions correctly. This check included review of all survey task responses, and was accomplished simultaneously with input of the survey information into the database. The most common error observed in the task response section of the surveys was completion of only one of the three performance measures boxes for each task. Finally, each survey was reviewed for overall consistency and appropriateness. This check involved reviewing the survey for errors and blatant disregard for survey accuracy. If the survey failed any one of these three checks, it was discarded.

The survey was entered into a database that was programmed in Access 2.0. This database allows for easy entry of the survey results, a flexible analysis, and customized reports.

As an additional method of ensuring database accuracy, an audit procedure was implemented from the very beginning of the data entry process. Since each survey required detailed data entry, the possibility for error was great, and an audit procedure was developed. Implementation of this audit procedure ensured that the database contained accurate information and virtually eliminated the possibility of systematic data entry errors.

4. ANALYSIS

4.1 Introduction

The survey questionnaire results form the basis of the task analysis, which is detailed in this section of the report. First, information related to the facilities and technicians that participated in the survey is detailed. The results from the Background Information section are reported. Then, the results of the task section of the survey in tabular form, grouped by subject area. A general discussion of the task analysis follows.

4.2 Profile of Sample

The surveys were collected from a total of 84 maintenance facilities. Each facility has been categorized into one of six groups, according to its primary business activities. The six industry segments are listed in Table 3.

Table 3: Industry Segment Abreviations

Figure 6 shows a breakdown of the facilities from which surveys were obtained by facility type. The largest number of facilities visited were those in the small general aviation and corporate aviation segments. While these categories do not represent the largest concentrations of AMTs, it was necessary to visit proportionately more of these facility types in order to obtain an appropriately representative sample from all industry segments.

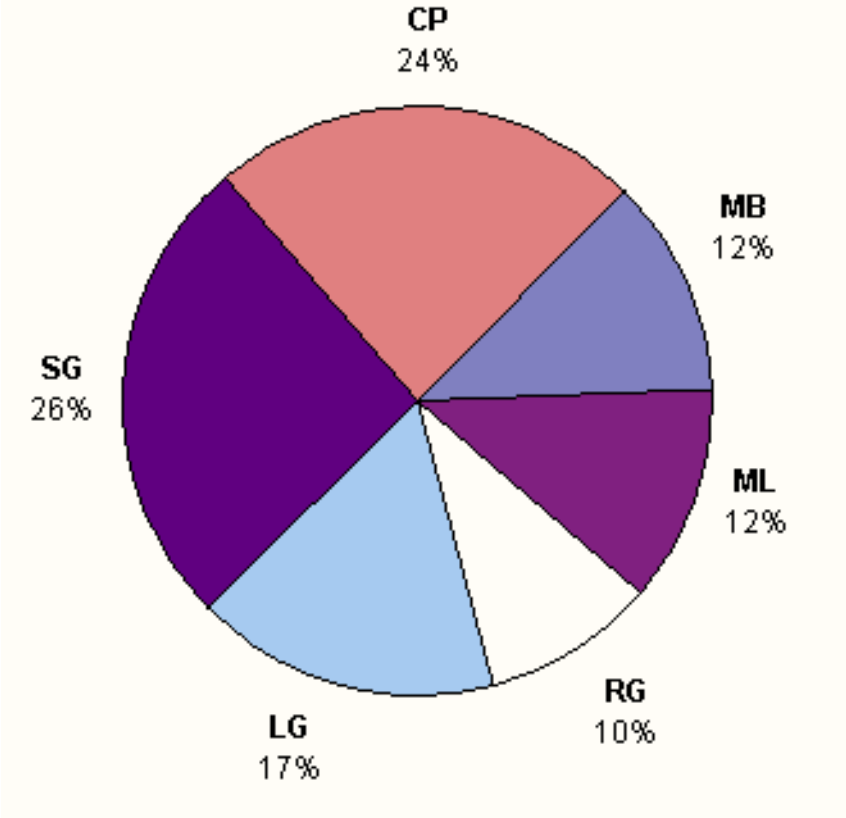

Figure 6. Percentage of Facilities Surveyed by Industry Segment

Figure 6 shows the percentages of surveys by industry segment. This breakdown details the actual representation in the database of the different facility types. The two largest segments of the industry are base (MB) and line (ML) facilities of the major airlines. Approximate matching of this percentage breakdown to actual employment levels in the industry was a key objective of the surveying process.

