Injury Hazards in the Construction Industry

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Although many occupational injury studies have been conducted on the construction industry, fatal injuries and lost work time injuries in this industry continue to rank among the highest in the nation. This paper presents an analysis of nonfatal (1981 through 1986) and fatal (1980 through 1989) traumatic occupational injuries in the construction industry using the Supplementary Data System and the National Traumatic Occupational Fatalities data bases. The lost workday case rate in construction was 10.1 per 100 full-time workers, which was nearly 2.5 times the occupational injury rate for all industries combined. The construction industry had an overall fatality rate of 25.6 per 100,000 full-time workers. This rate was more than 3.5 times the occupational fatality rate for all industries in the United States for the same period. To prevent occupational injuries and fatalities in the construction industry, intervention measures need to target specific occupations: machine operators, transportation workers, and craftspeople. Intervention measures also need to target such causes of injury as falls, electrocutions, and motor vehicle incidents.

The *Standard Industrial Classification Manual 1987* classifies the US economy into 10 major industry divisions.[1] Of these 10 industry divisions, construction was the sixth largest civilian employer, the fourth leading employer of men (nearly 7 million), and the seventh leading employer of women (687,000).[2] Construction continues to be a traditionally male-dominated industry, with the proportionate increase of women representing only tenths of a percent from 1980 through 1989.[3] In 1989, 4% of construction employees ranged in age from 16 to 19 years, 12% were 20 to 24 years old, 73% were 25 to 54, and 11% were 55 years or older. The construction industry is also a predominately white industry—almost 83% of its employees were white men and almost 9% were white women in 1989. Less than 7% were black men.[2]

This industry traditionally has been, and continues to be, plagued with occupational injuries and fatalities. Although the construction industry is only the sixth largest employer, fatal injuries and lost workday injuries in the construction industry rank among the highest in the United States. In 1989, there were 638,800 injury cases and 301,200 lost workday cases reported by the Bureau of Labor Statistics.[4] The total number of injuries in the construction industry was fourth among the major industry divisions, whereas the injury incidence rate (14.2 per 100 full-time workers) was the highest of any industry in the nation. The construction industry also had the highest lost workday case incidence rate (6.7 cases per 100 full-time workers) and lost workday rate (141.6 days per 100 full-time workers).[4] The overall fatality rate for 1980 through 1989 in this industry was 25.6 per 100,000 workers, second only to

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the mining industry, which had 31.9 fatalities per 100,000 workers.[5]

This article provides a detailed examination of traumatic occupational injuries (1981 through 1986) and fatalities (1980 through 1989) in the construction industry, including demographic characteristics, occupations, and circumstances of the injury.

Methods

Nonfatal Injuries

Occupational injury data were derived from the Bureau of Labor Statistics' Supplementary Data System (SDS) for 1981 through 1986. The SDS data base is composed of first reports of workers' compensation claims for injuries or illnesses involving lost workdays or fatalities from approximately 30 states. The SDS coding structure is based on the ANSI Z16.2 standard[6] for the collection of injury and illness data, and includes information regarding the injury outcome (eg, nature of injury and body part affected), and the injury event (eg, source of injury and type of incident or exposure).

Because workers' compensation laws vary among states, and state participation in the SDS program varies by year, 15 states (Alaska, California, Colorado, Delaware, Hawaii, Indiana, Iowa, Kentucky, Maryland, Missouri, Nebraska, Oregon, Washington, Wisconsin, and Wyoming) were selected on the basis of their participation during all 6 years and their comparable case definitions as set forth by the Bureau of Labor Statistics. Each selected state has one or more of the following case definitions for a compensable case: (1) injuries or illnesses resulting in death, (2) injuries or illnesses resulting in absence from work for either 1, 3, or 4 shifts or days, and/or (3) injuries or illnesses resulting in permanent disability.[7,8]

Although the SDS data base includes workers of all ages, to be consistent with available employment data, only those workers aged 16 years or older were included in the analysis. Additionally, SDS does contain records of occupational illnesses and fatalities. However, these cases represent a small percentage of the total: 4% and 0.1%, respectively. To facilitate analysis, all compensation cases were included (nonfatal injuries, illnesses, and fatalities). Because there were so few occupational illnesses and fatalities in these data, results and discussion of the SDS analysis focus on work-related nonfatal injuries.

