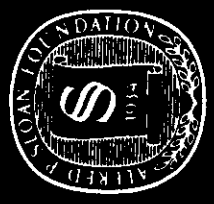

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KEY WORKFORCE CHALLENGES FACING THE AMERICAN CONSTRUCTION INDUSTRY: AN INTERIM ASSESSMENT

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REPORT NO. 3

THE UNIVERSITY OF TEXAS AT AUSTIN

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A Report of

Center for Construction Industry Studies

The University of Texas at Austin

Under the Guidance of the

Workforce Thrust Team

Austin, Texas

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EXECUTIVE SUMMARY

Tremendous challenges face the construction industry in attracting and maintaining a qualified workforce. Shortages of skilled craftsworkers have led to consideration of new methods to attract, retain, and provide incentives to workers; however, such short-term issues may obscure additional fundamental challenges such as adequate training, skills testing, and certification. The industry has focused on the following topics relating to the construction workforce: attracting and retaining a skilled workforce, the return on investment on training to construction firms, special incentives to attract skilled workers, multiskilling, impact of technology, impact of demographics, measuring and understanding productivity, and skills testing and certification.

Critical questions must be adressed in order to allocate resources effectively. Can the return on investment for training be measured efficiently to direct the training efforts of the industry? Is multiskilling a useful human resource allocation strategy? What is the impact of technology on the construction workforce in terms of wages, training, job distribution, and career paths? What has happened to productivity in the construction industry? There are no clear answers to many of these questions at this time. Research is needed to answer these questions and to mobilize the industry to make necessary changes.

The Research Workforce Group at the Center for Construction Industry Studies is directed to answering these questions. Reports in three research topics were recently completed: implementing a multiskilled workforce, workforce experiences with multiskilling, and measuring return on investment in training and education. Two topics currently being studied are construction labor productivity and the impact of technology on the workforce.

This report has three purposes. First, it serves as a primer on the nature and state of today's construction workforce and how it has developed over time. Second, it identifies key workforce issues of concern to industry leaders. Finally, it summarizes the findings of existing research and the research of the Workforce Group. This work is motivated by the identified key issues and the problems that they present, and it provides preliminary answers to some of the most important questions that are posed by these problems.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

The United States construction industry faces significant challenges, which have limited its growth and competitiveness. The industry is fragmented with most companies composed of less than 100 employees (Center to Protect Workers' Rights 1997). This industry fragmentation has caused difficulties in developing industry standards and in investment in training. Shortages of new entrants into the industry and insufficient craft training do not bode well for the future. In 1997, The Business Roundtable reported that 60% of construction companies faced labor shortages, which caused serious cost overruns or schedule delays (The Business Roundtable 1997). Most of these shortages are due to the poor image of the industry, the relatively deteriorating wages it offers, and the lack of clear career paths.

In 1997, The University of Texas at Austin and the Alfred P. Sloan Foundation created a multidisciplinary research program entitled the Center for Construction Industry Studies (CCIS) to investigate problems in the construction industry. To date, the program has established initiatives in four areas: (1) fully integrated construction processes, (2) implications of the shift of responsibilities from contractor to owner, (3) technology, and (4) workforce issues. The Construction Workforce Thrust Area is aimed at better understanding workforce characteristics, behavior, and utilization, in order to recommend changes in practice and policy, which will improve the industry. Our research is motivated by the potential for productivity improvement in the industry and by the possibility for human capital development to improve the economy. The initial concerns of the workforce study team were defined in April 1998, with input and guidance from the Sloan Construction Workforce Thrust Area Advisory Panel. They included:

1. Characterize the current status of the construction workforce;
2. Understand the labor incentives and disincentives;
3. Suggest methods to effectively utilize labor as a resource;
4. Understand the impact of demographic and technology trends; and
5. Determine possible mechanisms to change the value of the workforce.

Our research is focused on the construction industry in the United States, although some international workforces will be studied to show their relationship to the US workforce.

All sectors of the industry, commercial, heavy, industry, and residential, will be analyzed through the study of medium to large companies across the union and the non-union segments of the industry.

The Construction Workforce Thrust Area, led by Dr. Carl Haas, involves a diverse group of university researchers, as well as a panel of industry and labor participants. The University of Texas at Austin Research Team is composed of the following members:

- Christine Alemany, MS student, Civil Engineering Department
- Dr. John Borcherding, Professor, Civil Engineering Department
- Lynn Ann Carley, MS student, Civil Engineering Department
- Jason Eickmann, MS student, Civil Engineering Department
- Dr. Bob Glover, Research Scientist, Center for the Study of Human Resources
- Jorge Gomar, MS student, Civil Engineering Department
- Dr. Carl Haas, Associate Professor, Civil Engineering Department
- Dr. William Kelly, Professor, Sociology Department
- Ana Maria Rodriguez, MS student, Civil Engineering Department
- David Shields, Ph.D. student, Civil Engineering Department
- Dr. Richard Tucker, Director, Center for Construction Industry Studies

The Construction Workforce Advisory Panel is composed of the following members:

- Daniel Bennet, President, NCCER
- David Bush, President and CEO and President-elect of ABC, Adena Corporation
- Douglas McCarron, President, United Brotherhood of Carpenters and Joiners of America
- Ken Hedman, President, Bechtel Construction Operations
- James Jeffress, Construction Manager, DuPont Engineering
- Theodore Kennedy, Chairman and CEO, BE&K

The general methodology used in the development of the research has been based on a literature review, establishment of contacts, visits to successful and exemplary companies, development of detailed research plans, collection and analysis of data, and workshops on interim results. Research topics were identified through meetings with the Thrust Area

Advisory Panel which has guided the research efforts. The Advisory Panel has met the Research Team on three occasions, on October 1997, April 1998, and October 1998 in Austin, Texas. During these meetings, topics of concern to the industry were identified. Members of the panel provided guidance for the research efforts and reviewed the progress and initial findings of the Thrust Area. The completed research results will be documented and published by the Sloan program.

This initial report contains four chapters that summarize the preliminary research findings. Chapter 2 reviews what is known about construction workforce characteristics. Chapter 3 presents the results of the literature review of workforce issues facing the construction industry. Finally, Chapter 4 summarizes preliminary conclusions from research currently underway.

CHAPTER 2: PROFILE OF THE CONSTRUCTION WORKFORCE

2.1 Introduction

Accurate statistical information describing and characterizing the construction industry and its workforce are difficult to obtain. Accurate data collection is troublesome in part because of the unique characteristics of the construction industry, which include:

- the large size of the industry in the United States,
- the fragmentation of the industry,
- the relatively short duration of construction projects,
- the use of transient employment,
- the view in some sectors of the industry of human resources as a commodity,
- its geographically mobile workforce,
- the decline of the union sector and its documentation and information sources,
- contractors' consideration of company data as proprietary, and
- the relatively low funding of academic and industry research.

Several key sources of data and analysis do exist; however, all statistical information on the industry should be evaluated with skepticism. It is important to know the source and the circumstances of the data collection and analysis. The U.S. government collects a great deal of the available data, most of which is flawed due to the use of inadequate or unstable processes for collecting data on the industry. Industry organizations (including unions and various contractor organizations) collect data, but the data are either collected in a somewhat selective manner, or access to the complete industry is unavailable, or the data are analyzed in a discretionary fashion. The report, "*Characteristics of the Construction Craft Work Force*," prepared by the Construction Industry Institute in 1992, may be one of the most comprehensive and objective sources of information characterizing the work force. Yet, even this report acknowledged its limitations:

> The survey population was limited to craftspersons working for engineering, procurement and construction (EPC) companies. These projects tend to be larger in scope and longer in duration. The results of the survey may be

biased and not representative of the total United States construction craft workforce.

2.2 Contractor Organizations

Four principal national organizations represent general contractors. Associated General Contractors of America (AGC) has members from several sectors including building, heavy, highway and utility construction. The organization has been traditionally union-oriented, but now more than 50 % of its members operate on a non-union basis (called "open shop" or "merit shop" in the industry) or operate both union and non-union subsidiaries (termed "double-breasted shops" in the industry). Membership is 32,176 of which 7,235 are general contractors. The Associated Builders and Contractors (ABC) represent the largest group of open-shop contractors, yet this is estimated to be only 2% of all contractors in the United States. ABC membership includes over 21,000 contractors, subcontractors, material suppliers and related firms. Nearly 50% of ABC members are not construction contractors. The National Association of Home Builders (NAHB) is a federation of more than 800 state and local builders associations in the United States, which represents the housing industry. It has 190,000 members of which about one-third are homebuilders and/or remodelers. The remaining members are in closely related fields within the housing industry (e.g. suppliers of building products and services, mortgage finance, etc.). The American Road and Transportation Builders Association (ARTBA) is a federation of eight divisions representing the public and private sectors of the transportation construction industry. The eight divisions are: Contractors; Education; Manufacturing; Materials & Services; Planning & Design; Public-Private Ventures; Traffic Safety; and Transportation Officials. The Contractors Division represents a wide range, from very small specialty contractors to large national prime contractors, in all areas comprising transportation work, including highways, bridges, airports, railroads and mass transit.

Specialty trade contractors make up a large percentage of firms in the construction industry. The specialty contractors have developed trade associations which represent them. Table 2.1 lists major specialty trade associations and the counterpart unions that bargain with them.

Table 2.1 Principal Specialty Trade Associations and Union Counterparts in Construction
(Source: Northrup 1984, pp. 674)

Associations	Unions which Bargain with Associations
American Road and Transportation Builders	Operating Engineers, Teamsters, and others
Elevator Constructors Employers Association	Elevator Constructors
Independent Electrical Contractors	
International Association of Wall & Ceiling Industries	Plasterers
Mason Contractors Association of America	Bricklayers
Mechanical Contractors Association of America	Plumbers and Pipefitters
National Association of Heating-Cooling Contractors	Plumbers and Pipefitters
National Electrical Contractors Association	Electrical Workers (IBEW)
National Erector Association	Iron Workers
National Insulation Contractors Association	Asbestos Workers
National Roofing Contractors Association	Roofers
Painting and Decorating Contractors Association	Painters
Sheet Metal and Air Conditioning Contractors National Association	Sheet Metal Workers

2.3 Labor Organization

2.3.1 *Unions*

The AFL-CIO Building and Construction Trades Department was formed in 1908 and currently includes the following 15 affiliated international and national unions, including:

- International Association of Heat and Frost Insulators and Asbestos Workers
- International Brotherhood of Boilermakers, Iron Ship Builders, Blacksmiths, Forgers and Helpers
- International Union of Bricklayers and Allied Craftworkers
- United Brotherhood of Carpenters and Joiners of America
- International Brotherhood of Electrical Workers
- International Union of Elevator Constructors
- International Association of Bridge, Structural, and Ornamental Reinforcing Iron Workers
- Laborers' International Union of North America
- International Union of Operating Engineers
- Operative Plasters' and Cement Masons' International Association of the United States and Canada
- International Brotherhood of Painters and Allied Trades
- United Association of Journeyman and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada
- United Union of Roofers, Waterproofers and Allied Workers
- Sheet Metal Workers' International Association
- International Brotherhood of Teamsters

The union sector of the construction industry traditionally has conducted the bulk of the training of skilled workers. In 1982, the Business Roundtable Construction Industry Cost Effectiveness Project Report reported that unions provided 90% and open-shop provided 10% of the expenditures on training even though 60% of the construction market was open-shop and 40% union (The Business Roundtable 1982).