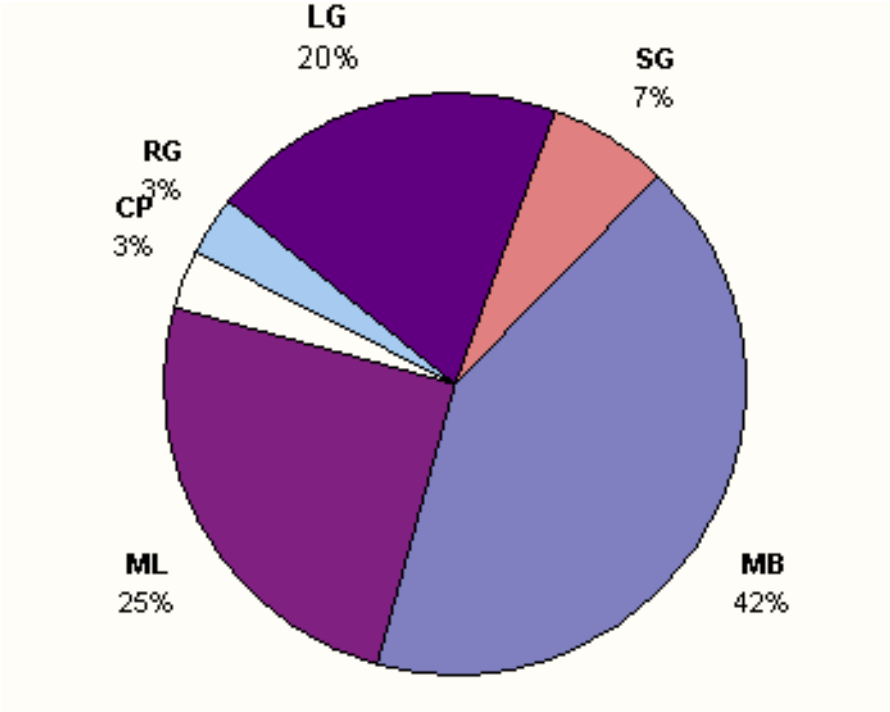

Figure 7. Percentage of Surveys from Each Industry Segment

Figure 8 and Figure 9 show estimates of industry employment levels obtained from the FAA Blue Ribbon Panel Study "Pilots and Aviation Maintenance Technicians for the Twenty-First Century, An Assessment of Availability and Quality." (FAA, 1993) This panel study used historical numbers of maintenance technicians and aircraft fleet size (1988 - 1992) and projected future numbers of maintenance technicians as a function of expectations for future aircraft fleet size by industry segment.

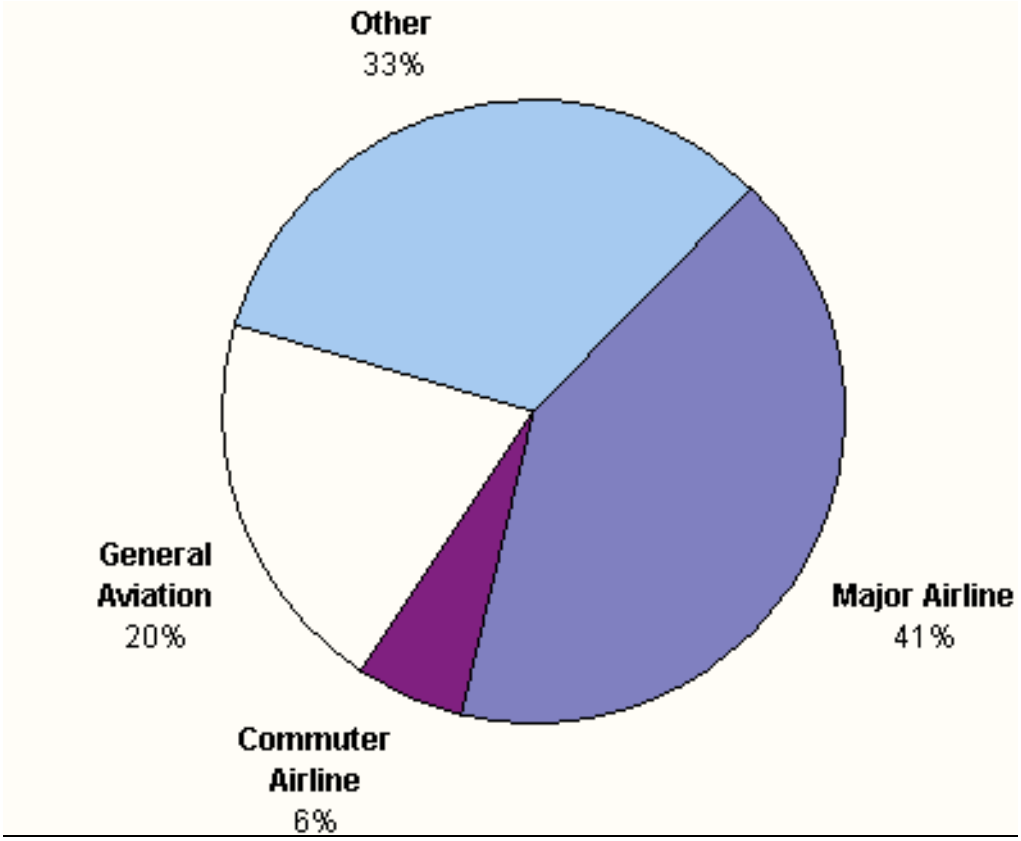

Figure 8. Blue Ribbon Estimates of Technicians In Each Industry Segment

The segments of the industry in the classification scheme used in the panel study are very broad (Figure 8), and different than those utilized in this report. However, an approximate comparison can be made by removing the "Other" category from the panel study data and recalculating the relative proportions. The panel study "Other" category includes maintenance technicians employed by the Federal government (military), aircraft manufacturers, and third-party component overhaul facilities, none of which were surveyed for this project. The resulting proportions are shown in Figure 9. A comparison of Figure 9 with Figure 7 reveals a close match between the survey percentages and the actual employment levels estimated by the FAA Blue Ribbon Panel Study.

