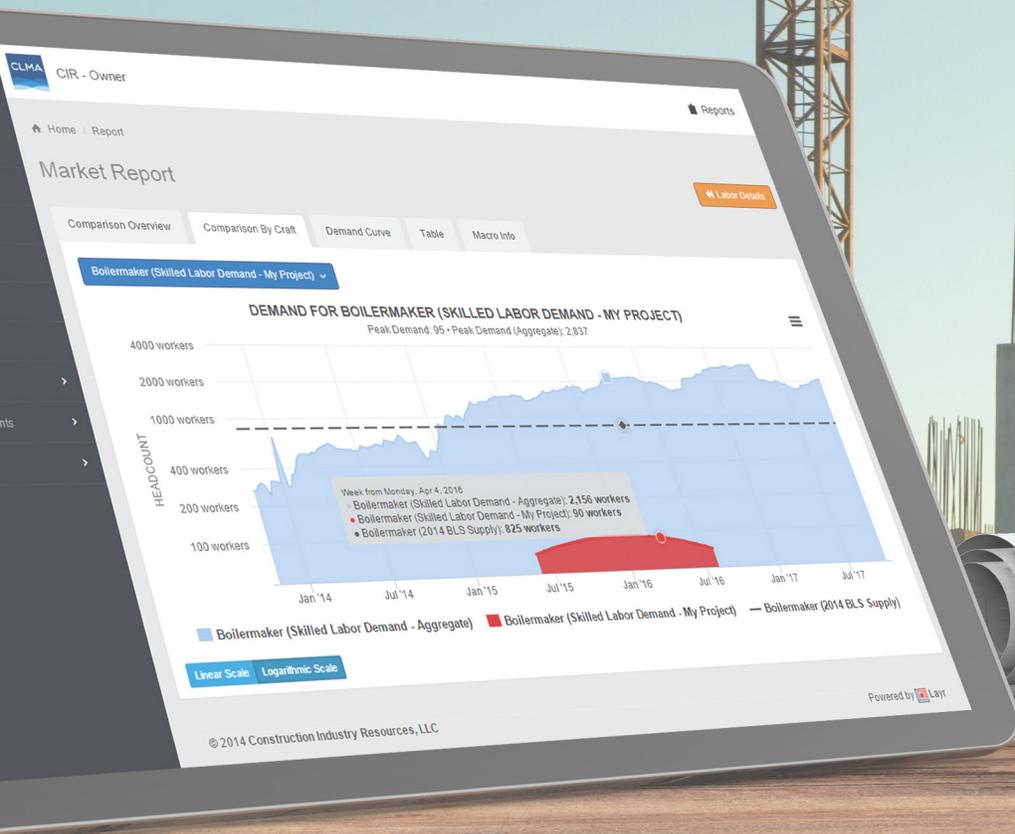




# Construction Productivity in an Imbalanced Labor Market





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## EXECUTIVE SUMMARY

The Construction Labor Market Analyzer (CLMA®) projects about \$3.5 trillion in non-residential construction activity across the United States through 2020. Peak labor demand to support this level of activity is estimated at more than 5.7 million workers. Yet, it is also estimated that the expected construction workforce during this period will peak at 4.7 million, equating to a very challenging potential shortfall of about 1 million workers.

Further, the decline of labor productivity over the past several decades essentially means that worsening labor shortages in the future are not likely to be sufficiently offset by the construction industry's deployment of automation and/or other labor-saving technology. Hindering productivity improvement further is the industry's inconsistent approach to the methodology by which it is measured - real improvement must be predicated on accepted metrics and standards.

Serious labor market challenges are addressed in this white paper, which are based on extensive industry surveys conducted over the past several years and CLMA® market supply/demand data. It discusses craft labor productivity trends and illustrates the short and long-term impact that anticipated labor shortfalls will have on the construction industry.

### SUMMARY OF FINDINGS

Following are noteworthy highlights from the full report:

***Productivity: A Historical Perspective...*** when compared to other major industries such as manufacturing, construction productivity has remained flat, or even in decline, over the past 60 years. Of the myriad reasons identified, here are a few:

- The construction industry today is essentially doing the same work in the United States, using U.S. materials and U.S. labor
- Unlike other industries, construction has not benefited from advances in automation that enables more work with fewer resources
- Lean construction has not yet gained enough of a foothold to make an impact on U.S. productivity

***Construction Productivity Today...*** data from multiple surveys confirm that the productivity situation has not changed for the better. Consider:

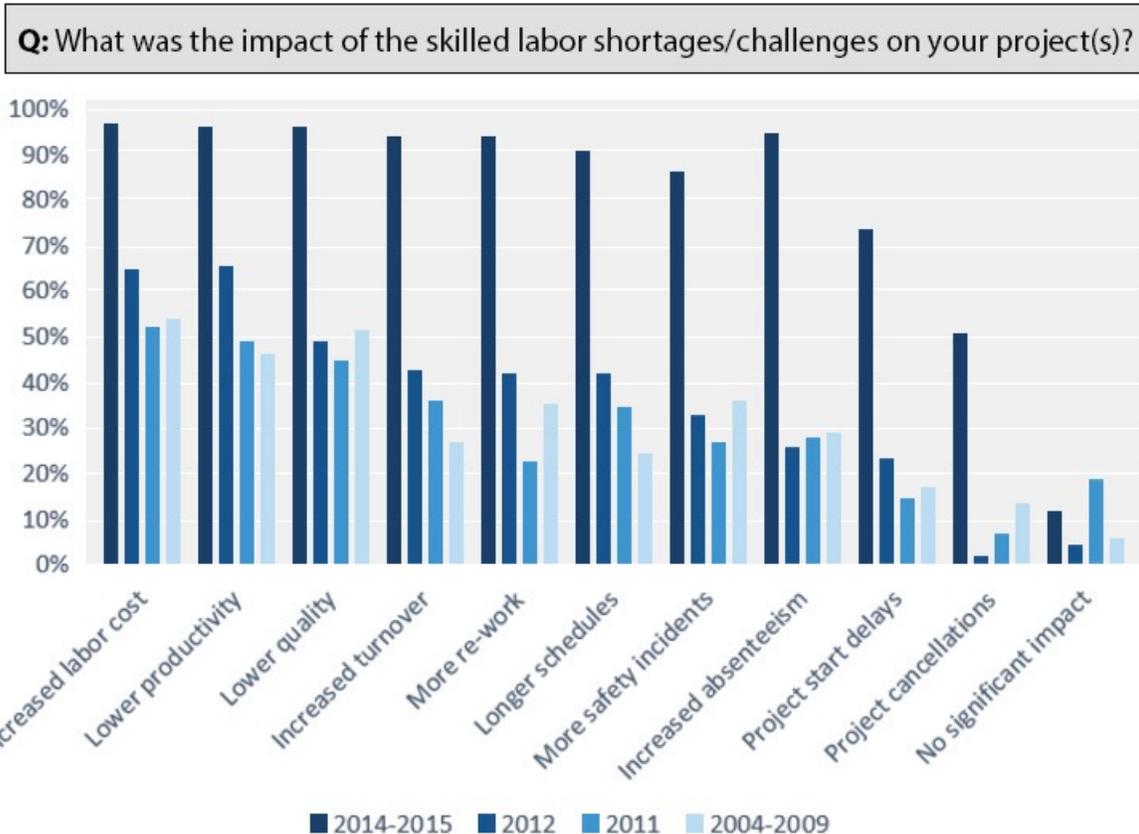
- 49% of owners, contractors and unions are seeing a decrease in overall productivity with an additional 22% seeing no improvement in already poor productivity factors
- The majority of those citing decreased productivity estimate the range of those decreases to be up to 10%, with many reporting substantially higher decreases

- Perceptions of productivity decline and related severity tend to correlate to areas with the most acute labor challenges, specifically the southeast and Gulf Coast regions

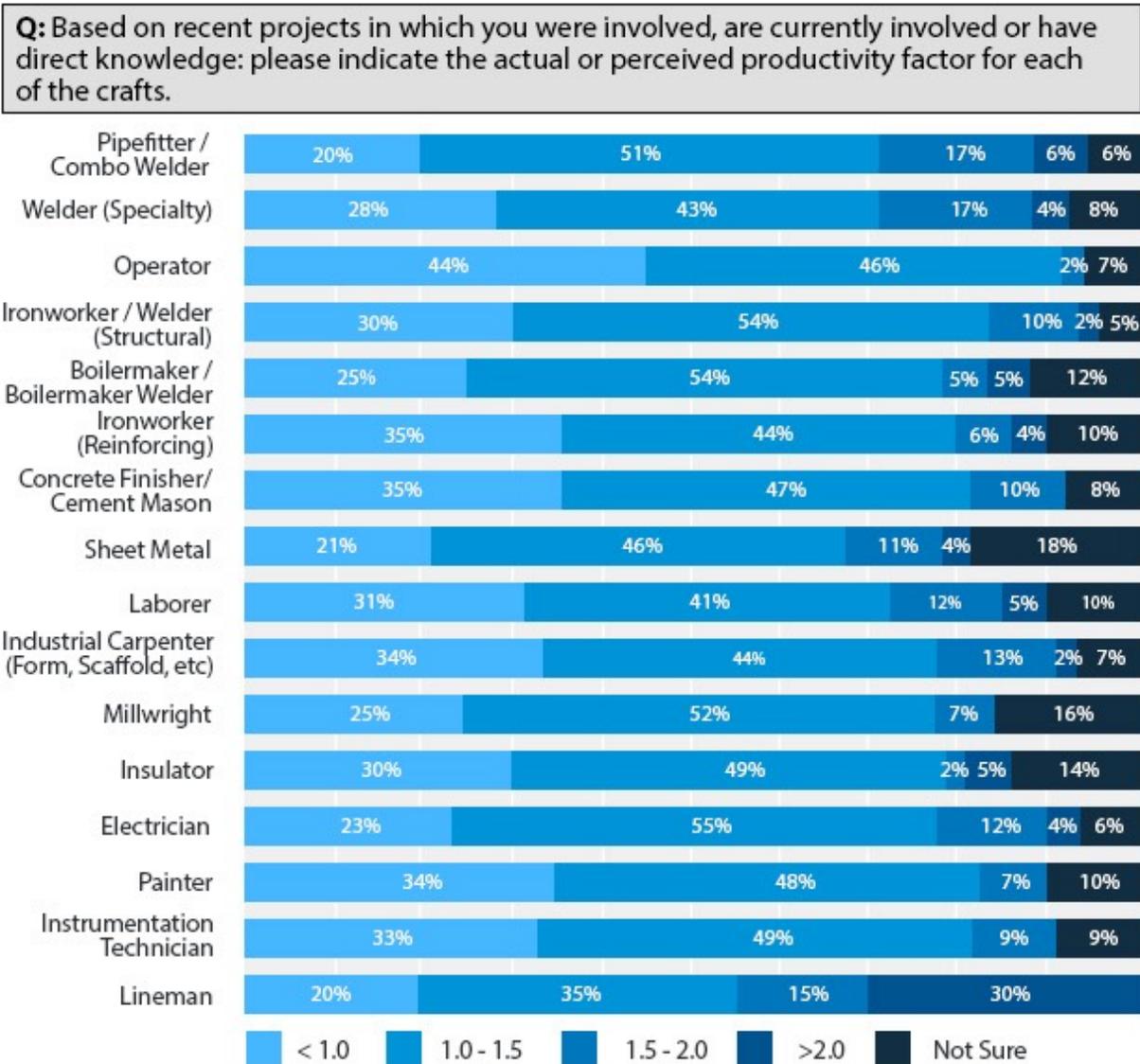
**Productivity and Project Outcomes...** the data demonstrates that poor productivity usually translates to poor project outcomes. This is particularly true in three areas:

- Worker safety
- Project deadlines
- Overall quality

**Impact of Skilled Labor Shortages on Productivity...** while labor shortages are a significant problem industry-wide, they are most severe in the Southeast and, in particular, the Gulf Coast region (TX, LA). Labor shortages are a clear leading indicator of poor productivity. The chart below shows how labor shortages have impacted construction over the past decade or so and demonstrates how the labor shortages in this post-recession expansion have impacted project outcomes even more seriously than before. A much larger construction constituency now reports being impacted and additional data shows an increasing severity of the impact.



The chart below illustrates how these shortages translate to productivity declines, by skill discipline, in the most challenged region, the Gulf Coast:



**Mitigating Project Risk...** this document explores a number of solutions to mitigate project risk, such as:

- Conducting thorough risk assessments prior to starting a project
- Moving work off-site to areas with more craft worker supply
- Planning labor shortages into the budgeting process



***Improving Productivity***... in addition, this document includes a number of suggestions to improve productivity in the face of anticipated labor shortages. Recommendations include:

- Exploring Lean Construction principles
- Developing high performance work systems
- Effective Front-End Loading (FEL) and risk planning

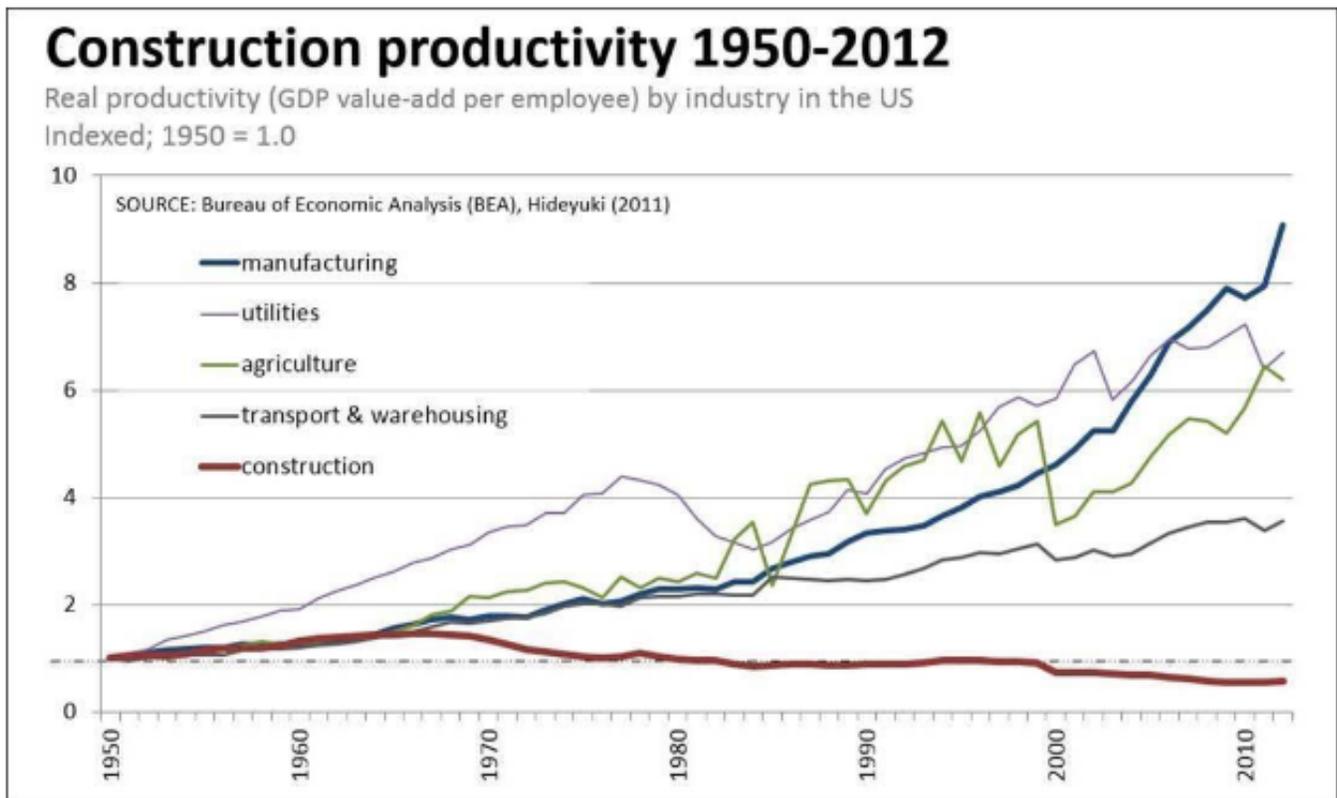
Effective risk management, workforce growth strategies and the capacity to accomplish the same or more work with fewer workers are all needed. The industry has the ability to deliver, but it must also summon the urgency to respond quickly rather than react to crisis.

