IPC BUILD ELECTRONICS BETTER®

BUILDING ELECTRONICS BETTER:

A PLAN TO ADDRESS THE WORKFORCE CHALLENGES FACING THE ELECTRONICS MANUFACTURING INDUSTRY

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IPC INDUSTRY INTELLIGENCE

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IPC BUILD ELECTRONICS BETTER®

BUILDING ELECTRONICS BETTER

EXECUTIVE **SUMMARY**

THE CHALLENGE

Electronics manufacturers globally report that their growth is constrained by an inability to recruit, onboard, retain, and upskill workers. This white paper presents a holistic view of the workforce challenges facing the industry and outlines IPC's approach to developing industry—wide solutions that are engaging, scalable, efficient, and effective. At the heart of IPC's approach is an unprecedented and ambitious initiative to create career pathways within this dynamic industry.

There is no singular workforce problem. Most of the rhetoric and literature surrounding workforce development focus on a singular facet: a gap between the knowledge and skills of the current workforce and the evolving needs of industry. While the skill gap presents a significant challenge to the electronics manufacturing industry, it is a symptom of deeper-rooted challenges.

The workforce challenge in the U.S. electronics industry is a byproduct of four key failures: the lack of an industry-driven pipeline, the lack of effective and efficient onboarding programs, the lack of a career pathways system, and the lack of a rapid upskilling infrastructure.

- **Pipeline:** The electronics industry has no well-defined and established school-to-industry pipeline which exacerbates the challenges precipitated by accelerated retirements, a widening skills gap, and geographic imbalances of labor. It also poses recruitment challenges unique to the skill level of the positions that electronics manufacturers seek to fill.
- **Onboarding:** The lack of a workforce pipeline shifts the educational responsibility from academic institutions to employers, but most manufacturing companies do not count training among their core competencies. Most companies are forced to rely on inefficient and ineffective strategies, such as shadowing and investing in the development of internal training capabilities. Unfortunately, individualized solutions focused on immediate needs and specific processes deprive workers of foundational knowledge and skills, limiting their overall utility and professional growth. These employees are more likely to resign within a short period of time and leave the industry altogether.
- **Pathways:** The industry also lacks a standardized industry-wide career framework that encompasses the essential roles in the electronics manufacturing industry, further limiting the effectiveness of training that academic institutions in industry pipeline partnerships impart to workers. A well-developed industry career framework includes industry-defined training and certification options that allow employees to demonstrate the acquisition of competencies at each stage of their professional journey. Employers that provide independently administered, stackable, and portable credentials help ensure both the proficiency and longevity of their workforce.
- **Upskilling:** The lack of a standardized training infrastructure limits the industry's ability to rapidly and effectively upskill the current workforce in response to new technologies, processes, and standards. The industry, in fact, is saddled with a teacher-centered instructional method that limits scale, undermines efficacy, and wastes valuable time.

These problems have contributed to industry workforce shortages that constrain the growth of the industry and lead to increased production costs in a fiercely competitive, thin-margin business.

EXECUTIVE **SUMMARY**

THE IPC APPROACH

IPCs plan to address the electronics manufacturing industry's workforce challenge focuses on developing a comprehensive strategy to bridge the growing skills gap and counteract the labor shortage exacerbated by demographic shifts and changing worker expectations. IPC's plan aims to not only address immediate labor market needs but also ensure the long-term sustainability and growth of the electronics manufacturing industry by building a skilled, adaptable, and motivated workforce.

Key elements of the plan include:

Creating an Industry-Driven Talent Pipeline: Establishing partnerships between educational institutions, businesses, government agencies, and non-profit organizations to ensure a steady flow of skilled workers into the electronics manufacturing industry.

Implementing Career Pathways Systems: Developing clear and structured career pathways that outline progression from entry-level positions to advanced roles, enhancing visibility of career advancement opportunities within the industry.

Investing in Effective Training and Education: Prioritizing the development of industry-defined training programs that equip individuals with the necessary skills and knowledge for employment in electronics manufacturing, including both technical and soft skills.

