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Industrial Maintenance Workforce in 2025

Preparing for Uncertainty

Introduction

The industrial sector is experiencing growing pains. Facility operators are counting on an influx of new workers from younger generations and stronger recruitment tactics for those already part of the workforce to keep pace.

Skill gaps are increasingly apparent as the most highly skilled maintenance workers in these industries reach retirement age during this critical period of growth.

A recent study completed by Deloitte and the Manufacturing Institute highlights these challenges:

- 1.9M jobs could be left unfilled by 2033 – roughly half the anticipated open roles
- The study says that a 'talent ecosystem" is necessary for growing the workforce, developing the right talent.

Other organizations have reported similar statistics related to workforce challenges. Estimates come in a range: **40-50% of skilled trades will reach retirement age in the next decade.** Skills transfer from these workers to new hires must happen now, or you face the loss of institutional knowledge – the complex processes and best practices your most experienced techs have developed to keep machines in good working order. Some retirement-age skilled workers are being asked to hold retirement due to their teams being so short-staffed.

It is critical that the sector regains the lost workers and continues on an employment growth path to meet the skilled labor gaps.

The consequences of inaction are uncomfortable and expensive: companies may face challenges keeping equipment in good working order, production levels could be jeopardized, straining contractual obligations, and risking problems with expensive equipment.

Every organization has a minimum number of technicians and maintenance team members they need to meet maintenance and repair demands. In this whitepaper, we'll cover:

- Ways that companies commonly overcome this massive hurdle.
- How to use training to improve operations and calculate a return on their training investments.
- Common-sense solutions that will make a big impact for your workforce in the form of easier recruitment, better knowledge gains, and more confidence, plus how to get more entry-level workers to join your ranks.
- Tactics to reduce the toll of retirements on your technical teams and help you future-proof your maintenance operations – keeping your ranks filled to an acceptable level now and in the future.

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Learning from a 2024 Plant Services & TPC Survey & Study

In 2024, TPC partnered with Plant Services magazine to survey industrial sector companies and discover their biggest challenges related to their workforces. The results of this study lined up with many of the challenges reported by Deloitte, but included in-depth questions related to the technical and technician workforce completing maintenance and repairs in the industrial sector.

Of those surveyed, the majority expected moderate to large percentages of their workforce to retire in next 10 years. 2/3 of those who responded **expected 11-75% of their maintenance and trades will retire in the next 10 years.**

At the same time, those surveyed said an average of **only 15% of their technical workforces are entry-level** – not nearly enough to train to replace the advanced technicians and specialists who are more likely to be approaching retirement age. And new workers just aren't fitting the bill. To make a

big impact, new hires must have the right skills and experience or a technical aptitude and willingness to learn. But with 10-30% openings in industrial maintenance, these same hiring managers need to also hire a massive number of non-technical workers they can train up via internal training programs or apprenticeships. This makes hiring and developing your technical workforce a critical way to safeguard your company's future.

Advanced technology adoption is compounding this issue. Working with new technologies requires continuous learning, but many facilities struggle to provide structured training for foundational skills, much less the right skills to prevent unplanned downtime and reduce the strain caused by an already strained global market. Understanding these complex technologies require a training system more advanced than simply shadowing the most experienced member of your team.

The demand is unmistakable: provide accessible learning opportunities that help all workers – regardless of experience level or aptitude – to gain and hone the skills they need to work safely, efficiently, and accurately.

The Demand for Efficient Maintenance & Troubleshooting

When faced with these unprecedented skilled worker shortages:

- Instead of preventive maintenance, staff may have to focus on repairs.
- Spare parts are more important to optimize – if they are unavailable, repairs can't happen.
- Troubleshooting must be more systematic to reduce mistakes and spare parts waste.

Spare parts availability has not recovered from COVID era and Federal-level moves like tariffs could compound this challenge, so optimizing use and minimizing replacement parts needed is critical.

Downtime related to missing spare parts could be indefinite, especially if the supply chain is further impacted by tariffs. Retooling lines to make different parts takes more time and money than is practical in most cases, so it's critical that when you have parts in stock, your team is only replacing them when completely necessary.