## Introduction

Construction productivity in the United States is in a challenging place. Actual project productivity data along with quantitative and qualitative information through interviews and survey feedback indicate that overall skilled labor productivity has been in decline and does not appear to be abating. A number of factors have contributed to this, including the construction industry’s reticence to change, skilled labor shortages, insufficient training, construction owners handing off projects to construction without completed scope, and more. This document addresses productivity from a historical perspective as well as the current state of productivity in the construction industry and concludes with some recommendations on how to move forward.

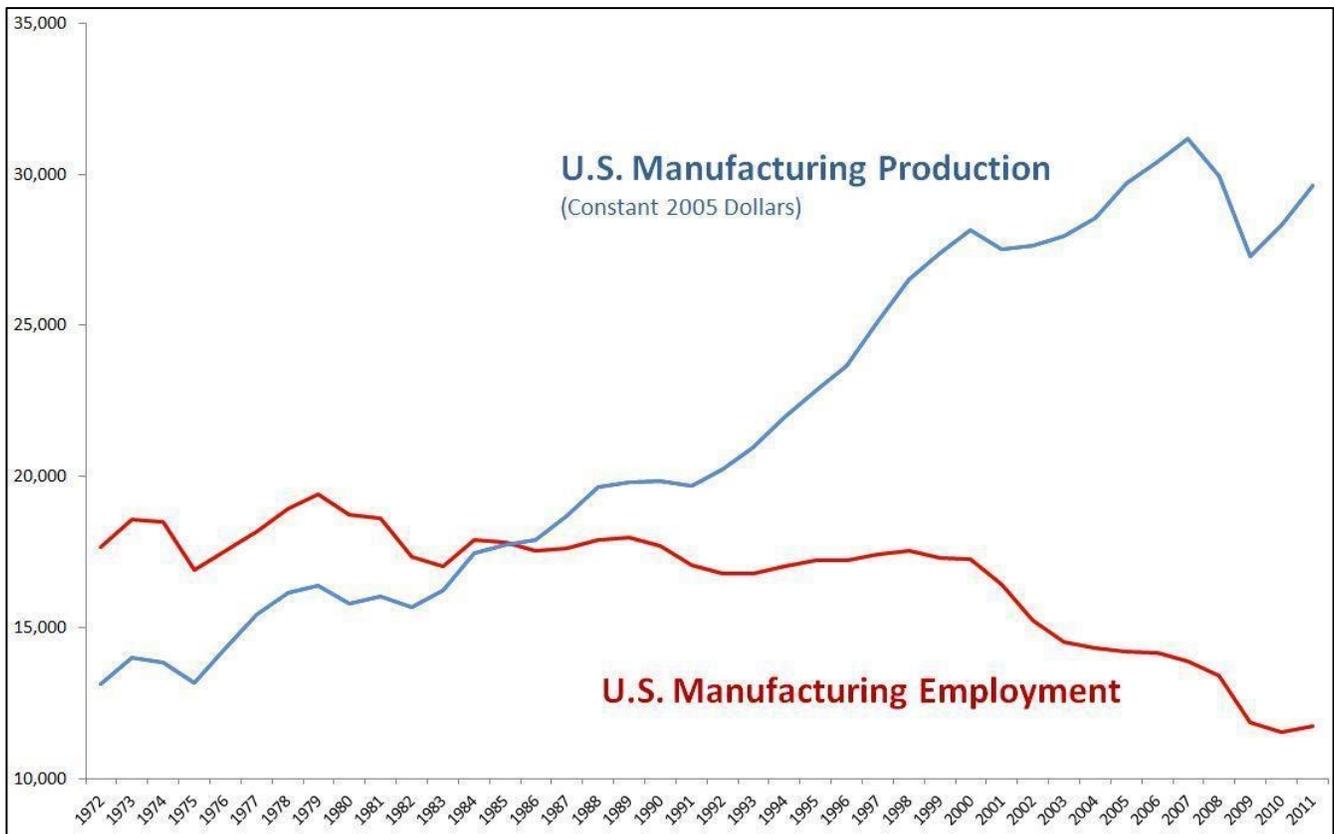
## Productivity Historically – Improvement vs. Decline

When viewing United States construction productivity historically, as we do in this chart below, it seems clear that while other industries thrive with higher production rates and lower labor needs, productivity in the construction industry has remained relatively stagnant at best, if not decreasing, since 1950. This chart is a macro look at total industry productivity based on the total value of the products produced (eg. GDP) divided by the hours worked in the industry (eg. Social Security hours reported by all employers for the industry they are in).



The chart is not a measure of output or productivity for an individual worker, but it does speak volumes about how each industry has performed to produce a total value with fewer people.

First, let's look at manufacturing which, while not fully comparable, is the industry often compared with the construction industry. To help illustrate the point, here is a chart with similar data in a slightly different format.



Contrary to popular myth, the total value of U.S. manufacturing is soaring. But, at the same time, the total employment is dropping. The result is higher productivity for the industry. What has been done in manufacturing to achieve this productivity improvement?

- High manual operations, which are difficult to automate and require a lot of labor to produce low-value products (clothing, toys, etc.), has been exported to other countries with lower labor costs. Therefore, most of the low productivity products are now manufactured outside of the U.S. and are no longer reported in the charts above. Yet, while they had low value and didn't impact the value curve much, they did have a significant impact on the employment curve.

- What are left in U.S. manufacturing are mostly high value products (equipment, automobiles, defense equipment, airplanes, etc.) that required less labor per unit. So these add a lot to the value of the product with lower labor use.
- In those areas of high-value, the manufacturing process is now highly automated through computers, robots, CNC machines, etc. Therefore, they get even more value from less labor.
- Most of U.S. manufacturing has embraced the principles of Total Quality and Lean Manufacturing in the work processes driving out rework and waste. Because rework and unnecessary work has been eliminated, direct work is at extremely high levels. In many companies, this is a policy, not optional or decided on a site-by-site basis.
- Most of U.S. manufacturing has adopted modern industrial relations models (high-performance work systems) which make individual workers more responsible and accountable and reduces the need for layers of supervision.
- Most U.S. manufacturing companies have extensive supply chain relationships which optimize the total efficiency of all the elements for the supply and installation of materials and components.
- In most manufacturing plants, the right materials or components are delivered directly to the individual's worksite on a timely basis (E.g. Just-in-time) making installation efficient.

The result of these improvements is that the U.S. manufacturing productivity (total value/total hours) has improved significantly.

Now, let's compare to the construction industry:

- Basically, still doing the same work. Except for minor examples, usually involving modular units, most of the value is still produced in the United States with U.S. labor.
- Much of the work continues to be low value/high labor and difficult to automate (concrete, bricklaying, steel erection, etc.).
- We have better tools, not much automation.
- Lean Construction is still something most companies try but few adopt corporately as an expectation of all workers.
- Few companies have adopted any modern industrial relations approaches and still rely on layers of supervision to complete projects.
- Rework is still significant and considered normal. While an effort is usually focused on who caused the rework, the no-value/high labor impact is captured in these curves.

- Direct work is only 40-60% of total hours on the project.
- Materials are stored in warehouses and lay down areas; therefore, hours are added for workers to find and transport the materials to the worksite. Materials are lost, stolen, damaged and result in delays and lost time.
- Much project construction work is done on overtime. Since it is high manual work, this frequently requires more hours to complete the same installation.
- The industry still deals with high levels of change throughout the construction process requiring more delays, rework, etc.
- In some cases, the engineering products are incomplete or in error at the time construction commences, resulting in delays, rework, etc.

The result of this lack of improvement is that there has been minor, inconsequential change in the reported productivity of the construction industry over the years.

For the construction industry to make significant progress on productivity on this chart, leadership needs to adopt a different approach to project execution and think in terms of how projects can be built with significantly less labor.

This is also critical to how the construction industry can survive the current and impending labor shortage. More work must be done with less labor. Steps have been taken in the right direction (E.g. Off-site fabrication, modularization, smart engineering models, collaboration, Lean Construction, workforce planning, etc.) but these efforts must be institutionalized, not optional.

## Productivity Today – A Marketplace View

In an effort to capture and understand current marketplace perceptions related to construction productivity, Construction Industry Resources (CIR, a.k.a. CLMA®) and the Construction Users Roundtable (CURT) have teamed up to administer annual construction marketplace surveys. Similar questions asked each year have enabled trends to be established showing that construction continues to struggle with low productivity and labor shortages across the country without much actual or perceived improvement.

### Productivity Survey Background

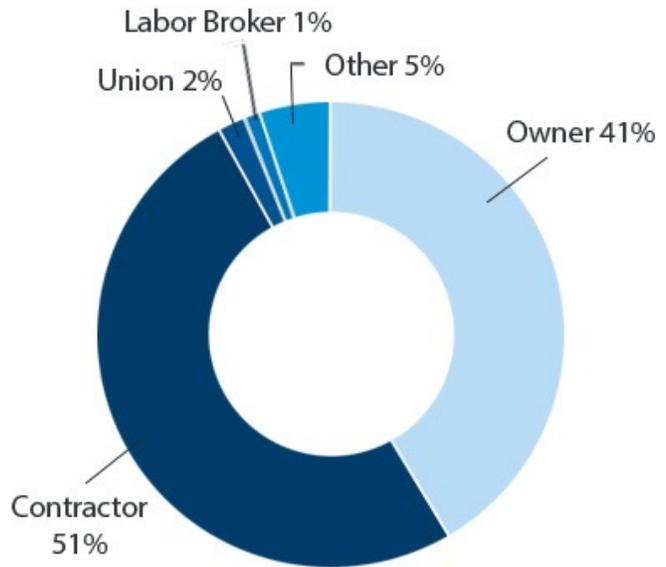
In early 2015, CLMA® administered the first annual productivity survey to owners and contractors to begin establishing industry trends from 2014 forward vis-a-vis productivity and labor shortages. The results of the 2014 survey are available in an earlier report. As a follow-up to that survey, another survey was completed in February 2016 to gain perspective for 2015 as

well as evaluate the change from 2014 to 2015. The most recent effort again surveyed owners and contractors, but also included labor unions and brokers. This report is based on the 2016 survey results with certain elements of prior research also included.

Findings concluded that owner issues today mirror those described from an historical perspective in the construction industry, a long-term productivity issue without much change and, in some areas, a trend towards decline.

Of those responding to the survey, a majority of the organization roles in the construction industry were either owner (42%) or contractor (51%). The other category also included some large engineering organizations. In addition, companies surveyed were asked to indicate their most likely labor posture – open shop, union, or merit shop. As shown in this chart, the respondents were balanced between open shop and union labor, making contracting approach business decisions based on the most advantageous position for their company.

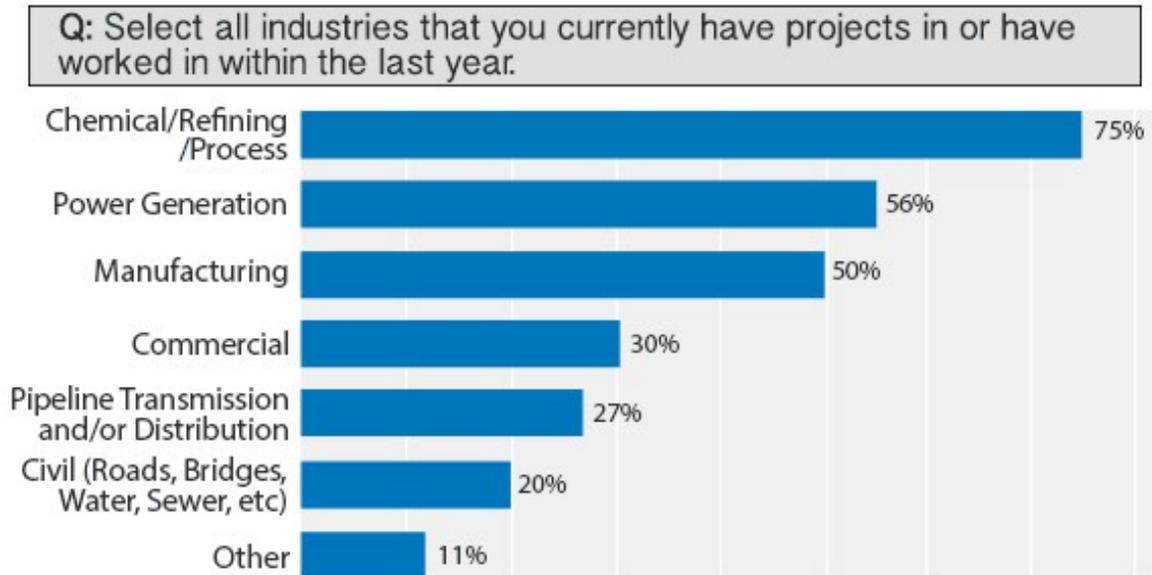
**Q: What is your organization's role in the construction industry?**



**Q: What is your organization's primary workforce labor posture?**



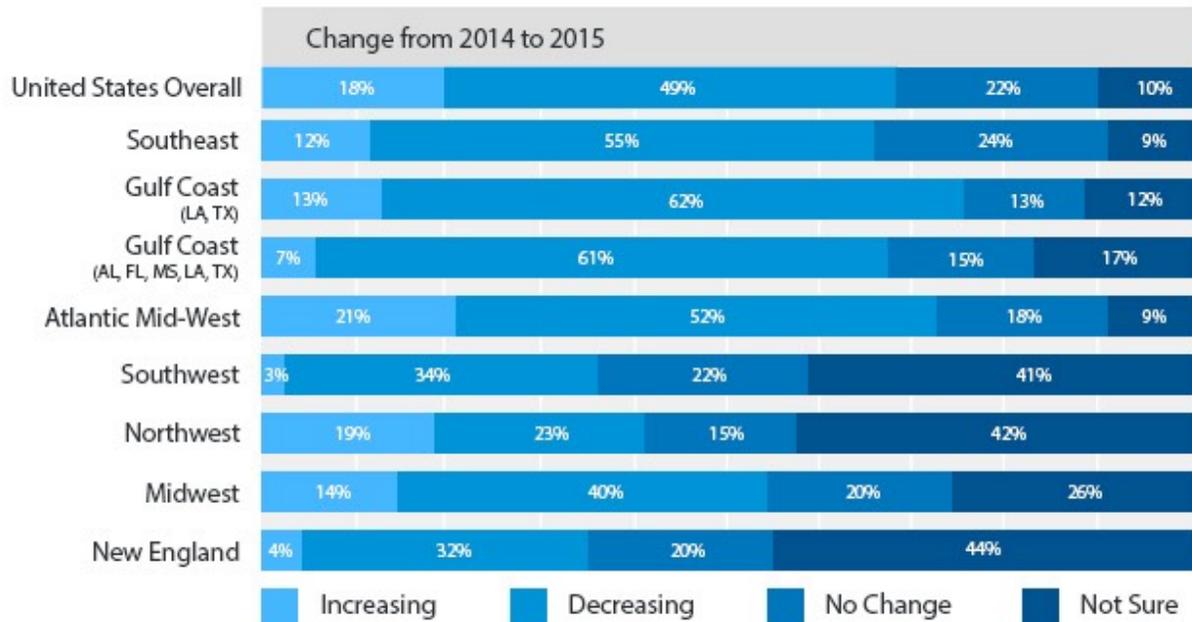
The survey further reflects the predominance of heavy industrial construction driven by oil and gas exploration, market opportunity and cheap feedstock prices. In 2015, 75% of companies surveyed had projects in the Chemical/Refining/Process industry followed by Power Generation at a relatively distant 56%. This is about the same position as in 2014 when growth in these markets began to be quite heated.