The SDS data used in this analysis have several important limitations. Because SDS does not include all states, the numbers presented in this analysis are not representative of the entire national labor force. The level of detail may vary among cases because of differences in reporting among individual employers.[9] Because the SDS is derived from employers' first reports to workers' compensation bureaus, incidents are likely underreported. Employers may underreport occurrences of injuries and illnesses because claims affect their experience rating, which determines workers' compensation insurance premiums.[10] Employees may not file for compensation because workers' compensation may pay only a portion of an employee's preinjury wages and there may be a waiting period of up to 8 lost workdays before the injury or illness is considered compensable.[10] Jensen[11] suggests that workers' compensation data may include mostly high pain injuries. Despite these limitations, the SDS has proven to be useful for targeting industry and occupation groups that are at an elevated risk of specific injuries,[12,13] and for determining characteristics of these injuries.

Employment data for calculating injury rates were drawn from the Bureau of Labor Statistics' *Geographic Profiles*[14] and the Bureau of the Census' County Business Patterns[15] data base. The *Geographic Profiles* is based on the Current Population Survey and includes annual average workforce estimates by state. The County Business Patterns data base is an annual census of approximately 48,000 employers. These data include first quarter and annual payroll and the total number of establishments and employees by industry and state. To calculate injury rates, employment data were derived for the same 15 states selected from SDS for this analysis.

Fatalities

Occupational fatality data were taken from the National Institute for Occupational Safety and Health National Traumatic Occupational Fatalities (NTOF) surveillance system for the years 1980 through 1989. The NTOF data are composed of information obtained from death certificates from 52 US vital statistics reporting units (the 50 states, New York City, and the District of Columbia). To be included, each death certificate must meet the following criteria: age 16 years or older, an "external" cause of death (International Classification of Diseases-9th Rev, codes E800–E999),[16] and the injury at work item marked "yes." It should be noted that although NTOF does not exclude military personnel, the data for this study are for the civilian population only.

Industry is defined as the "usual industry" of the victim and is coded into division level industry categories using the 1987 Standard Industrial Classification system.[2] For this analysis, the industry division for construction, including Standard Industrial Classification groups 15, 16, and 17, was used. Occupation is defined as the victim's "usual occupation" and, for this analysis, is grouped into major occupation divisions according to the 1980 Bureau of the Census Occupational Classification System.[17]

Limitations of death certificates used to ascertain work-related fatality information have been described previously.[18–21] Clarity of information on the originating document[19] and the lack of a national standard for the completion of the "injury at work?" item on the death certificate[21] are particular problems. Despite their limitations, death certificates identify an average of 80% of all work-related fatalities and are the single source that uniquely identifies the largest proportion of these fatalities nationally.[20] For these reasons, fatality frequencies presented in this paper should be considered minimum values.

Fatality rates for the construction industry were calculated using annual average employment data from Bu-

reau of Labor Statistics' *Employment and Earnings*[3] and the Bureau of Census' County Business Patterns[22] data base. The employment data from *Employment and Earnings* are based on the annual averages of the Current Population Survey, a sample survey of the population 16 years of age and over. Fatality rates are given for the nation, for occupation divisions, and for age groups.

Results

Nonfatal Injuries

Of all industry divisions, the construction industry had the highest rate of workers' compensation claims in the SDS data (Fig. 1). The rate for all private-sector industries for the 15 states included in this analysis was 4.3 per 100 full-time workers, whereas the injury rate for the construction industry was 10.1 per 100 full-time workers.