Skilled troubleshooting reduces unnecessary part replacements through:

- Reduced reliance on excess spare parts back stock to compensate for skill gaps.
- Mitigated supply chain costs and shortages in a high tariff environment.
- A better understanding of when and why parts should be replaced
- Finding root causes and fix the reason behind the broken part.

After all, replacing the same broken (but not necessarily problematic) part wastes your backstock of replacement parts.

Ensuring Your Tactics are Backed by Best Practices

Knowledge and habit are two sides of the same coin that skilled maintenance techs use to complete maintenance and repairs on time and on budget. It's critical to get a third-party check-up: not all habits produce ideal results. As new technologies get installed in your facility, best practices – and new practices – become standard. Every technician has to continue learning and evolving their techniques to keep up. And as regulatory compliance requirements improve operations and provide the safest working conditions possible, habits need to adapt accordingly. **Not every callous matches up with the latest tool; knowledge and skill might need an upgrade when your machines get one.**

HOT TAKE

A third-party training provider:

- Ensures proven and regulatory-backed industry standards are the focus.
- Eliminates outdated techniques and reinforces safe, effective procedures.

Learning Styles have Changed with New-to-Workforce Digital-Native Employees

As Generation Z solidifies its presence in the workforce and Gen Alpha reaches adulthood in the next few years, applying new strategies to recruiting these workers is how many companies will reach a sustainable maintenance team roster. But this digital-native future workforce learns differently. To get their attention, you have to offer training that teaches the way they learn, taking cues from their virtual learning experiences in 2020 and possibly beyond.

More than half of Generation Z (Gen Z) and the oldest swath of Generation Alpha (Gen Alpha) experienced the COVID-19 pandemic while they were in school, and they rapidly adapted to a new style of learning: fully online. Because of this experience during their core years in school and the way that technology is wrapped up into our daily lives, they have adapted to learn new programs and systems rapidly and key into automation naturally.

This school-aged experience is in sharp contrast to more experienced generations like Generation X (Gen X) and Millennials, who may have used some technology in school but who may or may not have had their own computers or mobile phones in homes or hands during their formative years. Approximately 2/3 of people in these generations completed high school before the first iPhone was even launched.

As a result, the newest adults in this country need to learn in ways that are technology-rich and digital in focus to do their best learning – whereas Gen X and Millennials might need a combination of digital tools and lessons and traditional classroom-based training.

These young and future workers, who will join the workforce in the coming years or who have some experience, are going to shape the future of the industrial sector. Giving Gen Z and Gen Alpha access to training that meets their learning preferences and technology habits is key to their biggest knowledge gains and most attention paid to training.

How to Set Yourself Apart and Attract Highly Experienced Technicians

A big part of recruitment is selling yourself as an employer, and the best recruiters have the best pitch. That's especially the case when trying to attract and hire experienced maintenance technicians and skilled trades: because so many maintenance rosters sit unfilled, they're able to shop around for the best jobs they can find. Sometimes the pitch is great, but the benefits package doesn't exactly match the needs of the recruited.

Training is one area many companies forget to mention during recruitment. But what if that's the thing you're missing? For maintenance team members, it clues them into how you feel about individuals' safety, facility safety, and tells them how much they'll be kept in the know when codes and standards change.

Among the most dangerous hazards workers can encounter are those related to maintenance activities. This goes beyond the statistics – trips, falls, those things are often on the individual. But if you're working with electrical systems, mechanicals, and repairs, mistakes carry much bigger risks: shock, arc-flash, and catastrophic failure of equipment.

If a boiler fails, there's another dangerous and expensive disaster. The consequences of these could be costly downtime, layoffs, injuries, fires, legal actions, fines, citations, and even death. Without a solid training program, these maintenance-related tragedies could be more common and more catastrophic.

DEFINING GENERATIONS

With some overlap, these two generations are the most important to hire as our workforce shrinks.

Generation X: born 1965-1980

- 27-40 years of experience

Millennials: born 1981-1996

- 11-26 years of experience

Generation Z: born 1997- approximately 2012

- 0-10 years of experience

Generation Alpha: future workforce born 2010-2024

- Starting to join the workforce in 2028

When you're trying to recruit highly skilled technicians – or savvy inexperienced new workers with plenty of potential – one big concern they may have is your safety record and your training programs. After all, they know that they can do everything right and still experience a safety hazard at the hands of someone less experienced. It is critically important that recruiters sell your company's safety record and training programs, but the two usually go hand in hand. Those who seek the best employers know that the training program recruiters offer is the best indicator of how safe they might be at that job.