### Productivity Survey Results

As discussed in the earlier section on historical productivity, the construction industry has seen little increase in productivity since 1950. In the CLMA® survey, respondents were asked to evaluate actual or perceived overall productivity circumstances by region based on their own projects and/or projects for which they have direct knowledge. The results in the following charts validate the same productivity trend.

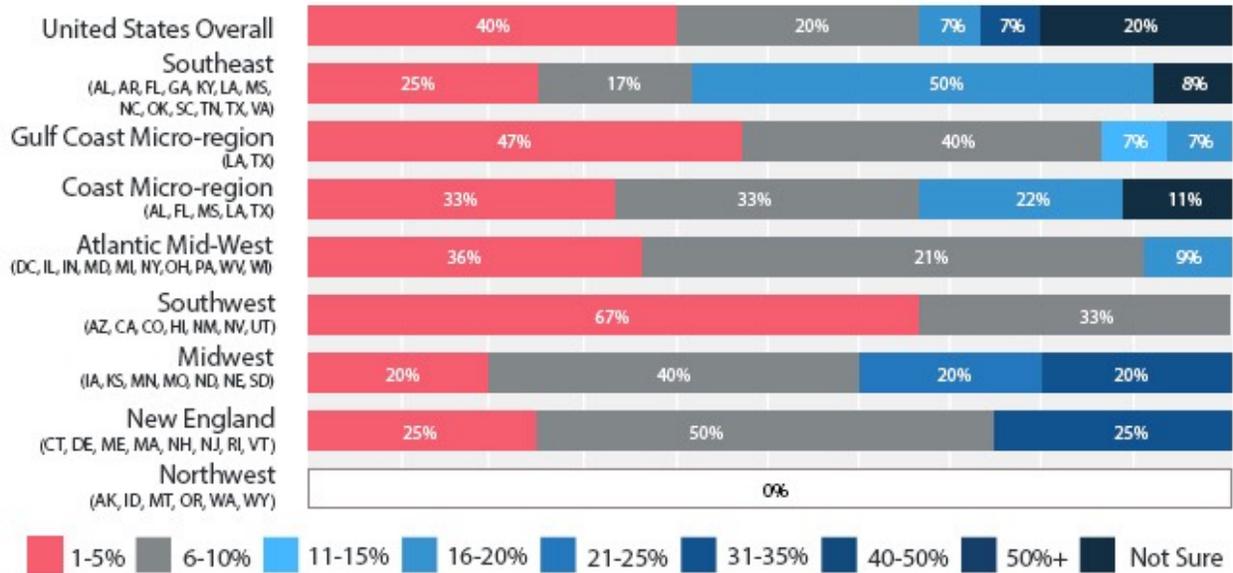
**Q:** Based on recent projects in which you were involved, are currently involved or have direct knowledge; please indicate the actual or perceived overall productivity circumstances in the following U.S. regions.



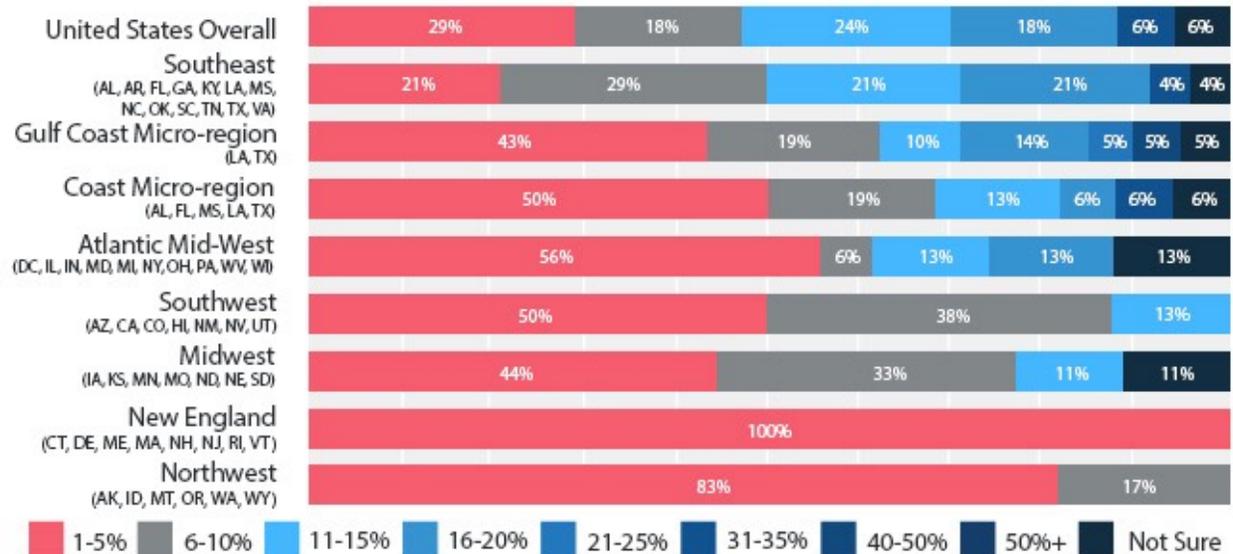
As indicated in the charts above, 49% of respondents (owners and contractors) indicated that the United States overall was seeing a decrease in overall productivity. Further, in five of the eight specific regions, a majority of respondents said productivity in those areas was decreasing – Southeast, Gulf Coast, Atlantic Mid-West, and Midwest – correlating to ongoing labor issues.

Next, we asked the owners and contractors who indicated a decrease how much productivity has decreased on their projects. Below are separate charts for the owner and contractor responses.

**Q: Based on recent projects in which you were involved, are currently involved or have direct knowledge; please indicate the actual or perceived overall productivity decreases in the following U.S. regions from 2014 to 2015: Owners**

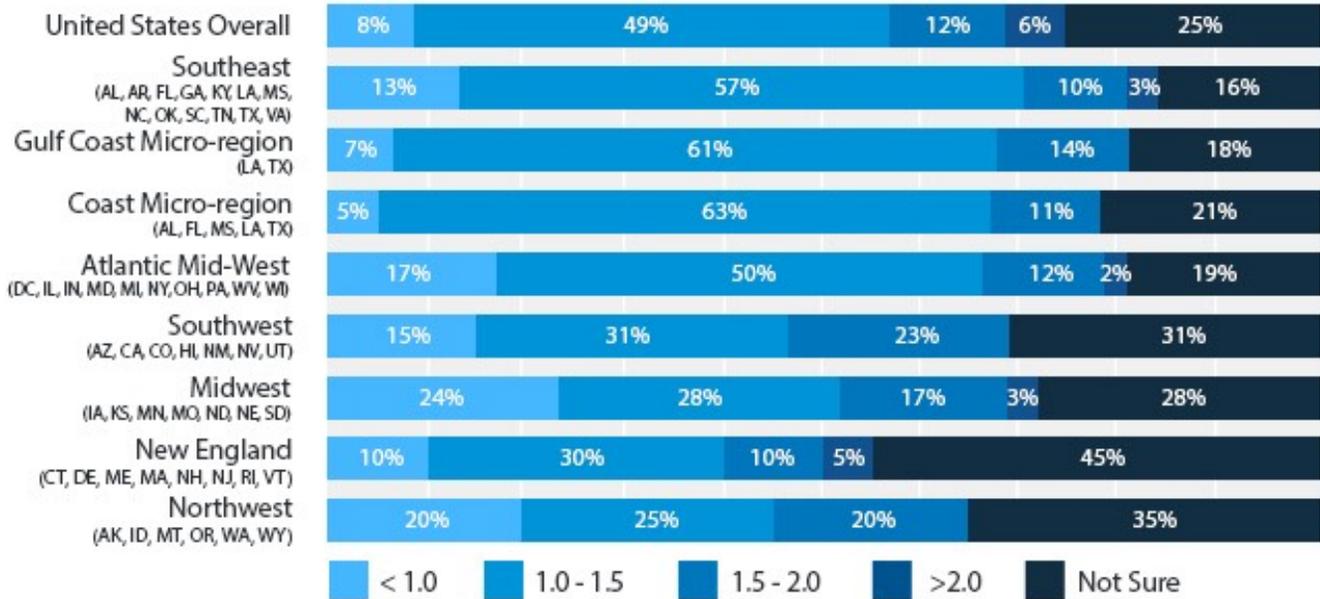


**Q: Based on recent projects in which you were involved, are currently involved or have direct knowledge; please indicate the actual or perceived overall productivity decreases in the following U.S. regions from 2014 to 2015: Contractors**



Of those respondents who indicated decreasing productivity, the vast majority stated that they believed productivity was decreasing up to 10%, although certain regions show greater decreases.

**Q:** Based on recent projects in which you are currently involved, or have direct knowledge; please indicate the actual or perceived overall productivity factors for the following U.S. regions. (<1 = high productivity)

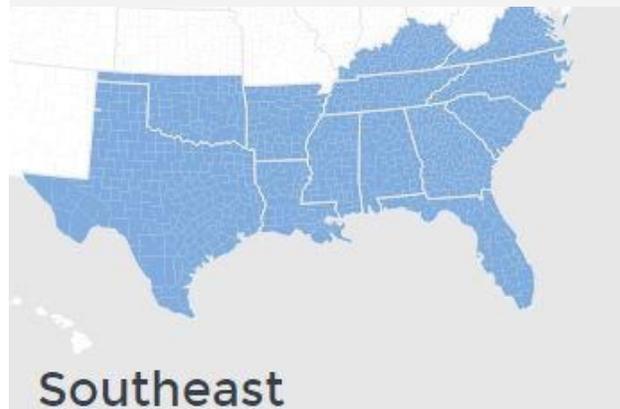


Why does productivity seem to be on the decline?

One reason in particular is the declining skilled workforce. The CLMA® tracks peak demand relative to base construction employment for every state and also rolls up the data into various regions. In the following three base-to-peak (B2P) tables, the workforce challenges for the southeastern United States is illustrated for the most skilled and in demand craft disciplines. Not every area of the country experienced the same severity of skills deficit; however, the southeast more broadly and the Gulf Coast in particular were seriously impacted.

In the table below, which reflects the 13-state CLMA® southeastern region, the data as of the first quarter of 2016 indicates a continual

**Note:** During the period of time for which this survey relates, productivity decline worsened at the same time labor shortages were increasing and as post-recession construction growth intensified.



challenge in the capacity of project stakeholders to find a sufficient number of workers to meet demand. This table correlates base employment to peak demand for all non-residential construction project activity as well as for the industrial construction market specifically. The industrial supply data is calculated by applying CLMA® industrial factors to the base Bureau of Labor Statistics data to account specifically for workers who are engaged on industrial-type projects, such as chemical facilities, refineries, manufacturing and power generation.

Comparison of Base Employment to Peak Demand: Southeast Region								
Traditional Construction Occupation Title	BLS Base Supply	Industrial Supply	Peak Demand (All)	Peak Demand (Industrial)	Peak Period (All)	Peak Period (Industrial)	B2P Rank	
							All	Ind.
Boilermaker / Boilermaker Welder	7,320	6,588	16,100	16,100	Apr-16	Apr-16	3	3
Electrician	199,290	39,858	134,315	36,037	Apr-17	Apr-16	1	1
Instrumentation Technician	13,650	12,285	11,368	11,368	Jul-18	Jul-18	1	2
Insulator	13,990	10,493	46,887	21,230	Jul-18	Jul-18	3	3
Ironworker (Reinforcing)	7,320	5,856	47,028	18,025	Jul-17	Jul-17	3	3
Ironworker / Welder (Structural)	24,020	21,618	76,382	18,234	Apr-16	Apr-16	3	1
Millwright	13,800	12,420	26,963	26,963	Apr-18	Apr-18	3	3
Operator (Heavy Crane)	13,540	8,801	8,226	6,854	Apr-16	Apr-16	1	1
Operator (Heavy Equipment)	172,610	51,783	162,151	10,362	Jul-18	Apr-17	2	1
Pipefitter & Combo Welder	129,920	38,976	82,362	46,323	Jul-18	Jul-18	1	3

A B2P ranking of 1 indicates a low probability of labor shortages, whereas rankings of 2 or 3 reflect likelihood or current labor imbalances. When aggregating the data for a broad 13-state region, as shown in the table above, the issues may not always be as apparent. Therefore, it is essential to have the capacity to examine craft supply and demand data as granular a level as possible.

Because of the known challenges in the Gulf Coast region, below we drill down to a tighter area that covers the coastal areas of Texas, Louisiana, Mississippi, Alabama and Florida. Within this region, we see that labor shortages are current, severe and persistent based on the resident workforce relative to the post-recession demand.



## Comparison of Base Employment to Peak Demand: Gulf Coast (All) Region

Traditional Construction Occupation Title	BLS Base Supply	Industrial Supply	Peak Demand (All)	Peak Demand (Industrial)	Peak Period (All)	Peak Period (Industrial)	B2P Rank	
							All	Ind.
Boilermaker / Boilermaker Welder	1,700	1,530	8,117	8,117	Apr-18	Apr-18	3	3
Electrician	43,537	8,707	48,739	22,215	Apr-17	Apr-18	3	3
Instrumentation Technician	1,938	1,744	7,937	7,937	Jul-18	Jul-18	3	3
Insulator	3,882	2,912	18,616	13,134	Jul-16	Jul-16	3	3
Ironworker (Reinforcing)	2,132	1,706	15,483	8,420	Apr-17	Apr-17	3	3
Ironworker / Welder (Structural)	6,418	5,776	27,481	10,728	Jan-17	Apr-16	3	3
Millwright	9,254	8,329	16,144	16,144	Jan-18	Jan-18	3	3
Operator (Heavy Crane)	6,666	4,333	3,987	3,508	Jan-18	Jan-18	1	1
Operator (Heavy Equipment)	33,100	9,930	38,844	4,351	Oct-16	Apr-17	3	1
Pipefitter & Combo Welder	28,623	8,587	39,170	30,680	Jul-18	Jul-18	3	3

An even deeper dive into the region covering the coastal areas of Texas and Louisiana presents compelling evidence that labor shortages are again current, severe and persistent based on the resident workforce relative to the post-recession demand. This is not to suggest that work is not being completed, but it does speak to the impact of having to bring in travelers, which contributes to higher cost and higher risk of losing workers to another project for an attractive incentive such as higher base pay or more overtime.

