

How To Get Gen Z To Wire Machines

Why Connectorized Control Systems Solve the Gen Z, Skilled Labour, and Tribal Knowledge Problems for Industrial Machine Builders

FOR

Senior leaders, VPs, engineering directors and controls managers at industrial machine builders

WHAT YOU WILL FIND INSIDE

- ▶ Why manual wire termination is a business risk, not just an engineering choice
 - ▶ The skilled labour shortage that is structural, not cyclical
 - ▶ How tribal knowledge walks out the door with every retiring electrician
 - ▶ The Gen Z workforce reality and what it means for your training model
 - ▶ The Monday morning scenario: why connectorized systems change the math
 - ▶ A practical framework for evaluating the full workforce cost of your current architecture
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OVERVIEW

Executive Summary

THE CORE ARGUMENT

If you are an industrial machine builder, the workforce that has built your machines for the last thirty years is retiring faster than the industry can replace it. The skilled electricians and control panel wirers who know how to wire complex machines correctly are leaving at a rate that the industry cannot match with new entrants.

The Gen Z generation of workers entering the workforce in their place has grown up in a world where you plug things in rather than wire them up. From their first smartphone to their gaming console, every device they have ever used was designed to be connected by plugging it in. Asking them to strip a wire, crimp a ferrule, insert it into a terminal, and tighten a screw is not just a training challenge. It is a skills mismatch.

This white paper makes a direct argument: the way we wire industrial machines was designed for a workforce that no longer exists in sufficient numbers. Connectorized wiring systems, built around pre-wired, tested cordsets and M8/M12 connector technology, offer a practical path to machines that can be built faster, with fewer errors, by a broader range of workers, and maintained without depending on someone who has been doing it for twenty years.

The argument is not that manual termination is wrong for every application. It is that most machine builders have never really calculated what their current control system actually costs across the full workforce lifecycle, and when they do, the numbers really change the conversation.

2.1M

Manufacturing jobs projected unfilled by 2030

Deloitte / The Manufacturing Institute

1.1 yrs

Average Gen Z job tenure in first five years of career

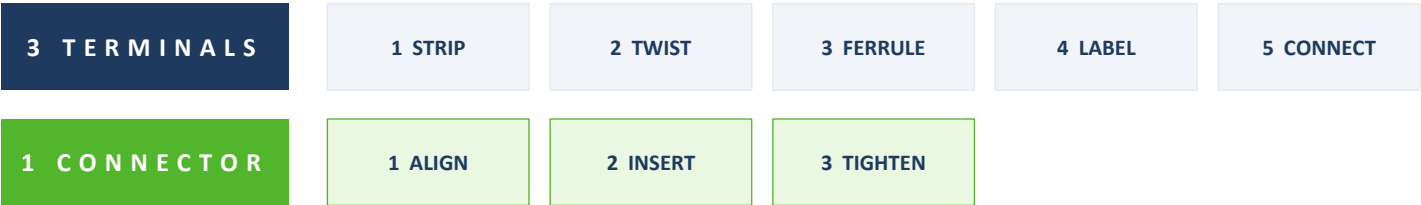
Randstad Workmonitor, 2025

<1 hour

To train a new hire on connectorized field wiring

Versus 2 to 4 years for a qualified panel builder apprenticeship

THE WORK ITSELF: WHAT WE ACTUALLY ASK PEOPLE TO DO



Five manual and variable operations versus three simple and consistent plug-in steps for a standard I/O device with 3 wires. Each manual step is a place where errors and build-to-build variation enter the system.

THE CORE FINDING

The workforce required to wire a complex control panel correctly is becoming structurally scarce. The workforce required to connect a machine using pre-wired M8 or M12 cordsets is the workforce you already have access to. That is not a minor operational difference. It is a strategic one.