After all – skilled maintenance workers are only as safe as their knowledge allows. If they are up to date on the latest codes, regulations, and best practices, they're more likely to know how to do the right, safe thing. Continuous learning helps grow and retain skilled technicians. Those seeking career advancement will be excited to learn about your training programs, because they understand they can learn and earn more over time.

In this highly competitive landscape, it's common for maintenance techs to company-hop to seek the best wages. But it's not just a numbers game: often, the recruiters who are the most successful have the best benefits packages to back up their words, including a robust training program. And if you can't fill those roles and complete routine maintenance because you're out-recruited by the company next door, where does that leave your operations?

At the end of the day, training isn't just a vehicle to better technical aptitude and fresher knowledge. It's the way you attract and retain the most experienced maintenance techs and how you fill your bench with new workers from Gen Z and Gen Alpha, securing your company's future.

PERSPECTIVE ON INDUSTRIAL MAINTENANCE WORKER SAFETY, 2020

- Maintenance workers experienced over 23,000 nonfatal injuries that required time off work
- 70 maintenance workers died due to a workplace injury or accident

The Future of Your Workforce: How to Attract and Retain Gen Z and Gen Alpha Workers

Your workforce's future is not won if you hire only the most experienced techs and trades you can recruit. Those team members are crucial to your current success, but balance is more important. You need to hire a mix of experience levels, including some inexperienced workers.

Most of Gen Z is already in the workforce, but Gen Alpha will join starting in 2028. If you're already struggling to hire entry-level workers, it will become a bigger challenge as more digital-native workers are part of your maintenance teams. Offering to train from scratch or continue their education in a format that makes sense to them is the way to solidify your tech roster for now and in the coming years, as your key players reach retirement age.

Train the way they learn

It's important to meet Gen Z and Gen Alpha workers where they are, providing training programs that hook them and train the way they learn. These are digital-first learner generations, raised with technology fully integrated into every aspect of their lives, who may be most comfortable learning online due to how the COVID-19 pandemic shaped their childhoods.

As tech-first communicators, they are familiar with everything being at their fingertips, and they're more likely to be comfortable on a computer or smart device than with paper training and videos and rote memory. Training must evolve to match their digital-first learning styles.

Training should be accessible via mobile devices for on-the-go learning. Successful training programs need to incorporate game-like elements to increase young workers' engagement and retention.

GEN Z REPORTS INTEREST IN THE TRADES

It's the right time to hire Gen Z! According to Thumbtack's Future of the Skilled Trades Report:

- 55% are considering a career in the trades
- 84% highly respect the career paths and those who choose them
- The gender divide is falling. Over half of Gen Z women report interest in a career in the trades, at a rate nearly that of men.
- Top trades of interest include: electrician (#2) and HVAC technician (#8)

Spark Interest in Future Team Members

Finding your footing with future members of the workforce can start before they finish school or trade programs. According to the Deloitte study mentioned earlier in this whitepaper, creating a talent ecosystem includes fostering relationships with local community colleges who offer vocational technology programs and technical colleges, plus working with K-12 schools to create programs that build excitement for careers in the industrial sector.

One opportunity could be inviting students to visit your facility and see what working in industry 4.0 is like. Organizations like The Manufacturing Institute build events that manufactures can use to connect with educators and students and make the industrial sector exciting for future generations.

Training shouldn't stop after trade school

Connect with vocational technology institutes to develop apprenticeship or internship programs with students learning the trades or industrial maintenance.

Use these programs to build employment interest and connection to your brand, while supporting someone's educational needs. Lean on the tech program to connect you with students but build on the foundations they create.

A successful apprenticeship program requires a robust foundation

Enhance your apprenticeships with a consistent knowledge foundation. Historically, companies have relied on a highly experienced technical leader for this foundation, but for young workers, this isn't enough.

Without a blended approach, your apprentices may miss out on best practices, latest techniques, and may inherit questionable shortcuts. A blended approach would be one that included with a consistent, actionable foundation learned through curriculum designed to train the way they learn – digitally, with interactive modules, gamified to reward successful troubleshooting practice.

