WHITEPAPER

Electrical Simulation Training

Leveraging a systematic training approach to bridge the skills gap

SIMUTECH MULTIMEDIA

EXECUTIVE SUMMARY

- The skills gap is real, and appears to be widening: a Deloitte study recently estimated that 2.4 million manufacturing positions in the US will go unfilled between 2018 and 2028, up from 2 million predicted in 2014.

- It's not just a Millennial problem—older workers facing a rapidly changing world of technology, automation, digitization, and other new systems, and many do not have the skills to meet the demands of the new factory floor.

- The skills gap has a cognitive component. A defined, systematic troubleshooting process is necessary when faced with multiple potential solutions, or no solution at all. Without a systematic process, maintenance troubleshooters will struggle.

- The automation paradox is that once a certain level of sophistication is reached, increasing automation results in longer mean-time-to-resolution, because machines take on the easier diagnosis and repair jobs themselves, and humans are left to solve nothing but difficult, abnormal conditions.

- Automation also reduces time between incidents, meaning that maintenance professionals see problems less frequently, limiting their ability to retrieve stored memories of how to repair them. Simulation training is one way to keep skills sharp and to be prepared for problems that happen rarely, but are nevertheless costly.

- Training is not enough: within two months, most trainees will lose about a third of the knowledge gained during training, unless they have the opportunity to apply and practice it continually.

- Manufacturers can combat the skills shortage by becoming "training organizations," by fostering a lifelong learning culture in which training is a visible part of daily work life, supported by all levels of management, and regularly scheduled with accountability mechanisms in place.

INTRODUCTION

Manufacturers have been turning to automation and training for some time now to help bridge the skills gap. While the talent shortage has plagued the industry for years, we are now seeing that it is more complex than just a lack of skilled young workers. The gap is widening at both ends of the age spectrum, and has multiple underlying causes that manufacturers must understand if they are to overcome it.

Meanwhile, automation and more recently the Industrial Internet of Things (IIoT) have ushered in a golden age of efficiency. Yet when it comes to the realm of maintenance, they have also caused their own set of issues. As smart machines become able to diagnose and perform simple repairs on themselves, they leave human maintenance workers with the undiluted difficult jobs.

Maintenance training is a therefore necessity, but on its own will only take a company so far. The knowledge is out there, but manufacturers need to understand how to bring it into their organizations and leverage it with an organizational culture that fosters continuous learning.

In this whitepaper, we discuss the causes of the skills gap, the necessity of a systematic approach to electrical troubleshooting training, and the best practices for setting up your own troubleshooting training program.

Mind the Gap

The skills gap is not new. Manufacturers in North America have been grappling with it for decades now. However, the gap does appear to be widening: a Deloitte study recently estimated that 2.4 million manufacturing positions in the US will go unfilled between 2018 and 2028,[1] up from 2 million predicted in 2014.[2]

Post-COVID-19, the manufacturing economy may contract, either permanently or temporarily, but the race to recruit skilled talent will intensify as companies attempt to recover from the shock of global shutdown. The fundamental issues underlying the skills gap have not changed; in order to solve them, manufacturers need to know the root causes.

Actually, the shortage of skilled manufacturing workers has been described in a number of ways, most commonly that it is (1) generational, (2) social, (3) educational, or (4) cognitive. Let's look at each of these possibilities.

Is the skills gap generational?

Many analysts point to Millennials as the cause of the skills gap. By 2025, Millennials will represent 75% of the US labor force.[3] However, Millennials and younger workers are not going into manufacturing jobs in large enough numbers, which is why the talent shortage is widely considered a generational phenomenon.

That is true, but it's not the whole picture.

In fact, the generation at the other end of the working age spectrum is also contributing to the skills gap. The huge baby boomer generation has reached retirement age and is leaving the workforce in droves. Older workers who remain are facing a rapidly changing work environment in terms of technology, automation, digitization, and other new systems. Despite their experience, they may not have the skills to meet the demands of the new factory floor.

In short, the skills gap is generational, but it is double-ended—coming from both ends of the continuum.

Manufacturers will have to approach the problem from both ends, by attracting Millennials and by upskilling older workers.

Is the skills gap social?

Manufacturing has an image problem.

Fewer than 5 in 10 consider manufacturing careers to be interesting, rewarding, clean, safe, or stable,[4] and only 3 out of 10 US families say they would encourage their children to enter a career in manufacturing.[4] Millennials are the most educated generation in history,[5] and tend to aspire to white-collar jobs.[4] Competition for workers is stiff across many industries, and for many younger workers manufacturing is simply not attractive as other alternatives.