01

SECTION

The Workforce Problem Is Structural, Not Cyclical

THE STRUCTURAL SHORTAGE

81,000

Electrician job openings projected annually through 2034

BLS Occupational Outlook

-14%

Projected electrician workforce shrinkage by 2030

Electrical Contractor Magazine

79%

Of machine builders say skills shortage has significant impact

Eaton / S&P Global, 2025

30%

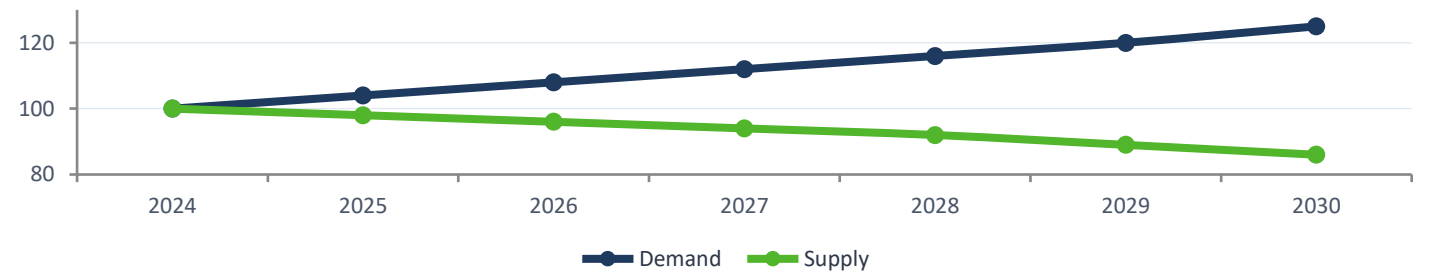
Of union electricians at or near retirement age

Manufacturing Institute / Deloitte, 2024

Traditional control panel wiring is skilled work. It requires electricians who understand schematics, can read wiring schedules, apply ferrules correctly, observe colour-code and sequencing conventions, and work to UL 508A or equivalent standards. That workforce is shrinking.

The US Bureau of Labor Statistics projects approximately 81,000 electrician job openings annually through 2034. The industry currently loses around 10,000 electricians per year to retirement and gains only 7,000 new entrants. Nearly 30 percent of union electricians are at or near retirement age.

ELECTRICIAN SUPPLY VS DEMAND (INDEXED, 2024 = 100)



Demand grows 25 percent by 2030 while supply shrinks 14 percent. Source: BLS, Electrical Contractor Magazine.

THE COST AND SCHEDULE RISK

Qualified industrial electricians in North America carry a fully loaded cost of \$40 to \$53 per hour. Field electricians performing on-site terminations can reach \$81 to \$136 per hour. This is not just a cost issue; it is a schedule risk. When your panel builder is unavailable, machines do not ship.

\$40 to \$53

Journeyman electrician, UL 508A panel

\$81 to \$136

Field electrician, travel and overhead

THE KEY QUESTION FOR YOUR LEADERSHIP TEAM

If the supply of qualified electricians tightens further over the next five years, which all available data suggests it will, what is the strategic risk to your production capacity and delivery commitments?

02 SECTION

The Tribal Knowledge Problem

WHAT LEAVES WHEN THE EXPERT RETIRES

In most panel shops and machine-building facilities, the ability to wire a complex control panel correctly is not documented in a procedure manual. It lives in the heads of experienced panel builders, who know where the wire duct gets congested on a particular machine, which terminal positions cause problems or rework, the torque feel for terminal blocks from a specific supplier. None of this is written down because, until recently, it did not need to be.

When that person retires, what leaves with them is a decision-making framework built from years of trial and error. The replacement may be technically competent, but they will make the same slow, expensive mistakes every new panel builder makes: the under-torqued terminal, the transposed label, the cable that is three inches too short.

Control panel wiring is a craft skill. Craft skills transfer through apprenticeship, not training manuals. The gap between reading a wiring schedule and executing a complex build correctly under schedule pressure is filled by experience, and experience takes years to accumulate.