From 1981 through 1986, the SDS data included a total of 702,867 workers' compensation first reports of injury to construction industry workers. The injury rate decreased 33%, from 10.6 per 100 full-time construction workers in 1981 to a low of 7.1 in 1986. There was a 31% decrease between 1984 and 1985. The highest injury rate was in 1984 (10.8 per 100 full-time construction workers).

Of the total injuries in the construction industry among the 15 states, 98% involved men. Fifty-nine percent of the total injuries occurred to workers under 35 years of age; the highest injury rate per 100 full-time construction workers was among workers in the 20- to 24-year-old age group (Fig. 2).

Eighty-five percent of the compensation claims were among the occupations of precision production/craft/repair (crafts) and laborers. Machine operators and laborers had the highest and second highest rates of injury, respectively (Table 1). The occupation division with the third highest rate, farmers/foresters/fishers, includes such occupations as landscapers, loggers, and tree trimmers.

Table 2 shows a distribution of nature of injury by part of body affected. Almost 63% of the injuries among construction workers resulted in three principal natures of injury: sprains or strains (34%); cuts, lacerations, or punctures (17%); and fractures (11%). The back was the body part most frequently injured. Along with fingers, legs, and eyes, these four groups made up 50% of the total. Sprains or strains to the back and cuts, lacerations, or punctures to the finger accounted for almost 23% of the total injuries to construction workers for the 6-year period.

Four sources of injury accounted for 47% of the total injuries. The four leading sources of injuries were metal items (18%), the working surface (16%), nonpowered handtools (7%), and wood items (6%). Cuts, lacerations, or punctures accounted for the largest number of the injuries caused

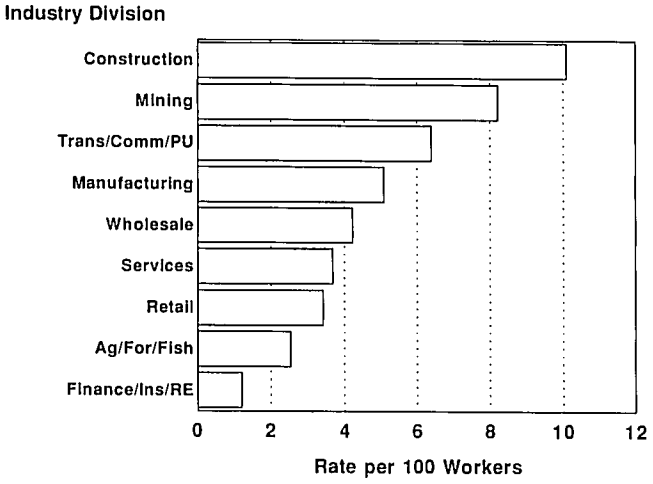

Fig. 1. Rate of occupational injuries by industry division: SDS, 1981–1986.

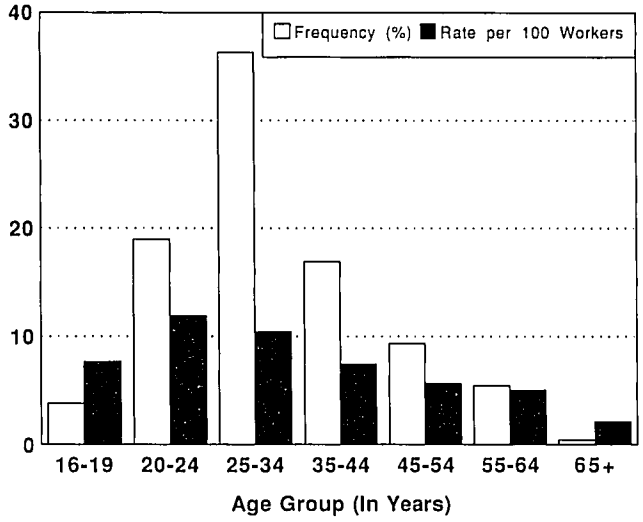

Fig. 2. Percentage distribution and rate of occupational injuries in the construction industry by age group: SDS, 1981–1986 (n = 702,867).