Promoting Awareness and Dispelling Myths: Launching outreach efforts to improve the perception of manufacturing careers, highlighting the innovative aspects of the industry, and addressing misconceptions about manufacturing jobs.

Fostering Collaboration and Support: Encouraging mutual support between academia and industry to facilitate the transition of students and trainees into the workforce, including internships, apprenticeships, and mentorship programs.

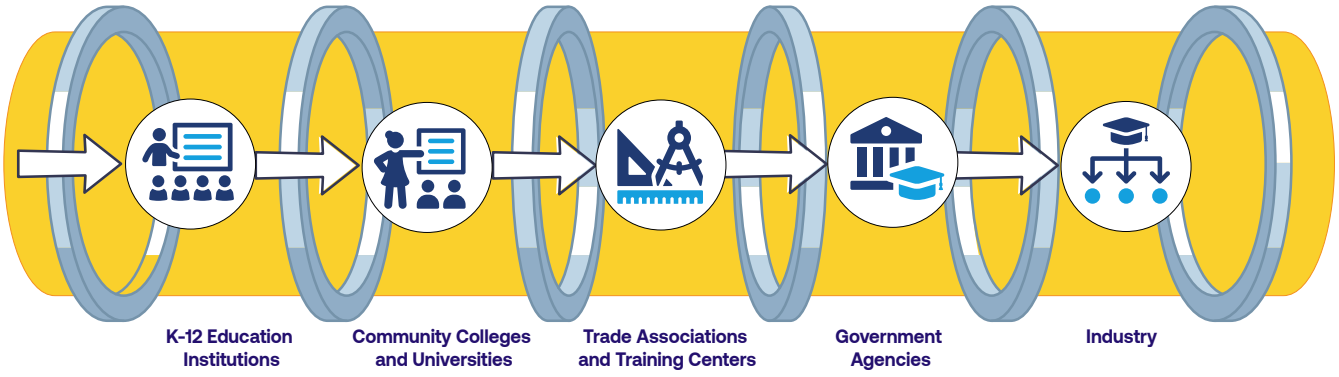
Utilizing Standardized Credentials: Supporting the adoption of universally recognized, stackable credentials that validate the competencies and skills of job candidates, making it easier for employers to assess and hire qualified workers.

IPC's collaborative, scalable, and efficient approach is establishing a standardized workforce pipeline and well-defined career pathways that will foster a skilled and proficient workforce prepared to meet the demands of the competitive market and secure a prosperous future for the industry.

The electronics manufacturing sector is experiencing a severe shortage of qualified workers. Rising demand for electronic devices across the commercial, healthcare, automotive, and industrial sectors will see the global Electronic Manufacturing Services (EMS) market grow from about $534 billion in 2023 to $856 billion in 2030. At the same time, approximately 10,000 baby boomers, defined as those born between 1946 and 1964, are retiring each day. By the time the last member of this generation retires in 2031, U.S. manufacturing is expected to have 2.1 million unfilled jobs. The negative consequences of these long-term economic and demographic trends have been exacerbated by recent post-pandemic shifts in worker expectations and a persistent manufacturing skills gap. The mismatch between the skills that manufacturing employers need and those that available workers possess is driven by a lack of technological and social skills, false perceptions of the manufacturing industry, and the social stigma of blue-collar work.

These challenges are substantial but not insurmountable. In keeping with IPC's mission to foster the success of electronics manufacturing companies, this whitepaper describes how an industry-driven talent pipeline and career pathways can create the ready pool of qualified job candidates that OEMs, EMS, and PCB manufacturers need to compete and grow over the next decade and beyond.

WHAT IS **A TALENT PIPELINE?**



A talent pipeline typically consists of educational institutions, trade associations, government agencies, and businesses working in concert to recruit and prepare a qualified pool of candidates for employment in a given industry. Pipeline stakeholders employ awareness building strategies such as career fairs, digital marketing strategies, and social media campaigns to dispel myths about jobs in manufacturing and introduce potential job candidates to career opportunities. Interested individuals are offered training, mentorship programs, internships, and other opportunities to acquire the competencies required to take on specific roles in the industry. Pipeline program graduates earn universally recognized, stackable, and portable credentials that allow employers to assess their level of competency and commitment to the field.