70%

Of operational knowledge that keeps a plant running is stored in people, not systems

Dovient Manufacturing Knowledge, 2026

2.8M

Manufacturing workers projected to retire by 2033

70+ million years of combined experience

\$27 to \$30

Hourly cost for a general assembly technician

Versus \$40 to \$53 for a journeyman electrician

WHERE THE KNOWLEDGE LIVES

OLD MODEL

In the worker

- Hands of experienced builders
- The torque feel of a screwdriver
- Undocumented routing decisions
- 20 years of trial and error

20 years to build. Lost in a day.

NEW MODEL

In the system

- The connector alignment keying
- The label printed on the cable
- The LED that confirms state
- Factory-tested at manufacture

One hour to learn. Persists forever.

"The knowledge required to wire a complex electrical panel correctly cannot be written down. It can only be transferred person to person, year over year, through repetition."

03 SECTION

The Pitfalls of Manual Termination

Manual termination on terminal blocks has been the standard approach to industrial control panel wiring for decades, and for good reason. When done correctly, by skilled people, using the right tools, under controlled conditions, it can be reliable. The problem is that those conditions are becoming harder to guarantee. Skilled labour is stretched, build schedules are tighter, panels are more complex, and every hand-made termination introduces another point where errors and variation can enter the system.

HIGH RISK

Under-torqued screw terminals

A screw terminal torqued below specification produces a connection that tests fine on the bench but loosens under vibration and thermal cycling in service. Research published in ResearchGate found that terminals torqued at 67 percent below specification show temperature increases of 13 to 16 percent, the beginning of the arcing and oxidation cycle that eventually produces an open circuit. Grace Technologies reports loose connections contribute to more than 30 percent of all electrical faults across industrial installations.

HIGH RISK

Ferrule omission and incorrect sizing

Ferrules protect stranded conductors from splaying inside a screw terminal and from being partially cut during tightening. An omitted ferrule, or one that is the wrong gauge for the conductor, produces a connection that may carry current normally but degrades under vibration or repeated thermal cycling. In a cabinet with several hundred terminations, detecting which specific connection has a substandard ferrule requires point-to-point testing that cannot be done at speed.

HIDDEN COST

Wire labelling errors

Every conductor in a complex panel must be labelled at both ends to enable tracing and troubleshooting. A mislabelled wire does not cause an immediate failure, it causes a diagnostic failure when something else goes wrong. The technician following the schematic to trace a fault ends up at the wrong terminal. Depending on the machine configuration, this can add hours to fault diagnosis. In a warranty or service context, those hours are your cost.

NOTE

A note on spring cage terminals

Spring cage terminals are mechanically better on vibration resistance. But the issue was never the clamping mechanism. It was workmanship-dependent variability at scale. A machine with 400 spring cage terminations still has 400 hand-made connections. Strip length, conductor preparation, and ferrule choice still matter.

THE DOWNSTREAM COST: REWORK AND WARRANTY EXPOSURE

A machine that arrives at a customer site with an incorrect termination requires a return visit by a qualified electrician at field rates. A single remedial visit costs \$81 to \$136 per hour plus travel. An engineering change order mid-wiring can easily cost 10 to 15 additional hours of skilled labour without producing any new machine capability.

THE 80/20 RULE MOST OEMS DO NOT TALK ABOUT

Industry practitioners often cite field wiring and manual termination points as the source of most electrical faults. Not the PLC, not the HMI, and usually not the software. The machine's weak point is often the wiring between the cabinet and the field devices. That is where variation enters, and that is where reliability quietly gets compromised.