TABLE 1
Percentage Distribution and Rate of Occupational Injuries (per 100 workers) in the Construction Industry by Occupation Division: SDS, 1981–1986 (n = 702,867)

Occupation Division	Frequency	Rate
Machine operators	3.7%	24.8
Laborers	27.5%	22.1
Farm/for/fish	0.5%	19.8
Crafts	57.9%	9.4
Service	0.5%	8.9
Transport operatives	5.7%	7.6
Tech/support	0.3%	2.8
Sales	0.2%	2.1
Exec/adm/mgr	2.1%	1.7
Prof/spec	0.3%	1.3
Clerical	0.7%	0.9
Not classified	0.6%	–

TABLE 2
Percentage Distribution of Occupational Injuries in the Construction Industry by Nature of Injury and Part of Body: SDS, 1981–1986 (n = 702,867)

Nature of Injury	Body Part					Total
	Back	Finger	Leg	Eye	Other	
Sprain/strain	16.6	0.4	3.7	0.0	13.6	34.3
Cut/laceration/puncture	0.1	6.2	1.6	0.6	8.4	16.9
Fracture	0.4	1.8	0.8	0.0	7.8	10.8
Contusion/bruise	0.5	1.1	1.7	0.1	5.6	9.0
Scratch	0.0	0.1	0.2	6.8	0.4	7.5
Other	2.1	1.5	1.7	1.6	14.6	21.5
Total	19.7	11.1	9.7	9.1	50.4	100.0

TABLE 3
Percentage Distribution of Occupational Injuries in the Construction Industry by Type of Incident and Occupation Division: SDS, 1981–1986 (n = 702,867)

Incident Type	Occupation Division					Total
	Crafts	Laborers	Transport Operatives	Machine Operators	Other	
Overexertion	13.8	6.9	1.2	0.7	1.3	23.9
Struck by object	12.7	6.8	1.0	1.0	0.9	22.4
Fall from elevation	8.3	2.9	0.7	0.2	0.7	12.8
Struck against object	5.6	2.3	0.4	0.3	0.5	9.1
Fall same level	3.5	1.7	0.4	0.2	0.4	6.2
Other	14.1	6.9	2.0	1.3	1.3	25.6
Total	58.0	27.5	5.7	3.7	5.1	100.0

by metal items (7%). Sprains or strains accounted for the largest number of the injuries caused by the working surface (5%).

The leading types of incidents or exposures were overexertion (24%), struck by an object (22%), falls from elevations (13%), and struck against an object (9%). Together, these four groups accounted for more than two-thirds of all injuries to construction workers during the 6 years. Table 3 shows a distribution of occupation divisions by type of incident or exposure. In every category the most frequent type of injury was either overexertion or being struck by an object.

Fatalities

Of all industry divisions, the construction industry had the second highest fatality rate for 1980 through 1989, exceeded only by the mining industry (Fig. 3). The fatal injury rate for all industries combined was 7.0 per 100,000 full-time workers, whereas the fatality rate for the construction industry was 25.6 per 100,000 full-time workers.

Based on the NTOF data base, there were 11,417 fatalities in the construction industry from 1980 through 1989. The fatality rate decreased 25% from a high of 28.9 per 100,000 workers in 1980 to a low of 21.7 per 100,000 full-time workers in 1989.

Of the fatalities in the construction industry, 99% occurred to men. Whereas 47% of the fatalities were in construction workers under 35 years of age, workers 65 years and older had the highest fatality rate (Fig. 4). Eighty-one percent of the total fatalities were white workers; 9% were black; 7% were hispanic; and 3% were of an other or unknown race or ethnicity.

The occupation divisions with the greatest frequencies of death in the construction industry were precision production/craft/repair (48%), laborers (27%), and transport operatives (12%). Figure 5 compares occupation division fatality rates between the construction industry and all industries. Construction industry workers had higher fatality rates than did the general workforce in every occupational classification except one (farmers/foresters/fishers). Laborers had the highest fatality rate in the construction industry: 39.5 per 100,000 full-time workers.