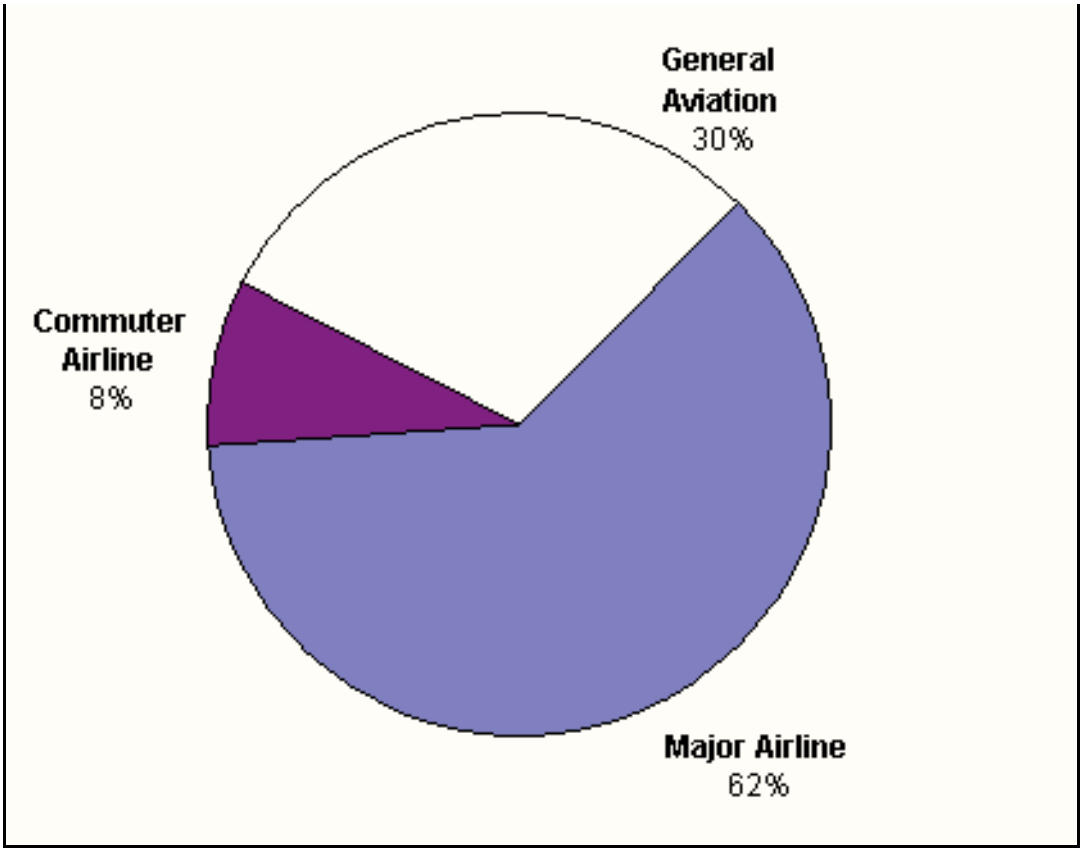

Figure 9. Blue Ribbon Estimates Adjusted for Comparison with JTA

4.3 Background Information

The background information included in the survey consists of information about job title, certificates and licenses held, sources of experience, and years of experience.