04 SECTION

The Generation That Plugs Things In

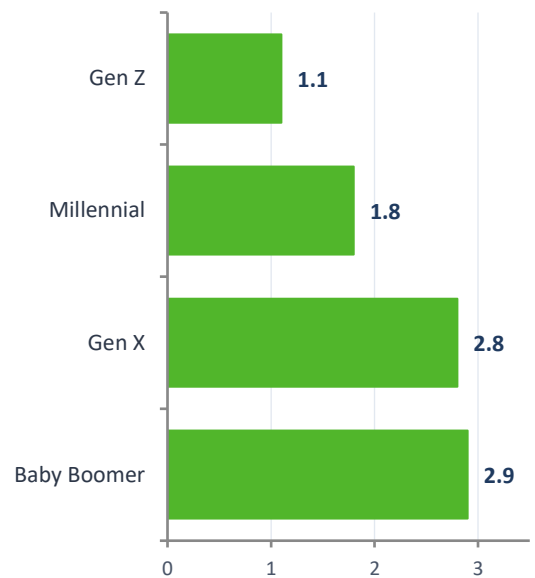
THE PLUG-AND-PLAY GENERATION

Generation Z, broadly those born between 1997 and 2012, is now the fastest-growing segment of the industrial workforce. They are also the first generation that has never known a world without plug-and-play technology. From their first smartphone to their gaming console, every device they have ever used was designed to be connected by plugging it in.

This is not a criticism of Gen Z, it is an observation about the world they grew up in. USB cables, HDMI cables, ethernet patch cords, they have been plugging things in their entire lives. The muscle memory is already there. The mental model is already there. When something stops working, their instinct is to check the connection or swap the cable. That is exactly the right instinct on a modern machine.

Asking them to strip a wire, insert it into a terminal, and tighten a screw is not just a training challenge. It is a skills mismatch, and one that gets more pronounced every year as your experienced controls people retire. Connectorized architecture meets Gen Z exactly where they are.

AVERAGE JOB TENURE (YEARS)



Source: Randstad Workmonitor, Gen Z Workplace Blueprint, 2025.

THE RETENTION REALITY

13%

Gen Z manufacturing workers who expect to stay longer than four years

40%+

Considering leaving manufacturing within six months

Randstad's 2025 research found Gen Z's average tenure in the first five years is 1.1 years, against 1.8 for Millennials, 2.8 for Gen X, and 2.9 for Baby Boomers. Manufacturing-specific research shows the picture is even tighter.

If training a new employee to work independently on a traditional panel takes 3 to 4 months, and the average Gen Z tenure is 1.1 years, the window of productive contribution before they leave is dangerously short.

By the time they are fully up to speed, you may already be closer to their exit than their starting point. That makes simpler, connectorized machine wiring more than an efficiency play. It becomes a workforce strategy.

THE SKILLS MISMATCH

Gen Z workers are not less capable than their predecessors. They are differently capable. The mismatch occurs when you ask a digital native to perform a task that was designed for an analog era. Connectorized wiring aligns with the intuitive model that Gen Z workers already have for how devices connect.

05 SECTION

The Monday Morning Scenario

Consider a practical scenario that will be familiar to any production manager who has tried to hire entry-level wiring technicians in the last few years.

TRADITIONAL TERMINAL BLOCK

Monday Morning — New Hire Arrives

- 01 New hire has no prior industrial wiring experience. Willing to learn.
- 02 Week 1 to 2: supervised introduction to tools, colour codes, ferrule crimping, terminal types.
- 03 Month 1 to 2: working on simple sub-assemblies under close supervision.
- 04 Month 3 to 4: beginning to work independently on straightforward panels.
- 05 Month 6+: genuinely reliable on complex builds. Training investment now realised.
- 06 If they leave before month 6, the entire training investment is lost. At 1.1 years of average tenure, this is a common outcome.

CONNECTORIZED M12

Monday Morning — New Hire Arrives

- 01 New hire has no prior industrial wiring experience. Willing to learn.
- 02 Hour 1: introduction to the labelling system and connector types.
- 03 Hour 2: supervised practice run connecting devices on a sample assembly.
- 04 Hour 3: working independently on the production machine.
- 05 If they leave at lunchtime, the replacement who arrives Tuesday morning is already productive by Tuesday afternoon.
- 06 The knowledge required to do the job is embedded in the system design, not in the worker's head.

THE TRAINING INVESTMENT CALCULATION

At a fully loaded cost of \$40 to \$53 per hour for a journeyman electrician, and 3 to 4 months of supervised training before independent productivity, the training cost per new panel builder is substantial. With a 1.1 year average Gen Z tenure, the return window on that investment is narrow.

