

## INDUSTRY STUDIES

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**CONSTRUCTION**

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STRATEGIC  
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HOME

INDUSTRY STUDIES  
2000**Construction****ABSTRACT**

The U.S. construction industry is vibrant, healthy, and growing. United States firms dominate the domestic market and maintain a competitive advantage in the growing overseas market. However, the shortage of skilled workers, the impact of information technology, changes in the way projects are financed and executed, and the privatization of public infrastructure—especially overseas—have altered the construction landscape, forcing the industry to reevaluate the way it does business. The process of adapting to these changes in the conservative, risk-averse U.S. construction industry has been slow but steady.

The government has an important role to play in this transition, especially in light of the industry's vital contribution to U.S. economic strength, military power, and ultimately its national security. Coherent and consistent policies that create a favorable environment for industry growth at home and abroad should help nurture and extend the industry's competitive advantage and help maintain its "world-class" stature.

Lt Col Christopher Bogdan, USAF

Ms. Catherine Doolos, Dept. of the Army

Mr. Robert Ford, Dept. of State

Mr. Calvin H. Garner, Jr., Dept. of the Air Force

Mr. Thomas Kane, Federal Emergency Management Agency

LTC Robert Keyser, USA

CAPT Robert King, USN

Col Karen Kohlhaas, USAFR

LTC Rodney Mallette, USA

Ms. Teresa Pohlman, Dept. of the Air Force

Ms. Vicki Preacher, Dept. of the Air Force

Mr. Gregory Reaves, Defense Intelligence Agency

Ms. Sharon Richardson, Defense Systems Management College

Col Gerald Sawyer, USAF

CAPT Jacob Wilkins, USN

COL Gary Berry, USA, faculty

Dr. Hugh Conway, faculty

Dr. Michael Frazier, OSD, Howard University, faculty

## **PLACES VISITED**

### **Domestic**

Associated General Contractors of America, Alexandria, VA

Boston Harbor/Central Artery Tunnel Project, MTA, Boston, MA

Clark Construction, Washington, DC, Convention Center

John F. Kennedy Airport, New York, NY

Muniz Air National Guard Base, Carolina, Puerto Rico

National Association of Home Builders, Washington, DC

O'Brien & Gere, San Juan, Puerto Rico

Parsons Brinckerhoff, New York, NY

Pentagon Renovation Project, Arlington, VA

Port Authorities of New Orleans, New York/NJ, and Puerto Rico

Raytheon Corporation, Boston, MA

Roosevelt Roads Naval Air Station, Puerto Rico

Sheet Metal Workers Union, Local 100, Suitland, MD

Stromberg Sheet Metal Works, Beltsville, MD

Urban Train Project, San Juan, Puerto Rico

U.S. Army Corps of Engineers, New Orleans District, LA

U.S. Army Corps of Engineers, Jacksonville District, San Juan, PR

U.S. Coast Guard, New Orleans, LA

U.S. Naval Mobile Construction Battalion Five, Puerto Rico

Virginia DoT, Springfield Interchange Project, Springfield, VA

Walk Haydel, New Orleans, LA

### **International**

Arturo Merino Benitez Airport, Buenos Aires, Argentina

Brazilian Navy, Directorate of Civil Works, Rio de Janeiro, Brazil

Brazilian Air Force, Directorate of Engineering, Rio de Janeiro, Brazil

Buenos Aires Subway System, Buenos Aires, Argentina

Chilean-American Chamber of Commerce, Santiago, Chile

Electrica Santiago, Santiago, Chile

Federation of Industries, Rio de Janeiro, Brazil

General Electric-Techint Power Plant, Buenos Aires, Argentina

La Rural Convention Center, Buenos Aires, Argentina

National Administration of Ports, Montevideo, Uruguay

San Antonio Terminal International Port, San Antonio, Chile

Santiago Airport, Santiago, Chile

Techint Construction Company, Buenos Aires, Argentina

U.S. Consulate, Rio de Janeiro, Brazil

U.S. Embassy, Buenos Aires, Argentina; Santiago, Chile; Montevideo, Uruguay

## INTRODUCTION

To an even greater degree than most U.S. industries, the construction industry plays a vital role in the calculus of U.S. economic power, military might, and ultimately its national security. The industry has an impact on nearly every aspect of the U.S. economy. The nation's infrastructure—energy systems, telecommunication links, roads, railways, seaports, and airports—and its major institutions—homes, schools, hospitals, and factories—are all a direct outcome of the productivity and innovation of the construction industry.<sup>[i]</sup> The industry is also critical to maintaining the U.S. industrial base and those components of the nation's infrastructure essential to the generation and projection of military power, including mobilization in times of emergency. If the United States is to maintain its economic strength and defense readiness—two key elements of its power base—then it is absolutely necessary for the U.S. construction industry to remain technologically and globally competitive.

## THE CONSTRUCTION INDUSTRY DEFINED

**General Size and Scope.** The construction industry is the United States' largest manufacturing sector and its second largest employer after the government, making up 6.4 percent of the total U.S. workforce. The industry accounts for over 8 percent of the nation's gross domestic product, with the total value of construction (new and renovated) expected to top \$900 billion in the year 2000.<sup>[ii]</sup> It is a highly diverse, fragmented, and fiercely competitive industry.