When you combine on-the-job learning through your apprenticeship program with engaging digital learning like a troubleshooting simulator and online training sequences they can use at their own pace, you'll hit the sweet spot for Gen Z and Gen Alpha learners: practical and approachable.

Understanding the gap

As many experienced workers reach retirement age, increases in total workers needed compound the hiring and retention challenges technical maintenance teams face.

Anticipated increase in available positions by 2033:

Industrial machinery mechanics: **17% growth**

- 2023: 429,500 positions
- Additional new positions by 2033: 80,400

Electricians*: **11% growth**

- 2023: 779,800
- Additional new positions by 2033: 84,300

Maintenance workers, machinery: **8% growth**

- 2023: 59,000 positions
- Additional new positions by 2033: 4,600

All positions across industries and levels are expected to grow only 4%.

*encompasses all electricians working in installation, maintenance, and repair

Building an Efficient Training Program

Upskilling employees or inexperienced new hires is key to bridging these hiring gaps, and regardless of a technician's experience level, they'll need a structured and flexible approach.

With a structured training plan, knowledge growth is accelerated, helping new hires transform into experienced techs without risk to life or limb. For new workers especially, digital hands-on learning is important – and newer training technologies allow technicians to train without the risks associated with working on your equipment.

By combining instructor-led training, online learning, and interactive simulations, companies can cast a wide net – being sure that each member of your team can grasp the concepts in a training style that resonates with them. A well-rounded program sets your most important team members up for skills growth, adaptability, and success on the job.

Ensuring Training is Effective

It's important to understand how effective your training program is. Training should be focused on continual improvement, and you can find out how effective it is by completing cycles of assess – train – reassess with on-the-job training evaluations completed before and after training. This helps measure knowledge retention and helps to show that your team understands how to apply the concepts they learned in training to real repairs. It's the perfect way to ensure face to face training with a live instructor is effective and allows team members to demonstrate their skills.

Using digital training tools offers insights into effectiveness, too. Whether it's tracking scores and replacement part costs over time while completing troubleshooting and repairs in a simulation to see rates of improvement or looking at test scores from online training year over year, digital training tools may have these assessments built in with reporting for managers to view and export real-time data on course completion and scores.

Measuring the Return on Your Training Investment

Figuring out how training impacts your bottom line is an important step in understanding the value of your program and calculating the return on the training investment. In the Plant Services survey completed in 2024 in partnership with TPC, companies relied on a wide variety of tactics for understanding training effectiveness. We'll take a brief look at the top 5 ways survey respondents reported using measurement tactics when calculating their training program's ROI. Respondents were allowed to select more than one method to show the total way that they calculated this return.

Indirect Ways to Calculate Training Program Effectiveness

The majority of survey respondents leveraged **simple statistics** to understand how training impacted safety. By calculating how frequent safety incidents are, comparing rates before and after your team trains, you can find out how much training impacts safety at a basic level.

Another calculation that nearly half of companies reported using is the **overall equipment effectiveness (OEE) rate**, which measures how well a manufacturing company can make good parts at the fastest rate possible without equipment downtime. It indirectly shows the power of your maintenance team and how effective their planned downtime is. Often, companies have specific ways they calculate this rate that considers their own internal processes and product to get a more robust calculation.

Mean Time Between Failures directly calculates how a maintenance team's activities impact downtime. With approximately one third of surveyed companies using this calculation, it's a common way to measure the reliability of an individual component or machine. It can help to predict when a failure might occur in a reparable system or component.

SIMPLE CALCULATIONS TO FIND OEE AND MTBF

Not sure how to get started finding your overall equipment effectiveness rate or mean time between failures? Use these basic calculations and track the calculations over time to find out how successful your team's repairs are.