A well-structured pipeline depends on the mutually beneficial relationship between trade associations, academic institutions, and industry. Trade associations such as IPC work directly with industry members to address the performance needs of their workforce. They collaborate with industry to: (1) define the competencies required to perform key job roles, (2) develop training that provides the requisite knowledge, skills, and abilities (KSA), and (3) create certification exams that validate the ability to perform a job to industry defined levels of proficiency. High schools, trade schools, career training centers, colleges, and military organizations can then adopt and deliver these industry approved training and certification programs to meet the workforce needs of the electronics manufacturers in their area.

Trade associations, schools, and training institutions shoulder most of the instructional responsibilities because their core competency is education. They equip students with fundamental knowledge and skills, laying the groundwork for employers to focus solely on company-specific training. This division of labor between trade associations, educational institutions, and industry shortens the time required for employees to achieve full productivity and consequently reduces the costs associated with extended periods of in-house, on-the-job training. The resulting productivity gains and cost savings on training programs incentivize companies to support the trade associations and educational institutions that provide job-ready employees. This support often comes in the form of funding, donations of material and equipment, industry volunteers, access to facilities and professionals, and feedback on the effectiveness of the programs.

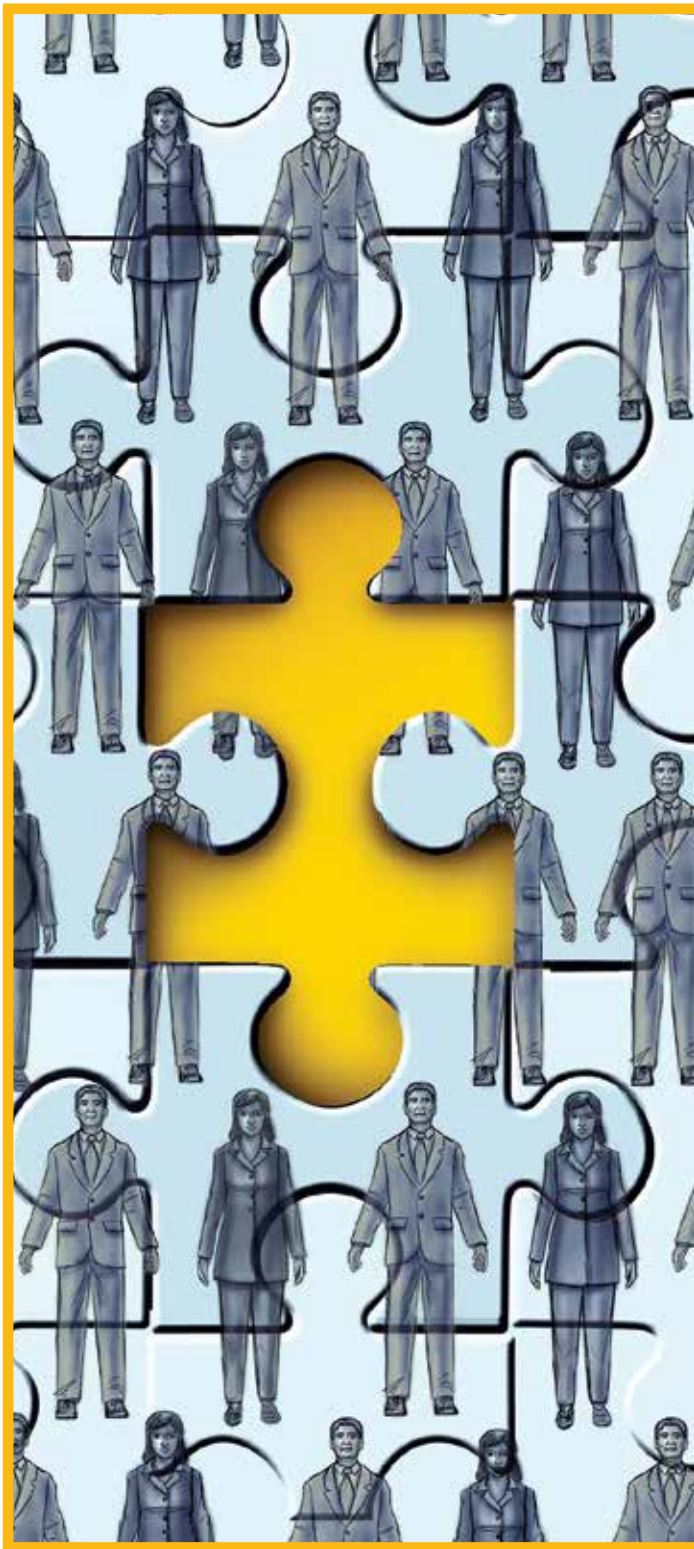
THE COST OF NOT HAVING A **TALENT PIPELINE**