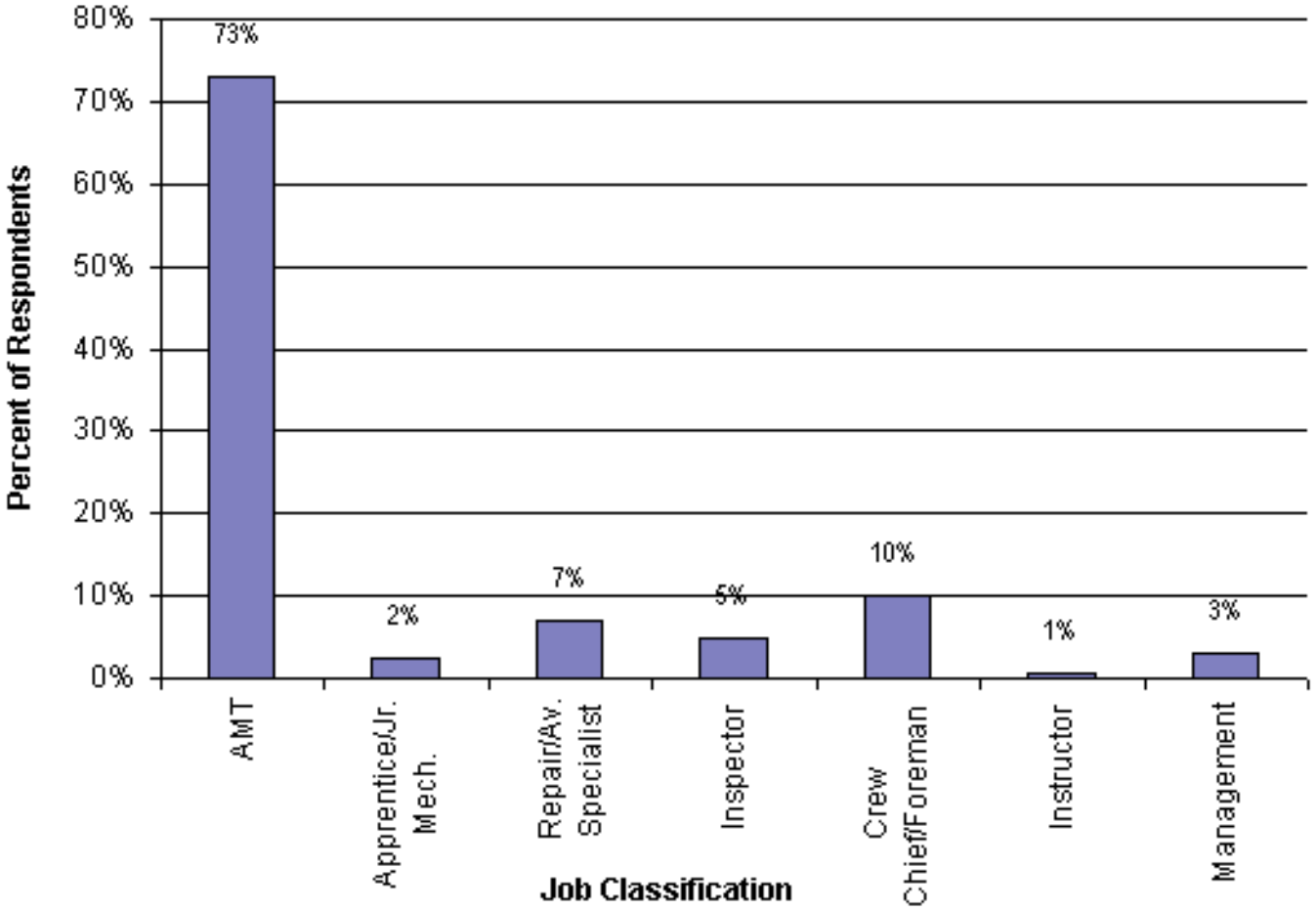

Figure 10. Job Classification of Respondents—All Industry Segments Combined

Figure 10 shows the percentages of survey respondents in each of seven job classifications. (The percentages total to slight more than 100% due to rounding). Most respondents indicated that their job title is "Aviation Maintenance Technician." Figure 11 shows the same data broken out by industry segment. This graph shows that the relative proportion of AMTs is significantly higher at major airline facilities than at general aviation and corporate facilities. It also shows higher concentrations of inspectors at small general aviation and corporate facilities.