As of 1998, ABC claims that 79% of all construction workers were not represented by a union, based on data from the U.S. Bureau of Labor Statistics (BLS) indicating that 21% of workers in the industry are represented by unions. (See Figure 2.1.) The Building and Construction Trades Department of the AFL-CIO counters the claim by pointing out that the BLS includes all occupational titles such as engineers, salespersons, and clerks from within the industry in their reports. Additionally, the BLS figures do not take into consideration such factors as the type of work being conducted, the dollar value of projects, or the number of hours worked. All workers in the industry are viewed equally, whether they are employed on a part-time basis, performing home repair work, or performing highly skilled, full-time work at commercial or industrial facilities. It appears that it is not presently possible to definitively determine the percentage of the construction industry's work force that is union or non-union with existing databases.

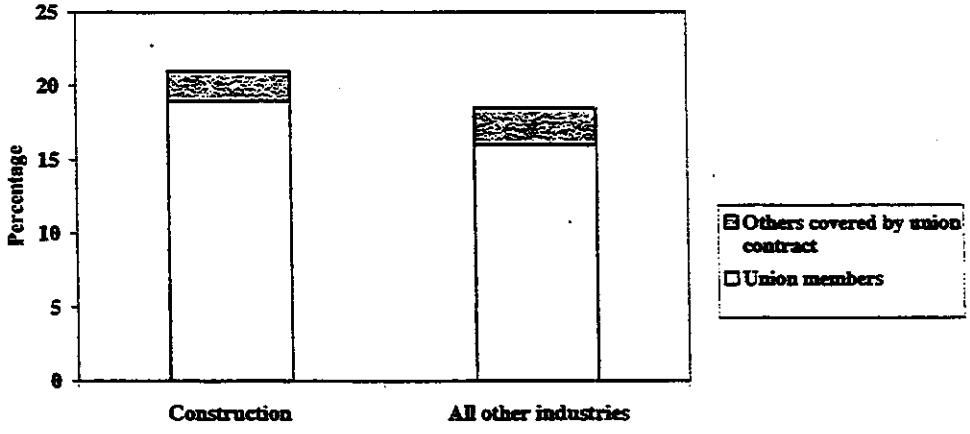

Figure 2.1 Union Density in Construction and All Other Industries, 1995
(Source: BLS data, CPWR(1997)).

According to the best data available, union density--the percentage of employees who report themselves as union members--has fallen by nearly half since the 1970s (Allen, 1994). The reported percentage of union construction workers declined by 48% between 1970 and 1992. Allen (1994) states that reasons for the decline in union density are debatable, but may include:

- Contractors' ability to choose their collective bargaining status due to reinterpretations of labor laws.
- Adversarial relationships between contractors and unions in the past.
- Closing of the wage disparity between union and non-union workers.
- Advantages in using union workers have eroded.
- Controls for labor costs have been developed.

2.3.2 *Open Shops and Merit Shops*

Since the 1960's, the number of open shop contractors has increased substantially due possibly to the points listed above or to increases in union wage settlements and other difficulties with unions such as jurisdictional disputes, restricted crew sizes, and hiring hall practices. Initially open shop contractors bid most successfully in the residential and small building markets since these markets typically require less skilled workers. However, there has been a continued progression of capability improvement such that there now exists an open-shop capability to competently execute the largest of projects.

Based on the results of questionnaires sent to 22,000 contractors, Northrup (1984) updated and expanded on the work of Northrup and Foster (1975) characterizing the open-shop sector of the construction industry. In 1984, Northrup concluded that open-shop construction accounted for about 70% of the total construction volume in the United States, including 95% of single-family homes; 80 to 85% of multiple, particularly high-rise, dwellings; 35-40% of industrial construction; and in excess of 50% of heavy and highway construction (1984, pp. 674).

One last characteristic, which describes the construction industry in the U.S. as well as in many other countries, is the fact that only a portion of the workforce is unionized. The case is true for many other industrialized countries such as England, France, Switzerland, Japan, and Canada to name a few. This split in union and non-union workers has many great impacts on the construction industry. Construction is performed differently with contractors that are union shop, merit shop, or a combination of the two.

2.3.3 *Advantages and Disadvantages of Each Sector*

The union and non-union sector each have strengths and weaknesses. Union labor is well trained and highly skilled through their methodical apprenticeship and training

programs. This sets the union sector apart from the non-union sector in which training programs have only recently become somewhat standardized. Jurisdictional disputes, restricted crew sizes, and hiring hall practices have been a union disadvantage in the past. For the non-union sector, the flexibility of assigning workers freely is an advantage. But the lack of a standard training program until recently has been a serious disadvantage to the non-union sector.

2.3.4 *Differences in Characteristics*

Union workers are primarily concerned with job site safety, job security, and working conditions. On the other hand, the primary concern of non-union workers is pay and benefits. Non-union workers do not have an organized voice in the construction industry; therefore, they are generally paid less than union workers. They are not as concerned with safety and better working conditions.

Differences in attitudes towards improvements in the construction industry may be due in part to the difference in the average age of union and non-union workers. In 1995, the average age for union members was 39.6 years while the average for non-union construction workers is only 34.5 years. (See Figure 2.2.) This age difference is meaningful because a craftworker's concerns change with age and experience level. Younger workers are not as concerned with permanent jobs, benefits, or safety as are older workers. Because union workers are older and generally better paid, they may give greater attention to these issues.

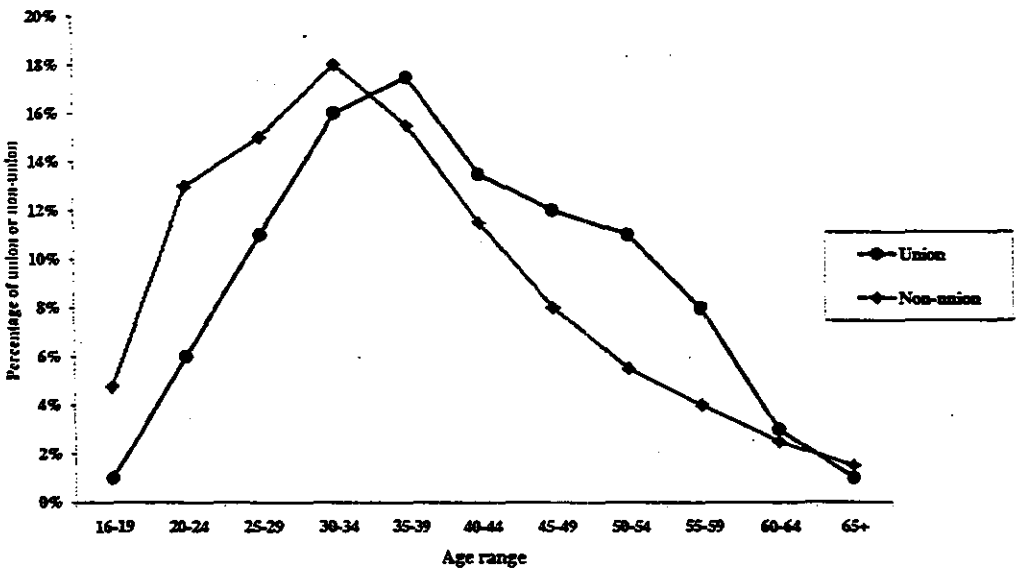

Figure 2.2 Age Distribution in Construction, by Union Status, 1995
(Source: The Center to Protect Workers' Rights 1997)

In 1997, CII commissioned the Work Force Retention Implementation Team Feedback Team (RT 98-3) to investigate whether member companies were still experiencing the same high rates of turnover observed in 1992 and to understand what companies were doing to combat this problem. Their objectives were to define the role that owner and contractor companies play in:

- Implementing methods to attract workers to the construction industry.
- Implementing methods to retrain workers to the construction industry.
- Identifying the benefits of successful retention programs.

Surveys with over 1,100 craft workers and more than 21 contractors revealed that 75% of the contractors surveyed were still experiencing shortages of craft workers. Shortages of contractor supervisors and professionals were less severe with about 35% reporting they were experiencing shortages of supervisors and about 50% saying they are experiencing shortages of professionals. About 70% of owner companies and about 60% of the contractor companies responded that these shortages have impacted their projects. The results from this research show the differences in attitudes between union and non-union workers. Because of these differences based on union status, it is important to keep this characteristic in mind.

2.4 Construction Workforce Training Programs

Construction apprenticeships emphasize the breadth of training by using rotation "through all aspects of the trade" as a common feature. Thus, for example, an operating engineer apprentice will learn how to operate and maintain at least three types of major pieces of construction equipment. Apprentices are full-time employees as well as trainees. Their training generally lasts for three, four, or five years--usually divided into six-month progress periods. Apprentices successfully negotiating one six-month period are advanced to the next at a higher wage rate in a scheme of progressive wage increases which lead to achieving full journeyman scale at the end of their apprenticeships. Construction workers who have completed apprenticeships tend to advance to supervisory status earlier and more regularly than other workers. They are also more steadily employed and, thus, enjoy higher earnings than other workers.

The construction industry is the largest user of apprenticeship in the United States, with nearly two-thirds of all registered American apprentices in construction trades. Part of the explanation for this concentration of apprentices is the unique incentive provisions for contractors conducting public construction work found in the Davis Bacon Act of 1931. This legislation applies to all federal construction projects. Several states also have "baby Davis Bacon" laws that mimic the federal legislation and apply to construction work funded by state monies. Under the Davis Bacon Act, contractors performing work in the public sector must pay "prevailing wage rates" to their workers. Specifically, contractors must pay the full journeyman wage rate that prevails in the local labor market unless they are registered apprentices. As a result, if employers want to hire employees and pay them at below journeymen rates, these workers must be registered apprentices. These provisions offer a unique incentive for employers to register their apprentices. No other industry has such an incentive to train; however, this incentive is limited to construction work in the public sector.

Apprentices and apprenticeship programs are registered either with the Bureau of Apprenticeship and Training (BAT) in the U.S. Department of Labor or with a State Apprenticeship Agency (SAC) under the authority of the Fitzgerald Act of 1937 according to federal regulations (29CFR29 and 29CFR30) originally promulgated in 1978. As categorized by type of sponsor, four types of apprenticeship programs exist in the United

States: (1) individual-joint programs, (2) group-joint programs, (3) individual-unilateral programs, and (4) group-unilateral programs.

2.4.1 *Union Apprenticeship Programs*

In the union sector of the construction industry, the most common form of apprenticeship are programs sponsored jointly by a union and a group of employers. Group-joint programs in construction are the largest, most visible, and usually best organized of American apprenticeship programs. For this and other reasons, the American public commonly identifies apprenticeship with the union sector. The collective bargaining agreement provides the union sector the advantages of a compulsory mechanism to finance apprenticeship training. Necessary funds are collected and placed into a dedicated training fund, usually on the basis of a certain number of cents per hour worked in the jurisdiction covered by the collective bargaining agreement.

The apprenticeship program is administered by the Joint Apprenticeship and Training Committee (JATC) which is usually composed of three employer representatives and three worker representatives. In no case does a union administer an apprenticeship program on its own. Apprenticeships conducted in the union sector are administered jointly by a union and an employer or group of employers. The local JATC operates under the broad curricular and program guidelines promulgated by a Joint Apprenticeship and Training Committee at the national level. Some trades have negotiated financial support for national training funds, which develop and disseminate curricular materials, and offer professional development in the form of education in pedagogy as well as technical updates for apprentice instructors. Most local JATCs also offer continuing training to journeymen to update or upgrade their skills as well.