The three leading causes of death for construction workers were falls (25%), electrocutions (15%), and motor vehicle–related incidents (14%) (Fig. 6). Table 4 shows the distribution of fatalities among construction workers by occupation division and cause of death. Falls, machine-related incidents, motor vehicle-related incidents, electrocutions or struck by falling objects were the leading causes of death for all occupation divisions.

Discussion

Nonfatal Injuries

Based on the SDS data, the construction industry had the highest occupational injury rate of all industries from 1981 through 1986 for the 15 states included in this analysis. The injury rate of 10.1 per 100,000 full-time construction workers was nearly 2.5 times the occupational injury rate for all industries combined. This rate is based on the 15 states that were selected and on a comparable number of lost workdays (4 or less), and therefore should not be viewed as a national estimate. If a different set of states were chosen and the restraints on the lost workdays were changed, then the injury rate would likely change. However, this rate is similar to the total case rate and the lost workday case rate that are reported in the Bureau of Labor Statistics (BLS) Annual Survey and are based on national data.[23]

Although the rate of injuries reported to workers' compensation agencies declined by nearly 33% over the 6 years, the sharpest decline occurred between 1984 and 1985. More analyses must be performed to determine whether this represents an actual drop in the rate of claims in the construction industry or is an artifact of reporting in the workers' compensation system. Although other studies have reported similar declines in SDS cases for other industries from 1981 through 1985,[11] a review of lost work-

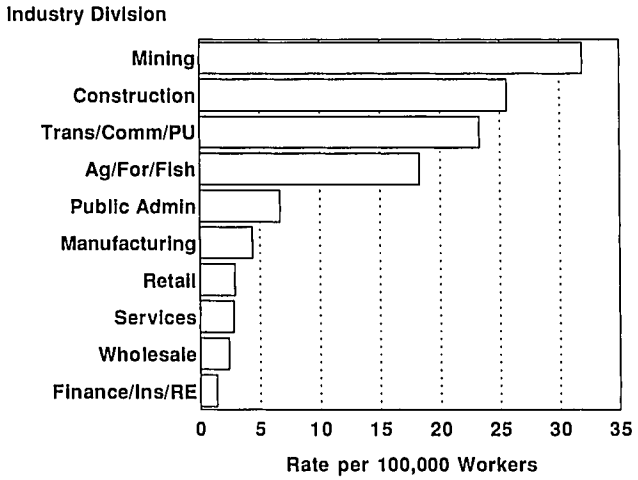

Fig. 3. Rate of fatal occupational injuries by industry division: NTOF, 1980–1989.

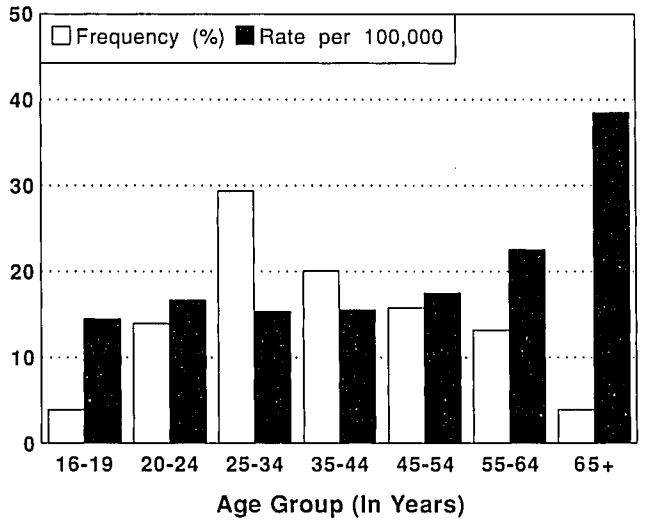

Fig. 4. Percentage distribution and rate of fatal occupational injuries in the construction industry by age group: NTOF, 1980–1989 (n = 11,417).