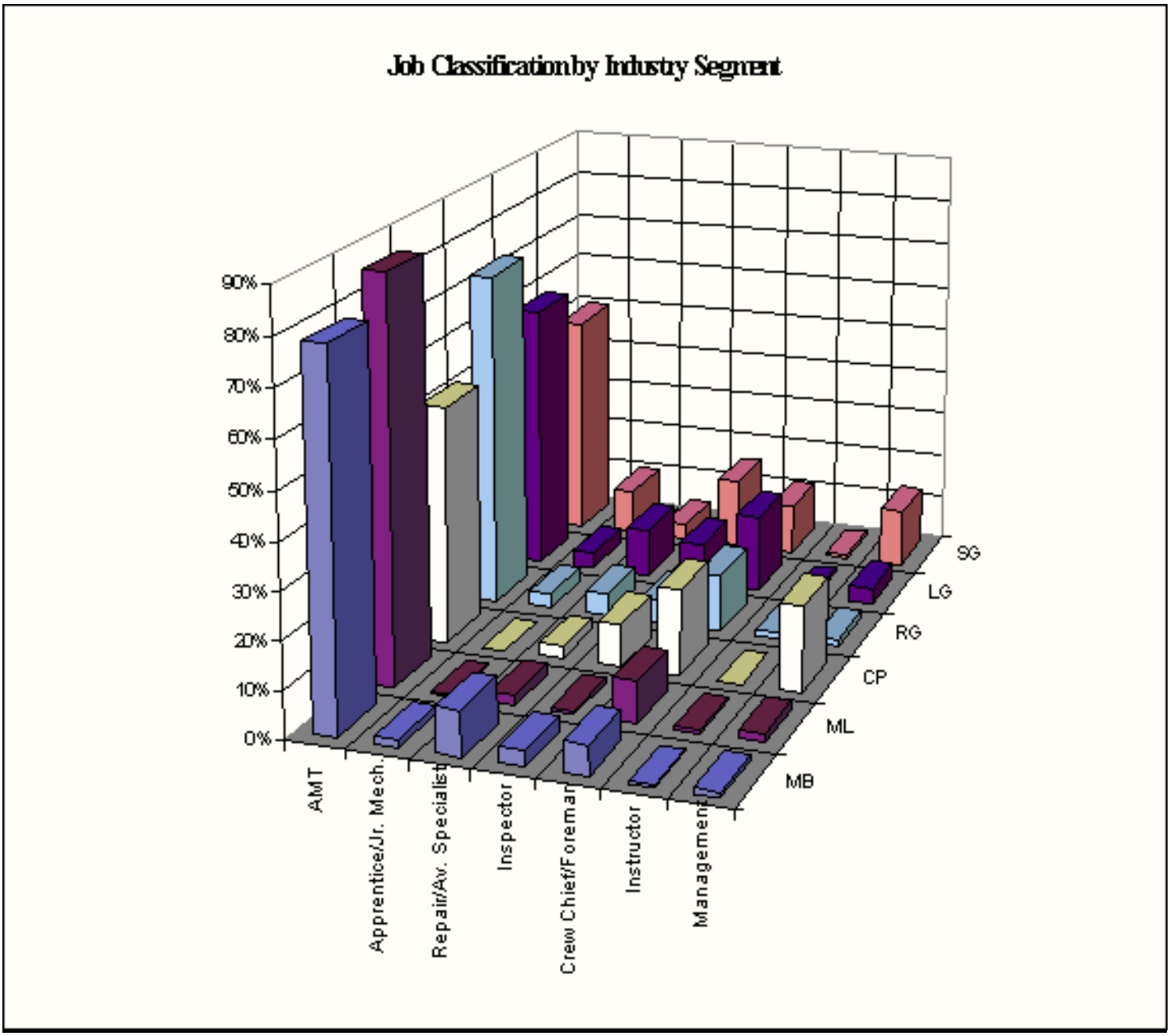

Figure 11. Job Classification of Respondents by Industry Segment

Figure 11 shows the average years of experience for all survey respondents broken out by industry segment. The overall average across all industry segments is 16.1 years. This graph shows that regional airline technicians have on average the fewest years of experience at 10.5 years, while technicians at corporate aviation facilities have on average the highest level of experience at 19.9 years. The differences in average experience levels between industry segments are consistent with industry trends.