Most of the joint construction programs conduct classroom training for apprentices two evenings per week after regular employment times at facilities owned by the industry. Except in Wisconsin (where state law mandates that apprentices be paid for attending related training), apprentices usually attend these classes on their own time. The instructors for these evening sessions generally also work in the industry, usually as foremen or supervisors. Some states offer funding through school districts or community colleges which partially defrays the salary of the instructor and other expenses of the related classroom instruction. Several of the better-financed industry programs in larger cities employ apprenticeship

coordinators who organize the program and monitor the quality of the training on the job. In most trades, JATCs also serve as sponsors for apprentices who then become attached to the industry rather than to individual firms.

One advantage of the industry-level approach is that if one contractor runs out of work, the apprentice can easily be shifted to employment with another signatory contractor to continue his/her apprenticeship. Also, rotation in employment among several firms often provides a more diverse and richer training experience than remaining with a single firm for the entire term of apprenticeship. A disadvantage of the industry-wide approach is that the JATC members (who are volunteers) assume personnel functions in screening and selecting applications, activities that are commonly undertaken by individual firms in other industries. Under strict equal opportunity laws and regulations, screening and interviewing a sizeable pool of interested applicants can be a significant burden on volunteers whose primary vocation is to manage their firms or work at their paying jobs.

2.4.2 *Non-union Apprenticeship Programs*

Non-union craftworkers have been slow to utilize apprenticeship, despite the advantages offered by such programs. The open shop, or merit shop, sector of the construction industry does not have the long tradition of apprenticeship training enjoyed by the union sector, where craft apprenticeships in some trades can trace their roots back more than 100 years. In part, this was due to difficulties in getting their training programs registered with BAT or SACS. Policies were not clarified and enforced to allow open shop contractors to register their programs until the 1970s and in some states during certain time periods, State Apprenticeship Councils (SACs) have continued to make the registration process difficult for the non-union sector in construction.

However, the non-union sector has made important strides in developing workforce training since the 1970s. Most of the largest firms in the non-union sector have staffed training departments that organize training functions according to the needs of the firm. In addition, certain contractor associations of open shop contractors, especially the Associated Buildings and Contractors (ABC) and the Associated Independent Electrical Contractors Association (AIECA) have taken steps to promote training and to organize a network of local apprenticeship programs. For example, ABC collaborated with a curriculum development Laboratory at Oklahoma State University to develop "Wheels of Learning" which is now

used in many secondary schools and community colleges. ABC's Construction Education Foundation collected funding to support a National Center on Construction Education and Research (NCCER), currently located at the University of Florida at Gainesville. Local programs have started across the country and the sector is reaching out to schools to develop a pipeline of students interested in working in the construction industry through various school-to-career arrangements. Even so, training in the union sector of the construction industry is generally more common and better organized than in the open shop sector today.

2.5 Demographics

The construction industry is the largest industry in the United States, but it is fragmented making it difficult to collect and disseminate information. When major problems arise in the construction industry, fragmentation makes it difficult to implement solutions industry-wide.

A literature review indicated that demographic changes are significantly affecting the workforce. Demographics of the construction workforce are discussed with regard to skilled craft worker shortages, age, race, gender, workforce skill levels, education, and literacy levels.

2.5.1 *Skilled Craft Worker Shortage*

Since the early 1980s, the construction industry has experienced shortages of skilled workers. In August 1996, construction unemployment rates fell to 8.8%, the lowest in seven years, while the national unemployment rate was near 5.1%, which was the lowest in 22 years (Krizan and Tulacz 1996). The Business Roundtable surveyed its member companies in 1996 and found that 60% of the respondents reported a shortage of workers. From this survey, one out of four companies surveyed had noted serious cost overruns or schedule delays due to shortages of workers. The craft worker shortage problem has not improved and predictions show that this problem will only continue to worsen (Judy and D'Amico 1997).

There are several reasons why this problem is plaguing the industry. First, the construction industry has a poor image that causes difficulties in attracting new workers. Young people about to join the workforce perceive construction work as dirty, non-professional, and non-technical (CII Source Document 77 1992). The 1996 *Wall Street Journal Job Almanac* polled young people to determine the careers they were interested in

pursuing. The poll revealed that a career as a construction worker ranked 248th out of 250 career choices. The unfavorable image of the construction worker and belief that there is no career path in the construction industry are large deterrents for young people deciding whether to enter the construction industry. Moreover, jobs in high tech manufacturing industries offer better working conditions, are less physically demanding, offer better pay, and have a much better image than jobs in the construction industry.

In addition to the construction industry's inability to attract new workers, the industry encounters problems maintaining its existing workforce. Workers continue to leave the construction workforce at a greater rate than those entering it. *Engineering News Record* reports that contractors have resorted to paying longevity bonuses, referral bonuses, and promising more hours to workers in various trades (Korman, Kohn, and Daniels 1997). Some contractors are directly partnering with unions in order to maintain enough skilled workers on job sites (Kearney 1997).

Reasons for leaving construction are myriad. The nature of the industry is such that continuous employment for workers is not assured. The length of employment for workers is unstable due to varying labor requirements, frequent terminations, adverse weather, and sporadic use of specialty work. Workers must often move to find new work, causing familial disruption. These factors, among many, motivate workers to leave the industry.

2.5.2 *Age, Race, and Gender*

Many changes are taking place in the American workforce. Overall, the workforce is aging, becoming more ethnically diverse, and proportionately more female. Although the workforce is diversifying with larger numbers of minorities and women working, the actual population growth rate is decreasing. The large increase in births after World War II caused the generation known as the baby boomers. After this increase in births, birth rates fell back to normal. Population growth in years after the baby boomers has since declined leaving fewer entrants into the workforce. In part, this gap has been filled by increases in immigration.

According to the United States Bureau of Labor Statistics, the average age of the labor force is increasing (U.S. Bureau of Labor Statistics 1993). Between 1993 and 2003, the labor force between the ages of 45 to 64 is expected to grow faster than any other age group as the baby boomer generation continues to age. Using Census information, Judy and

D'Amico have projected each age group's share of the total U.S. population from 1900 to 2030 (Judy and D'Amico 1997). (See Figure 2.3.) The 65 and older age group is expected to comprise slightly over 20% of the total population by 2030.

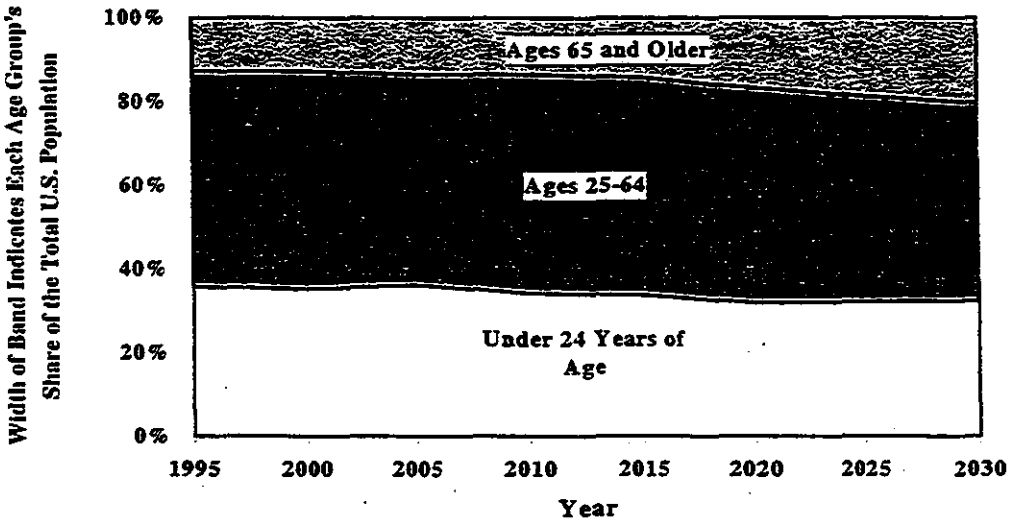

Figure 2.3 American Ages, 1900-2030
(Source: Center to Protect Workers' Rights, 1997)

The implications of the baby boomers' aging are important to the labor workforce and to the construction employers. As the baby boomers reach retirement age, social security benefits are expected to fall short. Many in the baby boomer generation will need to remain in the workforce in order to sustain their financial security. In addition, employers will need these workers to stay in the workforce because of the slowing population growth. Much construction work is demanding physically and requires frequent moving, which makes it especially difficult for many older Americans. Construction employers will have to find ways to keep qualified workers employed making use of their expertise and knowledge while taking their age into consideration. Currently, the average age of the construction workforce is significantly lower than that of other industries. (See Figure 2.4.)

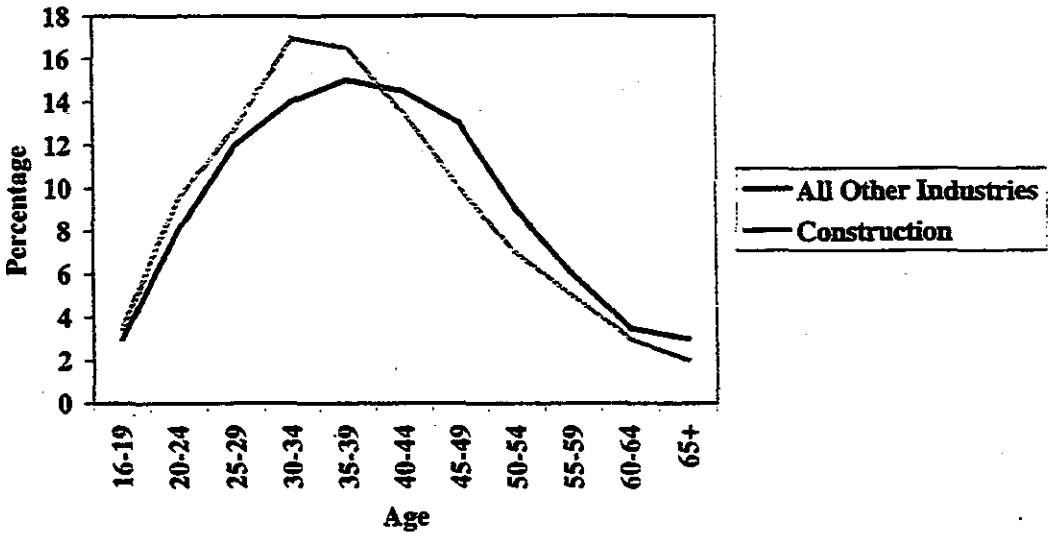

Figure 2.4 Age Distribution of Workers
(Source: the Bureau of Labor Statistics 1995)

The ethnic composition of the workforce has also been changing for the last few decades. The Institute for Workplace Learning expects the diversification to continue through 2020, when the birthrate among minorities should begin to plateau (Ballen, 1991). (See Figure 2.5 for a projection of the ethnic composition of the American workforce as it changes from 1995 to 2020.) Asians and Hispanics are projected to be the fastest growing groups in the workforce increasing by approximately 41% and 36%, respectively, by 2006 (Bureau of Labor Statistics, 1997). The African-American labor force is predicted to increase by 14%. By comparison, whites are expected to grow by only 9%.