**Structure.** In general, the construction industry is divided into three broad categories based on the type of construction work performed: building construction, heavy construction, and specialty trade construction. These sectors require differing workforces and company skills, processes, and materials and equipment, giving the industry a highly diverse character.

1. Building construction, sometimes referred to as general construction, includes

construction of homes, office buildings, production plants, and other similar buildings. This sector represents nearly 30 percent of all domestic construction firms and contributes over 45 percent (\$382 billion) of the total value of construction.<sup>[iii]</sup>

2. Heavy construction involves the building of the nation's infrastructure, including roadways, seaports, airports, bridges, dams, and energy production facilities and grids. This sector represents 6.5 percent of firms and contributes 15 percent (\$128 billion) to industry revenue.<sup>[iv]</sup>
3. Specialty trade construction includes work such as plumbing, painting, carpentry, bricklaying, and electrical work, as well as the sheet metal, heating, and air conditioning trades. This is the construction industry's largest sector, accounting for nearly 65 percent of total companies and 40 percent (\$336 billion) of the value of construction.<sup>[v]</sup>

Two other important sectors—architectural and engineering services and construction materials—complement the activities of the three primary contractor groups. Agricultural and engineering firms perform the vital function of designing and engineering construction work, while the construction materials sector provides the raw components—e.g., bricks, concrete, steel—for the industry. Together, these five components constitute the construction industry.

***Construction Firms and Industry Fragmentation.*** The construction industry landscape is dominated by small companies. There are over 656,000 construction firms in the United States alone. Of these firms, over 62 percent have fewer than 4 employees, while less than 1 percent have more than 100.<sup>[vi]</sup> This fragmentation, coupled with the aforementioned diversity, makes the construction industry highly competitive, putting a premium on profitability, performance, and reputation. The stiff competition coupled with easy entry into the industry by specialty trade contractors—initial capital requirements are typically low—are conducive to a higher rate in construction than in other domestic businesses.<sup>[vii]</sup>

## CURRENT CONDITION

The construction industry is in its ninth consecutive year of growth. The overall health of the U.S. and world economies has driven this expansion. Low domestic interest rates, predictably low rates of inflation, and the improved fiscal position of the federal and state governments have spawned increased construction work within the United States. As a result, the U.S. industry is vibrant and robust and maintains a huge competitive advantage in the domestic market, which represents over 20 percent of the \$3.6 trillion world market.<sup>[viii]</sup> Internationally, the U.S. industry is beginning to compete more successfully as it exports many of the skills at the root of its

domestic dominance: design, construction management, safety, and quality.

**Spending.** Construction spending has steadily increased each year over the past decade, with an almost 35 percent increase in the total value of new construction since 1990. For 1999, the industry committed over \$700 billion to new construction and put in place nearly \$200 billion in additions, alterations, maintenance, and repair work.<sup>[ix]</sup> The only exception to this decade-long increase has been in the area of military facilities. The reduction in military construction spending is a result of the drawdown of the military since the end of the Cold War.

This overall pattern of increased spending is expected to continue into 2000 with an 8 percent increase over 1999.<sup>[x]</sup> However, construction spending is very sensitive to interest rates, and slowdown in the pace of construction work is expected for the near term as the government increases interest rates in order to keep inflation under control.

Prospects are better, however, for the long term: new government legislation and a growing economy (although slower than in the previous few years) point to increased spending in construction. The Transportation Equity Act for the 21<sup>st</sup> Century (TEA-21), passed in 1998, provides \$200 billion for new highway construction, capital improvements in roads and bridges, and support for mass transit projects.<sup>[xi]</sup> The Aviation Investment and Reform Act (AIR-21), modeled after TEA-21 and signed into law on April 5, 2000, provides \$40 billion to the Federal Aviation Administration for airport improvements.<sup>[xii]</sup> Both will boost public construction spending and help modernize aging U.S. infrastructure.

**Financing.** Construction is a capital-intensive industry. Large up-front investments are needed to begin and execute projects. Success or failure in some cases rests on the ability to skillfully finance the project. In response to increased competition, many firms are finding innovative ways to finance construction projects. Joint ventures, public-private partnerships, privatization, and other creative funding methods are being used to share financial risk and transfer some of the financial burden from government owners and potential customers to developers and contractors. This is done in an attempt to make the projects affordable and more attractive to potential customers. Arrangements of this type are commonplace overseas. A consortium of construction firms—often a U.S. firm teamed with one or more local companies—will use future revenues from infrastructure operations (e.g., highway tolls, airport landing/use fees) as collateral for the initial capital investments needed to execute the project. Foreign governments are using this method of project financing more and more because it allows them to build or renew infrastructure long before they can afford to do so alone. It also gives construction companies business that they might otherwise not have. However, this comes at a cost to the construction firms in terms of increased financial risk. In the future, companies will have to become more savvy in terms of how projects are financed—both to attract customers and to manage their own financial risk.