The B2P tables above reflect CLMA® projected labor risk challenges through 2018; however, these challenges have been consistent over the past several post-recessionary years and have progressively worsened as the construction economy improved and commodity prices skyrocketed. If anything, labor risk in the near term looks to be a bit less severe as some projects in high-demand regions have seen their schedules moved to the right and in limited cases cancelled.



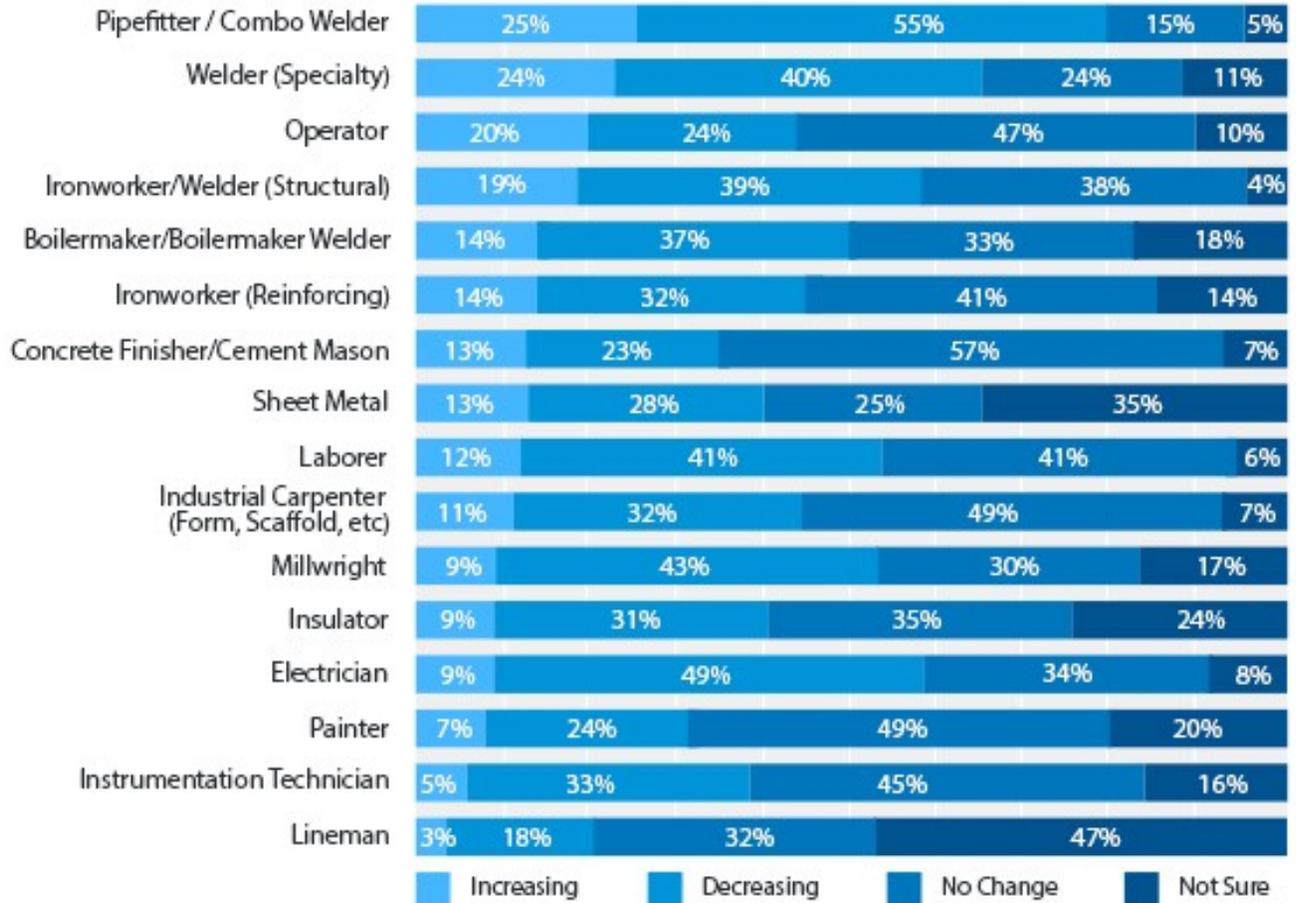
## Comparison of Base Employment to Peak Demand: Gulf Coast (TX & LA) Region

Traditional Construction Occupation Title	BLS Base Supply	Industrial Supply	Peak Demand (All)	Peak Demand (Industrial)	Peak Period (All)	Peak Period (Industrial)	B2P Rank	
							All	Ind.
Boilermaker / Boilermaker Welder	1,525	1,373	7,104	7,104	Apr-18	Apr-18	3	3
Electrician	25,466	5,093	36,445	18,193	Apr-17	Apr-16	3	3
Instrumentation Technician	998	898	6,383	6,383	Jul-18	Jul-18	3	3
Insulator	3,138	2,354	14,781	11,894	Jul-16	Jul-16	3	3
Ironworker (Reinforcing)	1,797	1,438	9,576	6,368	Apr-17	Apr-17	3	3
Ironworker / Welder (Structural)	4,678	4,210	20,796	9,164	Jan-17	Apr-16	3	3
Millwright	7,201	6,481	13,120	13,120	Jan-18	Jan-18	3	3
Operator (Heavy Crane)	5,227	3,398	3,412	3,124	Apr-16	Apr-16	1	2
Operator (Heavy Equipment)	22,224	6,667	24,247	3,644	Oct-16	Apr-17	2	1
Pipefitter & Combo Welder	17,415	5,225	29,816	25,483	Jul-18	Jul-18	3	3

To further buttress the position stated above that labor shortages produce productivity decline, our survey asked to indicate how productivity for each craft has changed over the period of time from 2014 to 2015.

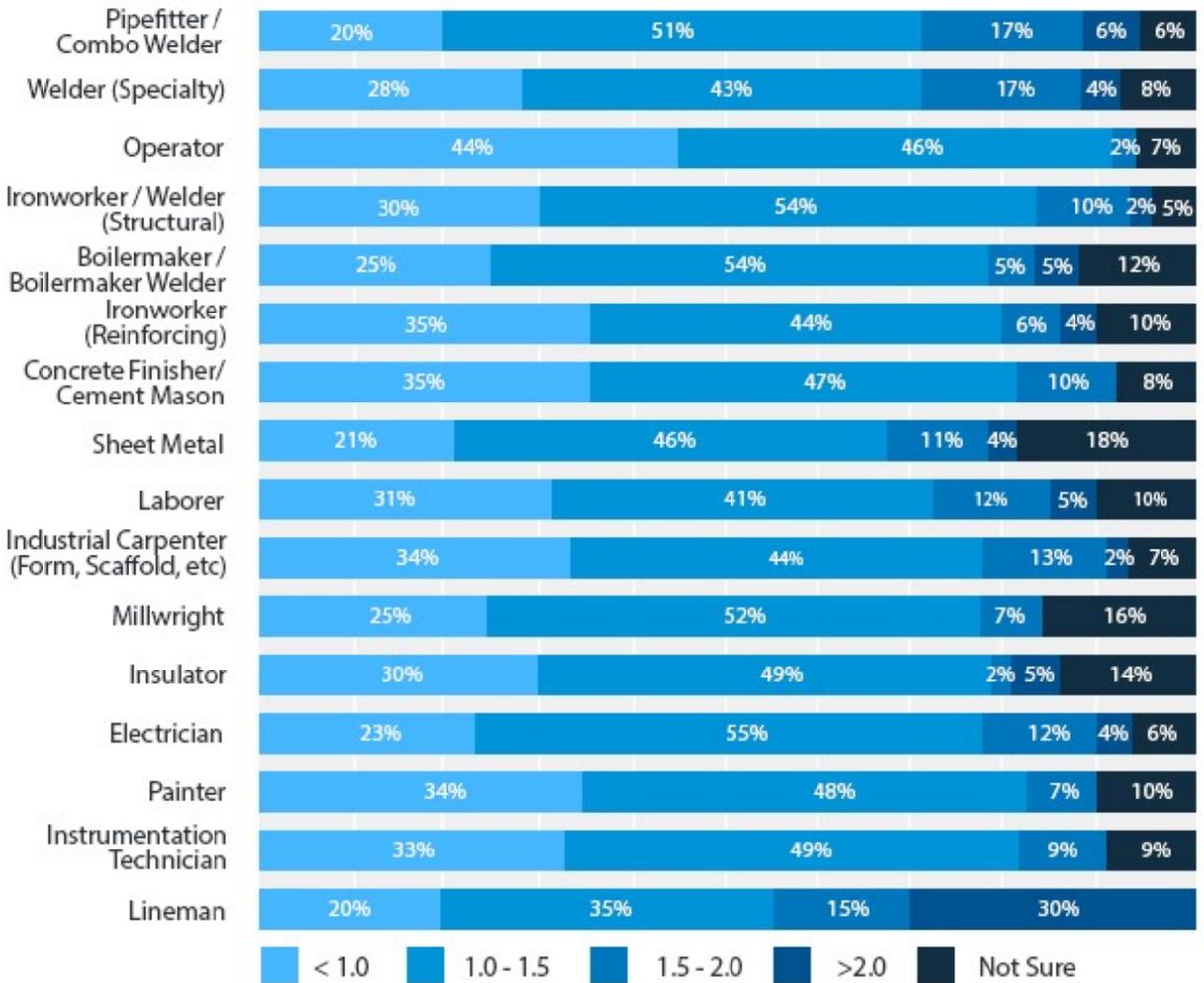
The chart below shows owner, contractor and union perceptions about the percent increase or decrease in productivity for the skilled crafts more acutely in demand and imbalanced. For nearly every discipline, there is a general perception that productivity is declining. Respondents gave an average decrease in productivity of 37% for boilermakers, instrumentation technicians, insulators, ironworkers (reinforcing & structural), millwrights, operators, pipe-fitters, and specialty welders; and an average decrease of 31% for the remaining crafts.

Q: Based on recent projects in which you were involved, are currently involved or have direct knowledge: please indicate the actual or perceived productivity change for each of the crafts.



Our survey drilled down further by asking our respondents to identify specific productivity factors ranges for these same crafts. As shown in the chart below, responses lean heavily toward productivity factors in excess of 1.0. In interviews with selected project stakeholders, we found a perception among many that productivity factors in excess of 2.0 have become the norm for the Gulf Coast region with many reporting 2.5 and higher – a startling trend that industry must address.

**Q: Based on recent projects in which you were involved, are currently involved or have direct knowledge: please indicate the actual or perceived productivity factor for each of the crafts.**

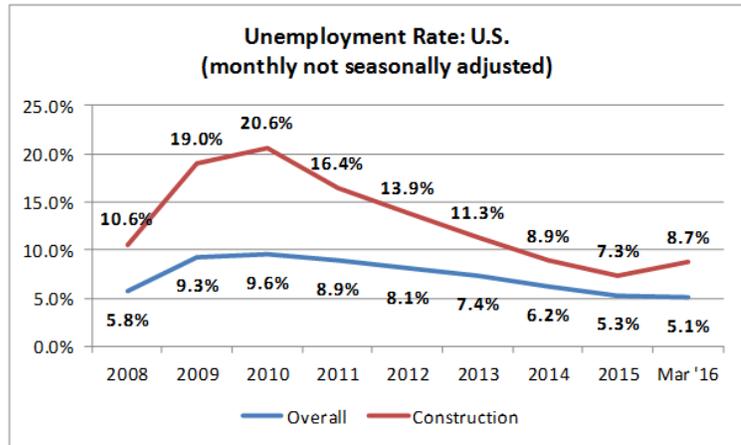


The data from the survey and the CLMA® indicates a significant decrease in productivity in regions with the most severe labor imbalances. This direct correlation indicates that skilled labor availability has a direct impact on productivity. The survey results also indicate a direct impact on safety, schedule and quality.

### Craft Labor Availability Challenges

To better understand current construction industry employment and possible future trends we have analyzed labor trends currently and over time.

When construction employment plummeted during and immediately following the Great Recession, the construction unemployment rate (accounting for both residential and nonresidential categories) skyrocketed. While unemployment rose for most industries, construction fared among the worst, with unemployment for the industry hovering at 20% in 2009 and 2010. Annual residential and nonresidential construction



Source: U.S. Department of Labor

unemployment has fallen steadily since its peak and while it remains higher than the all-industry rate, the gap has narrowed considerably in each year since the downturn. During 2015, after construction unemployment crept up at the start of the year (a typical trend during the winter when construction activity often slows), it fell to just 5.5% in July, its lowest rate since 2007 and lower than the then all-industry, non-seasonally adjusted, rate of 5.6%. For the year, just 7.3% of workers were unemployed, compared to 8.9% in 2014.

With the increased construction activity and improved employment conditions, more workers have returned to the industry, allowing the construction labor force to rise from its recessionary low. However, the increase in the labor force slowed in 2015 and for the year, just 10,000 individuals joined the nation's supply of residential and nonresidential workers. Furthermore, year-over-year increases in the construction labor force have been seriously insufficient. And at an estimated 5.4 million, the current nonresidential labor force remains well below its pre-recession peak of about 6 million. What's more, the labor force is aging and with 12.2% projected to retire within the next five years, the nonresidential labor force could soon fall to 4.7 million, resulting in an even tighter job market. Indeed, the supply of workers having the skills demanded is a concern and as skills shortages intensify, contractors are often forced to turn away work, abandon projects altogether and/or become very selective about which projects they choose to pursue.

As the labor force ages, there is significant concern that the skills shortage faced by the construction sector will become increasingly more dire. While the industry is not alone in confronting an aging labor force, it is failing to replenish the supply with younger workers. In 2015, 31.4% of those employed in construction (residential and nonresidential) were under the age of 35, which not only is down from 32.1% in 2014, but also compares to an overall rate of 34.6% for all industries. Construction's median age of 42.7 is up from last year, too, and is higher than the all-industry median age of 42.3. And with 68.6% of construction workers above

the age of 34 and 20.5% over 54, the implications are that more than one-fifth of construction workers will retire within the next ten years (up from just over one-tenth in 2002) and that as many as 12.2% will leave within the next five (assuming an average retirement age of 65). To avoid this situation, the industry must work harder to attract and train a younger demographic. Yet evidence from the Labor Department indicates a 40% decline in apprenticeship programs between 2003 and 2013, blaming much of the decline on construction's blue collar image.