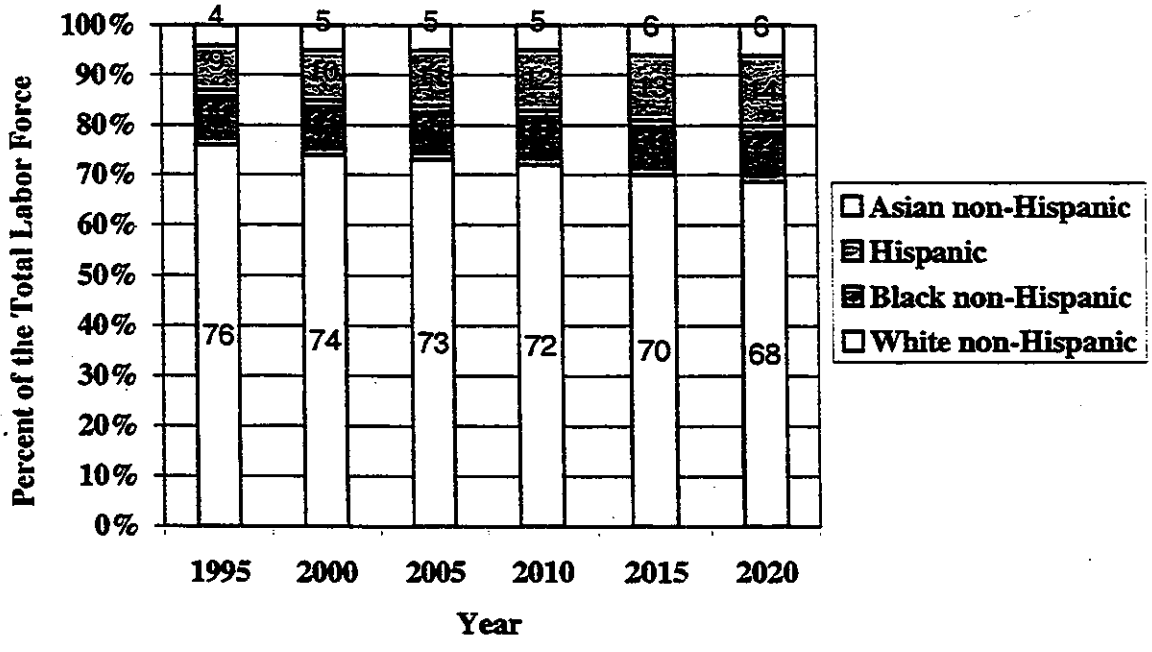

Figure 2.5 Projected Ethnic Composition of the U.S. Workforce, 1995-2020[1]

Although the workforce is diversifying to include more minorities, the proportions of minorities currently in the construction industry are surprisingly low. The construction industry has apparently made little progress in recruiting minorities to work in the industry. Racial minorities include Hispanics, African Americans, American Indians, Aleuts, Eskimos, Asians, and Pacific Islanders. They comprise only 11% of the construction industry workforce as of 1995 (The Center to Protect Workers' Rights 1997). (See Figure 2.6.)

[1] The original sources of information for this chart are from the Bureau of Labor Statistics projections to 2005 and the Hudson Institute projection 2010-2020 (Judy and D'Amico 1997).

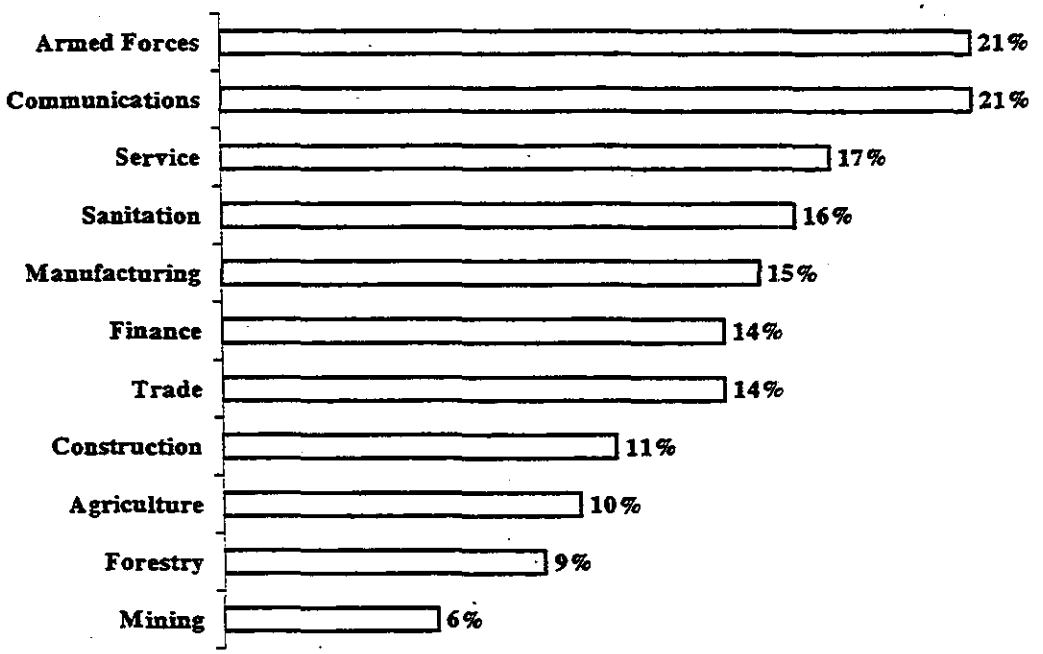

Figure 2.6 Percentage of Employees in Racial Minorities, by Industry, 1995
(Source: The Center to Protect Workers' Rights 1997[2])

An increase in gender diversity of the American workforce will continue (Judy and D'Amico 1997). In 1994, women comprised 46% of the workforce. By 2020, half of the workforce will be women. A four-percent increase may not seem significant, but this figure represents an estimated 12.5 million more women in the workforce by 2020. However, the participation of women in construction is low (See Figure 2.7). In 1995, the Bureau of Labor Statistics reported that only 10% of the construction workforce are women, and most are concentrated in clerical, administrative support, or managerial positions. Eighty-two percent of women in construction work in these job titles, thus very few women work in the trades (See Figure 2.8). With more women in the workforce, flextime, day care, and various other programs will become issues of greater importance. In other industries, these programs are already successfully in use. The construction industry will have to adapt to the increase of women in its workforce.

[2] The original source of information for this chart is from the Bureau of Labor Statistics, *1996 Current Population Survey Earnings File.*

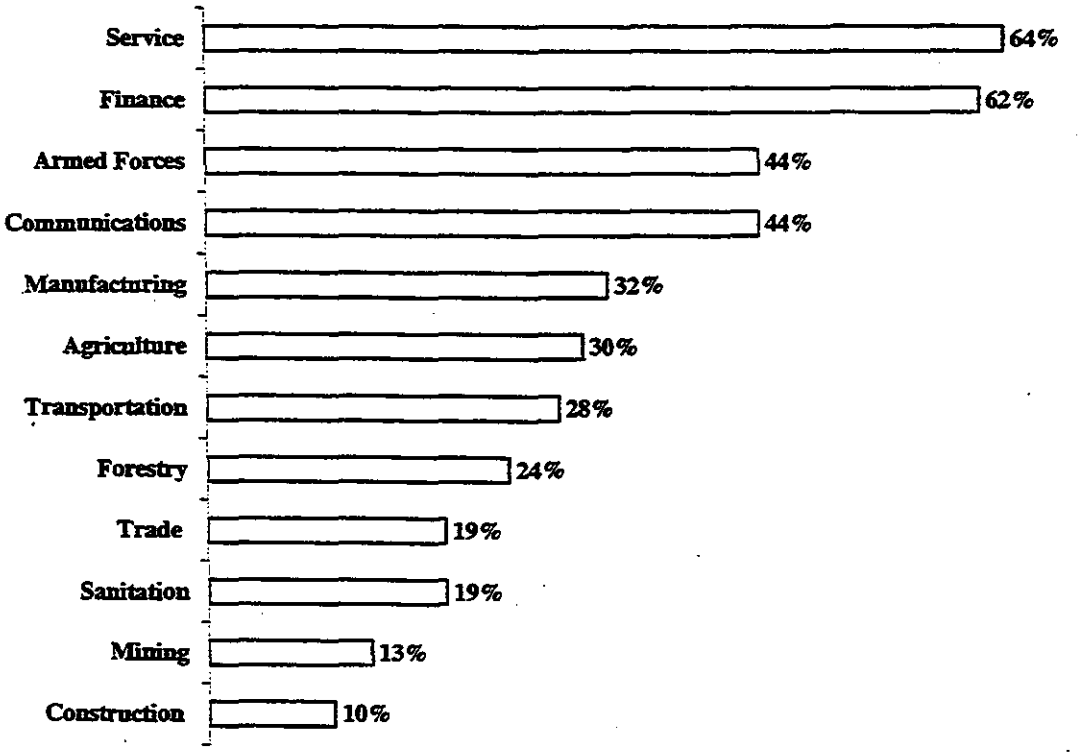

Figure 2.7 Percentage of Female Employees, by Industry, 1995
(Sources: The Center to Protect Workers' Rights 1997)

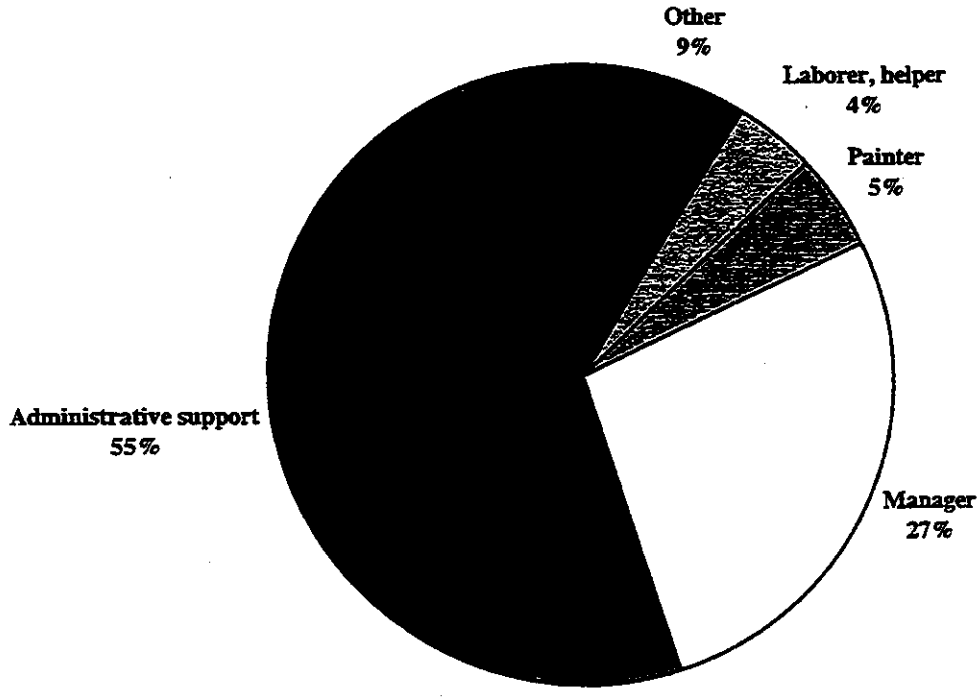

Figure 2.8 1995 Distribution of Female Construction Workers among Occupations
(Source: The Center to Protect Workers' Rights 1997)

2.5.3 *Workforce Skill Levels, Education, and Literacy Levels*

Another important aspect of the demographics of the workforce is the education level of workers. The general education level of the construction workforce is critical for several key reasons. Reading, interpretation, and problem solving skills are involved at all levels of construction. Workers must be able to read and understand construction drawings from which they work. Design professionals who construct these documents may expect literacy levels higher than what may be actually observed.