The electronics industry does not yet have a highly developed, easily accessible pipeline program like those that reliably feed work-ready talent into fields such as machining, welding, and automobile maintenance and repair. This leaves most of the career-specific educational process in the hands of company executives with little or no academic expertise, and it significantly reduces the number of qualified job candidates retained in the industry as a whole.

This challenge is compounded by the fact that most manufacturing companies do not count training among their core competencies. Those companies without a pre-existing educational infrastructure capable of offering extensive new hire training are forced to invest in it internally or rely on inefficient and ineffective strategies such as job shadowing.

The lack of a pipeline poses an even greater challenge to the industry as a whole. Companies that cannot hire a steady flow of qualified candidates often resort to developing tailored solutions to specific needs as they arise. However, this approach deprives employees of essential industry knowledge and skills, limiting their ability to contribute beyond narrowly defined roles or advance their careers. Employees who lack prospects for advancement, transferable credentials, or skills are much more likely to leave the industry as soon as a better opportunity arises. This is the worst possible outcome from an industry-wide point of view. While no employer wants to lose employees to potential competitors, the migration of qualified workers from company to company within a single industry ensures the availability of job-ready candidates that industry members can hire to scale their operations as needed. In contrast, all industry members lose when employees migrate to other industries.

This brings us to the important role that industry-wide career pathways play in providing a universally qualified and motivated electronics manufacturing workforce.



SKILL SPECIFIC RECRUITMENT CHALLENGES

The lack of a talent pipeline poses recruitment challenges unique to the skill level of the positions that electronics manufacturers seek to fill.

OPERATOR LEVEL: The electronics industry relies upon a constant influx of mostly unskilled workers to fill the role of operator. Companies that fill these positions without the benefit of a talent pipeline often rely on career placement services, local partnerships, and public services that are not always geographically or financially feasible. Moreover, the costs to train new workers in basic manufacturing (e.g., taking measurements, reading assembly instructions, interpreting tolerances) and industry-specific skills cuts profit margins and favors companies that can afford to hire in-house trainers.

It is also important to note that the electronics manufacturing sector competes with other industries for the same entry-level workers. With limited opportunities for advancement and wage growth and with comparatively high skill requirements, electronics manufacturing companies are losing current and potential workers to other industries such as retailers who pay entry level staff an average of $15 per hour plus benefits such as college tuition.

TECHNICIAN LEVEL: The role of the technician responsible for programming, operating, and maintaining automated systems is gaining increasing relevance as automated technologies continue to take over the highly repetitive tasks of most operators. The projected threefold to fourfold increase in industrial automation over the coming decade will increase the demand for these types of technicians. However, when compared with operator training, technician training entails a larger investment on the part of both employers and job candidates. Without a talent pipeline, employers must compete for qualified veteran workers and invest scarce resources in costly technician training programs.