U.S. Age Demographics														
Age Group	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
<b>Total, 16 and over</b>	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<b>16-19</b>	2.9%	2.8%	2.7%	2.6%	2.7%	2.6%	1.8%	1.6%	1.4%	1.4%	1.7%	1.6%	1.5%	1.5%
<b>20-24</b>	10.6%	10.2%	10.7%	10.7%	10.5%	9.9%	9.0%	7.5%	7.2%	7.2%	6.7%	7.0%	7.2%	7.3%
<b>25-54</b>	75.5%	75.5%	74.6%	75.0%	74.7%	74.6%	74.7%	75.0%	74.9%	74.6%	73.1%	72.0%	72.0%	70.7%
<b>25-34</b>	-	-	-	-	-	-	-	-	-	-	23.5%	22.9%	23.4%	22.7%
<b>35-44</b>	-	-	-	-	-	-	-	-	-	-	24.0%	24.1%	24.3%	24.7%
<b>45-54</b>	-	-	-	-	-	-	-	-	-	-	25.5%	24.9%	24.3%	23.4%
<b>55 years and over</b>	11.0%	11.5%	12.0%	11.7%	12.0%	12.9%	14.6%	15.9%	16.5%	16.8%	18.6%	19.5%	19.3%	20.5%
<b>55-64</b>	-	-	-	-	-	-	-	-	-	-	15.1%	15.5%	15.4%	16.4%
<b>65 years and over</b>	-	-	-	-	-	-	-	-	-	-	3.5%	3.9%	3.9%	4.0%

Source: U.S. Department of Labor, Bureau of Labor Statistics

As construction users continue to demand a skilled workforce, skill level, willingness to travel, and an aging workforce are expected to greatly affect the project outcomes. As noted in the table above, the BLS reported the age group of 16 to 19 year-olds (i.e., the age group traditionally seen as entering the labor force) to be 2.9% of the workforce in 2002, while the share was just 1.5% in 2015, a total decrease of 47%. At the other end of the spectrum, the age group of workers 55 and older was only 11.0% in 2002, yet 20.5% in 2015.

From a different perspective, when we track new workforce entrants by combining the age groups comprised of 16 to 24 year-olds, we see a 34% reduction over the past decade. Correspondingly, there is a 75% increase in the number of workers reaching 55 years-old or older. These trends over the past decade (and more) demonstrates an aging workforce and declining pipeline growth that is alarming to industry leaders who rely on these skills to build their projects.



To better understand these dynamics, the CLMA® collects and tracks supply information directly from contractor and labor provider payroll information, which is refreshed every 90 days. When looking at this CLMA® supply data, and assuming an overall average retirement age of 61 years old for industrial craft disciplines, the most prevalent participants within the CLMA®, the age attrition is expected to be 11% in two years, 17% in five years, and about 28% within ten years. This projects a potential exodus of 4.6% to 7.4% more craft workers within five to ten years in the industrial market as compared to the overall construction industry.

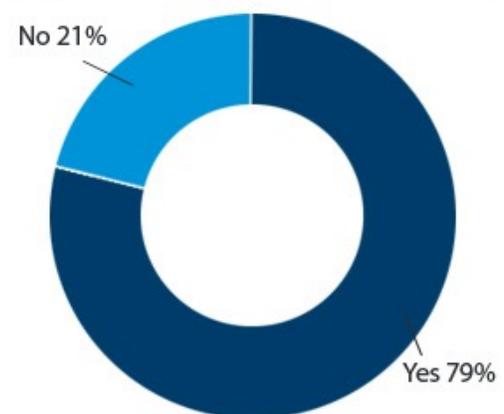
But while craft disciplines seem to generate the most angst whenever the issue of labor shortages and risk are discussed, the reality is that the attrition of construction professionals (E.g. engineers, project managers, supervisors, etc.) is equally concerning, if not more so. As shown above, based on an overall retirement age of 64, the age attrition for professionals is expected to be 14% in two years, 21% in five years, and 31% within ten years. This represents aggregated data for the entire United States; however, some companies report that they are bleeding these critical workers, who possess highly valuable knowledge and experience, at an even more rapid pace than the data would suggest.

This is daunting news as the labor participation rate for all age groups is at a 38-year low, falling to 62.4% in September 2015. Moreover, new construction hires have decreased 11.7% since 2008 at the same time average job openings have increased 39.8%. This signals rising demand in the construction industry, decreasing supply, and an expected shortfall of available craft due to an aging workforce.

If every skilled worker were positioned within the U.S in close proximity to where projects demanded him or her, the workforce challenge would be significantly mitigated. However, the willingness for workers to travel has understandably declined over time as workers value time at home and with family over the difficulties of work-related commuting.

On the other hand, based on their current travel behavior as gleaned from contractor and union based payroll data, a good number of skilled craft workers do still seem willing to relocate and/or travel to projects, driven by the desire for employment and the incentive of additional pay and/or per diem. The CLMA® is tracking this information and based on the data assembled, about one-third (on average) of the workforce in this data set is willing to relocate for a given project. In a labor shortage environment, this is an essential input in prudent project planning.

**Q: Are you having any problems finding qualified skilled labor for your projects anywhere in the U.S.?**



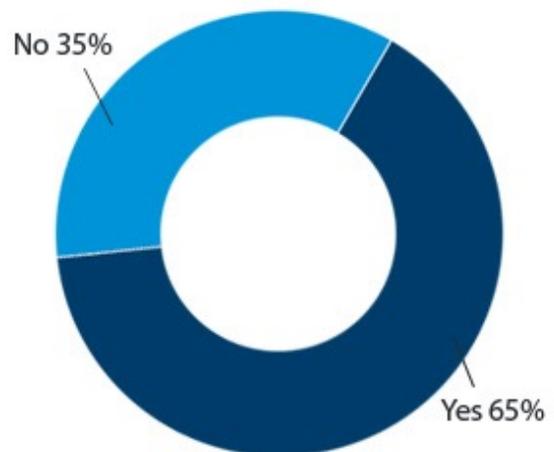
In addition to the hard data collection through the CLMA®, our survey inquired of the respondents as to their challenges finding skilled labor. Seventy-nine percent indicate that they struggled to find qualified skilled labor for their projects over the past year or so. Our productivity survey from the previous year yielded a very similar result suggesting that the construction industry has seen very little improvement in its capacity to replace the rapidly diminishing workforce.

Similarly to the challenges associated with finding skilled craft workers, 65% of the survey owners and contractors indicated problems finding and retaining professional talent. Construction organization downsizing and outsourcing trends, along with age attrition is decimating the availability of requisite knowledge and experience needed to deliver successful projects, particularly mega-projects.

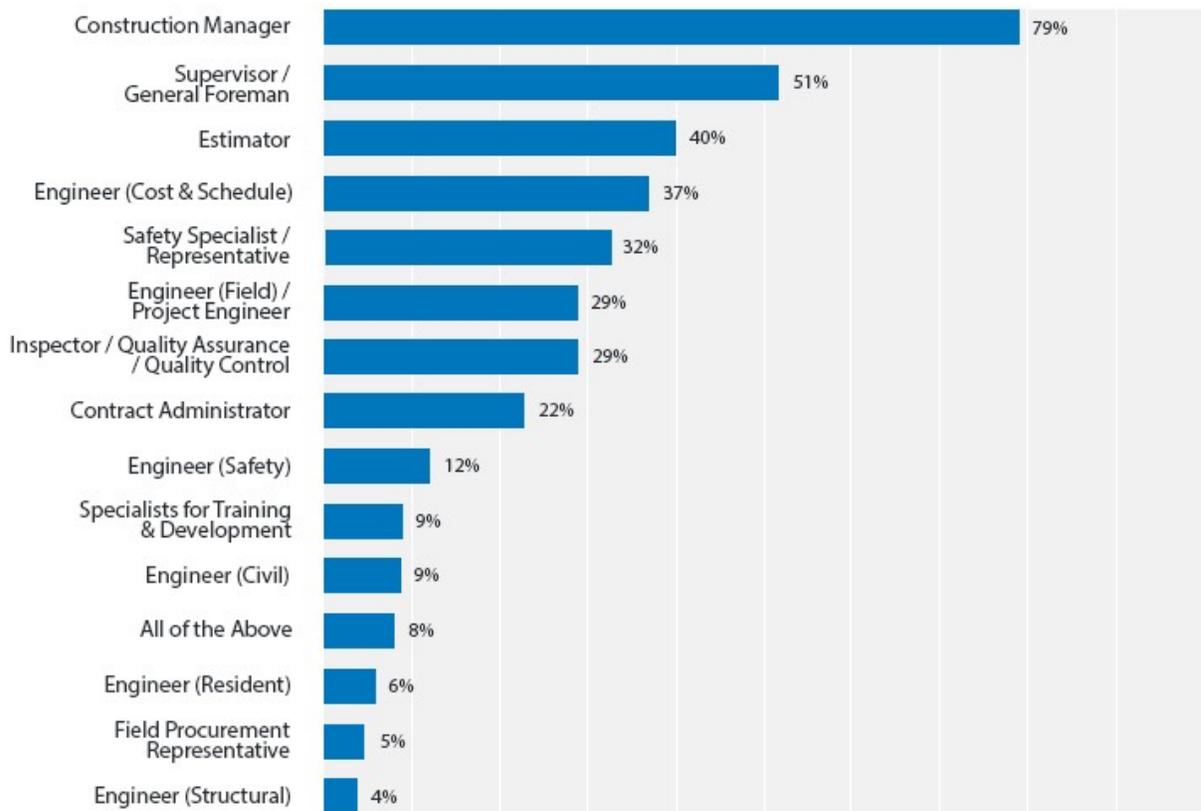
At 79%, construction managers was the top challenge. Coming in second was Supervisor / General Foreman at 51% followed by Estimator at 40%. Looking at these responses, it is apparent that companies are having the most issues finding experienced positions not entry-level workers. The CLMA® estimates that attrition for Construction Managers specifically in 5 years is about 38.4% versus an average of 16.8% for craft positions.

This large disparity may be the reason companies are having such a hard time finding experienced positions; more professionals are leaving the workforce than are entering. In fact, according to the Bureau of Labor Statistics, there has been a 61% increase in the number of construction staff reaching the age of 55 or more. In our May 2015 productivity survey, 52% stated they are having problems finding professional positions reflecting an increase of 10% in less than one year. At that time, Construction Manager was also the highest position in question with a 79% responding that was their biggest challenge.

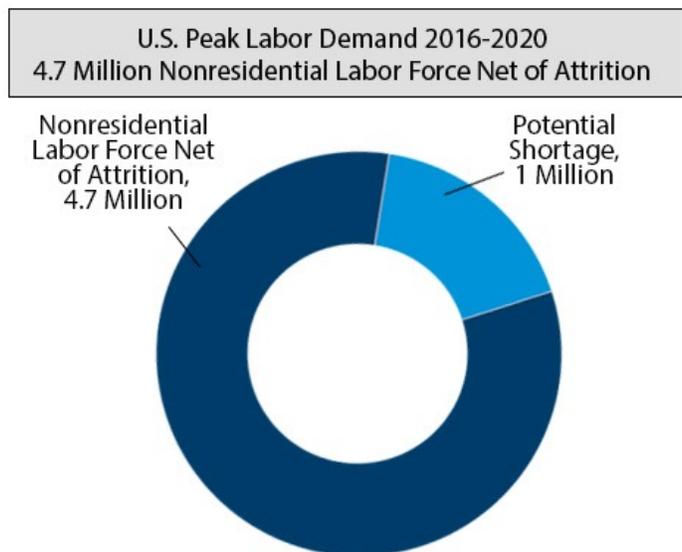
**Q: Has your company experienced problems finding & retaining professional construction positions?**



**Q: What construction professional positions is your company having trouble finding and retaining?**



Overall, with the construction labor force still down relative to pre-recession levels and another 12.2% craftsmen due to retire, concerns of worsening labor shortages are valid, particularly in light of the decline in apprenticeships. The CLMA®, reflecting an overwhelming percent of project spending, projects about 3.5 trillion dollars in nonresidential construction activity to occur in the U.S. during the next five years, resulting in an estimated peak labor demand of more than 5.7 million workers. Yet, with a potential labor force of 4.7 million, a deficit of about one million workers appears to be a real possibility.

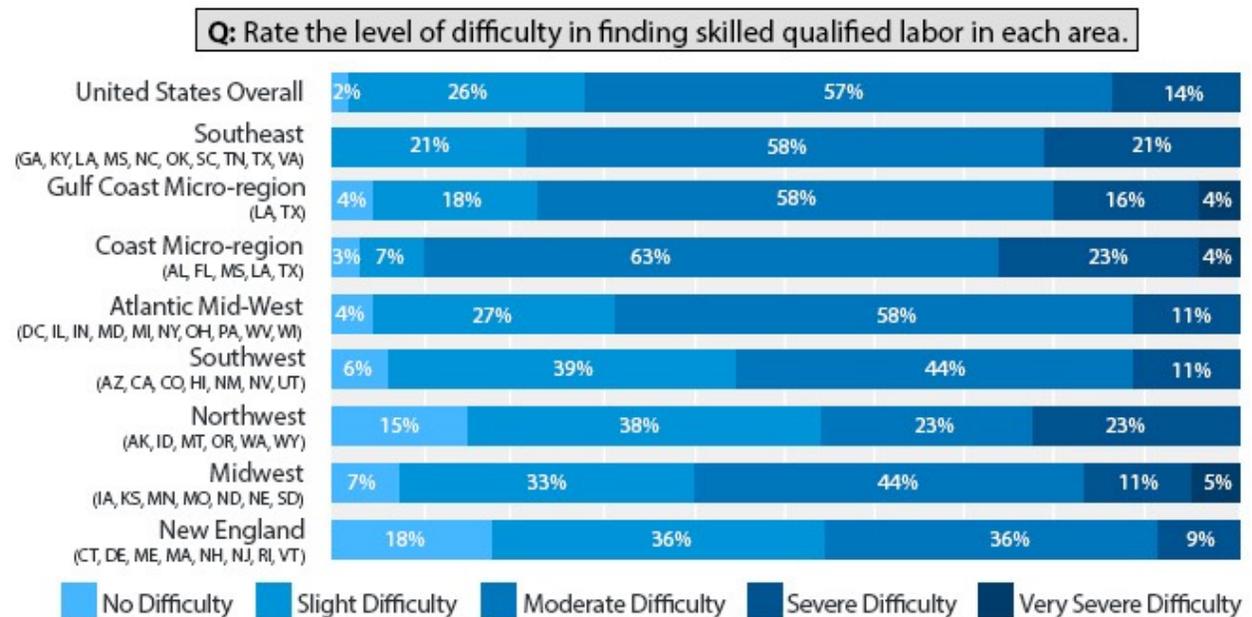


## Craft Labor Shortage Impact

All of the meaningful data over the past 1½ to 2 decades validates that labor shortages, particularly severe shortages impact every element of project performance, including productivity. **There is a very clear correlation between the deterioration of productivity and the shortage of essential skilled craft labor.** The CLMA® data enables this correlation at a highly granular level of detail as shown in the base-to-peak tables displayed earlier in this document. These tables substantiated the challenges in finding and placing highly skilled craft workers when and where they are needed for the southeastern United States and for the more localized Gulf Coast regions.

A detailed, granular level of understanding project labor risk is an important point of distinction as it suggests there are leading indicators that can be observed and used to effectively mitigate and manage project risk. Let's examine the impact of labor shortages below.