According to the 1992 National Adult Literacy Survey performed by the National Center for Education Statistics, an estimated 40 million Americans over the age of 16 had only rudimentary reading and writing skills. This figure accounted for approximately 21 % of the adult population in 1992. A study conducted in Birmingham, Alabama found that the

local construction workforce's literacy levels were not significantly different from the national population's levels and were, in some respects, slightly higher than average (Crowley, et al., 1997). Yet, given the low reported literacy levels on the national population, this fact is not consoling.

2.6 Inflation-Adjusted Wage Trends

Construction wages have not maintained pace with wages in other industries over the last 20 years. (See Figure 2.9.) According to the Bureau of Labor Statistics, the average annual wage of a construction worker increased only 3.8% per year, as compared with an average annual raise of 4.3% in other industries. These wage trends have adversely affected the industry's ability to attract and hold qualified workers.

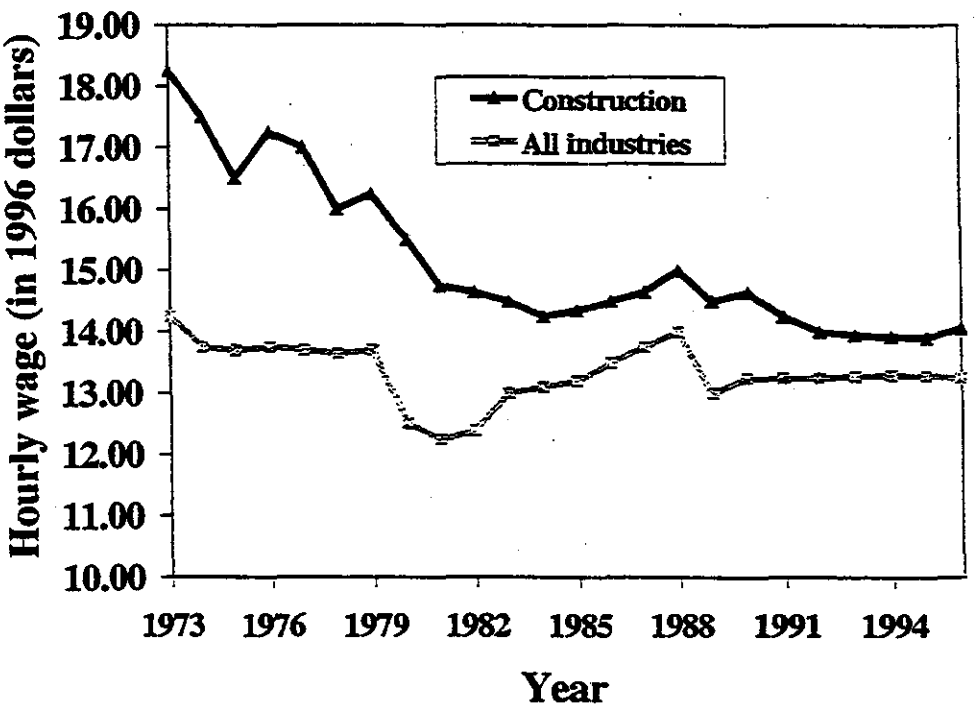

Figure 2.9 Inflation Adjusted Wages
(Source: Hirsch & MacPerson , 1995)

CHAPTER 3: CRITICAL ISSUES

A literature review was conducted to provide the research team with the necessary background to understand the needs and characteristics of the construction industry in the United States. It was based on a combination of various resources: (a) academic documents resulting from previous research efforts, (b) available statistics, (c) articles from specialized engineering magazines, and (d) data obtained from several industry organizations including the Construction Industry Institute, the Center to Protect Workers' Rights, and The Business Roundtable. This literature review included a profile of the American construction workforce, its composition and characteristics, and issues on human resources management and new labor strategies, specifically multiskilling. Our Construction Workforce Thrust Area Advisory Panel identified the issues in the following sections to be of the highest priority.

3.1 Attracting and Retaining a Skilled Workforce

CII Research Team 135 (RT 135) analyzed the steps that the construction industry should undertake to assure a well-trained, diverse workforce. This research attempted to understand the causes and consequences of the industry's image problem, contractor's concerns about high craft turnover rates, and craftworkers' low wages and fringe benefits. It was also motivated by the prediction of shortages of construction workers by the U.S. Department of Labor.

Several CII members participated in this research effort. More than 1000 craft workers were surveyed. The gathered data allowed the research team to identify why craft workers leave the industry and what can be done to retain them. The study found that responses differed greatly between unionized and non-unionized workers. Unionized workers are concerned about permanent jobs and safety, while non-unionized workers' primary concerns are pay and job security. Some reasons for these differences were identified and are as follows:

- Open shop workers lack collective bargaining power,
- Union workers have relatively good pay and benefits, and

- The age of the worker affects their concerns; Younger workers, many of whom are not unionized, are concerned with pay, while older workers are concerned with permanent jobs, benefits and salary.

RT 135 found that the inability of owners and contractors to address attraction and retention issues of mutual concern would ultimately result in higher project costs and longer project schedules (CII Conference 1998). This research team made several recommendations for owners and contractors to ensure qualified craftworkers, including the following:

- Make the industry attractive to potential future workers,
- Make workers aware of the industry's challenges,
- Improve work environments,
- Provide career paths for workers,
- Initiate continuous training and certification programs,
- Pay competitive wages,
- Develop an employee retention program, and
- Improve screening of applicants.

This study concluded that the implementation of these practices could reduce turnover rates, thus increasing the probability of a project's success.

3.2 The Return on Investment on Training to Construction Firms

Evaluation of return on investment (ROI) can enhance the understanding of human capital as a significant factor of productivity growth and as a critical variable in the process of technological change. It provides critical information to improve the transfer of knowledge and skills from classroom to work. Furthermore, it identifies potential cost-savings through greater accountability and efficiency in training.

The Business Roundtable recommended training as the most important mechanism to assure the successful performance of the industry and to confront the skilled workforce shortage (The Business Roundtable 1997). However, owners and contractors hesitate to invest in training since its benefits are difficult to measure. The unique characteristics of construction exacerbate the difficulties of measuring ROI to training efficiently. There are a variety of participants working on a project from start to finish, the jobs are of short duration,

and job instability is increased by technological and financial forces. Also, work is generally performed outdoors, subject to many uncontrollable variables that may bias the ROI evaluation. The most important obstacle to evaluating the results of training is that employees are attached to their crafts and not to their employers, who pay for the training and are interested in measuring the ROI to their firms rather than to the industry as a whole.

The literature review of ROI and the analysis of the construction workforce resulted in two key questions:

- Can the ROI for training be accurately assessed effectively and efficiently? If so, how?
- How does it affect business, labor, and government policy?

3.3 Special Incentives to Attract and Return Skilled Workers

In late 1996, The Business Roundtable studied workforce shortages and offered suggestions to combat the problem in the future. Most construction companies reported that the shortage of craft workers was due to the limited supply of qualified candidates rather than an increased demand for them. Many companies have initiated incentives to attract skilled workers. The most popular incentives used were providing opportunities for overtime (which 36% of companies utilized), special recruiting (32%), special wage rates (14%), completion bonuses (12%), signing bonuses (4%) and other types of monetary compensation (2%). To date, the effectiveness of these incentives has not been measured.

Some companies have created additional incentives to improve retention of skilled craftworkers. These incentives address many of its workers' concerns such as mobility, career path, training, employment stability, image, childcare, and hardship. More innovations are emerging, although their potential has not been measured. Their efficacy is supported by the companies' experiences rather than by formal evaluations of results.

3.4 Multiskilling

New labor strategies have been suggested to overcome labor shortages and make a more efficient use of craftworker resources. One strategy whose benefits are being realized is multiskilling. Multiskilled workers are proficient in a range of skills that allows them to participate in work in different specialized areas. A worker may be highly skilled in one

area, but the knowledge that is possessed in other areas increases the number of tasks in which that worker may participate. Multiskilling decreases the number of workers required within a project, thus reducing the impact of labor shortages. Additional potential benefits can be realized for the construction industry (CII 1998).

Multiskilling practices currently in use benefit projects in a variety of ways. (Stanley 1997) Multiskilling better utilizes existing workers and provides significant benefits to workers. Furthermore, research has produced an implementation guideline for multiskilling strategies based on past implementation strategies in the construction and manufacturing industries. (Villalobos 1997) This guideline is successful only with the support of top management and workers and requires the development of recruiting, training and compensation policies in order to assure adequate implementation. CII Research Team 137, under the guidance of Dr. Carl T. Haas at The University of Texas at Austin, investigated the extent to which multiskilling has been used in the construction industry and the applicability and potential of this labor strategy. The study, co-sponsored by CII and NCCER, has produced several reports including "An Analysis of Multi-skilled Labor Strategies in Construction" (Burleson 1997), "Benefits, Impediments and Limitations Associated with the Use of Multiskilled Labor Strategies in Construction" (Stanley 1997) and "Implementation of Multiskilling in the Construction Industry (Villalobos 1997).

Burleson utilized the CII Model Plant to investigate three multiskilling labor strategies. The CII Model Plant is a simulated petrochemical facility which CII fabricated shop drawings, schedules, and resource loading. The three multiskilling labor strategies used in Burleson's research are dual skill, four trades, and theoretical maximum. The following provides a description of the three strategies:

- Dual skilled: workers possess two skills which are utilized in a project's critical path,
- Four trades: workers are categorized in one of these trades, electrical, mechanical, civil, or general, and
- Theoretical maximum: super-workers possess skills in all trades.

The schedule for the CII model plant was developed on Primavera Project Planner. Resources for each of the strategies were loaded and led to the conclusions summarized in Table 3.1.

RT 137 recommended that future research efforts should establish how multiskilling could lead to improved productivity and improved annual income, along with the craftworkers' reaction to these changes. Additionally, it suggested that a cost model for training should be developed, as well as implementation tools. Subsequent research on these topics is described in sections 4.2 and 4.3 of this report.

Table 3.1. Benefits of Various Approaches to Multiskilling
(Source: Burleson, 1997)

Strategy	Reduction in Required Work Force	Increase in Average Employment Duration
Baseline	0%	0%
Dual skill	18%	18%
Four Trades	35%	47%
Theoretical Maximum	46%	77%

3.5 Impact of Technology

Considerable research has been conducted on the impact of technology on the workforce. Most of it has been of a general nature and focused on resulting requirements in the K through 12, college, and vocational education systems. However, some researchers have focused on the impacts technology has on specific industries. Hunter and Lafkas at Wharton have studied the impact of information technology on work practices and wages in the financial industry (Hunter and Lafkas, 1998.) Kathy Shaw and her colleagues at CMU, have focused on the steel industry. Yet, no one has focused on the impact of technology on the construction industry's workforce.

Computers are ubiquitous and have had profound impacts on office and field work. Those who trained for a career in type setting and printing are out of work and training for new jobs. Computer graphics made much of the training of commercial artists obsolete in

the early 1980's. Computer aided drafting and design is estimated to have eliminated 90% of the draftsmen positions in construction in the 1980's.

Technology eliminates, creates, and changes jobs. Of those jobs that it changes, it can have an up-skilling or de-skilling effect, or a combination of these two effects. For example, resolved motion control for construction equipment can reduce a skill requiring unusual manual dexterity to one easily acquired by almost anyone. In contrast, new software for project controls may require more skill and certainly additional training. Computers are profoundly changing work such as automated welding which requires cognitive rather than dexterous skills. In all these cases, the skill changes and requirements imposed by technology impact the nature and distribution of jobs in the industry, career paths, and training requirements for the industry.