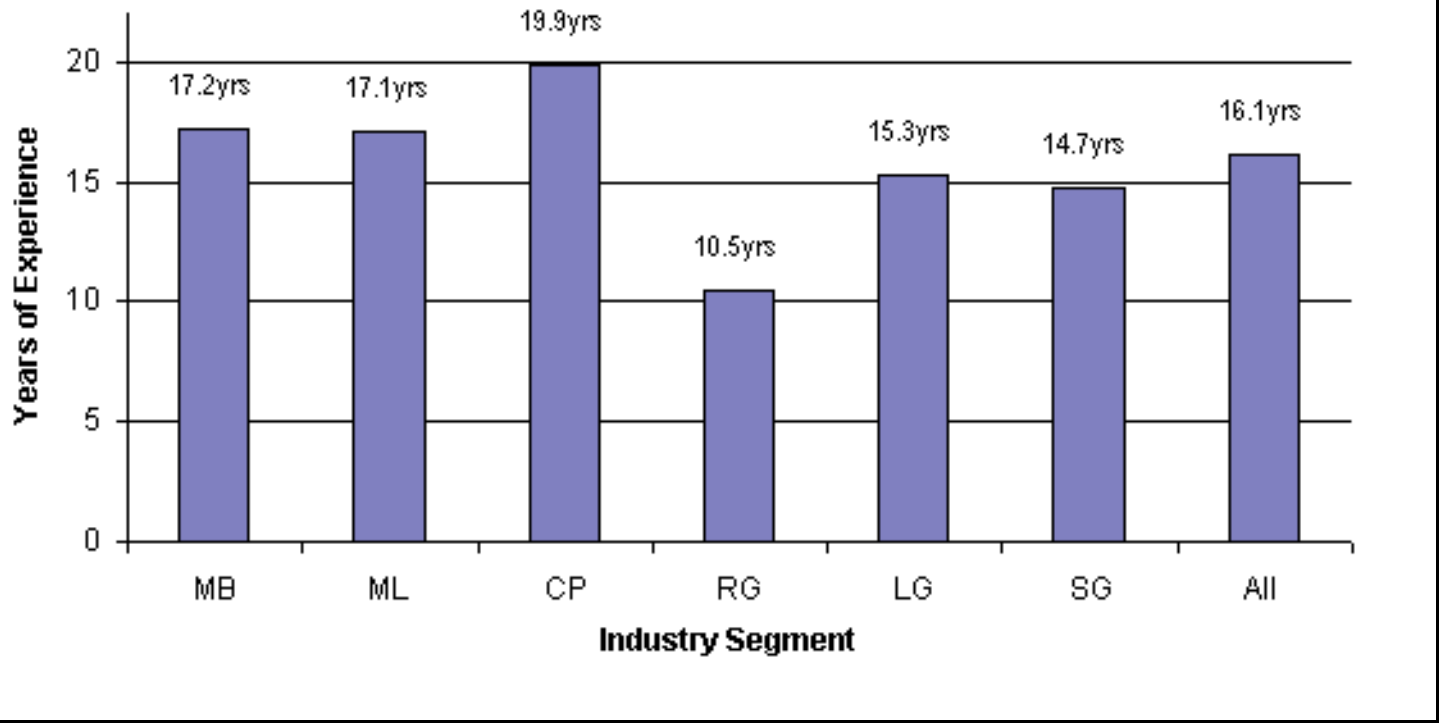

Figure 12. Average Years Experience By Industry Segment

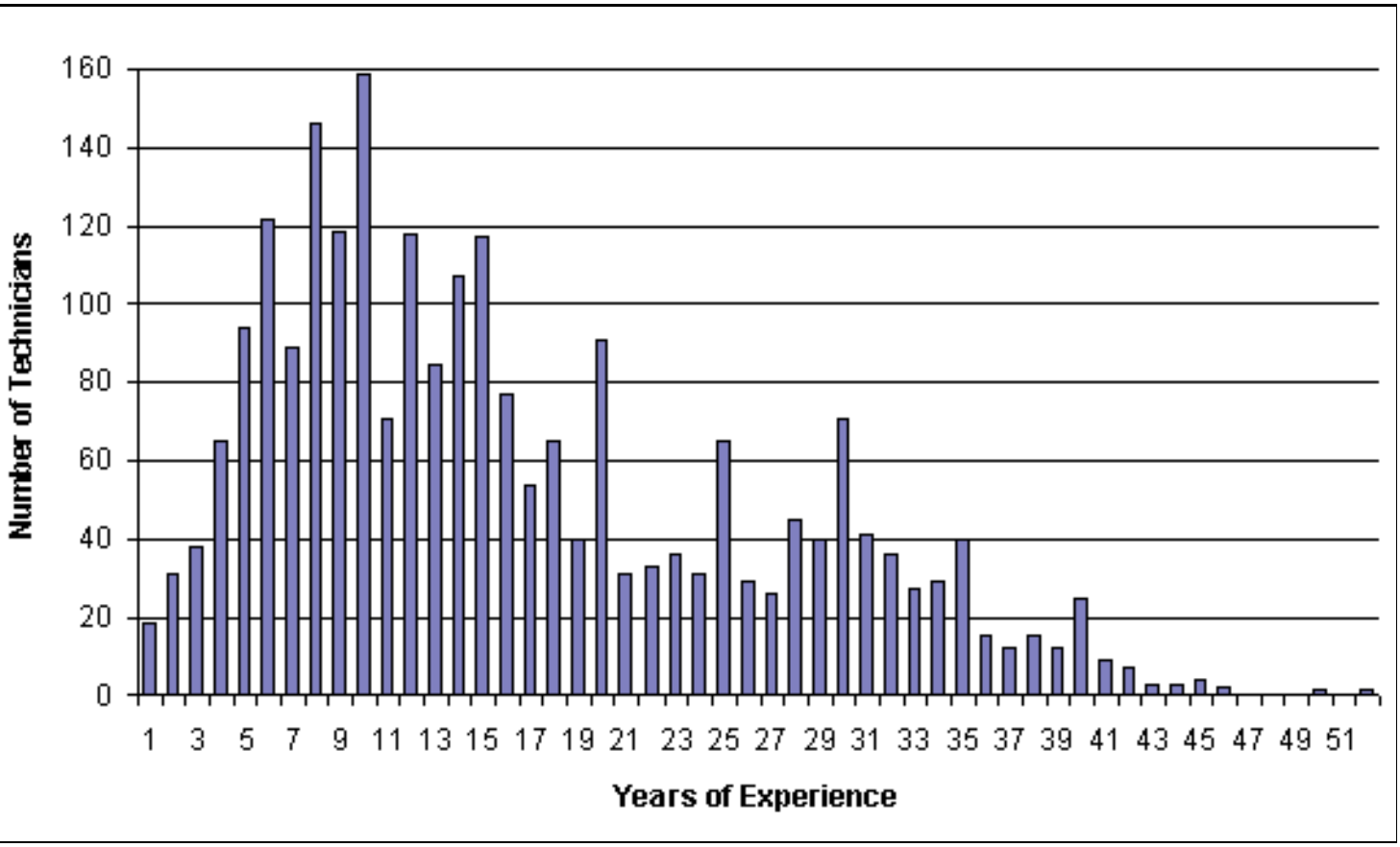

Figure 13. Frequency Count of Years Experience for All Respondents

Figure 13 depicts the frequency distribution of the years of experience data. The median experience for all survey respondent is 14 years. The frequency distribution exhibits a bimodal shape, where the medians of the two modes are

approximately 10 years and 29 years of experience. The concentrations of technicians with these levels of experience correspond to the two historical periods of major airline expansion in 1985 and 1966. Also evident from the frequency distribution is that there are relatively few technicians with 0-4 years of experience, indicating that there has been relatively little new hiring over the last few years.

Figure 14 shows the sources of experience indicated by survey respondents. The most common source of experience for all technicians is the military, where 36 percent of respondents indicated they had acquired experience. Each survey respondent indicated an average more than two sources of experience. Figure 15 shows the same data broken out by industry segment. This graph shows that when broken into industry segments, the most prevalent source of experience for all respondents is within the same industry segment.