**Global Market.** The United States is the world leader in the construction industry. This nation's firms have a particular advantage in the areas of project design, management, environmental controls, safety, and construction quality. Numerous overseas projects are proudly described as "meeting American standards." Such benchmarking of U.S. quality is a vivid indicator of the industry's strength, solid

reputation, and leadership abroad. Last year, most exports of U.S. construction services went to the Asia–Pacific region (45 percent), followed by Latin America (25 percent) and Europe (15 percent).<sup>[xiii]</sup> The overseas market represents a significant growth opportunity for U.S. firms, especially the rapidly industrializing countries of East Asia and Latin America.

By contrast, foreign construction contractors have made few inroads into the U.S. market. In 1998, foreign firms accounted for less than 10 percent of the U.S. construction market.<sup>[xiv]</sup> However, acquisition of U.S. companies by foreign firms is growing, and U.S. contractors face strong competition at the highest end of the spectrum from large foreign firms that can successfully execute “megaprojects.”

***Privatization.*** A large portion of the overseas market involves infrastructure privatization. Many developing nations cannot afford the high initial investment costs of infrastructure projects; therefore, they are turning to privatization—supplementing public funds with private capital—as a way to develop infrastructure faster and cheaper. This is also proving to be a more efficient way of operating and maintaining the infrastructure. In fact, most privatization projects have 15–25 percent lower construction costs and 20–40 percent lower operating costs than classic government-owned projects.<sup>[xv]</sup> Although the United States has privatized portions of its infrastructure—most notably the utilities sector, with smaller efforts in highways, prisons, and water treatment plants—this represents only about 5 percent of worldwide privatization.<sup>[xvi]</sup> By contrast, foreign nations are privatizing everything from energy and water treatment plants to highways, airports, and seaports.

***Labor.*** A union–versus–non-union divide is one of the more salient characteristics of domestic construction labor. (Another, the shortage of skilled workers, is discussed later in this report.) Currently, only 19 percent of construction workers are members of a union.<sup>[xvii]</sup> Union representation, long a powerful influence throughout the industry, still plays a role in large commercial and government projects, but has lost some of its clout in recent times. Non-union (open-shop) work now accounts for as much as 80 percent of the dollar output for construction in the United States. Unions, however, are moving to reclaim this lost territory and tend to regard non-union workers as a pool of potential members. They are aggressively moving to organize these workers. Despite their diminished role, unions are still an important source of training for many specialty skills.

***Research and Development.*** Characteristic fragmentation, diversity, and fierce competition of the construction industry combine to make research and development (R&D) difficult. The federal and state governments play a major role, accounting for nearly two-thirds of a \$3.5 billion annual R&D effort. The National Institute for Standards and Technology, the Department of Transportation, and the Department of Energy all sponsor, conduct, or cost-share with industry and academia activities in such areas as structural safety, fire and earthquake safety, building materials, intelligent transportation systems, and energy systems. The National Science Foundation funds more than 70 percent of academia’s construction R&D efforts, which center on basic “curiosity-driven” research in the areas of advanced materials

and structural safety.<sup>[xviii]</sup> Nonprofit organizations such as the Construction Industry Institute and the Civil Engineering Research Foundation are also important as R&D information brokers and private sector R&D agents. They attempt to bridge the gap between the industry at large and ongoing R&D efforts.

The Army Corps of Engineers' Engineering Research and Development Center and the Naval Facilities Engineer Command's Engineering Service Center conduct the lion's share of government R&D. These organizations seek solutions to the problems of aging infrastructure, asymmetrical threats to facilities, and costly construction methods. They are finding new ways of evaluating and repairing structurally degraded buildings, creating new materials to rehabilitate aging structures and harden facilities, and developing efficient building methods to reduce construction costs. They are also sharing the innovations spawned by these efforts with the private sector in an attempt to push innovations to the field more rapidly.

***Regulations/Codes/Standards.*** A wide range of regulations, laws, and standards affect the U.S. construction industry. Such guidance is necessary to protect the interests of business, community, and individuals and to address concerns such as safety, quality, and the environment. However, many firms face a bewildering array of codes that often conflict with each other and change from one jurisdiction to another. Continued efforts are needed to press for a single set of national codes and standards.

Globally, the impetus for adopting ISO standards will affect the industry. The two ISO standards relating to construction are ISO 9000 (Quality Assurance and Business Practice Documentation) and ISO 14000 (Environmental Management). Despite industry opinions that these standards are duplicative and used as trade barriers overseas, U.S. companies will ultimately have to adhere to such regulations if they wish to compete successfully in certain international markets.

## CHALLENGES

The future health of the construction industry may very well depend on its ability to anticipate, shape, and respond to key issues, challenges, and opportunities. The three most significant of those challenges—a critical shortage of skilled labor, the burgeoning influence of information technology, and revolutionary changes in the global construction market—are dealt with at some length in the Essays on Major Issues section of this paper. There are other issues of note, however.

***Project Delivery.*** The industry is changing the way it executes construction projects in response to customer demands. The traditional design–bid–build process—where design and construction functions are sequential and performed by separate companies—is losing favor because it is slower and less responsive to customer needs. It is being replaced by the design–build approach—a “one-stop shopping” method where a single entity is responsible for design and construction, and building begins after only a small portion of the design is complete. This change presents a challenge for those firms incapable of delivering a “turn-key” project and will force them to expand their capabilities or seek to complement them through joint ventures and partnerships. With an expected

increase in the use of design–build to over 45 percent in the next few years, it is imperative for companies to develop this capability in order to remain competitive.