3.6 Impact of Demographics

The changing demographics in the US will impact all industries, including the construction industry. Two books published by the Hudson Institute, *Workforce 2000* and *Workforce 2020*, have predicted future trends in work and the workforce. Further research indicated that the construction industry recognized that changes needed to be made with respect to the construction workforce. In 1992, the Construction Industry Institute had formally documented these workforce issues into *Characteristics of the Construction Craft Work Force* (Gehrig, Slobojan, Waldo, and Gehrig, 1992).

Diversification greatly impacts the workforce by affecting education levels, literacy rates, and necessary job skill levels. Our literature review revealed that the workforce is diversifying in several key ways: the average age of Americans is increasing, more women are being included, and more minorities are entering the workforce. As the average age of American workers continues to increase, retirement may be out of reach for many whose savings accounts and benefits fall short of their needs (Judy and D'Amico 1997). These older Americans will be unable to perform tedious and physically demanding work such as construction, but their need to continue working will force them to find alternative jobs. In addition, construction is a male-dominated industry. With more women in the workforce the construction industry at present will alter significantly. Finally, the U.S. population is

becoming more ethnically diverse. A rise in Hispanic and Asian populations will change the work force, and immigration laws will help determine how quickly the workforce diversifies.

3.7 Measuring and Understanding Productivity

Labor productivity is of central importance to the health of the United States' economy. Due to the large size of the construction industry, productivity changes within it directly and significantly affect the national productivity and economic well being of the U.S. In 1997, new-construction-put-in-place accounted for roughly 7% of the GDP, and if one includes remodeling and repair work the total rises to over 10% of GDP (Barry 1998). Construction productivity has exercised tremendous indirect influence on American society, as well. For example, productivity increases in residential construction due to the advent of tract housing made home ownership a viable option for millions of Americans previously locked out of the market. This led to the development of the suburb and forever altered the landscape of American culture and society (Lasby 1996). Because of these reasons, concern over productivity in the construction industry has been expressed.

Construction labor productivity remains one of the least understood factors in the American economy. The U.S. Bureau of Labor Statistics maintains productivity indices for all significant sectors of the economy except construction. The BLS contends this is due to a lack of "suitable data" (Jablonski 1998). This information vacuum has fostered the formulation of several perceptions concerning construction labor productivity.

Attitudes towards the subject vary widely among engineers, industry officials, and economists. Many question the existence of any construction productivity decline (Eisner 1994, Griliches 1988), while others speculate as to the causes. Most engineering academics believe that construction labor productivity has decreased over the past thirty years. Perceptions of those in construction are harder to judge, though at least a few industry leaders have stated that productivity has increased in the last 15 years. Economists are somewhat split. Clearly there is a lack of agreement and understanding concerning this critical issue. Identifying the major productivity trends in construction and understanding their causes would be of great benefit to the industry and to policy makers. Work toward this goal is described in Section 4.5 of this report.

3.8 Skills Testing and Certification

Skills testing and certification for the construction trades are dynamic and developing. At present there are no nationwide or industry-wide standards for skills testing in all of the construction trades, but proficiency exams are being developed in several areas. The four main origins of skills testing and proficiency exams are occupational licensing, the National Skills Standard Board in Washington D.C., the National Center for Construction and Engineering Research (NCCER) certification program, and other independent industry initiatives.

Typically, licensing is established in occupations in which there are perceived public safety issues. Examples include boilermakers and asbestos removal workers. Occupational licensing can occur at the local, state, or national level. Passing a proficiency exam is generally part of the requirements to obtain a license. These examinations may include a hands-on, or performance, test in addition to a pen-and-paper exam. For example, the examinations for both jouneyman-level and masters-level plumbers in Texas require applicants to pass a performance test in which they are required to plumb a model building and perform selected fabrication tasks according to standards.

A second origin of proficiency exams and skills testing is the various initiatives that have spawned through the National Skills Standard Board (NSSB) and related activities. The establishment of the NSSB was preceded by 22 pilot projects with various coalitions of industry groups and educational organizations funded by the U.S. Department of Education and the U.S. Department of Labor. Three of these pioneer projects dealt with aspects of construction work: (1) heating, ventilating, and air conditioning (HVAC), (2) electrical work, and (3) certain specialty work conducted by construction laborers, including concrete work, lead abatement, and open cut pipe laying. In 1997, the NSSB contracted with the Center to Protect Workers Rights to convene a national voluntary industry coalition for construction skills. The first meeting of this Construction Skills Coalition was held in June 1998 in Washington, D.C. and attracted wide participation from industry representatives. In addition to activity on skill standards at the national level, a few states - including Illinois, California, and Texas - have funded industry efforts to produce skill standards. Some of these state grants have focussed on skills related to construction.

Thirdly, the NCCER is working in conjunction with various partner associations to create a craft training program. The craft training program that the NCCER has developed provides competency based, task driven, modular training. A combination of craft training manuals, multimedia CD-ROMs, and structured classroom activities conducted by instructors makes up the training program.

Lastly, other independent industry initiatives are trying to create a standard for skills testing. Some of these tests and certifications have been developed by vendors, especially vendors of dangerous equipment where worker safety is of paramount concern. Examples of this can be found in the power nail gun industry. Likewise, safety concerns motivated the Mason Contractors for "Rough Terrain Fork Lift Safety and Maintenance."[3] In other cases, the primary motivation is to promote the development of a skilled workforce which can install quality work safely, thereby enhancing the market for the product or material. An example of this type is the American Concrete Institute (ACI), which created its own certification and testing process. Concrete finishers who desire certification from ACI must pass a pen and paper exam as well as a hands-on performance test that is evaluated by trained and certified judges. Specialty endorsements are also available for concrete finishers of "super flat" flooring needed in computer-controlled robotic warehouses.

[3] See Mason Contractors Association of America. 1992. "Rough Terrain Fork Lift Safety and Maintenance Training Manual." Oak Brooke, Illinois: Mason Contractors Association of America.

CHAPTER 4: CURRENT RESEARCH

4.1 Introduction

Initial topics for research, which addressed the critical issues discussed in Chapter 3, were suggested by the Workforce Advisory Panel and the research team. Because a few high priority issues were already receiving significant attention by CII research teams, the Workforce Group has focused on the remainder to the extent that its resources allowed. In a series of meetings with the Workforce Advisory Panel, the Sloan Construction Center's Board of Advisors, Sloan Foundation representatives, and a working group from a CII Board of Advisors, the issues were prioritized. The following topics were found to warrant research: implementing a multiskilled workforce, workforce experiences with multiskilling, measuring return on investment in training and education, construction labor productivity, and impact of technology on the workforce. Studies investigating contracts approaches to implementing a multiskilled workforce, workforce experiences with multiskilling, and the measurement of return on investment in training and education were recently completed while topics currently being studied include construction labor productivity, the impact of technology on the workforce, and metrics-based high performance work teams in construction.

4.2 Workforce Experiences with Multiskilling

One partial solution to problems of recruiting and retaining a skilled workforce is to implement a strategy of skills enhancement and diversification. This strategy seeks to utilize the current workforce more effectively, thereby improving career opportunities for construction workers while reducing the numbers of skilled workers needed. Skills enhancement and diversification has demonstrated benefits to owner organizations, project managers, and workers (Stanley 1997). Research indicates that the use of a skill-enhanced workforce can decrease project labor costs, decrease overall project cost, and increase productivity (Burleson 1997). Management can assign multiskilled workers to tasks more freely. This ease of assignment helps to reduce idle time on projects. In turn, workers conduct challenging and varied work and enjoy increased employment duration, increased

job security, increased earning potential, and improved site safety. Skills enhancement and diversification decreases the number of new workers needed in the construction process which reduces accident rates and the risk of injury to workers. Accidents are less likely to occur because workers are experienced and familiar with the site and project.

An understanding of construction workers' attitudes and experiences can help better determine the potential of new labor utilization strategies and help to implement those strategies more effectively. The primary objectives of this study were as follows:

1. Investigate craft workers' reactions to and experiences with skills enhancement, skills diversification, and multiskilling in various forms,
2. Investigate demographic trends and their impact upon the implementation of skills enhancement and diversification.

The scope of this project was limited to the U.S. construction industry's workforce. Both union and non-union sectors of the industry are included. The study was performed using contacts provided by the Sloan Center's Workforce Research Team members, the Construction Industry Institute, and by a Multiskilling User Focus Group set up under the auspices of a related research project.

The research effort began with a literature search of related topics. The study included construction workforce demographics, literacy and education level of craft workers, formulation of research surveys, and implications of technology on construction and workers. Articles, theses, and dissertations relating to skills enhancement and diversification have also been examined.

Next, interviews with craft workers were performed on a construction job site located in Austin, Texas. These interviews investigated craft workers' reactions to and experiences with skills enhancement, skills diversification, and multiskilling in various forms. It also examined the reaction of various demographic groups of workers to the implementation of skills enhancement and diversification. The interviews were performed over a length of several weeks. Through the interviewing process, it was possible for the researcher to observe the workers and determine their attitudes towards training and acquiring new skills. After completing 15 interviews, a survey was formulated using the responses received in the interviews to develop survey questions.

To ensure quality, the survey was beta-tested on three construction job sites in Austin, Texas. Pilot survey data were then analyzed and interpreted with respect to the project objectives. After testing at the first site, numerous changes to the survey were made to clarify the wording of the questions and to ensure that workers were answering the questions that were desired. The surveys distributed at the second and third beta testing sites were identical so that an analysis over more than one site would be possible.

Procedures for distributing and collecting the final version of the surveys were intentionally varied. Surveys were distributed differently at each site to determine how distribution would affect the response rate of the survey. The most effective method of distribution was to pass out and pick up the surveys during lunch. This allowed workers to answer the survey without disrupting the project. Response rates differed by over 52% by picking up the surveys the same day they were distributed instead of allowing workers to take the survey home and return it the following day.

The final survey generated over 1,000 responses and is documented in CCIS Report No. 4. Among the conclusions generated, highlights include:

1. **Workers have been working outside of their primary trade:** Approximately 70% of the survey's respondents have worked in trades other than their primary trade while 25% have not worked outside of their primary trade.
2. **Workers would rather learn about many skills than specialize:** Over 68.5% of workers surveyed would like to learn about many skills and 28.5% prefer to specialize.
3. **Multiskilling, within trades and between trades, is a viable option for the construction industry from the standpoint of open shop labor.** It would also be beneficial to union labor, yet considerable changes in the structure of building trades unions would be necessary to take advantage of multiskilling.
4. **Multiskilling generally allows workers to work more weeks per year and to obtain better wages.** (See Figure 4.1)