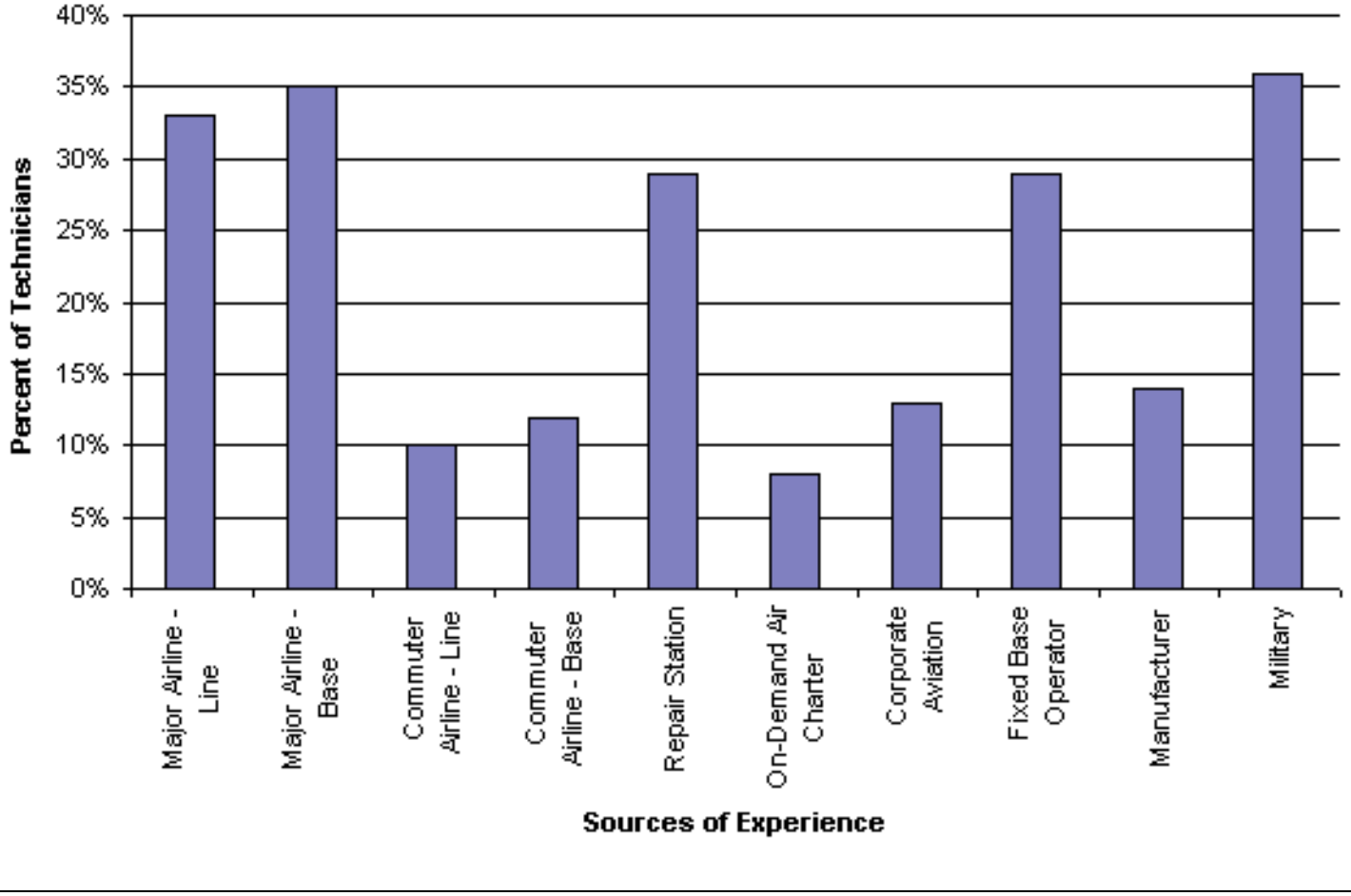

Figure 14. Sources of Experience for All Respondents

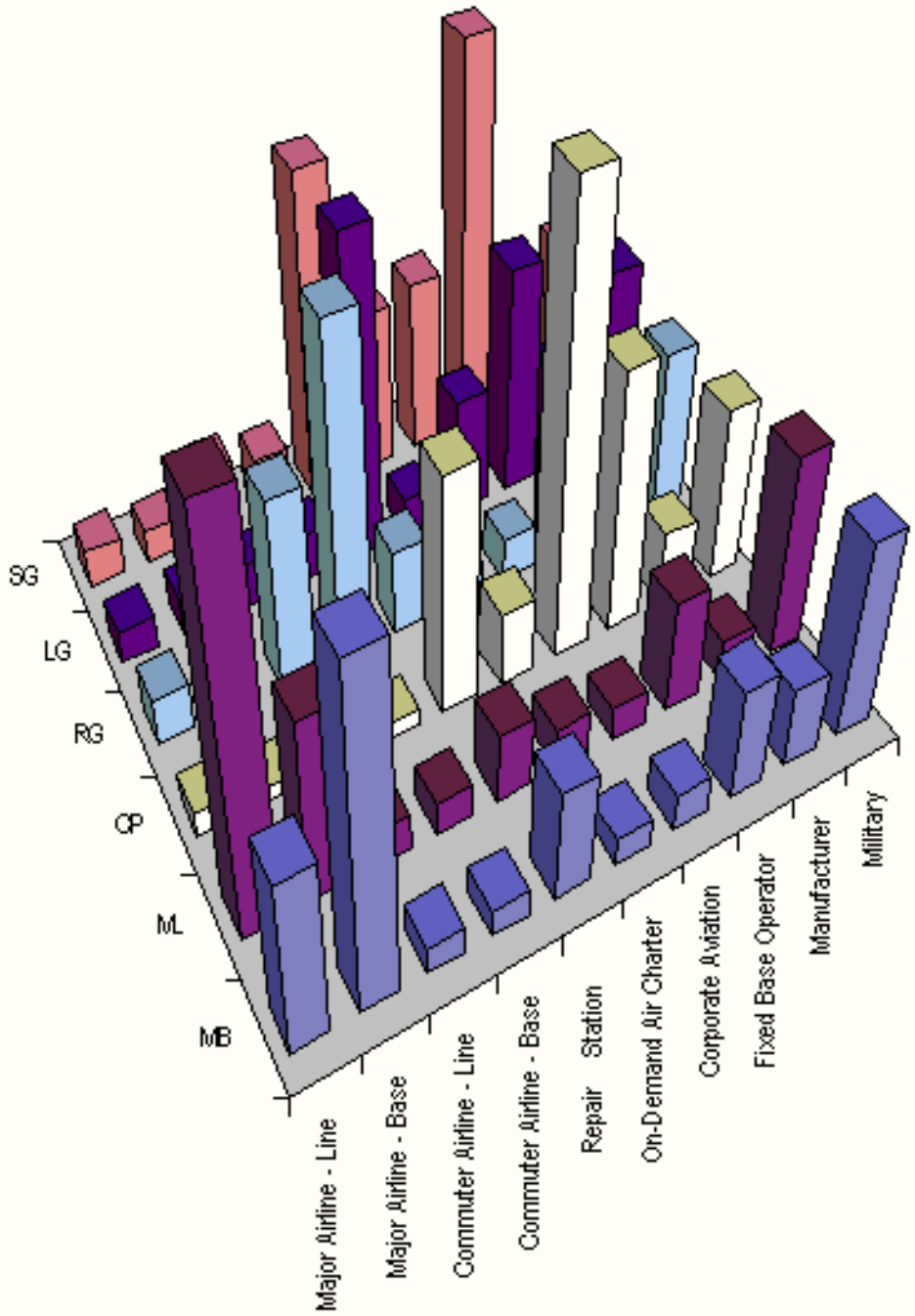

Figure 15. Sources of Experience By Industry Segment

4.4 Task Analysis Survey Results

The 303 tasks, four evaluation dimensions, and six facility types create more than 7,000 data points that need to be interpreted. In order to manage this much data, the 303 tasks have been divided into 20 subject areas. Each subject