***Problems in R&D.*** Construction-related R&D in the United States suffers from various problems that minimize its impact on the industry. In a fiercely competitive environment—with thin profit margins—individual firms, especially the smaller ones, simply cannot afford to conduct R&D or pay the added regulatory costs of introducing new technologies. Consequently, R&D spending in the construction industry is consistently low. In 1997, the industry spent only 0.6 percent of total revenues on R&D, whereas most other industries committed 4 to 6 percent. An unfocused and uncoordinated effort among the various R&D sectors (i.e., firms, academia, government, and nonprofit organizations) makes this chronic underfunding worse.

Additionally, concerns over liability and the devastating consequences of losing one’s reputation should innovations fail leave little incentive for companies to introduce new technologies. So even when new technologies are available, it is cheaper, easier, and safer to stick with “tried and true” materials and methods.

The U.S. construction industry runs the risk of stagnating and losing its competitive edge if it cannot make its R&D efforts more effective and overcome these problems and barriers.

***Privatization.*** Construction firms in the United States are hesitant to respond to overseas privatization initiatives because their involvement exposes them to significant economic and political risks. Many infrastructure projects are highly politicized, and success is often linked to government policies and political factors beyond the firm’s control. Additionally, many U.S. firms do not have an in-house “design–build–operate–maintain” capability and do not regard these capabilities as core competencies. Nor do these firms have the resources or know-how to finance such projects. A strong U.S. economy, evinced by substantial government surpluses, has also suppressed the need for federal and state governments to privatize. Consequently, U.S. firms have not developed extensive privatization experience. This inexperience, coupled with the perceived risk, drives many U.S. companies away from potential privatization work, leaving the door open for foreign competition.

## **OUTLOOK**

### ***Long-Term Health of the Construction Industry***

Despite the difficult challenges confronting it, the U.S. construction industry is healthy and should continue to grow in the short term along with the overall U.S.

economy. Furthermore, as the country inevitably moves to rebuild its decaying infrastructure, the industry will be well placed to benefit from new major domestic projects. In addition, there are likely to be new opportunities for privatization, especially in the areas of transportation, electricity, and water treatment. In addition, information technology will offer enormous opportunities for expanding productivity, while innovations in project delivery and financing are helping to maximize investment and increase efficiency.

The long-term health of the industry is largely dependent on the state of the nation's economy. While the construction sector has expanded greatly during the unprecedented economic expansion of the 1990s, any economic downturn would adversely affect it—the many small firms of the industry in particular. The construction sector's response to the severe labor shortage it faces will also be a critical factor in its future growth. The industry must find ways to shed its image as an unglamorous profession and thus better compete with other sectors of the economy for skilled workers.

### *International Markets*

Those in the industry should also work to develop investment strategies conducive to more ready acceptance of the higher risks of working abroad. The international market should prove an excellent arena in which either to exploit new growth opportunities or to compensate for slower growth at home. Despite the economic upheavals of 1998, worldwide construction rose by 11.8 percent that year to \$3.6 trillion, a trend that is expected to continue in the foreseeable future.<sup>[xix]</sup> The U.S. industry is well placed to take advantage of overseas opportunities, as it already enjoys a strong foothold in key markets in Asia, Europe, and to a lesser extent, Latin America. The current domestic economic expansion is no rationale for surrendering to the competition possibly lucrative overseas markets, particularly those of developing countries.

### *National Security Implications*

Through the building and maintaining of the U.S. infrastructure, the construction industry makes a vital contribution to the nation's economic strength and military power, and thus its national security. Continued U.S. prosperity depends heavily on the viability of this infrastructure, as nothing moves through the economy—goods, money, information, energy, or services—without passing through or using it. Similarly, the ability of the United States to generate and project military power depends on the industrial base and national transportation network created by the

industry. Finally, the construction industry is essential for mobilization, as it enables the United States to strategically transform and adapt its peacetime economy and industrial base to a wartime footing. Simply put, the health of the U.S. construction industry is essential to the nation's security.

Certain trends in the industry have immediate and far-reaching national security implications. On the positive side, U.S. firms are gaining extensive international experience as they venture into the global market. This experience will pay great dividends as the U.S. government, in response to the rising terrorist threat, endeavors to strengthen the security of its facilities (e.g., embassies) abroad. It will also benefit the military, which is increasingly dependent on the industry for overseas infrastructure support. The Army's Logistics Civilian Augmentation Program is an important example. Finally, this international industrial know-how can provide for improved cultural and political perspectives, and thus better position the United States for regional crises or global engagement.

On the negative side, the shortage of skilled labor could limit industry growth and drive costs up. Public opposition to government efforts to re-capitalize and fund infrastructure upgrades through privatization also constrains construction growth. These two trends can impede the progress of the government's efforts to renew the nation's infrastructure. Prolonging this much needed renewal increases the risk of economic slowdown and may eventually result in a degradation of U.S. ability to mobilize quickly and, thus, to generate and project military power.