OEE = Availability × Performance × Quality

$$\text{Availability} = \frac{\text{Actual hours worked}}{\text{Scheduled working hours}}$$

$$\text{Performance} = \frac{\text{Number of products produced}}{\text{Number it's possible to produce at maximum speed \& efficiency}}$$

$$\text{Quality} = \frac{\text{Good products}}{\text{All products}}$$

$$\text{MTBF} = \frac{\text{Total operational time}}{\text{Number of failures}}$$

Direct Ways to Calculate Training Program Effectiveness

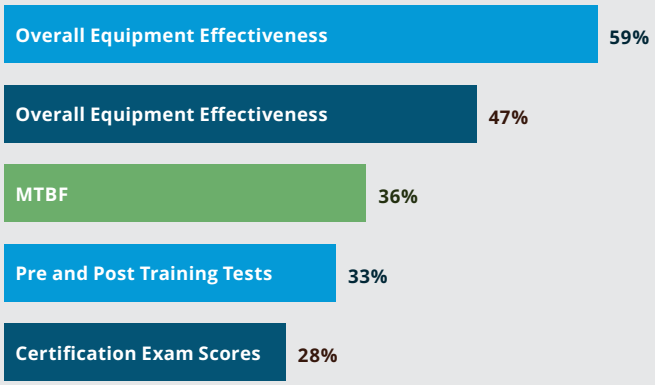
Pre and Post Training Tests, used by 1/3 of respondents, are the training industry standard in measuring knowledge gained and retained during training.

Test on training-related knowledge before and after your team completes training to understand how much more they've learned. Using pre- and post-tests, also called On the Job Training Assessments, are used to show someone has developed "demonstrable skills" – a key requirement for many trades in the industrial space, such as the NFPA 70E requirement that only those with demonstrable skills handle repairs and installation.

Certification Exam Scores: Measuring improvement in exam scores, even if one is not required, is a short- and long-term way to see how knowledge changes over time. Those who filled out the survey focused on certification exams, but companies can do knowledge checks when it makes sense to decide when training is needed or how effective it has been, especially when comparing scores over time. Nearly a third of survey responses were from those who use this tactic to determine the effectiveness of their training programs.

Ultimately, **a combination of calculations will net the best results.** It's important to include pre and post training tests, but other methods can determine how well knowledge was applied. When analyzed together, this set of return on investment calculations will tell you exactly how well your training program is performing and help you determine the value of your training program.

Survey Says: Top ways companies measure return on training investments, from the study completed in 2024 with Plant Services



TPC: Here for your team now and in the future

Let's work together to build up your team's skills and prepare your company for a sustainable maintenance workforce. As more jobs become available and so many highly experienced techs consider retirement, harnessing the freshest generations of workers is part of what future-proofs your maintenance operations.

With TPC, you can be confident in the quality of the training your team will receive. TPC's industrial maintenance training programs are built on the collective knowledge of our real-world-experienced instructors. They're grounded in industry codes, safety regulations, and proven learning best practices. Each TPC online course and training simulation is developed in collaboration with learning design experts to ensure training is effective, engaging, and aligned with how people actually learn.

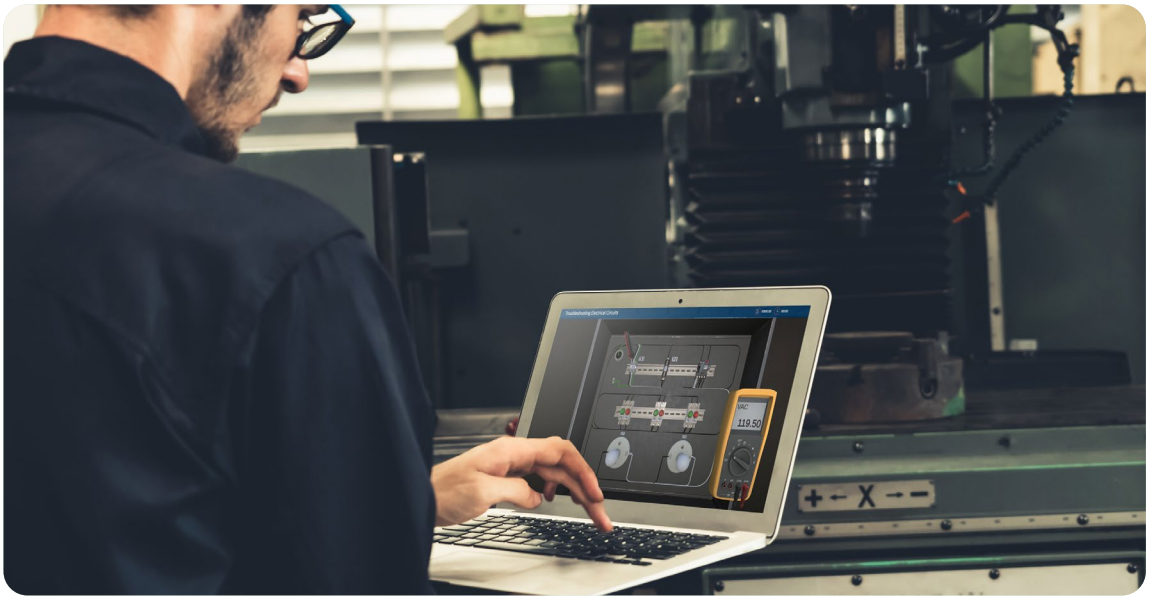
Training is an investment in your company's future and safety, not a cost. When your team is skilled, confident, and prepared, you gain a long-term competitive advantage through improved maintenance, reduced downtime, and a stronger safety culture.