Connectorized architecture reduces the specialized wiring knowledge needed early and frees skilled electricians from supervising repetitive terminations. With a 1.1 year average Gen Z tenure, that makes the return window far more realistic.

06

SECTION

The Workforce Cost Comparison

Evaluating manual termination versus connectorized architecture on component cost alone produces the wrong answer. The business case rests on total workforce cost across the full machine lifecycle, from build through commissioning, field service, and the ongoing cost of training a high-turnover workforce.

TABLE 1 — WORKFORCE AND RELIABILITY COMPARISON

Factor	Manual Terminal Block Wiring	Connectorized IP67 System
Skill level required	Journeyman electrician - UL 508A, schematic reading, ferrule application	General assembly technician - identify cable, plug in, verify LED
New hire ramp time	3 to 4 months to independent productivity on complex builds	Under 1 hour to productive on field device connections
Labour cost	\$40 to \$53/hr fully loaded; panel shops bill \$45 to \$50/hr	\$27 to \$30/hr fully loaded for assembly technician
Wiring error rate	Human-dependent - strip length, ferrule, torque, labelling all variable	Near zero - pre-tested factory cordsets, no hand termination
Build-to-build consistency	Significant variation between builders, builds, and locations	Standardised cordsets produce identical results every build
Tribal knowledge dependency	High - experienced builders carry undocumented process knowledge	Low - process knowledge embedded in system design and labelling
Field service skill	Licensed electrician - \$81 to \$136/hr including travel; schematic tracing	Any technician - swap cable, no tools required, per-channel LED diagnosis
Downtime diagnosis speed	2 to 6 hours - intermittent faults, build variation complicates tracing	8 to 12 minutes - LED indicates fault, cordset swap confirms
Workforce resilience	Vulnerable - key person departure causes immediate capability loss	Resilient - process is documented in the system, not in individuals

THE HONEST CAVEAT

IP67 hardware typically costs more per unit than IP20 equivalents. The business case rests on total system cost - components, cables, enclosures, labour, commissioning, and lifetime maintenance - not on component-level line items. OEMs who evaluate connectorized architecture on component cost alone will always reach the wrong answer.

07 SECTION

The Reliability Case

FACTORY-TESTED VS FIELD-MADE CONNECTIONS

Every M12 cordset leaves the factory having been electrically tested. The connection between conductor and connector pin was made under controlled conditions, with the correct tooling, by a process that is verified before the product ships. There is no equivalent quality gate in a manual terminal block termination. Once that connection is made on the shop floor, its quality depends on the person, the tool, the lighting, the available time, and the pressure of the build schedule.

In a machine with 200 field device connections, a connectorized architecture means 200 factory-verified connectors. A traditional architecture means a minimum of 600 wire connections made by hand, each one a potential source of variation that may not manifest as a fault until the machine is in service under load and vibration. That is the uncomfortable part of manual wiring: the problem may not show itself during build, or even during commissioning. It may wait until the machine is running 3 months later, while production waits and troubleshooting suddenly becomes very expensive.