## GOVERNMENT GOALS AND ROLES

Given the essential contribution that the construction industry makes to the national security of the United States, the government has a vested interest in ensuring its continued strength and competitiveness. As a consumer, regulator, investor, and partner, the government can exert significant influence on the future direction of the industry by creating a favorable environment for it and by promoting those elements of the industry that further national interests and objectives.

***Shaping the Global Financial Environment.*** Foreign nations with strong, stable economies tend to invest in a wide range of construction projects—public and private—creating opportunities for the U.S. industry abroad. The government should continue to support international financial institutions such as the International Monetary Fund and World Bank and continue its direct aid programs to help foster favorable economic conditions among U.S. trading partners.

***Open Access to Markets.*** The U.S. government should continue to execute policies that provide open access to foreign markets. These policies include direct bilateral engagements and the Department of Commerce's Advocacy and Trade Compliance programs, which help reduce trade barriers, level the playing field for U.S. firms, and attempt to eliminate unfair business practices, such as bribery. The

government can also help reduce the risks U.S. firms face in certain overseas markets through Export-Import Bank programs that insure U.S. companies against losses from political unrest or currency devaluation.

***Research and Development Strategy.*** The government should provide a coherent R&D strategy that coordinates the disparate efforts of academia, industry, and government agencies. As part of this coordinating effort, it should create an industry-wide construction R&D data bank to better reveal overlap, duplication of effort, and areas of neglect—all in an attempt to better distribute federal dollars in support of the national strategy. Finally, the government should adopt and promote policies that will lower the barriers to the incorporation of new technologies and otherwise facilitate innovation. Such policies could include a combination of incentives, preferential contracting, and a shift to “best-value” rather than “low-bid” contract awards.

***Labor.*** The construction industry’s most serious short-term problem is the lack of skilled workers. Government can help address this problem by enhancing vocational training programs throughout the country in partnership with industry, unions, and schools. This effort could be made in tandem with ongoing attempts to expand job opportunities for inner-city and rural areas that continue to suffer high youth unemployment rates. As part of this program, the government should continue to fund the School-to-Work Opportunities Act, which provides federal funds to vocational school programs that provide apprentice-like training.

***Infrastructure Investment and Privatization.*** The nation’s basic infrastructure is aging rapidly and requires major investment for repair and replacement. Federal, state, and local governments need to recognize the seriousness of this problem and broaden and increase their infrastructure spending beyond the levels in the TEA–21 and AIR–21 legislation. In addition, governments at all levels should increasingly consider privatization as a viable alternative to more traditional forms of government or quasi-government control. The United States lags well behind other parts of the world in the privatization of infrastructure and may be missing opportunities for funding major domestic projects at lower initial cost through privatization. The government should also increase, where appropriate, the use of the design–build approach for project execution, as it is proving to be a cheaper and faster way to complete construction projects.

***Standards.*** The construction industry faces myriad complex and sometimes overlapping regulations, codes, and standards. Federal, state, and local governments should continue to take steps where possible to consolidate, simplify, or clarify these requirements. Such measures help reduce costs in the construction industry and allow for more timely delivery of needed construction services.

## CONCLUSION

The U.S. construction industry is vibrant and healthy. It maintains a competitive and comparative advantage overseas, with many of its strengths—e.g., quality, management, safety—becoming benchmarks for the rest of the world. Moreover, the industry’s contribution to U.S. national security is pervasive and unmistakable. By building and maintaining the U.S. infrastructure, the industry forges the backbone of the U.S. economy and provides the foundation for generating and projecting U.S. military power.

The construction landscape is changing, however, and the industry can ill afford to be complacent about its dominant position. Information technology, customer demands, and the drive to deliver projects faster and cheaper without compromising quality are changing the way projects are financed and executed. Additionally, the shortage of skilled workers and the privatization of public infrastructure—especially overseas—are forcing the industry to develop innovative solutions to remain competitive.

The government has a vested interest in ensuring that the industry overcomes these challenges and remains strong so it can continue to support national security requirements. Consequently, government should continue to play a strong role in promoting and sustaining the industry. Consistent and coherent policies that help the industry to gain access to foreign markets, conduct more effective R&D, and overcome its reluctance to engage in privatization projects can go a long way toward nurturing and extending the competitive advantage in the U.S. construction industry.

Ultimately, the industry’s future will depend on the quality of the choices that government and industry leaders make and how well they work together in meeting the challenges that prompted those choices. There can be no doubt that the U.S. construction industry—in partnership with the government—will succeed in overcoming these challenges, remain strong and healthy, and continue to be the bedrock of America’s economic and military might.

## **ESSAYS ON MAJOR ISSUES**

### **THE CONSTRUCTION INDUSTRY’S LABOR SHORTAGE**

*Vicki Preacher and Gregory Reaves*

The shortage of skilled labor, including craftsmen, engineers, and managers, is the most daunting challenge to the construction industry. Although the industry is in its ninth year of expansion, there are not enough skilled workers to meet the current market demand. In fact, the Bureau of Labor Statistics estimates that the construction industry needs to recruit and train 240,000 workers each year to replace those leaving the industry and to accommodate the industry’s current growth.<sup>[xx]</sup> This need far exceeds the 50,000 new workers entering the industry each year. If the current

shortfall continues, it will eventually sap the industry's strength and productivity, constrain its growth, and drive up costs.