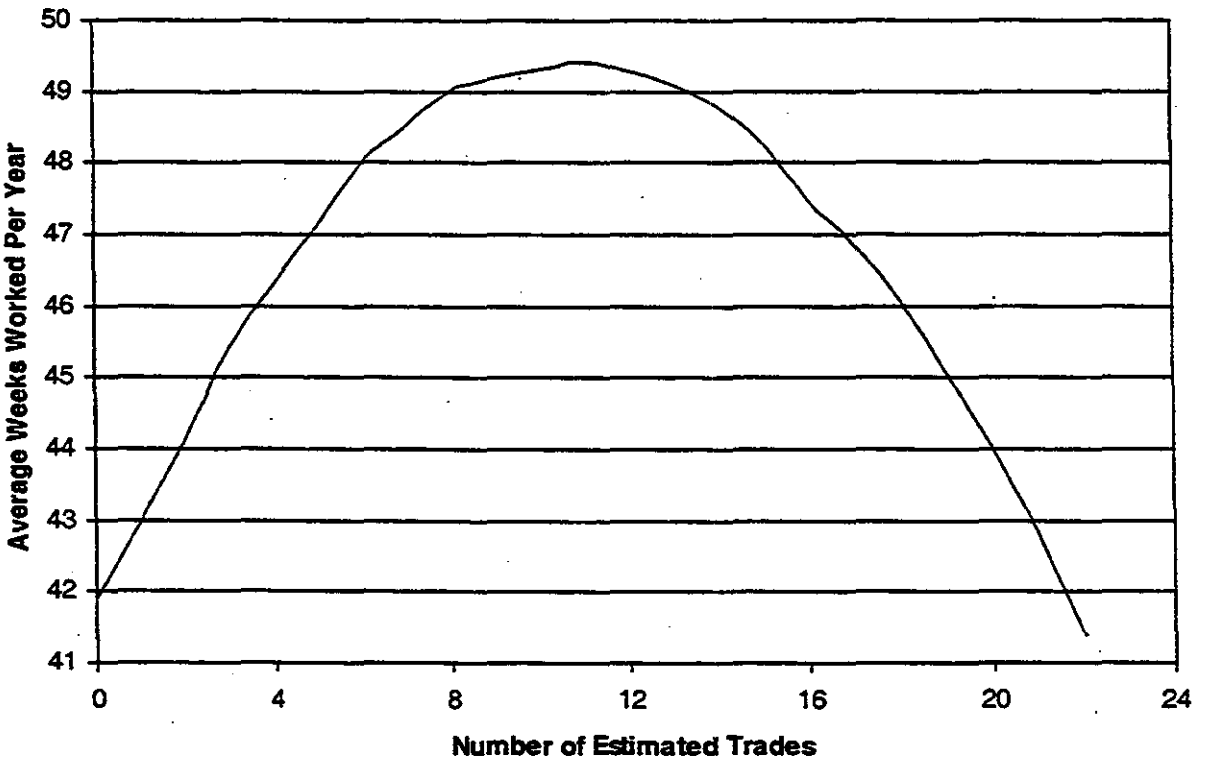

Figure 4.1 Individuals' Breadth of Secondary Skills in Different Trades vs Average Number of Weeks Worked Per Year[4]

Our analysis initially determined basic average responses, means, standard deviations, and key relationships. Ongoing analysis objectives include the following:

1. Separate the carpenters' data from the rest of the sample, and further analyze both groups.
2. Separate the Texas data from the rest of the sample, then analyze both groups.
3. Separate the union and non-union groups, then analyze both groups.
4. Statistically relate the questions of "Are you planning to leave the industry?" to workers' skill levels.
5. Develop a predictive model of craft workers' interest level in learning additional skills and training through the use of demographic factors.
6. Identify the frequency of skill combinations.

[4]Data from the Carpenters Union were excluded from this analysis because its large group of homogeneous respondees distorted the results. Union respondees were being trained as instructors and were thus highly paid and experienced compared to the average worker.

4.3 Implementing a Multiskilled Workforce

In a multiskilled environment, workers are proficient in more than one skill, are able to participate in different tasks, and are able to complete a given activity without the need of changing crews. CII Research Team 137 (CII, 1998) reported that many companies regard multiskilling as a tool to increase productivity, mainly because its implementation allows a reduction of idle time. Idle time is reduced because the time required for the transition of crews is avoided and because crews may solve problems more quickly due to the many skills they possess.

Another outcome of multiskilling is increased worker motivation. Multiskilling allows workers to participate in a broad variety of tasks, thereby avoiding repetitive, boring jobs. Borcherding found that performing a productive job is a large motivator for a construction worker while a nonproductive job creates dissatisfaction (Borcherding, 1974). Since multiskilling assures continuity of job and reduction of idle and nonproductive time, workers can be more motivated. Also, through the use of multiskilling, workers may stay longer in a project because they are able to perform tasks within different phases of the work. This permanency gives them a feeling of belonging to the project and being a more fully active part of the building process motivates them.

Although the implementation of multiskilling offers real potential to generate savings and benefits for project performance and increased worker motivation, two main issues must be overcome to obtain these advantages. First, multiskilling avoids craft jurisdiction by assigning tasks to workers according to their abilities and the project's needs, not according to their affiliation or identification with a specific craft. This may cause some unions to resist the implementation of certain forms of multiskilling. Nevertheless, agreements with labor unions have been established to broaden the working area of their members. An in-depth study of the special characteristics of construction unions and construction contractors should be conducted before suggesting an appropriate mechanism for gaining the unions' support for multiskilling in order to facilitate the utilization of multiskilling in all areas of the construction industry. Second, multiskilling requires changes in the traditional company structures and management systems. To obtain the maximum benefit from their performance, a multiskilled workforce needs to be planned and managed with the aid of a staffing department which sets training and wage policies, establishes mechanisms to learn about the

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workers' skills and background, and maintains an information system of all elements required to develop the multiskilled workers and to appropriately plan their work schedules.

Although the allocation of individual workers is not normally considered in conventional methods of project scheduling activities, the multi-skilled workforce needs to be scheduled and organized to maximize the average on-site duration of workers, reduce the labor requirements and include the skills' combination required by the project. Craft composition must be considered according to the sequence of tasks to be performed because multiskilled workers assigned to simple tasks may increase required labor costs.

Currently, multiskilled workforce composition is not considered during a project's long-term scheduling process. Instead, the allocation of workers is made on the basis of short-term plans (Stanley 1997). Previous research found no formal methodology available for planning a project using multiskilled workforce; however, CII RT 137 identified several implementation tools that need to be developed to assure that multiskilling may be utilized by many contractors. Research on mechanisms to plan and schedule a multiskilled workforce was initiated to suggest a scheduling methodology for a multiskilled project by examining current practices. From a literature review, we identified 10 companies in the US that have accumulated considerable experience managing a multiskilled workforce. These contacts are the mechanisms through which information on current practices was gathered.

Information was obtained through office visits and telephone interviews with selected contractors in order to gather data on implemented scheduling techniques, examples of multi-skilled projects' schedules, existence of supportive databases, and documentation of training and employee development, employee compensation, and project execution strategies (CII, 1998). Interviews focused on management methods for multi-skilled projects including actual practices for planning and scheduling and the specific information requirements for implementation. Their current practices were documented, and common procedures were identified after analyzing these practices. These practices were found to have been developed over time though trial and error. Additionally, the documented practices on planning and scheduling a multiskilled workforce were based on the experience of successful construction firms; however, our research did not directly evaluate the net benefits of these practices or suggest improvements to them.

Investigation of current practices used at the surveyed companies supported Stanley's finding that multiskilled workforce composition is not considered during the long-term scheduling process. Instead, the allocation of workers is analyzed during the short-term planning (Stanley, 1997). Some companies consider multiskilling during the planning phase of a project by combining activities that involve similar crafts and assigning a complete work unit to a single crew without considering craft boundaries, since the workers are multiskilled. However, the exact composition of the workforce is not considered. Managers have recommended that computer software should be developed to assist with the development of crew composition and project staffing. This software would formulate the optimum allocation of workers according to specific objectives such as minimization of transfers, reduction of labor costs, maximization of workers' time on a project, and reduction of workforce size.

Although planners attempt to increase the effectiveness of multiskilling by combining similar tasks, the advantages of multiskilling are, in practice, assured by the foremen's ability to assign tasks to the proper workers. The success of multiskilling greatly relies on the foreman's personal knowledge and ability to assign workers to appropriate tasks and compose crews effectively. The foreman assigns tasks to workers according to what he or she knows about them and their capabilities as well as his or her own experience on former projects.

A formal methodology or process for scheduling a multiskilled workforce was developed considering an efficient allocation of resources to assure that project performance is improved through the use of multiskilling (See Figure 4.1). It was developed by identifying several objectives considered during the scheduling process, using these objectives as a means for evaluating the scheduling methodology, and using the objectives to analyze the advantages of the suggested methodology. The scheduling methodology should be used as an implementation guideline and as a basis for future research efforts on multiskilled workforce optimization. It is defined in greater detail in CCIS Report No. 5.

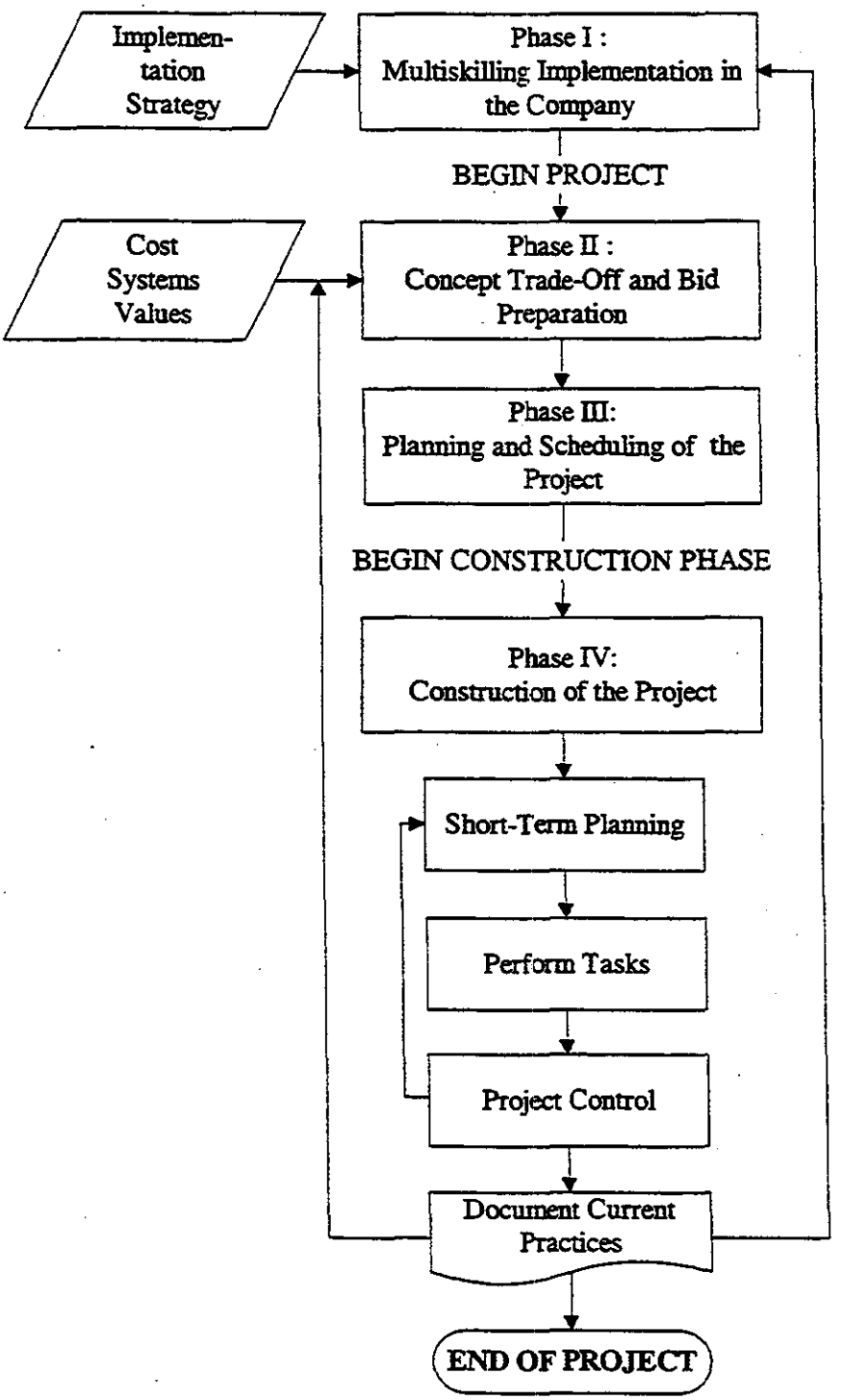

Figure 4.1 Suggested Planning and Scheduling Methodology for a Multiskilled Workforce

4.4 Measuring Return on Investment in Training and Education

The need for more effective and comprehensive training has long been a concern in the construction industry. In the early 1980s, the Construction Industry Cost Effectiveness program of the Business Roundtable produced a series of research reports which recognized the importance of training for the long-term vitality of the industry (Business Roundtable 1983). More recently, the Business Roundtable, along with a growing number of industry experts, has amplified the seriousness of this need and specifically recommended the development of ROI evaluation as a crucial driver of the continuous improvement of training (Business Roundtable 1997; Liska 1994; Krizan 1997; Korman 1997a, 1997b).