The manufacturing industry as a whole would benefit from rehabilitating its image to break down the social barriers preventing new graduates from going into manufacturing. Fortunately, exciting innovations taking place in the industry, including the Industrial Internet of Things (IIoT), automation, robotics, and digitization, have the potential to inject new energy into recruitment strategies.

Is the skills gap educational?

It is often suggested that students are graduating high school and post-secondary institutions without the necessary educational background for manufacturing jobs, notably the STEM (science, technology, engineering and math) subjects. While this is certainly true, and apprenticeship programs declined in the US by 40% between 2003 and 2013,[6] there is certainly no shortage of technical colleges, online learning opportunities, and even corporate training programs to bring new workers up to speed. The information is out there.

In our assessment, the problem is not the knowledge base.

Is the skills gap cognitive?

Even if the knowledge base isn't the culprit, there still may be a *cognitive* component to the skills gap. In other words, the knowledge may be there, but there may be a problem translating all that acquired knowledge into useful skills and the ability to thoughtfully consider and troubleshoot problems.

A study on the "systems approach" to creating skilled technicians to service industrial equipment[7] found that there are essentially two types of cognitive errors leading to mistakes on the factory floor:

1. **Knowledge-based errors.** This kind of error simply has to do with not having enough relevant information to do the task at hand properly. It can mean not having enough of a knowledge base about an electrical component, or it could mean not having access to manufacturer's instructions, or being unaware of how to test that the repair work has been done correctly.

   These types of errors can be addressed fairly easily. As we noted above, there are many sources of knowledge available.

2. **Observed.** This type of error is typical when base knowledge is applied incorrectly, or (1) when there either too many solutions available, or (2) no apparent solution at all.

   In the first case, a decision must be made between the multiple potential solutions. In the second case, a decision must be made about what to do given the lack of solutions available. For example, perhaps a part cannot be fixed and must be replaced, or a process is no longer working and must be changed completely.

   What both situations have in common is that, if there is no predefined way to deal with the situation, troubleshooters will struggle—perhaps resorting to trial and error, or replacing good parts in the hope that that will solve the problem. Efficient troubleshooting requires a systematic process.

   In addition, knowledge of installations needs to be big-picture. Pioneering troubleshooting training researchers Schaafstal and Schraagen found that troubleshooting training requires a systematic approach, and that it must happen at the functional level rather than the component level.[8]

   Think of airline pilots, who spend many hours in a flight simulator before their first real flight. They obviously need to understand the various individual components and subsystems in the aircraft, and have learned about them in the classroom. However, it is critical that they see and understand how all of these components interact with one another in the actual experience of flying the plane. The flight simulator is a realistic yet safe environment where they can get the functional "big picture" of how everything works together, and where they can practice applying that knowledge before taking off into the skies.

   There is a cognitive component to the skills gap. The manufacturing industry must provide maintenance staff with the necessary knowledge base, as well as a systematic decision-making framework for troubleshooting electrical problems, and a safe environment for applying and practicing that knowledge.

The Systematic Approach

Schaafstal and colleagues[9] found that when a systematic approach was used in troubleshooting, it was far more effective, solving twice as many malfunctions in less time that those trained in the traditional way. Not only that, training can actually be shortened by 33% without loss of performance,[9] meaning that a systematic approach is far more cost-effective than traditional troubleshooting training.

Many manufacturers know from experience that the quality of troubleshooting training can vary dramatically depending on the ability of individual instructors. An added benefit of training in a systematic approach is that it improves consistency across maintenance personnel. They will all master the same proven process, without variation based on instructor competence.

An example of a systematic approach is the Simutech Training System. Our program teaches a proven five-step process for troubleshooting: Observe, Define, Identify, Test, and Replace. Each trainee learns in the program this approach to troubleshooting electrical faults in manufacturing machinery. If a trainee is struggling with any of the concepts, they receive additional coaching, hints, lessons, and practice until they have thoroughly grasped the material.

The Automation Paradox

As plants and factories have become increasingly automated and integrated, manufacturers have been reaping the benefits of increased production and decreased waste. Automation has evolved to the point where many "smart" production-line machines can diagnose themselves when something goes wrong, and even self-repair.[10]

So, it's fair to expect that the more automation increases, the less time it will take to repair it and the easier maintenance will become. This has been true, but only to a point, because of what is known as the "automation paradox."

The automation paradox[11] first described by Lisanne Bainbridge in 1983 is a counterintuitive outcome in the relationship between automation and mean-time-to-resolution. The paradox states that, in the beginning, automation does decrease the time spent on repairs in the factory, but once the machinery reaches a certain level of sophistication, increasing automation eventually causes an increase in mean-time-to-resolution for maintenance personnel. This is because the simple, "normal" problems that used to be the low-hanging fruit for humans to fix are now done by the machines. Human maintenance staff are responsible for all of the difficult problems and none of the easy ones, skewing their numbers and lengthening the mean-time-to-repair. Maintenance is therefore becoming more challenging in the age of automation.