ENGINEER LEVEL: Various sectors of the electronics industry, such as aerospace, medical, and automotive, compete for a limited number of engineers entering the workforce every year. Many of these other sectors benefit from pipeline programs that expose engineering students to career opportunities. Individual companies in different industry sectors also partner with educational institutions and trade associations to provide apprenticeship programs that allow engineering students to gain valuable work experience and build relationships with potential employers. Some of these sector- and company-specific recruitment and training efforts meet with success. However, an industry-wide talent pipeline would be able to cast recruitment nets across a much wider area and provide training and certification programs that substantially increase the diversity and quality of job-ready engineers across all sectors of the electronics manufacturing industry.

WHAT IS **A CAREER PATHWAY?**

Career pathways chart the routes employees take from entry-level positions to more advanced roles, often incorporating various levels of education, training, certifications, and work experiences that align with the demands of a specific industry or sector. Career pathways allow individuals to quickly discern the knowledge, skills, and experience required to perform a specific job. They also show how the acquisition of those competencies can help workers prepare to perform the next, usually more complex, role in a given field.

On the face of it, it seems logical for each company to develop their own career pathway framework, but this approach has limited effectiveness for employees, individual businesses, and the industry as a whole. A more universal framework that defines the attributes and qualifications for operators, technicians, engineers, and other essential roles would allow academic institutions in pipeline partnerships to impart the training that all employees and employers need to succeed on an individual and organizational level. A standardized career pathway system, with corresponding industry training programs and credentials, would also help companies across the industry to quickly and accurately assess job candidates and their potential for growth.

THE COST OF NOT HAVING **CAREER PATHWAYS**

The lack of universal career pathways and training programs limits an employee's potential to grow within their field. Where there could have been an employee inspired by the prospects of a career in electronics manufacturing, there is instead a worker who does a job for the highest bidder. And as you might expect, attrition is higher among the latter group. In fact, studies show that 40% of employees who do not receive the training required to perform effectively leave their positions within the first year.

A growing percentage of people prefer to work for companies that provide educational opportunities and facilitate advancement within their field. For example, in a 2018 global analysis of the forces shaping the workforce of the future, 52% of Millennials cited the potential for career growth as the most important characteristic they look for in an employer. A 2016 Gallup survey reported similar findings with 59% of Millennials, 44% of Gen Xers, and 41% of Baby Boomers identifying training and growth opportunities as important considerations when applying for a position.

More recent research indicates that this generational demographic trend became more widespread and pronounced during the recent spike in staff departures known as the Great Resignation. According to the U.S. Bureau of Labor Statistics a historic high of over 47 million Americans voluntarily quit their jobs in 2021. In a March 2022 Pew Research study, 63% of those surveyed said they quit their jobs in 2021 because their employers did not provide opportunities for advancement.

The Great Resignation probably came as no surprise to Andrew Chamberlain, the chief economist and senior director of machine learning for Glassdoor. Citing his company's 2017 study on attrition in the Harvard Business Review, he noted that, "even after controlling for pay, industry, job title, and many other factors, we find workers who stay longer in the same job without a title change are significantly more likely to leave for another company for the next step in their career." When you consider that the median cost of turnover amounts to 21 percent of an employee's annual salary, it's surprising that more companies do not take Chamberlain's advice to "provide clear paths for employees, moving them through job titles on a regular progression over time."

ADDRESSING THE ISSUES: **FROM PATHWAYS TO PIPELINE**

IPCs Role in Creating the Industry's Talent Pipeline

IPC was established in 1957 to serve as the collective voice of six companies who saw the future of electronics in the breakthrough technology of printed circuit boards. Today, IPC is the global, non-profit trade association that provides standards, training, certification, industry intelligence, and public policy advocacy to over 3,200 member companies involved in the design, fabrication, assembly, and testing of printed circuit boards and wire harnesses. As the knowledge hub of the electronics industry, IPC continues to innovate and leverage emerging technologies to help industry members create reliable products; reduce costs and waste; comply with regulations; and capitalize on technological advances.