In 1997, the Business Roundtable published a challenge to owners, contractors, contractor associations, and labor organizations, stating that they "must work jointly to develop methods to evaluate training delivery and its impact." This is seen as an essential element of a larger comprehensive effort to build a training system that can address the critical needs of attraction, retention and maintenance of a skilled construction workforce. The Sloan Center Construction Workforce Research Thrust has conducted a review of using ROI analysis to measure the effectiveness of training and education in construction

Over the last two decades, a broad consensus of interests has been forged on the vital importance of improving education and training for addressing economic problems of stagnant productivity, inefficient allocation of resources, inadequate development and utilization of human capital, and related social problems of families, schools, and communities. The present economic landscape is dominated by three major forces: 1) the "internationalization" of the economy in which it is more difficult to set prices, outputs, wages, and working conditions according to domestic standards; 2) the "third industrial revolution" generated by microelectronics and information technologies; and 3) rising customer expectations of quality and intensifying demand volatility (Marshall 1994). In response to these forces, skill requirements are rising and overall investment in training is increasing. However, most experts consider much more is needed and that it must spread beyond the managerial and professional ranks where it is now concentrated (USDOL 1996; EQW 1994). Furthermore, training must be made more effective and responsive to industry needs by embedding into it a system of rigorous evaluation.

The increasing demands for a highly skilled workforce have arisen at a time when the construction industry faces serious problems in recruitment and retention. The decline of young people entering the industry, combined with the average age of 47 for journeymen, places the industry in serious need of attracting talent. According to the National Center for Construction Education and Research (NCCER), the construction industry is short approximately 240,000 workers per year, with that number continuing to increase. The industry also tends to lose personnel as they exit the industry upon reaching the age of 30, which greatly diminishes the returns from training investments. The Business Roundtable, and many other industry policy groups, research centers and experts, have called attention to training as a major strategy for responding to the needs of the construction workforce.

Conceptually, the application of ROI analysis to training is a logical extension of human capital theory in labor economics, pioneered by Theodore Schultz and Gary Becker, which posits that upward-sloping wage profiles reflect investments in human capital. Human capital theory holds that education and training inputs (human capital) are directly related to worker productivity and thereby wages (return on investment). Jacob Mincer extended the model to include On-the-Job Training (OJT). Understanding the returns to investment in human capital can provide insight into the comparative quality and effectiveness of different training programs.

Evaluation can also contribute to greater results from training by making training more accountable, yielding at the same time enormous potential cost savings. Benchmarking information has become a critical planning tool in all areas of business, including training. The international ISO 9000 standards dictate specific requirements for documenting corporate training. This is reinforced by similar requirements in the Malcolm Baldrige National Quality Award.

This research aims to contribute to the construction industry's planning and operational capacity to meet crucial existing and future workforce needs in attracting, retaining, and training and maintaining a qualified workforce. We focused on developing an understanding of the cost-effective application of ROI analysis to training programs in the construction industry as a means for their continuous improvement.

Researchers have found that training is best evaluated in the larger context of a firm's entire set of managerial and production strategies, functions and practices. Business returns

to training are optimized when this entire set forms a coherent "organizational logic" supportive of training. Furthermore, three conditions must exist before human resource practices can improve economic performance: (1) employees must have the skills and knowledge that managers lack; (2) they must be given the motivation to apply them; and (3) the production system must channel their efforts towards performance improvements (MacDuffie 1994; Ichniowski 1996; DOL 1993; Ernst & Young 1995).)

The task of conducting rigorous and reliable ROI evaluation of training often exceeds the resources and expertise of most individual construction owners and contractors. Cost-effective ROI evaluation of training must overcome the following obstacles:

- Attribution of effects to training is very difficult due to the influence on firm performance by a complex myriad of other factors. Too many variables enter into profit determination to single out the impact of any incremental training expenditure. Most ROI figures are not precise, although they tend to be as accurate as other estimates that organizations routinely make.
- Evaluation is complicated by serious data collection and measurement problems.
- Costs of training are generally known up front, before training, but benefits may accrue slowly over time.
- Objectives of training proposals are often murky and the rate of return cannot be measured if the meaning of return cannot be defined in quantifiable terms.
- Cultural resistance is perhaps the main reason ROI is not measured for training. Managers tend to view ROI studies merely as promotion and marketing efforts by the training department. Moreover, the "best practice" companies in terms of training are often the most resistant to measure ROI, preferring to accept the value of training as an article of faith.
- The costs of evaluation are also a major barrier, perceived as exceeding the benefits from training, as well as those that might develop from learning ROI.
- Informal training and learning-by-doing, which are important sources of learning, are embedded in production and therefore very difficult to measure.

Despite these obstacles, considerable progress has been made in training measurement and evaluation, reflective of its growing importance. Table 1 shows a "paradigm shift" in training evaluation, depicted by Phillips (1997) as a shift from "training for activity" to "training for results."

Table 4.1. Paradigm Shift in Training Evaluation
(Source: Phillips (1997), pp. 5)

Training for Activity	Training for Results
Characterized by:	**Characterized by:**
• No assessment of performance	• Assessment of performance effectiveness
• No effort to prepare participants to achieve results	• Results expectations communicated to participants
• No efforts to build partnerships with key managers	• Partnerships established with key managers and clients
• Planning and reporting on training focuses on inputs	• Planning and reporting on training focuses on outputs

The fragmentation of the construction industry makes it very difficult for the industry to meet this challenge in any comprehensive and systematic way. Construction is a $400 billion per year industry, supporting almost 1 million general contractors, 50,000 architect and consulting engineering firms, 25,000 building materials dealers, over 70 national contractor associations, 15 building and construction unions, 10,000 building-code jurisdictions, and over 8 million employees. This fragmentation of the construction industry, in combination with the trend of increasing project complexity and shorter time restrictions, greatly limits its ability to build effective training evaluation systems.

Clearly, the most critical test for cost-effectiveness and rigor is how well an ROI instrument fits with the unique characteristics of the construction industry. The industry is complex, diverse, and highly localized. It uses a multiplicity of contractors and crafts and encompasses a wide range of skills. Its labor markets are characterized by short-term attachments, in which individual employees are hired by a number of employers on projects

usually of short duration. Given this context, the criteria for the ROI instrument includes the following:

- Usable at both the individual firm and association or consortium levels, though focused on the expertise and resources available at the latter, which can yield wider scope and complexity of ROI analysis;
- Appropriate for many forms of training (e.g., apprenticeship, craft, modular, task-oriented, etc.);
- Adaptable to other human resource practices;
- Inclusive of the broad range of informal learning, which is a significant and extensive source of training;
- Controls for other inputs that influence performance such as technology (prefabricated materials, tools and equipment) and work practices; and
- Appropriate for a wide band of occupations.

The considerations outlined above make developing a cost-effective "ROI in Training" toolkit both timely and greatly needed. Further study may contribute significantly to addressing the needs of attracting and retaining a skilled construction workforce.

4.5 Construction Labor Productivity

The Sloan Workforce group attempted to determine productivity trends and causes over the last three decades. In a preliminary study, six common tasks were selected for examination. Each had experienced different levels of technological change. The tasks include 2x4 stud wall framing, open web joist installation, hand trenching to depths of less than 5 feet, compaction with a sheep's foot roller, 6-inch steel pipe installation, and installation of acoustic ceiling tile. Means' Cost manuals were used to trace the benchmark values for these tasks as a reflection of productivity trends. Unit labor costs in constant dollars and daily output factors were compared over time for each task. In tasks experiencing technology advances, both productivity and daily output increased. For hand trenching, unit labor costs decreased due to a decline in real wages. (See Figure 4.2.)

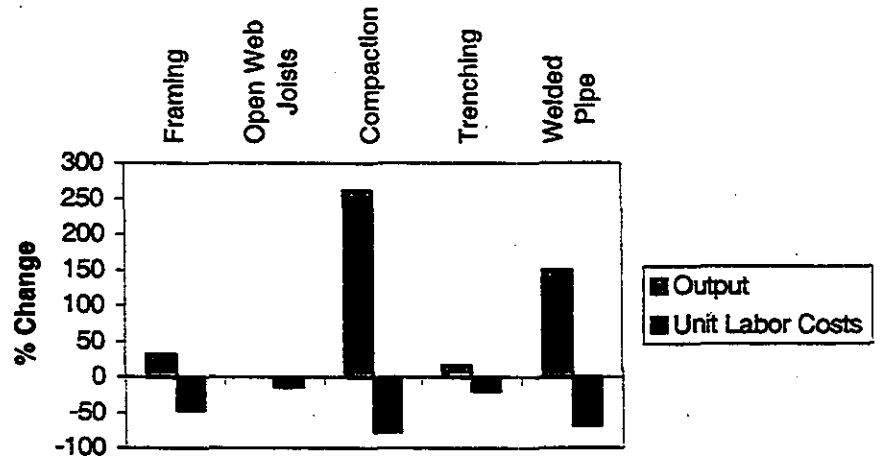

Figure 4.2 Change in Output and Unit Labor Costs 1974-1996

In continuing research on productivity, over 100 additional tasks are being examined to substantiate the preliminary observations regarding productivity and output and to gain further insight into the role of technological change. In addition, work samples from 72 projects in Austin, Texas over the last 25 years were examined. While corporate data on productivity exists, it is normally held closely, since it is considered a strategic asset. However, industry members of the Advisory Panel who are from industry can refer to their corporate data when reviewing the results produced by this study. It is expected that the results will be significant additions to the published knowledge base. Further work on this topic is reported in CCIS Report No. 6.

4.6 Impact of Technology on the Workforce

The pace of technological change is accelerating in construction, and its impact on the workforce will be profound. Training requirements, career paths, and wages may all change significantly. New skills will be required and new crafts may even emerge. Management, labor, and government will need to understand and anticipate these changes in order to plan for them, adapt to them, and hopefully take advantage of them.

The research of the Sloan workforce group is directed to respond to these needs. Our research is concentrated on three types of technological change: (a) the impact of computer and information technology on the construction workforce, (b) the impact of hard technology

such as robotics on the workforce, and (c) the impact of technology-driven organizational changes such as industrialization on the workforce. Focusing on specific activities, such as welding, facilitates isolating the impact of technology as well as the resulting changes.

4.7 Conclusion

The results of our research are valuable to all segments of the construction industry. Reports on three research topics were recently completed: implementing a multiskilled workforce, workforce experiences with multiskilling, and measuring return on investment in training and education. Two topics currently being studied are construction labor productivity and the impact of technology on the workforce. Each topic addresses the skilled labor shortage, which is becoming a pervasive concern to construction industry leaders.

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