### ***Root Causes of the Labor Shortage***

There are many reasons why the construction industry is experiencing, and will probably continue to experience, a labor shortage in both blue- and white-collar positions. The first is a combination of reality and image. In today's high-technology world, the thought of physically demanding work performed in harsh and hazardous conditions with little chance of advancement has very limited appeal. Given a booming economy, workers are opting for higher paying, more stable, and physically less intense work. At the same time, construction work is thought of only in terms of a back-breaking, dirty, low-level job performed by unskilled, uneducated people. This less than savory image motivates parents and high school guidance counselors to steer young adults away from the construction industry toward college and what they consider to be more glamorous work. Even top-end, construction-related engineering jobs are losing their appeal. According to Laurin McCracken, chief executive officer of the Global Design Alliance, an engineering headhunting firm, current engineering graduates "are all going to Hollywood or into the video game business," with more than half of all graduating engineers going into high-technology fields that are in no way related to the construction industry.<sup>[xxi]</sup>

Also contributing to the labor shortage is a poor overall training system. Construction skills cannot be learned in a classroom alone; they are acquired through a combination of on-the-job training and classroom instruction. Unfortunately, there is no structure in place for quickly and effectively training those who do enter the field. As local unions have become smaller or disappeared, so too have their training programs. Consequently, scaled-down union apprenticeship programs are unable to handle a major influx of trainees. Adding to this problem is the fact that vocational training in high schools is practically nonexistent, and there are too few nationwide training programs to turn out a substantial number of skilled workers.

The construction industry's image problem and today's booming economy further complicate the training problem by drawing more educated workers away from the construction industry. The result is that employers and unions are forced to accept less educated applicants who then need remedial education—basic reading, writing, mathematics, and English language skills—before they can even begin to learn construction skills. This overtaxes the meager training facilities currently in place and greatly slows the pace at which they can turn out trained workers.

### ***Costs of the Labor Shortage***

A Construction Industry Institute study shows that 75 percent of contractors are experiencing labor shortages that cost them time and money.<sup>[xxii]</sup> There are simply

not enough workers to keep projects on schedule, and even on some complete crews, apprentices now make up the majority of workers. Home builders alone are reporting that it takes 3–6 weeks longer to build a house today than in 1998 because of the worker shortage.<sup>[xxiii]</sup> The shortage of skilled workers is also threatening the quality of construction, as inexperienced apprentices tend to make more mistakes requiring correction. Inadequate supervision of these workers can cause some of these errors to go unrecognized or, even worse, ignored so as not to delay the project. As quality decreases, the cost of liability insurance, the cost of maintaining the structure, and the risk of injury due to catastrophic failure increase.

A second cost of the skilled labor shortage is the increase in on-the-job injuries. Construction work is inherently dangerous even for skilled workers, but poorly trained workers are at greater risk of injury on the job. These injuries further compound the labor shortage (fewer able-bodied workers) and drive up workers' compensation costs. A telling statistic of this increased risk and cost is the fact that construction accounts for only 6.4 percent of the U.S. workforce, but a third of workers' compensation costs.<sup>[xxiv]</sup>

Possibly the greatest cost of this labor shortage is the one associated with retaining quality personnel. Labor is, in fact, the limiting factor in the growth of many companies. In order for firms to take advantage of the currently favorable economic conditions, they must invest heavily in finding and keeping good workers. Increased wages and benefits needed to attract and keep skilled laborers translate directly into increased construction costs for the customer. The cumulative negative effect of the labor shortage is then to reduce quality and safety, drive up the time it takes to complete projects, limit company growth, and raise the overall costs of construction projects for the construction firm and its customer.

### ***What Industry Can Do***

The first step that the construction industry can take to mitigate the labor shortage is to try to attract more and better qualified people. In conjunction with unions and nonprofit organizations, companies should begin an aggressive campaign to court nontraditional workers, such as women and minorities, for the traditionally white male skill trades. At the same time, the industry must enhance its image; by highlighting the skills needed to become a premier craftsman, the industry can shed the notion that only those who cannot do anything else build with their hands. With respect to recruiting young adults, perhaps a model along the lines of the Air Force's "It's a Great Place to Start" campaign—accompanied by training and educational incentives—can win over uncommitted high school students.

Companies can promote the idea that people are their most important asset by building compensation and benefit packages that emphasize this. In the past, unions provided stability and job security for workers who traditionally had little company loyalty and moved from job to job. With the decline in unions, this institutional stability has been weakened. Companies must work with government, unions, and

schools to beef up local and national training facilities and make long-term commitments in education and training. Today's generation, along with educators and parents, must learn to see construction as a career, not just temporary seasonal work.

Finally, since none of these recommendations will fix the problem overnight, companies should look to integrating information technology and automating processes to fill voids left by labor shortages. Electronic data transfer, for example, could help the industry avoid the high costs associated with moving engineers and draftsmen from project to project. It could also allow firms to transfer technical work to other locations where engineers are available or the cost of such work is cheaper.