area includes four tables: a subject area grid, the frequency and percent response results, criticality results, and difficulty to learn results.

The grids describe the level of task detail in each subject area. The vertical side of the grid three general categories of tasks: inspection, repair and replace, and troubleshooting. The horizontal side of the grid is comprised of systems or components that are applicable to the subject area. The corresponding tasks are listed in the appropriate box. Table 3 outlines a sample subject area grid, "Ignition and Starting."

Table 4. Sample Subject Area Grid

The three remaining tables report the survey results for each of the tasks by industry segment. Percent response and frequency data are combined into a single table for each task in the subject area. Criticality and difficulty data results are each listed in an individual table. An example table for frequency and percent response is listed in Table 5.

Table 5. Example of Data Tables for Frequency and Percent Response

	B	Inspect high-tension systems	3	65										

The task "Inspect high tension systems" at major airline, line facilities is reported as "3." The key to the frequency, criticality and difficulty to learn measures are listed in Table 6. Technicians perform this task at a major airline, line facility on a monthly basis. The percent response for this task at a major airline, line facility is 65%.

Table 6. Definition of the Rating Scales

Survey Results by Subject Area

Airframe or Structure

Cabin Atmosphere Control

Task Function	air conditioning	pressurization	oxygen
Check, test, service, inspect	A, B, C	F	I, J, K
Repair, remove, replace, modify and calibrate	D	G	L
Troubleshoot	E	H	

Frequency—Cabin Atmosphere Control						

Criticality—Cabin Atmosphere Control							

Difficulty—Cabin Atmosphere Control								

Cleaning and Corrosion Control

Task Function	cleaning	corrosion control	painting/ finishing
Check, test, service, inspect	A, B, C	D, E, F	
Repair, remove, replace, modify and calibrate		G	H, I, J
Troubleshoot			

Frequency—Cleaning and Corrosion Control													

Criticality—Cleaning and Corrosion Control						

Difficulty—Cleaning and Corrosion Control								

Fuel System

Task Function	storage	distribution	related systems	accessories
Check, test, service, inspect	A, B, C, D	H, I	L	
Repair, remove, replace, modify and calibrate	E, F	J	M	N, O, P, Q
Troubleshoot	G	K		

Frequency—Fuel System													

Criticality—Fuel Systems							

Difficulty—Fuel Systems							

Landing Gear

Task Function	tires	brakes	main/nose gear	retractable gear	anti-skid systems
Check, test, service, inspect	A, B	E	G, H, I, J, K	P, Q	U

Repair, remove, replace, modify and calibrate	C, D	C	L, M, N, O	R	V
Troubleshoot		F		S, T	W

Frequency—Landing Gear

Criticality—Landing Gear

Difficulty—Landing Gear

Structures: Doors, Windows, and Wings

Task Function	doors	windows	wings	equipment/furnishings
Check, test, service, inspect	A, B, C	C	G	H
Repair, remove, replace, modify and calibrate	D, E	F		
Troubleshoot				

Frequency—Structures: Doors, Windows, and Wings														

Criticality—Structures: Doors, Windows, and Wings							

Difficulty—Structures: Doors, Windows, and Wings							

Structural Repairs and Welding

Task Function	sheet metal	specific materials	welding	soldering
Check, test, service, inspect				
Repair, remove, replace, modify and calibrate	A, B, C, D, E, F, G, H, I, J	K, L, M, N, O	P, Q, R	S, T
Troubleshoot				

Frequency—Structural Repairs and Welding													

Criticality—Structural Repairs and Welding							

Difficulty—Structural Repairs and Welding

Avionics

Autoflight

Task Function	autopilot	autothrottle	autoland
Check, test, service, inspect		C	E
Repair, remove, replace, modify and calibrate	A		F
Troubleshoot	B	D	

Frequency—Autoflight														

Criticality—Autoflight							

Difficulty—Autoflight							

Communications

Task Function	voice/data communication	ACARS	accessories
Check, test, service, inspect	A, B	E	G
Repair, remove, replace, modify and calibrate	C		H, I
Troubleshoot	D	F	

Frequency—Communications

Criticality—Communications

Difficulty—Communications								

Navigation

Task Function	flight data	flight instruments and accessories	flight management
Check, test, service, inspect	**A, B**	**G, H, I, J**	**S, T, U, V**
Repair, remove, replace, modify and calibrate	**C, D, E**	**K, L, M, N, O**	**W, X**
Troubleshoot	**F**	**P, Q, R**	**Y, Z**

Frequency—Navigation

		EFIS												
		EFIS												

		VOR ILS												

Criticality—Navigation							
		EFIS					
		EFIS					

						<FO		