Troubleshooting and Time-between-incidents

At the same time, automation does increase the time between downtime incidents, meaning they are fewer and farther between. This is a good thing. It does, however, have an yet another unintended consequence for maintenance: since maintenance pros encounter these problems less often are less familiar with them, it takes longer to fix them. This is because our ability to retrieve knowledge from long-term storage in our memories depends on using it frequently.[11]

Think again about the example of flying a plane. Most aspects of flying a passenger jet are now fully automated. That makes it far easier than it used to be to fly the plane, unless one of those systems fails.[12] Since most flights go off without a hitch, most pilots don't experience system failures very often. However, if it did happen, the pilot would very quickly have to figure out how to solve the problem because the lives of all on board depend on it.

This is why pilots are required to keep their skills sharp by regularly practicing in flight simulators. Simulators allow them to tackle situations they wouldn't frequently see in real life so that they can be prepared for any eventuality. Simulators also allow for repetition of tasks until they become second nature—and can be recalled under pressure. Regular practice keeps the pilot's skills fresh.

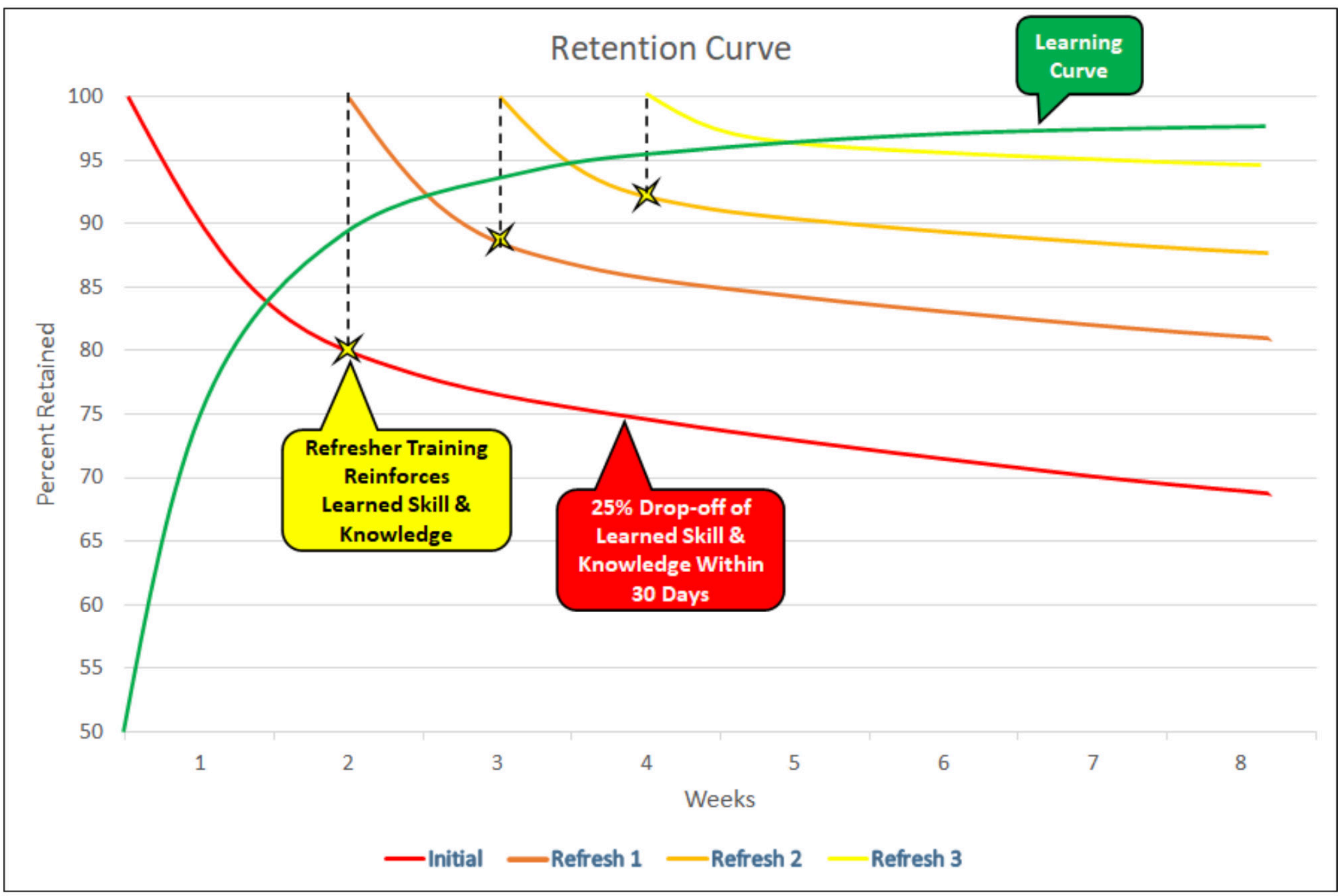
Automation has decreased downtime and increased productivity, efficiency and even new jobs in the manufacturing industry,[13] but the paradox is that maintenance has become more demanding.