## **INFORMATION TECHNOLOGY: CHANGING THE FACE OF CONSTRUCTION**

*Catherine Doolos, Calvin H. Garner, Jr.,*

*and Sharon Richardson*

The application of information technology as a business process tool is gaining momentum in the construction industry. While the infusion of information technology in the construction industry has been slower than in other industries, senior executives are beginning to realize the economic value of the new technologies. According to a survey conducted by Barbour Index Information Services Group, "around 90% of construction industry people still use paper-based systems. . . . However, paper-based systems are on the wane in the industry. Around 60% of the 400 respondents said they expected to receive technical and product information online within the next two years."<sup>[xxv]</sup> The rationale for this change is to gain competitive advantage by improving the effectiveness of business processes.

Information technology tools enhance business processes in the areas of communication, design, project management, and training. Communication is one of the most productive uses of information technology in the construction business. Automated tools such as Internet Web sites and e-mail provide the capability for instantaneous communication between geographically dispersed owners, designers, contractors, customers, and suppliers. The consequent reduction in the time for information exchange inevitably shortens the decision cycle.

Likewise, the use of information technology design tools in the construction industry is growing by "leaps and bounds." In design techniques, for example, most drawings were produced with pen, ink, and vellum 20 years ago; now designers use AutoCAD files to create three-dimensional, photorealistic images of a building. The computer

workstation has replaced the drafting table, and new generations of computer capabilities are now measured in months, not years.[\[xxvi\]](#)

Information technology also offers tools that improve project management processes. Project management software such as Primavera Planner is applied to resource management business processes during the construction phase to manage labor allocation, material usage, and cash resources. This has the potential for tremendous savings in costs and time. Another principal means for managing projects electronically is through Web site collaboration. The project leader has the ability to input data points electronically, then to plan, schedule, and track the performance of the project with all team members—in the United States or worldwide. A survey conducted by McGraw-Hill's Construction Information Group found that more contractors are embracing the Internet as a project management tool. About 43 percent of 262 responding contractors indicated that posting project management information on the Internet is a vital component of project collaboration.[\[xxvii\]](#) Exploitation of this technology appears to be invaluable for high-intensity, short-duration projects because it facilitates quicker decisions, which save costs and time.

The entry of information technology into the company's business processes has, of course, raised employee information technology training to priority status. According to an *Engineering News-Record* survey, however, construction companies are not investing enough time and money to keep their employees current in the latest technologies. In fact, a majority of firms indicate that they bury the costs of applications software training with other general business expenses, thereby treating it as a less than critical factor.[\[xxviii\]](#) To reverse this trend, construction executives must make a commitment not just in dollars, but also in the philosophy and attitudes that will be necessary to spark the creative use of information technology.

### ***Challenges***

There remain significant barriers to the initiation of information technology. Change does not come easily, especially to those who are culturally oriented to traditional non-automated processes. It appears difficult for many construction professionals to move instrumentally from the pencil to the laptop, or philosophically from "walking around—hands-on" techniques to a "cyberspace-remote/removed" approach. An article in *The New York Times* notes, "Enthusiasts say they have noticed a shift in the attitudes of the biggest construction firms in recent months, and they hope a trickle-down effect could compel more subcontractors to catch the Web wave—or face the prospect of losing work."[\[xxix\]](#)

Among the converted, many companies are beginning to use a 24-hour, 7-day engineering, work-sharing, and decision-making process via the Internet, thereby allowing for the instantaneous transfer, review, modification, and approval of designs by project professionals dispersed worldwide. However, there are real issues and concerns about data security, systems standardization among different work groups, and the ability to successfully transfer data of significant size while maintaining the needed quality of graphics and captured images. Such concerns typically make companies hesitant to adopt information technology.

## *Outlook*

Construction industry executives are taking a role in industry migration to the Internet and the digital world. Construction is no different from any other industry: winning work is critical. Competition is tight, and executives realize that they must be in the forefront of technology to achieve and sustain a competitive advantage. A growing number of companies believe information technology is the answer and are now spending 3–6 percent of their net revenues on new technology. Most say that they are planning to increase spending in the future.[\[xxx\]](#)

How should the construction industry focus future spending on information technology? A first priority for large projects, with many sites dispersed around the globe, is standard application platforms for interoperable communication among all team members. For example, some construction companies are creating standard setups (computer hardware and software) so that the information technology staff can quickly pre-package an entire network system and ship it to the field. This standardization among global team members is an emerging trend that other companies should follow.

Another focus area for construction companies—large or small—is the government’s electronic bid process. The industry currently uses a mixture of electronic and manual processes. However, information systems that make use of new technology to capture the entire solicitation process are foreseeable. Such systems will create a virtual environment in which contracting officers can post documents and update information from any point in the world with Internet access. A major return on investment can be expected from such a system, for it will substantially simplify, and shorten, the administrative procurement process.