Our digital solutions just make sense:

- **Online Training** is a flexible, subscription-based solution with which your techs can learn at their own pace, with shorter lessons on critical maintenance-related topics. Start and stop as needed, and train whenever there's time – between tickets, repairs, and preventive maintenance. Perfect for young learners' knowledge gains.
    - Available on unlimited per-seat basis for those who need to learn the most
    - For more experienced groups or as a supplement to internal training, available as a per-course quantity, so any team member can choose the specific topic they need, when they need it.
- **TPC Simulations** give the gamification and immersive troubleshooting practice that young workers, especially, crave.

TPC Simulations are impactful and engaging for team members of all experience levels.

- Fully online, this tool takes knowledge from a basic electrical maintenance to in-depth troubleshooting.
- It's a tool for everyone that helps you measure team members' progress and costs associated with the virtual repairs they are making.
- Helps your team learn a systematic troubleshooting approach to find the root cause and fix that, instead of replacing the part it broke.
- Gives managers insights into where knowledge gains have happened.



TPC Simulations is a better place to practice than on your expensive equipment

How it works:

- Your maintenance team practices troubleshooting techniques on a computer or smart device in a 3D, realistic environment with familiar components and tools.
- They start and stop any time, without requiring downtime to learn on your machines.
- They gain actionable skills and learn how to find the root cause of a fault.
- They practice with progressive faults, getting harder over time as they improve their skills.

With managers in mind:

- Team managers assign interactive training modules to their employees.
- Those managers see results in real time, including time and cost of repairs.

The results:

- The tool transforms your team into confident and competent troubleshooters.
- No risk to life, limb, or equipment when you train in a simulated environment.

We provide our clients complementary solutions and software to effectively scale their maintenance programs and measure effectiveness over time. When it's time to build your training program, we're here to lend a hand. Let's discuss your unique challenges and figure out together how to overcome them with a training program tailored to your company and team, with the tools to help you calculate the return on your training investment.

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Ready to tackle the toughest people problem of the next decade?

Click here to connect with a training expert.

Training Feature	Online Training	Simulations	Instructor-Led training
Multi-day intensive seminar with live instruction			✓
Unlimited Access Per User – Subscription-Based	✓	✓	
Electrical Training	✓	✓	✓
HVAC Training	✓	✓	✓
Mechanical Training	✓		✓
Safety Training	✓		
Plant Management Training	✓		✓
Flexible – start and stop as needed	✓	✓	
Developed by Experts	✓	✓	✓
Covers a systematic approach to troubleshooting		✓	✓

Sources:

https://themanufacturinginstitute.org/manufacturers-need-as-many-as-3-8-million-new-employees-by-2033/

https://www.plantservices.com/workforce/workforce-development/article/33016801/steps-to-address-the-critical-skills-shortage-in-industrial-maintenance

https://b2b.tpctraining.com/2024-Industrial-Maintenance-Prep-WP

https://www.bls.gov/iif/snapshots/osn-maintenance-and-repair-workers-general-2016-20.htm

https://blog.thumbtack.com/inspired-by-social-media-gen-z-is-increasingly-drawn-to-the-skilled-trades-30a9c352d61a

https://nces.ed.gov/

https://www.bls.gov/ooh/installation-maintenance-and-repair/industrial-machinery-mechanics-and-maintenance-workers-and-millwrights.htm#tab-6