First, the 79% of respondents identified above as struggling to fill craft positions were also asked to identify the severity of difficulty and the impact of the problem in the most challenging region where they recently had project activity.



In all of the nine regions presented, the overwhelming majority of owners, contractors and unions in the construction marketplace responded that they are having some level of difficulty finding qualified, skilled labor ranging in difficulty from slight to severe. Both Gulf Coast regions and the Midwest were the only three regions where respondents registered very severe difficulty finding skilled labor. This current data representing the past couple of years correlates directly to

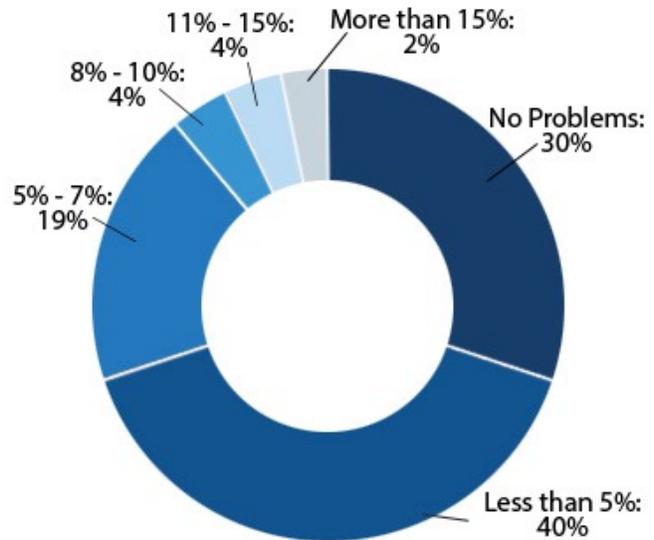
CLMA® reports which, at the time, indicated significant imbalances of skilled workers, in particular the most highly skilled and acutely imbalanced – Boilermakers, Pipefitters, Pipefitter (Combo) Welders, Electricians, Millwrights, Ironworkers, Welders, Instrumentation Technicians, Insulators and Heavy Equipment Operators.

The impact of these shortages was real and costly as at least 49% of project stakeholders in the southeast and Gulf Coast regions reportedly increased compensation (wages, per diem, incentives, overtime, etc.) to attract workers to their projects and mitigate shortage risks. This drove up cost, but didn't translate to improved quality or productivity as less skilled or experienced workers were paid premium compensation in order to help meet demand.

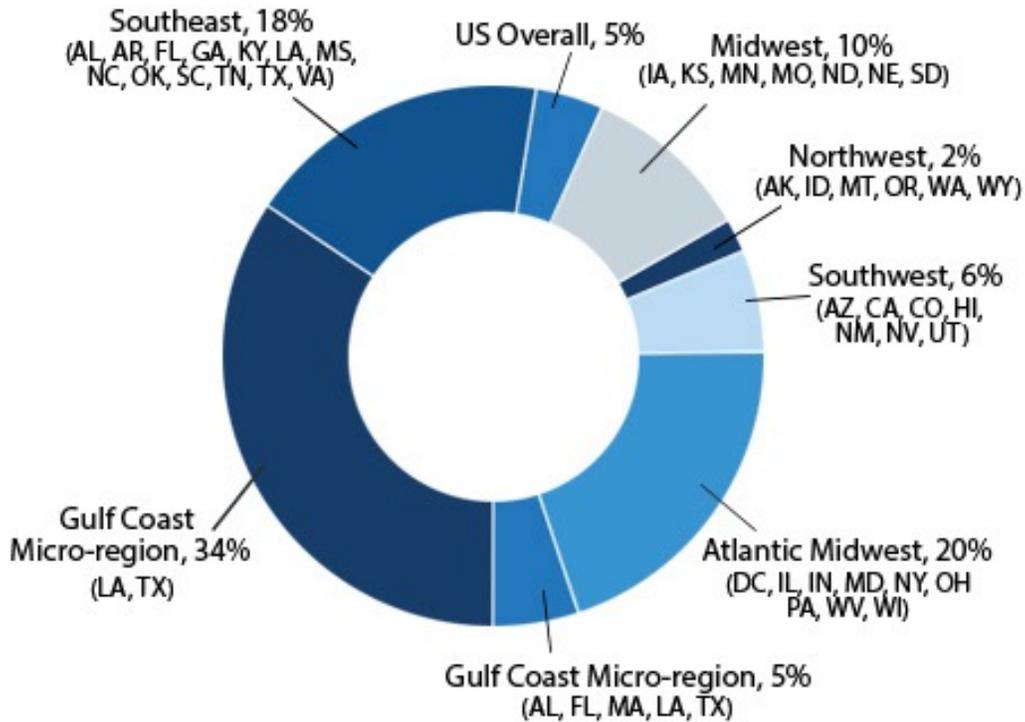
To illustrate this challenge of cost versus quality, our survey respondents were queried about the quality of their workers, in particular welders. A majority of owners and contractors stated they are experiencing weld failure problems. Fifty-nine percent indicated they are experiencing up to a 7% weld failure rate, with about 10% seeing double-digit weld failure rates. Based on anecdotal evidence and feedback from CLMA® participants, these weld failures are reportedly due to unqualified and/or insufficiently trained labor, as well as other factors. Yet while experiencing these and other challenges, labor costs continued to escalate. Our prior productivity surveys yielded similar results.

In addition to identifying troubles associated with finding skilled labor, participants were asked to identify their most challenging regions in which they work. Not surprisingly, the Texas and Louisiana coastal region proved to be the most challenging followed by the Atlantic Mid-West and the southeast overall. These challenges were driven by the reasons already noted such as oil and gas opportunities and commodity prices. In short, these are the regions with the highest industrial construction activity in the nation.

**Q: What is the percent of weld failures you are experiencing based on projects from 2014 - 2015?**



**Q: What is your most challenging region where you are having problems finding qualified skilled labor and/or experiencing increasing wage costs?**



To further understand the impact of labor market conditions in the regions where our survey respondents were executing projects, we asked them to identify how the skilled labor shortages have impacted the project(s) about which they were or are directly knowledgeable. The chart below compares 4 data sets from the Construction Users Roundtable (CURT) Workforce Development Committee research as well as CLMA® research.

The time periods reflect industry stakeholder impacts for that timeframe, regardless of when the survey was conducted. For example, the data for the 2004-2009 time frame was received in 2011 and respondents were asked a series of questions to elicit feedback on how the pre-recessionary construction boom and the related craft labor shortages impacted their projects. All of this data is a lagging indicator of the very real impact of not being able to put the right workers in the right place at the right time to meet project demand. As we discussed earlier, it is also a leading indicator that effective planning could potentially overcome.

While there is variation in how labor challenges impacted projects based on industry role (owner, contractor, union), geography and other factors, there is consistency in the top

challenges – higher cost, lower productivity and quality, longer schedules and increased safety issues.

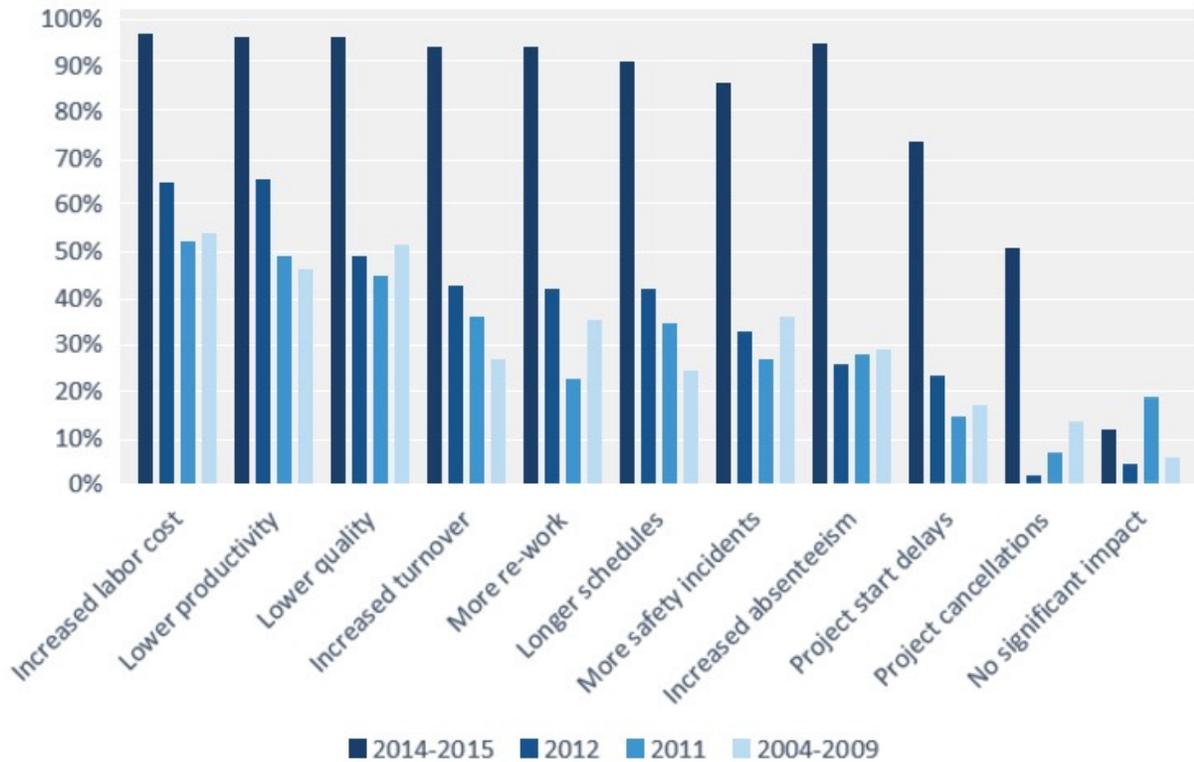
In the pre-recession period of high construction workload, many industrial owners unexpectedly experienced skilled labor shortages which severely impacted costs, schedule, quality and safety. During that period, there were too few skilled workers relative to existing project demand.

In order to attract skilled workers to their projects, contractors were paying higher wages and bonuses. With lower skilled workers they experienced lower productivity. Total labor costs increased by very large margins and in many cases, this exceeded all contingency allowances. Also, project startup dates were missed, additional quality issues arose and rework was required. Many project managers needed to ask for additional funding and/or had to delay the startup dates for their projects. Even more important, and unacceptable, accidents increased.

In a separate 2007 CURT research project, 100% of the owners stated they experienced labor-induced cost increases of 5% or greater. A zero to 5% labor budget may be within expectations or set contingency, but overruns begin to add up to serious budget challenges for medium to very large projects.

What's noteworthy is that 54% of those same CURT owners reported that labor shortages increased costs by 15% to 20%; and thirty-five percent of the CURT owners had to manage labor cost escalation greater than 20% over budget. Those high percent overages have a very costly impact on project budgets and contingency, so it is not surprising that the top ranked impact for all survey years related to labor cost and budgetary matters. As noted earlier, past performance is usually an indicator of future outcomes; and the data in this chart reinforces that axiom.

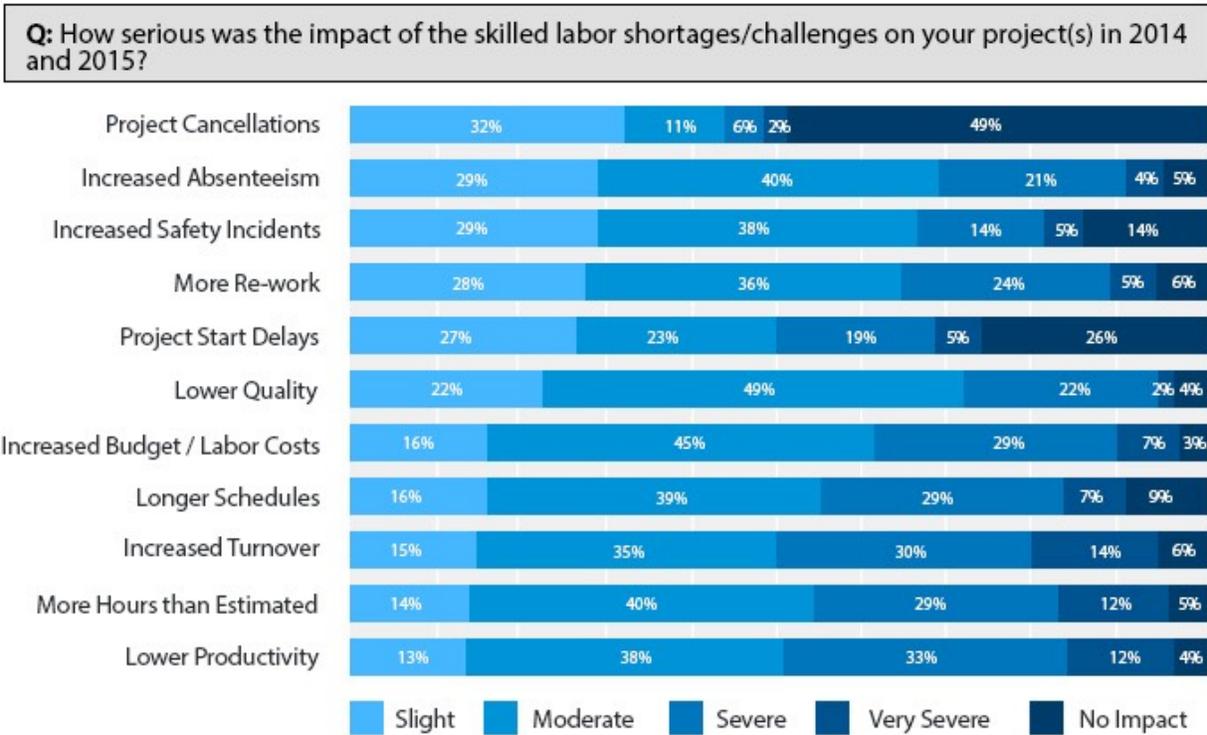
**Q: What was the impact of the skilled labor shortages/challenges on your project(s)?**



While this chart chronicles the overall impact of skilled labor shortages during periods of high demand over the past decade or so, what’s most noticeable and startling is the most current data which reflects the labor imbalances of 2014-2015. This is when the industrial construction market was at its height prior to the collapse of commodity prices. For the top challenges – higher cost, lower productivity and quality, longer schedules and increased safety issues – about 90% or more of the respondents report pain points resulting from labor shortages. In other words, the same challenges realized before the Great Recession returned and continue to replay over and over, this time for a much larger project stakeholder constituency.

In the earlier section we described how craft workers exited the workforce by choice or otherwise during the Great Recession and overwhelmingly didn’t return when construction rebounded. That’s displayed here as the pain being felt now is exacerbated by industry’s lack of capacity to fill a craft worker pipeline and meet demand.

In our most recent survey we began asking respondents to provide feedback on the severity of the impact they are feeling, in addition to identifying the impact. The results are remarkable. For owners and contractors who felt a moderate to severe impact from the labor shortages the results range from 43% (delayed project starts) to 73% (increased labor costs). An average of 64% of the respondents reported moderate to severe impacts with the median being 66%.