Simulation modeling, another application on the cutting edge of technology, can be used to improve project design processes. Such modeling permits the assessment of a change prior to its physical implementation, thus avoiding costly mistakes and rework. It can also be used both as a training aid and as a tool for experimenting with organizational changes and new working practices. A major advantage of simulations is that they permit an organization to conduct risk-free “what if” scenarios. This ability is most effective in creating a more efficient and effective organization.[\[xxxi\]](#)

**Conclusions.** The construction industry is slowly, but steadily, increasing its use of information technology systems. To remain competitive, construction companies must incorporate these new technologies or face an uncertain future in which competitors—who use information technology to improve their businesses—will have an advantage and outperform them. Many companies are embracing new tools, such as collaborative systems, electronic contracting, and simulation modeling. Although there are barriers to overcome, the current business environment—fast-paced, profit-oriented, and customer-motivated—will drive companies to improve

their processes to remain viable and competitive. Information technology holds great promise as a means of increasing construction industry productivity.

## CONSTRUCTION AND THE GLOBAL MARKET

*Jacob Wilkins*

A recent study of the most fertile market for tomorrow's U.S. construction industry concluded that it, in fact, lies in the United States. A rather modest annual growth in construction spending is more than compensated for by its sheer volume—ranking first internationally, with 1999 revenues of nearly \$900 billion. The soundness of its economy and governing laws also make the United States the least risky market. The study also found lucrative opportunities in national markets of moderate size and growth and low risk, such as France, Germany, Portugal, Greece, and Sweden. Large markets such as Japan, China, and Korea are made less attractive by protectionism and economic uncertainty.

### *U.S. Market and Foreign Competition*

Foreign company penetration of the U.S. construction market has been modest. This scarcity of foreign contractors building in the United States can be explained in terms of building standards and divergent opinions on business ethics. China's Haier Group, which planned construction of as many as seven factories in South Carolina, provided a vivid example of this last year. The firm proved woefully unprepared for environmental protection, occupational safety, and electrical safety codes and requirements, casting doubt on whether any construction will be undertaken. Foreign firms also have a notorious record of U.S.-defined ethical violations. Most recently, a prominent French bridge builder was indicted by a federal grand jury in Boston for rigging bids on the Central Artery Tunnel project.[\[xxxii\]](#) Representatives pointed out that the firm had broken no French law.

Several major foreign firms have proven effective in penetrating the U.S. construction market, and it appears that the strategy of choice is buyout. France's Vivendi recently acquired proven performer U.S. Filter and, through that firm, has bid on several water sector contracts. Last year, Germany's Hochtief Ag agreed to buy up common shares of the New York-based Turner Corporation. Such takeovers are largely friendly, with the foreign firm keeping its purchase intact, and using its expertise in local codes, regulations, and business practices to function effectively in

the U.S. market.

### ***Overseas Market and the U.S. Industry***

While domestic business dwarfs its overseas construction, the United States is the world leader in building abroad. In 1998, the United States received more foreign construction revenues than all Western European firms combined. In particular, U.S. project design is the world leader by a wide margin; in 1998, 43 percent of all major projects worldwide used U.S. designers. In a time of economic uncertainty abroad, the U.S. construction industry offers not only refined expertise, but also a new philosophy, which lessens owner risk. Furthermore, U.S. designers have embraced the “total solution” concept, in which forged “strategic alliances” provide owners with not just designers, but project developers as well.

Whereas foreign firms prefer to penetrate the U.S. market through buyouts, it appears that U.S. builders as a whole find success by creating overseas partnerships. This is notably the case in Western Europe and, to a lesser extent, South Asia.

### ***Privatization—An Emerging Reality Overseas***

Another important global trend affecting the construction industry is the privatization of public infrastructure. In countries at every stage of development, national and local governments—the traditional sources of infrastructure investment—are now driven by the lack of resources and the need for better and more efficient services to seek private sector involvement in infrastructure development. At present, there are nearly 800 privately financed infrastructure projects valued at over \$530 billion in various stages of development in 68 countries worldwide.<sup>[xxxiii]</sup> Privatization efforts are most advanced in Western Europe and East Asia. However, Latin America is moving quickly and aggressively to privatize its new infrastructure development.

Significant opportunities exist for increasing the U.S. construction industry’s share of the global privatization market. Latin America will likely offer the best opportunities due to its proximity, laws that protect investors, and growing governmental commitment to the privatization effort. To better compete in the global market, however, the U.S. construction industry will have to recognize that construction delivery is no longer viewed as simply constructing a “facility,” but rather as creating long-term value for an owner. Clients increasingly expect the builder’s commitment to encompass the entire life cycle from financing and design to construction and operation.

### ***Conclusions***

World dynamics of the past decade have profoundly changed the marketplace for U.S. construction, and changes continue. The U.S. construction industry has adapted to the uncertainties of the global economy by adopting nontraditional, streamlined delivery strategies that shift risk away from owners and create incentives for contractors. Prejudices against foreign contractors are circumvented by forging “strategic partnerships” with reputable host country firms. Foreign competitors are beginning to embrace progressive strategies, however, and promise stiff competition in the future. In addition, the growing global trend toward the privatization of infrastructure development poses a new challenge for the industry: adapt to the needs of a changing world, and continue to lead in construction innovation.

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