Training is not enough

According to Steven Sears, Training Manager at FCA Fiat Chrysler Automobiles, the old adage "Use it or lose it" most definitely applies to training. When people learn knowledge without applying it—using it—within one month they will only retain 75% of what they learned. That's a 25% drop-off in only 30 days. The more time that goes by without applying the knowledge, the less will be retained; by eight weeks, retention for most people will be under 70%.[14]

This means that in the space of two months, most trainees will lose about a third of the knowledge gained during training, unless they have the opportunity for plenty of practice, an unacceptable waste of training dollars.

This is confirmed by Bainbridge, who found that students who receive knowledge in a theoretical classroom situation without appropriate practical exercise will not have a meaningful framework and therefore will not be able to retrieve the information.[11] That's why even pilots that have been flying for 20 or 30 years still have to spend time in the simulator regularly.



Source: Sears, S. Tools and strategies to train online. Webinar presented in partnership with Simutech Multimedia; April 9, 2020.

Becoming a Training Organization

Manufacturing companies need to become training organizations. In other words, training has to become part of the fabric of their culture.

In order for trainees to take ownership of their training, it's essential that training is a visible part of the corporate culture. Staff need to know that management takes the training seriously and is tracking success metrics.

Managers, administrators, and coaches must all be seen to be involved and supportive.

As part of this culture, a commitment is necessary: both staff and management have to be committed to the success of the program. Some organizations even use formal commitment letters that both staff and management sign, stating they understand the benefits that training brings to them, and their responsibilities for participating in it.

Manufacturers need to use the full complement of tools at their disposal. Simulators are a valuable tool, but on their own are not enough. Knowledge still must be taught before students can practice in the simulator. Not only that, everyone has a different learning style. Program designers need to help their staff acquire the knowledge, practice it, and ultimately apply it in the real world.

Scheduling

Scheduling training into the busy work week is essential to becoming a training organization. Without this basic discipline, other projects and immediately urgent tasks will always take priority. Regular training, practicing, and refreshing will be bumped down the To Do list until they happen rarely if at all.

For training to be sustainable, it has to happen on a defined, realistic schedule. In our experience, two hours a week is generally ample time, but it won't materialize unless a time is set aside regularly and adhered to.

If staff are saying they are "too busy" for training, the irony is it may be because they have not yet undergone training. Untrained workers spend more time using guesswork and trial and error to solve problems. Training will ultimately make staff more efficient and less busy.

One way to help with time constraints is for management to offer training in small, manageable chunks or modules, that workers can do on their own, at their own pace, or even from home. Another way is to implement training solutions that use "gamification," meaning they incorporate the entertaining aspects of video games while still transmitting knowledge and encouraging practice. Employees are less likely to complain about being too busy if the training is actually fun.

Accountability

Part of becoming a training organization is putting some accountability mechanism in place. This can take the form of the commitment letters mentioned earlier; checklists (these can be simple, just to ensure completion of the agreed upon tasks); a review process with the employee that is informed by data (e.g., a training program that tracks trainee progress and shows where they are excelling or struggling); continuous assessment (compared to a baseline taken before training begins); and rewards and recognition for completing training, practice, or refresher courses.

When training is a visible part of corporate culture, supported by management, regularly scheduled with accountability mechanisms in place, companies can be satisfied they have built a culture of lifelong learning.

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The Simutech Training System is a complete ecosystem consisting of seven simulation-based electrical troubleshooting training modules plus the Simutech Admin Portal. The interactive modules cover core and advanced electrical troubleshooting of circuits, PLCs, and industrial controls widely used in manufacturing equipment. Your maintenance professionals will learn how to diagnose and repair electrical faults in complex production machinery quickly, effectively, and safely, ensuring the smooth automation of your production output.

Develop the workforce you need. Sign up for a demo today.

For more information on Simutech Multimedia, visit www.simutechmultimedia.com, call us at 1.866.942.9082.

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