So what does all this data mean in the real world of project execution? To answer that question, the Construction Industry Institute initiated a research project (RT-318 – Is There a Demographic Labor Cliff that Will Affect Project Performance?) in collaboration with CURT, the CLMA® and the National Center for Construction Education and Research (NCCER). The two-year project was completed in mid-2015 and released in August 2015. This research concluded and validated that the labor shortages are real, that they are worsening and that projects will feel the pain.

As this table below shows through the empirical data from this project, the more severe the labor staffing difficulty the more cost will increase and schedules will lengthen. This research also demonstrated, as reinforced by our survey data above, that the safety impact from these challenges is unavoidable. The RT-318 research examined numerous completed projects in the post-recession construction market and found that whenever craft worker shortages occurred, increased safety challenges were also present with varying degrees of severity. Labor risk and safety risk go hand-in-hand.

There are options to mitigate cost and schedule risk; however, no one is willing to accept more injuries. Poor productivity is costly, but can be overcome; however, injured workers and fatalities is unacceptable. Construction owners and contractors must get serious about the problem and urgent about the solution.

<b>Craft Labor Staffing Difficulty</b>	<b>Average Cost Change (%)</b> (95% Confidence Interval)	<b>Average Schedule Change (%)</b> (95% Confidence Interval)	<b>OHSA Number of Recordable Incident Cases per 200k Hours</b> (95% Confidence Interval)
<b>Moderate - Severe</b>	<b>17.3%</b> (8.4%, 26.2%)	<b>22.5%</b> (11.5%, 33.4%)	<b>0.94</b> (0, 2.84)
<b>Slight</b>	<b>3.2%</b> (-0.9%, 7.3%)	<b>12.8%</b> (7.7%, 17.9%)	<b>0.43</b> (0, 1.72)
<b>No Difficulty</b>	<b>-6.2%</b> (-10.7%, -1.8%)	<b>6.4%</b> (1%, 11.8%)	<b>0.26</b> (0, 1.25)

## Construction Outlook

What do we see going forward? First, as construction continues its frenetic pace in the U.S., despite the dip related to commodity prices, persistent shortages of qualified labor will continue to threaten growth and productive project execution. With 71% of firms reportedly planning to expand payrolls in 2016, labor shortages will persist as the rate of new workers coming into the industry fail meet the demand for skilled labor. What's worse, age attrition is outpacing new entrants, further exacerbating the problem. If you can find and retain them, expect to pay more for qualified craft workers in 2016 in both wages and incentives. Early planning will be essential because the earlier and more effectively you understand labor risk, the more effectively you can mitigate it.

Second, productivity will continue to decline without meaningful steps to reverse this trend. As discussed at the beginning, other industries such as manufacturing have made changes that have significantly improved productivity. However, construction has not followed suit and the result of this improvement deficit is minor, if any, positive change in reported construction industry productivity over the years.

Manufacturing and construction are admittedly very different; however, for the construction industry to make significant progress on productivity, leadership needs to adopt a different approach to project execution and think in terms of how projects can be built with significantly less labor. This is critical to how the construction industry will survive the growing labor shortage. In addition to growing the skilled labor workforce, more work must be done with less labor. Steps have been taken in the right direction (E.g. off-site fabrication, modularization,

smart engineering models, collaboration, workforce planning, etc.) and we'll discuss those below, but these efforts must be institutionalized, not optional. In the short-term, effective, early-FEL planning; improved and consistent training; and effective apprentice-to-journeyman crew mix ratios can help improve project execution while building a workforce prepared to productively do the work that technology, automation and robots may never be able to complete.

Third, market uncertainty tends to equate to cautious project selection which is currently happening and unlikely to abate as long as labor shortages persist in a high-demand construction market. Prior to the Great Recession, the construction marketplace was booming and craft workers were in short supply. Contractors became very selective about the projects on which they even chose to place a bid. Often, owners were getting few or no bid responses as expectations were very high and contractors chose to work on projects where they had the highest level of confidence they could deliver on expectations. Contractors have this luxury in an expanding market, which currently defines the construction market. This contractor response to market conditions is repeating itself and shows little sign of letting up in the near future.

Fourth, downsizing of internal owner construction programs and organizations has become a consistent theme post-recession and increases an owner's risk of realizing cost, productivity, schedule, quality and safety issues on capital projects. Downsizing also impacts the overall construction industry as senior, talented professionals are pushed out or re-aligned internally. To address this, owners should seriously consider important items such as succession planning and knowledge transfer (E.g. mentoring programs); how they will adjust to this new reality and understand project impacts and risks; how contracting strategy will be affected; the role of the owner and the sufficiency and core competencies of owner's representatives. Downsizing for capital projects staff is not the same as other corporate downsizing; owners must put a structure in place to ensure accountability, validation, risk mitigation and productivity.

Based on survey research and anecdotal evidence, it's clear that productivity is an issue for construction stakeholders across the board. Among other reasons, poor productivity is fueled by labor shortages, which shows no sign of easing, and the construction industry has struggled to gain momentum and increase productivity since 1950. Labor shortages equals poor productivity which the data consistently shows is a leading indicator of higher cost. The fact is, for owners to achieve the most productive use of every capital dollar, there must be a sufficient number of skilled workers available in the right place at the right time. In the following section, we will cover key areas of improvement to consider as a path toward meaningful productivity increases is pursued.

## Productivity Tomorrow - Factors for Improvement

Most owners execute capital projects to meet a business need. Adding capacity, new product rollout, cost savings or meeting environmental regulations are all common business needs for projects. In funding the projects, these corporate business needs are translated into the specific project objectives for cost, quality, schedule and safety and these become the primary measures of success or failure for the project team.

In owner organizations, the firm commitments for cost and schedule become key elements in the company's multifunctional execution plan for the facility. For example, manufacturing will be hiring and training new personnel to operate the facility on the planned startup date, finance will be allocating funds for the expected capital cost, purchasing will be contracting for raw materials, packaging materials deliveries and sales will be planning the marketing rollout of new capacity or products. Missing project cost and schedule targets due to low productivity, poor quality, rework, etc. will have a significant impact on many parts of the company and is usually considered a major failure in most organizations.

On a personal level, owner project managers, construction managers and team members base their careers on their ability to deliver projects consistently. Those who are not able to meet project objectives may have significant career impacts, and excuses are usually insufficient.

Because of the importance of meeting project objectives, most owner companies have skilled people and proven work processes to deliver consistent results. As part of these processes, most owners evaluate project risks that could impact their ability to deliver the objectives and then take appropriate actions to mitigate these risks in their project planning.

Occasionally, there can be unexpected risks that impact projects and cause missed objectives, but as stated earlier, the skilled labor shortages of the current market should not be one of those unexpected risks for at least two reasons – first, we've seen the shortages coming and we've felt the impact in the past, so we know what to expect; and secondly, there are now sophisticated tools such as the CLMA® to assist in pinpointing labor challenges in early front-end loading. Based on previous experience, skilled craft labor shortages can cause many owners to miss project targets but those risk are foreseeable and potentially manageable.

When project execution begins without adequate information about labor availability, or a well-planned labor risk mitigation plan, the project's leadership can be surprised by a skilled craft labor shortage. These surprises extend to the owner, general contractor and subcontractors. The leading indicators should prepare stakeholders for this.

## What Leading Indicators Help You Anticipate and Avoid

As demonstrated by the data presented here, labor shortages, productivity decline and other risks go hand-in-hand in the construction industry. Now, let's apply this data to the real world of projects in a skilled labor shortage environment, which the United States appears destined to experience for an extended period of time as Baby Boomers retire and the labor pipeline continues to empty.

Here we examine possible scenarios for projects not prepared or expecting severe skilled craft shortages:

- The project starts with a standard plan for recruiting labor to the project based on current competitive wages and benefits and expecting to use the contractor's normal methods for recruiting workers. Normal communications such as advertisements, emails and texts are used to connect with workers from past projects.
- As the project team builds up their workforce and start requiring more skilled workers, particularly in the mechanical trades, they find it more difficult to recruit. More workers are not available because they are already committed to their current project. Some will not change jobs because their current projects are paying per diems or working overtime or have bonus incentives in place to retain workers.
- Eventually, the issue of recruiting workers becomes a more serious project issue and extra advertising and recruiting efforts are put in place. The contractor's corporate resources are involved. The project team starts talking about the need for per diems or expanded per diems, incentive bonuses or even higher wages to attract skilled workers to the project. On union projects, the contractors start meeting with the union leadership about travelers.
- Meanwhile, on the project, absenteeism and turnover is a growing issue as workers are being recruited to other projects. There is a clear shortage of good foremen, lead craft workers and journeymen to maintain the schedule. Missing workers and turnover reduce the productivity.
- With fewer skilled workers available, the contractors try to maintain their workforce by accepting foremen and workers with lower skills. Work continues but there are issues with lower productivity, lower quality and more rework and, frequently, more accidents.
- Eventually the challenge becomes a significant project issue. The contractors formally share their concerns with the owner. Additional data about other projects is collected. They start talking about the need for significant wage increases to compete. Aggressive per diems and incentive bonus plans are implemented to increase worker income.

- As the work pace declines because of inadequate worker supply and lower productivity, the issue becomes how the project will meet the project completion schedule objective. Increasing the workforce to achieve a faster pace is not possible due to the inability to find workers. Increasing productivity is not possible because the current workforce is insufficiently trained and skilled.
- Sometimes contractors propose doing work out-of-sequence with a focus on the work where they have adequate skilled labor. This usually leads to lower productivity because the originally planned optimum sequence has now been altered or abandoned.
- Subcontractors are also impacted by a skilled craft labor shortage. They also have difficulty staffing projects and meeting schedules. Frequently, they have to stop bidding on any new projects because they have limited resources. When that happens, quotes for any new work will be higher than the budget as more subcontractors decline to bid or submit high courtesy bids. In some cases, when staffing risks are too high, subcontractors will only work on time & material contracts.
- Eventually, extended overtime is proposed to achieve the schedule. Extended overtime increases labor costs with premium overtime payments and data demonstrates also reduces productivity further.
- Most projects with skilled worker shortages experience higher accident rates. Lower skilled workers, more turnover and extended overtime are all probable causes of increased accidents.
- Labor cost forecasts continue to increase when the contractor implements higher wages, per diems, incentive bonuses and overtime premiums increasing the cost per hour. On the other hand, more hours are required resulting in lower productivity caused by lower-skilled workers, more rework, extended overtime, more accidents and increased absenteeism and turnover. Ironically, more hours means the project needs more skilled workers than originally expected to complete the project.
- When project leadership has to focus on the impact of the labor shortage, they are distracted from their normal responsibilities for planning and managing the project. This leads to more daily issues in the field, and the work is not executed at the same level of performance as a normal project.
- Project morale is now low. Everybody knows the project is behind schedule and exceeding project costs. Quality and safety issues are recognized.
- If the startup is delayed, then the construction contractor's organization will be kept on the project longer which increases project overhead costs above the original budget.

- At some point, the extra cost will exceed the contingency allowances for the project and it is no longer possible to achieve the cost and schedule objectives. The owner's project manager is required to request additional project funding and schedule relief.
- While some projects get cancelled, most projects eventually do complete. By then, the contractor and owner's project management's credibility is damaged.

This may seem extreme, but anyone who has experienced this scenario can attest to the chaotic environment that unexpected risks and low productivity produce. It is a sad, avoidable scenario, yet parts or all of it occur regularly on projects during craft labor shortages. It doesn't need to be this way.

## Owner Recommendations to Lessen Project Risk

There are a number of high-value options available when adequate time is invested during a project's early front-end planning that enable skilled labor risk identification and mitigation. Here are a few actions that every project owner and contractor should be evaluating early in the process.

- **Conduct a project risk assessment:** Use a tool like the CLMA® to analyze regional labor demand and availability and identify high risks. The earlier a problem is identified, the greater the range of available options and capacity to influence the outcome.
- **Change the project location or timing:** For some owners it is possible to avoid local labor shortages by adjusting the project location or timing.
- **Get the budget and schedule right:** Labor shortages usually increase costs and delay startups. It is important that these factors be included in the project budget and schedule before commitments are finalized.
- **Plan for a workforce shortage:** To minimize the risks of a labor shortage, it is critical that the owner get the right resources involved in the early front-end planning for the project.
- **Attract and recruit the best workers:** Owners need to optimize all of their opportunities to attract the best workers to their projects, including getting the right contractors with proven capability to staff projects.
- **Remove work from the project work site:** Typically, a workforce shortage is limited to a specific region. By moving work to other areas using prefabrication, modularization and pre assembly, it is possible to reduce the demand for local labor resources.
- **Leverage regional collaboration:** In many areas, owners and contractors effectively share information about their projects and collaborate on workforce development issues.

- **Alternate contracting strategies:** A labor shortage causes a high risk to a project's successful completion. Contracting strategy is a means to share risks appropriately between owners and contractors, but it must be done carefully to achieve the best results.
- **Retain the best workers:** If the owner and contractor are successful in attracting skilled labor to their project, then it is essential to retain them through completion and not lose workers for small, incremental compensation differences. Providing a well-managed project with good working conditions is frequently successful in minimizing absenteeism and turnover issues.
- **Labor productivity:** Improving productivity can reduce the need for additional workers. By using proven tools for planning and executing the work, contractors can optimize productivity on the site and reduce the risk of labor shortage problems.

Each of these strategies are contained in the ***Skilled Labor Shortage Risk Mitigation (WP-1101)*** white paper released by the Construction Users Roundtable in early 2015. This document expertly assembled the robust leading practices of owners and contractors who have experienced the shortage scenarios outlined above and learned how to plan and execute projects more effectively. In this document, each of these areas is further developed with specific recommendations, case studies of actual experience on projects and links to industry resources for further information. In total, it is an excellent resource for owners and contractors to plan and execute their projects.

These tools significantly increase the likelihood that you execute successful projects, meet project objectives and have a long and fruitful career in the industry with a reputation for consistently delivering projects on time, on budget, with quality and without accidents.



## Owner Recommendations to Improve Productivity

Compared to the manufacturing industry, the construction industry faces many challenges such as high labor/hard to automate work, little automation, rework, and high levels of change.

We've acknowledged the differences between these industries, but it's important to avoid the temptation to hide behind the mindset that "the construction industry is different from manufacturing" without looking at the underlying issue – the capacity to build projects with significantly less labor. Some longer-term construction approaches that could work include:

- Serious, meaningful implementation of Lean construction principles
- High performance work systems with higher worker involvement

- Collaboration with material suppliers in the development of material components requiring less field labor, which creates possibility for more supplier fabrication
- Collaboration with architects and engineers in the selection of materials and components which would require less field labor
- Better materials management from supplier to workforce,
- Optimize automation of fabrication and modularization.
- Improved Front-End planning to reduce change and rework.



In the short-term, effective, early-FEL planning; improved and consistent training; and effective apprentice-to-journeyman crew mix ratios can help improve project execution while building a workforce prepared to productively do the work that technology, automation, and robots may never be able to complete. Outlined below are several key areas detailed in the CURT white paper titled ***Managing Construction Productivity (WP-1301)*** which was released in January 2016, as well as other options where companies can work to improve productivity?

### Communication

Effective communication is a vital element among teams, owners, engineers and contractors. History has shown that when companies encounter problems within a project, it is often from poor communication. It's an obvious need but many times can put the project at risk for delays and cost overruns. If a construction site is not 100% aligned on documents, tools and methods, the project has a higher risk of missing its objectives.