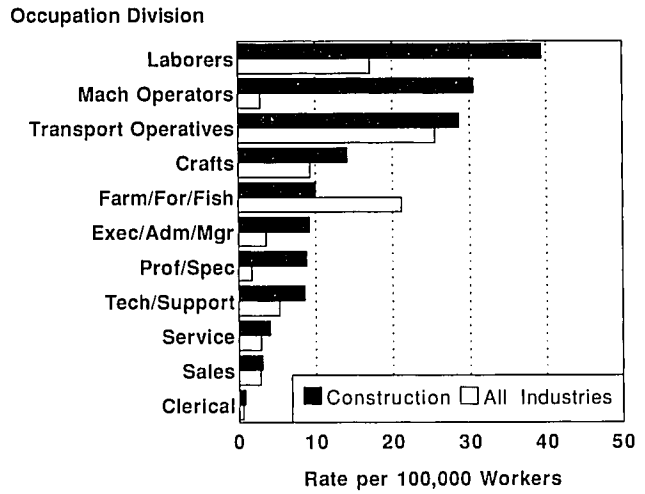

Fig. 5. Rate of fatal occupational injuries by occupation division—construction industry versus all industries: NTOF, 1980–1989.

day case rates in the BLS Annual Survey indicates that the injury and illness rate from 1984 through 1989 remained relatively constant (6.9 to 6.8 per 100 full-time workers).[24]

In the current study, craftspeople and laborers suffered 85% of the injuries in the construction industry. Overexertion, being struck by an object, or falling from an elevation were the leading causes of injuries among both of these occupations. Sprains or strains to the back involving working surfaces, metal items, or boxes or barrels, and cuts, lacerations, or punctures to the fingers involving metal items or unpowered handtools were the major injury producing incidents.

Fatalities

Based on the NTOF data, there was an average of 1142 work-related fatalities per year in the US construction industry from 1980 through 1989. Other studies have reported different estimates. From 1980 through 1989, the Bureau of Labor Statistics reported an average of 778 construction-related fatalities per year in its annual survey.[25] The OSHA fatality data base[26] for 1985 through 1989 reported an average of 958 fatalities per year in this industry. The National Safety Council estimated an average of 2190 deaths per year in the construction industry for 1981 through 1990.[27]

Some of the variation in the estimates of occupational fatalities reported in the above studies is due to differences in case definitions.[26–28] Because of these differences, the estimates are based on slightly different populations. The NTOF system excludes workers under the age of 16 and work-related deaths that are not a result of an external cause of death (eg, occupational illness). The National Safety Council reports include workers age 14 to 16 years and includes an inflation factor for work-related motor vehicle fatalities.[27] NTOF underestimates the number of work-related fatalities caused by motor vehicles.[18–20] The NTOF data base does not exclude self-employed workers, employees covered under legislation outside of OSHA's jurisdiction, or employees of small companies. Both the OSHA fatality analysis and the BLS Annual Survey exclude at least some of these groups.[26]

In this study, the construction fatality rate of 25.6 per 100,000 full-time workers was exceeded only by

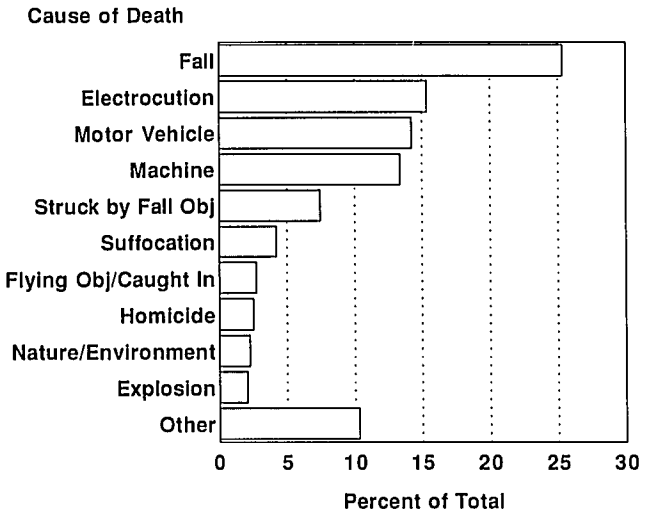

Fig. 6. Percentage distribution of fatal occupational injuries in the construction industry by cause of death: NTOF, 1980–1989 (n = 11,417).