75%

Reduction in fault diagnosis time

IP67

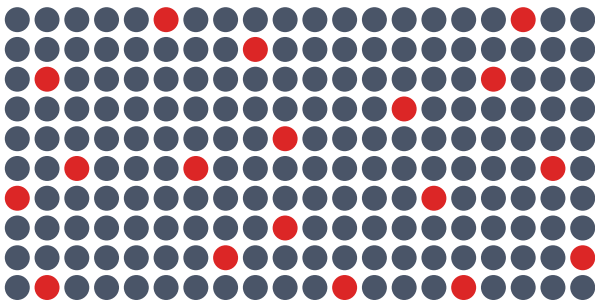
Min protection vs IP20 panels

\$50K+

Cost of 1 hour unplanned downtime

200 FIELD DEVICE CONNECTIONS — WHERE THE QUALITY IS DECIDED

FIELD-TERMINATED · HAND-MADE



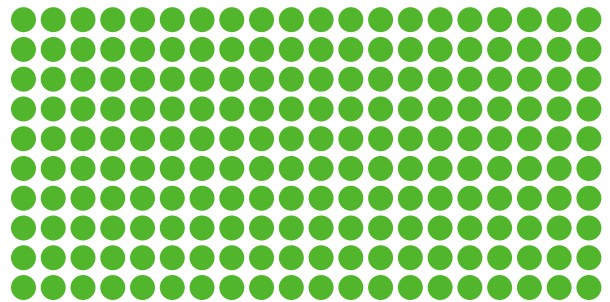
Each red dot is a manual connection point that may degrade in service. You will not know which.

DIAGNOSIS TIME

2 to 6 hrs

Trace schematic, test point-to-point, identify which of hundreds of terminations has failed.

FACTORY-TESTED · PRE-VERIFIED



Each connection is verified at manufacture. Quality is constant, not variable.

DIAGNOSIS TIME

8 to 12 min

LED indicates the fault zone. Swap the suspect cordset, confirm green LED, done.

THE RELIABILITY ARGUMENT IN ONE SENTENCE

A connectorized architecture does not just reduce the probability of a wiring fault. It reduces the time to find and fix one from hours to minutes, and it puts that capability in the hands of any junior technician on your floor, not the most experienced controls engineer.

CONCLUSION

Five Propositions

The argument in this white paper rests on five core propositions. Each one stands on its own and is supported by practical data, field experience, and the realities machine builders face every day. Taken together, they point to something larger than a vendor preference or the latest technology trend. They show a structural change in the economics of building, commissioning, and maintaining industrial machines.

THE FIVE PROPOSITIONS

01

The workforce required for traditional panel wiring is structurally scarce and getting scarcer.

This is not a temporary shortage driven by economic conditions. It is a demographic reality driven by retirement rates that exceed new entrant rates, and it will not reverse within the planning horizon of any machine builder operating today.

02

The Gen Z training model for traditional panel wiring is economically broken.

When average tenure is 1.1 years, and training to independent productivity takes 3 to 4 months, the return window on training investment is too narrow to sustain. Any production model that depends on hiring and retaining experienced control engineers and panel builders is operating on borrowed time.

03

The tribal knowledge transfer chain is breaking at the same time.

With 2.8 million manufacturing workers projected to retire by 2033, the undocumented process knowledge that keeps complex machines running reliably is leaving faster than it can be transferred. Every retirement is a knowledge event, not just a headcount event.

04

Connectorized architecture embeds process knowledge in the system design, not in individuals.

Pre-wired, tested cordsets and connector systems move the quality decision from the installation floor to the factory. The knowledge required to make a correct connection is encoded in the connector format, the labelling system, and the LED indicator, not in the experience of the person holding the cable.

05

The transition is practical, not theoretical.

Connectorized systems are not emerging technology. They are deployed at scale in packaging, food and beverage, pharmaceutical, and automotive manufacturing globally. The engineering knowledge to implement them is available. The business case is calculable. The only remaining question is when.

THE BOTTOM LINE

The workforce that built your machines for the last thirty years is retiring. The workforce replacing them grew up plugging things in. The architecture of your control system should reflect that reality. The question is not whether to make this transition. It is whether you make it on your own terms, or under pressure.

Ready To Do Something About It?

If this white paper has raised questions about your current wiring practices and what it's actually costing you, a Connectivity Workshop is the logical next step. It is a straightforward, engineering-to-engineering review of your wiring process. No obligation, no sales pitch.

COMPLIMENTARY OFFER

The Connectivity Workshop

- A 180-minute on-site review of your current electrical design and wiring approach
- We identify the specific areas where complexity, wiring methods, or component choices are costing you time and creating risk
- You receive a clear, prioritized list of recommendations and practical steps you can act on immediately
- Conducted on-site. No cost. No obligation. No sales pitch. Just engineering insight.

Request your free workshop at

ConnectivityColin.com/workshop

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