Project teams are not always communicating at the front-end planning stages and therefore encounter issues down the line. To plan earlier on and have all project stakeholders communicating prior to the project launch is to be able to operate efficiently together. While planning before the project begins, determining set methods of communication is key to launching a successful project. Having a consistent process will bring together all stakeholders and greatly affect their ability to handle any issues the project may face. Often, the most challenging piece is helping owners and contractors see the value in an up-front investment that can have a significant effect on bringing projects in on time and within budget.

### Team Morale

In an industry with severe labor shortages and struggles to find qualified, skilled laborers, team morale is an important element that can boost project productivity. Communication and team morale ultimately go hand in hand – as teams feel more informed through stronger communication, they become more engaged with the project and with team leaders.

Similarly, project kickoff meetings paired with regular meetings allow for verbal communication across all stakeholders. On-site daily meetings can cover important safety reminders and include daily goals that can increase work ownership and ultimately, project buy-in. These meetings also give opportunity to discuss any possible changes in the project that can prevent error or rework. When employees feel more informed, they become more confident in their work and the project as a whole.

To keep construction teams on point, listening and valuing their feedback builds relationships and boosts overall morale. Identifying what motivates employees gives owners and supervisors the opportunities to improve labor plans. Similarly, clearly defining expectations and project plans is instrumental in keeping teams and projects on track for success.

### Site Supervision

Successful projects are driven by owners who wisely choose leaders who will increase overall safety and productivity of a project. During a labor shortage, it's even more difficult for companies to find strong leaders who can manage people, motivate teams, mentor, solve problems and be an on-site coach.

Safety considerations begin from the top down for construction projects. The importance a supervisor puts on safety directs how the team perceives and reacts. Through team meetings, supervisors can direct the conversation with safety reminders and drive safety as an important topic on site.

Strong, influential site supervisors are key to driving productivity on a project. Owner's' efforts to ultimately improve productivity begins with the management team. By managing key project factors such as labor, hours and progress, site supervisors can use the information to decide whether the project is on schedule. Aside from identifying the productivity of the project, ideal site supervisors will know what to do if the need to recover progress or simply maintain progress arises. Ultimately, owners and contractors should both have the ability to manage productivity for every project.

### Handoffs to Construction

One of the most significant issues that causes low productivity on projects is the high level of change during the construction phase of the projects. Engineering changes frequently cause rework which disrupt schedules, increase labor hours and costs and affect worker morale. Improving the completeness and quality of the engineering package should be an important objective of the owners and engineering contractors.

The owner can have the most impact on the engineering package by focusing on high quality Front-End Engineering. Getting firm decisions in the early phases of the project with appropriate involvement and commitment will minimize later disruptions during the engineering and construction phases.

Owners should also plan their project to optimize the completion of engineering before the start of construction. Frequently, rushed projects start construction too early to try to achieve an earlier completion by maximizing the overlap of engineering and construction. This approach results in construction starting work before adequate engineering has been completed; and frequent design changes as the engineering is completed creates rework and lower productivity.

The recommended approach is based on the work of the Construction Industry Institute in their research report [RS6-3 – Model Planning and Controlling System for EPC of Industrial Projects](#). This recommends a collaborative detailed planning process to optimize the overlap of engineering and construction.

### Workforce Development

The skilled labor shortage that plagued construction projects prior to the Great Recession has returned as the construction industry continues its resurgence. What's different this time is that the emerging challenge will likely have lasting effects. Since many workers left the industry during the last downturn, and those remaining are transitioning out as the U.S. undergoes an age demographics shift, the construction labor shortage has returned leaving companies competing for qualified new workers while struggling to retain existing talent. The problem is real, and as those workers prepare to exit the workforce it's becoming apparent that the number of new workers entering the workforce to replace them is insufficient. It's past time to address this very serious construction labor supply/demand imbalance. Companies need to take an immediate proactive approach because it takes time to train new workers and to bring them from new entrants, to apprentice, to skilled, productive tradespersons.

The result of all this attrition and the ensuing shortages means that fewer workers with the requisite skills are on job sites and this has a direct impact on construction productivity.

To meet these challenges, contractors need to develop and aggressively execute employee recruiting and incentive plans to grow and retain the construction workforce. Retaining skilled construction workers in today's business climate goes beyond money, it can make a real difference in project success or failure and of course project productivity. Recruitment and training is an ongoing and costly challenge, and many contractors are concerned about making this investment of time and money only to have those workers poached by other contractors.

This is where owners have the capacity to make a real difference. Owners don't hire skilled workers, contractors do, but owners still have a key responsibility. Owners can play a significant role in growing the workforce by evaluating contractors using the [Contractor Workforce Development Assessment](#) tool. The CWDA objectively measures a contractor's commitment to workforce development. Contractors subscribe to the CWDA online, answer a series of questions and upload documents to support their answers. The assessment is submitted to a non-biased, third party for review and the contractor is assigned an overall score. The contractor

can then grant access to project owners to view their CWDA score. This allows owners to pre-qualify contractors for selection based on their proactive efforts to recruit, train and retain skilled workers. The process is very similar to safety pre-qualification, so we know it works.

The CDWA identifies a contractor's strengths and allows owners to qualify contractors based on industry leading practices, promoting the safe and proper completion of projects on-time and on-budget. Additionally, the CWDA levels the playing field for contractors by raising the bar and motivating them all to develop the workforce or risk not being able to compete for projects.

### Prefabrication / Modularization

Craft labor shortages and productivity declines are increasingly driving project planners to explore construction alternatives, and this trend will likely continue. Prefabrication and modularization enables on-site field work to be minimized by moving some of the work hours to other locations. These options have been used effectively for many years to build units in areas of high labor availability or lower cost and to ship completed units to remote areas with labor restrictions. In this case, the local labor shortage may make prefabrication and modularization an attractive alternative that may not have been pursued under normal labor conditions. Additionally, building complex industrial units in a controlled environment usually leads to improved productivity because of automation and efficiency.

Despite the actual or perceived productivity value of prefabrication and modularization, they may not always be the right solution for a project. They require significant lead time and often mean intense logistics planning to move a modular unit into place. Modularization also requires additional time in early phases of a project. The cost of these additional planning needs must be balanced against the cost savings realized in an off-site, controlled labor environment and the potential higher cost of attracting workers to the project site. A realistic cost-benefit analysis should always be completed before pursuing prefabrication and modularization.

The prefabrication and modularization site should be viewed the same as any other construction site. It has all the same controls and management that are required on the more typical construction site. Early contractor involvement with the modular fabricator is important and frequently this requires earlier contractor selection.

Managing change is essential on projects with significant modularization and prefabrication. With final design, modular fabrication and on-site construction in progress, all critical interfaces must be managed to avoid major issues for final installation.

Module fabricators, prefabrication suppliers and construction contractors should be selected carefully for their skills and experience working with projects with significant off-site work. There are specific skills required for successful projects, and these should be considered in pre-qualification and selection.

The following are additional suggestions for effective modularization and prefabrication:

- Design components so they can be lifted and erected efficiently.
- Design cable installation and general electric distribution in the 3D model.
- Involve travel and logistics specialists to ensure the best shipping method and timing.
- Be aware of potential high risks included in shipping and handling of large modules.
- Schedule shipping and handling to avoid bad weather.
- For cost savings, look at opportunities to reducing the size of the facility, reducing the length of pipe and cabling and overall module size.

Many times, process components and materials are shipped to the work site unassembled, requiring additional field work for final assembly before installation. In a labor shortage, it may work better for the supplier and/or an off-site, pre-assembly locale to complete as much of the assembly as possible to minimize the on-site effort required.

When considering modularization, owners and contractors should think about:

- Storage issues – Plan for how the items need to be stored and positioned while in transit and staging.
- Transportation issues – Plan for permitting, cost and issues related to crossing oceans.
- Early planning – Modularization tends not to work when introduced mid-project; its advantages are best realized when it is planned for early in the project.

### Get the Right Crew Mix

Every owner and/or project leader wants the best, most qualified workers on their project. The problem is that as older, experienced workers (often the lead journeymen and foremen) head to retirement, and without an appropriate plan for on-the-job training, the opportunity is missed to have the journeymen mentor and pass their knowledge and experience on to the next generation. To achieve this objective, every owner and contractor should ensure a crew mix that appropriately balances journeymen, apprentices and craft helpers.

In addition, it is not necessary to have journeyman complete all the work required. Apprentices and craft helpers can provide a cost effective method to provide needed support for the skilled journeyman. In this way, having the right crew mix can increase the overall productivity of the skilled journeymen and reduces overall average wage costs for the crew.

There is much debate over what is the right crew mix ratio. In many cases, there may be union contracts, government regulations and/or apprentice program standards which define minimum standards for apprentice ratios. Also, most contractors should have their own company



standards and approaches to determining crew size and mix for their projects based on their own scope of work, experience and skills available.

With all of these existing standards in place, it is difficult to recommend a single crew mix which will work for all conditions. The best approach is that every contractor has a well-defined and executed approach to establishing the appropriate crew size and mix for every craft on every work package. The final size and mix of crews should be included in the detailed work plans for each scope package and should be approved by the foreman, superintendent and project leadership. These final plans should be developed so they are the optimum approach to achieve the highest productivity, lowest cost and best opportunity for training and development of the future workforce.

The owner's role in this process is to have high expectations of all contractors that they have a defined consistent approach to planning the work, which should include establishing the optimum crew mix for each scope of work.

#### Employ Effective Risk Identification Tools

The [Construction Labor Market Analyzer®](#) helps owners, labor suppliers and all project stakeholders effectively measure, mitigate and manage project risk. The CLMA® does this by providing reliable, actionable labor market data and intelligence. By collecting capital and maintenance project information directly from owners, strategic business relationships and/or his own market research; and by collecting skilled labor supply data directly from contractors, unions, labor brokers and self-performing owners; the CLMA® produces reliable, market-based project planning data to help you control and avoid labor costs and challenges.

The CLMA® now also enables contractors, owners and unions measure, track and benchmark project productivity at a high level, or as granular as craft, unit and cost control. This productivity benchmarking collaboration with CURT will enable the development of standards to help industry stakeholders understand productivity in the marketplace and guide them in taking steps to improve it.

The CLMA® helps you quickly and easily identify labor risk for any non-residential construction project, anywhere in the U.S., up to 5 years out, and then analyze your risk mitigation options for more effective planning. The key to this risk planning is reliable labor market intelligence. That's the strength of the CLMA®. Owners trust the CLMA® with information that facilitates project-based demand projections; and labor providers trust the CLMA® with information that facilitates payroll-based supply availability and attrition projections. The CLMA® tools and services are the collaborative environment where information is shared confidentially, providing high-value data to improve how labor risk is understood and projects are executed.

## 1. Labor Market Intelligence Tools

How many craft workers do you need? How many craft workers are available? Know with confidence how project spending changes impact the balance of construction labor. Arm yourself with cutting-edge tools and knowledge to understand and mitigate your project risk.

- Manage Projects – User friendly project management in a confidential and collaborative environment allowing visualization of skilled labor supply/demand imbalances along with project labor risk tracking and risk mitigation solutions linked to project planning/execution stages
- Project Labor Forecaster® – Identification of craft discipline need and detail
- Manage Labor – Visualization of market supply headcount, mobility and attrition
- Manage Wages – Capacity to use your own wage and per diem data to manage projects
- Measure Productivity – Understand your project's productivity over time relative to market metrics and internal estimates
- Market Intelligence –Dynamic labor scenarios for any geographic region by zip code radius, one state or multiple states with actionable labor data for 49 crafts and 14 professional positions, up to 5 years out, including geo-identification of when and where to re-allocate craft resources
- Market Resources and Knowledge Center

## 2. Wage & Per Diem Projections

How will wages and per diems change over the next 3-5 years? How will this impact your project labor cost and how you compete for labor? This compensation projection and comprehensive wage and per diem analysis can be done for any state/region based on trends and/or economic forecast.

## 3. The 20/20 Foresight Report

Uncertainty is the enemy of effective project planning, creating high project risk and low productivity. The 20/20 Foresight Report online resource is updated constantly by skilled CLMA® analysts and economists to help you visualize supply/demand information and understand the economics of construction labor market risk. This market intelligence is a must-have resource for any stakeholder.

- National and regional macroeconomic construction perspective
- Economic indices and construction employment tracking and context
- Dynamic supply/demand shortage rankings (Base-to-Peak) by state/region and craft
- Skilled worker age and retirement trends by craft discipline

- Quarterly analysis on the impact of oil/gas prices on construction

#### 4. Personalized Analysis & Service

In addition to CIR's robust online tools, reports and data, work with clients is often done in tailored ways to ensure specific analytical needs are met. Customized, detailed labor market analysis targeting specific states/regions, crafts, data, etc. is available, and common requests include:

- Customized analytics, dashboards, and reporting solutions
- Custom Project Labor Forecaster® algorithms specific to client's unique projects
- Personalized service, analytics and reporting where we do all the work for you
- Construction management supply/demand analysis
- Single project risk analysis and validation
- Resources for downsized construction organizations

### Conclusion: What's Next After What's Next?

Data presented in this document from industry surveys, the CLMA® and other sources, establishes that construction productivity is decreasing, labor risk is increasing and construction craft and professional talent is fleeing the workforce at an alarming rate. Now what?

Some argue that current commodity prices have eased the pressure. Perhaps in the short-term, but the data doesn't seem to agree with that assessment longer term. Further, labor and productivity challenges are persisting simultaneously with the current market. As we consider where the United States and the world stand in the current economic cycle and catalogue the risks they face, it is worthwhile remembering that economic cycles take years to unfold and repeat themselves over decades. We believe it's important to look not just at what comes next, but what comes after what comes next, and there are many reasons to think critically about what subsequent economic cycles will bring.

The next economic cycle, if indeed we are near the end of the current one, would be enabled by exceptionally low commodity prices, which will generally lift the quantities demanded and specifically aid growth in both developed and developing nations. The next cycles will also benefit from on-going gains in technical knowledge. Science and technology are advancing at a rapid pace. Some of the resulting innovations will hopefully be both productivity enhancing and product creating, which are exceptionally supportive of economic growth. The future holds promise no matter where we stand in the current cycle.

Lower energy and commodity prices will eventually lift demand, in which case additional investments along the Gulf Coast and other regions of the country will ensue. Of course, as with any economic analysis, there are always elements of uncertainty and unknowns that should encourage caution and a watchful eye.

What appears to be quite certain in the construction marketplace is that labor shortages, attrition and productivity challenges are advancing rapidly; and for the industry to be ready for the next up-cycle, effective planning and meaningful workforce development must be priorities. Without a significant improvement in recruiting and training the workforce and in how work is done in the field, it is expected that labor shortages will continue to plague the construction industry through both up and down cycles in the overall industry. It is essential that the construction industry aggressively pursue two parallel tracks:

- Employ effective craft workforce growth strategies
- Develop effective approaches to accomplishing the same or more work with fewer workers

Both are demanded. The industry has the capability to deliver, but it must also summon the urgency to respond quickly rather than react to crisis. The leading indicator data and tools available to us provides a great roadmap to set an effective and productive project execution course.