TABLE 4
Percentage Distribution of Fatal Occupational Injuries in the Construction Industry by Occupation Division and Cause of Death: NTOF, 1980–1989 (n = 11,417)

Occupation Division	Cause of Death						Total
	Fall	Electrocution	Motor Vehicle	Machines	Struck by Falling Object	Other	
Crafts	17.1	9.7	4.5	4.3	3.0	9.7	48.3
Laborers	5.5	3.5	4.5	3.6	2.9	7.1	27.1
Transport operatives	0.4	1.0	3.5	3.8	0.8	2.3	11.8
Exec/admin/mgr	1.4	0.7	1.1	1.0	0.5	1.9	6.6
Mach operators	0.7	0.3	0.1	0.4	0.3	0.7	2.5
Other	0.3	0.2	0.6	0.3	0.0	2.3	3.7
Total	25.4	15.4	14.3	13.4	7.5	24.0	100.0

the mining industry and was more than 3.5 times the occupational fatality rate for all industries in the United States. Compared with occupations in all major industry divisions, the occupation divisions in the construction industry had higher death rates in all but one occupation. Laborers and machine operators in construction had fatality rates more than twice as high as those in all industries. More than 75% of the fatalities in the construction industry resulted from falls, electrocutions, motor vehicle incidents, machinery incidents, or falling objects.

Conclusions

This study has identified groups within the construction industry that are at an elevated risk of nonfatal and fatal injuries. To prevent nonfatal occupational injuries, intervention measures need to focus on laborers and craftspeople and on those occupations that are likely to be injured from overexertion, being struck by an object, or falling from an elevation. Intervention measures to prevent fatal traumatic occupational injuries should focus on laborers and machine operators and on those groups that are likely to be involved in a fall, electrocution, motor vehicle incident, or machinery incident. Clearly, there is a need to focus additional safety research and injury prevention programs on these occupations and causes of fatal and nonfatal injury.

The national public health objectives for the year 2000, set forth by the Public Health Service in Healthy People 2000, include goals to reduce the fatal and nonfatal injury rate among construction workers.[29] The National Institute for Occupational Safety and Health recently established a construction initiative to accelerate research that would lead to a reduction in work-related injuries in this industry. Future research needs to provide task-specific data for describing the events leading to injury through improved surveillance and analytical research. These data will help identify specific risk factors associated with specific injury events so that effective interventions may be developed. Future research also must focus on determining and overcoming barriers to the use of existing protective technologies. This research will allow development of more effective methods of implementing consistent and proper use of existing technologies at the construction site. For injury events lacking adequate intervention strategies, there continues to be a need to develop new technologies and new work practices that better protect construction workers.

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The Secret to Productivity: Glass

Forget about raises, promotions, and percs. The real employee motivator is a window. According to a 1200-person survey by University of Michigan psychologist Rachel Kaplan, workers with views of the outside world show more enthusiasm for their jobs, less frustration, more patience, better concentration, and fewer physical ailments. There's something spiritually enriching about being able to let your eyes wander to the misty horizon.

What about their co-workers in windowless cubicles? This crowd's attitude, relatively speaking, stinks. They're less imaginative and more irritable. Concentration is a problem, too, for this wall-staring group. And you would think that window-sitters would be more prone to boss themselves, daydreaming as they gazed on those sweeping panoramas. Nope.

It doesn't even matter if you work in the city. Kaplan found that those with only a lone tree or two in sight had more job satisfaction than the hapless souls without. The vista beyond the window doesn't need to be natural to juice up morale, either. Buildings and parking lots do the job. So the next time your boss catches you gazing out the window, don't hesitate to say it's for the good of the company.

From Up Front, *Business Week*, November 22, 1993, p 8