As the principal standards organization and certifying body of the electronics manufacturing industry, IPC is uniquely positioned to help create, sustain, and grow a universal, standardized talent pipeline. Academic institutions and industry members are essential pipeline partners. However, few educational organizations have the resources to develop comprehensive curriculums around specific industries like electronics manufacturing. Similarly, these efforts represent a costly departure from every company's core competency. In contrast, IPC routinely pairs volunteers from all sectors of the industry with its in-house technical and education experts to create and revise the standards, training, and certifications that both academia and business rely on to educate their students and employees.

Over the last five years IPC has worked closely with industry members to: (1) identify the essential job roles that together form career pathways; (2) determine the competencies required to perform each role; (3) create the training needed to acquire those competencies; and (4) work with academic institutions, businesses, government agencies, and other non-profit organizations to adopt IPC career pathways and training as part of a cohesive talent pipeline that serves every sector of the electronics manufacturing industry.

Defining the Essential Roles that Comprise Career Pathways

IPC has been working closely with experts across all sectors of the industry to delineate the competencies required to perform the roles critical to every company's success. The resulting career pathway system (CPS) will allow individuals and organizations to map out educational and experiential trajectories within and across roles. For example, the CPS can be used to identify the academic pipeline programs, IPC workforce training courses, apprenticeship programs, and on-the-job training that facilitate the transition from the role of assembly operator to that of inspector or from the role of inspector to that of quality engineer.

The essential roles identified by IPC and its industry partners include:

- Operator Level: Assembly Operator, Wire Harness Operator, PCB Operator, Assembly Inspector, PCB Inspector, Trainer
- Technician Level: Manufacturing Technician, Production Technician, Design Technician, Quality/ Test Technician
- Engineering Level: Production Engineer, Manufacturing Engineer, PCB Designer/ Design Engineer, Quality Engineer

The data IPC collected through industry job task analyses, competency mapping activities, and workforce development working groups allows IPC to identify the key competencies and tasks for each job role. They also allow us to identify the variations in competencies and experience requirements that delineate one role from another. For example, the competencies required to perform the job of an assembly operator and a PCB fabrication operator clearly vary to a degree that merits classifying them as different roles. The difference between an inspector and senior inspector is more subtle. They share the same basic skill set but the additional experience required to perform the senior role merits separating the job of inspector into two roles.

Comparing the competencies required to perform different roles also allows individuals to identify the knowledge, skills, and abilities they need to transition from one role to the next. For example, if 30% of the competencies for job role 1 and job role 2 overlap, then an individual in job role 1 can easily identify and focus on the other 70% of competencies needed to perform job role 2.

The competencies and experience required to perform a given role evolves with advances in materials, technologies, and processes. These factors, along with emerging applications, also lead to the creation of new job roles. Therefore, the widespread and continuous dissemination of new career opportunities is key to attracting new talent and keeping employees up to date. As we've seen, career pathways also play a critical role in increasing motivation and curtailing attrition.

Creating Training for Onboarding and Growth

IPC learning specialists and industry experts use the competencies defined in the previous step to create the training required to perform each essential role. Industry subject matter experts define the scope and ensure the accuracy of the requisite knowledge and skills. IPC learning specialists then employ research-based instructional strategies to design learning experiences to facilitate the rapid assimilation and application of new knowledge and skills on the job. The collaboration between the best minds in electronics manufacturing and instructional design allows IPC to deliver the most efficient and effective training in the industry; most efficient because it focuses specifically on industry needs and most effective because it reduces the time required to assimilate and apply new learning on the job.

The instructional effectiveness of IPC training programs is driven by a variety of research-based techniques designed to engage participants and facilitate their ability to recall and apply what they've learned in complex, real-world settings. For example, IPC learning specialists employ a carefully curated mix of media—including audio, text, video, animation, and virtual simulation—to illustrate concepts, processes, and problems. This encourages active learning, accounts for different learning preferences, improves understanding and retention, and facilitates real-world connections.

IPC has been working closely with experts across all sectors of the industry to delineate the competencies required to perform the roles critical to every company's success.

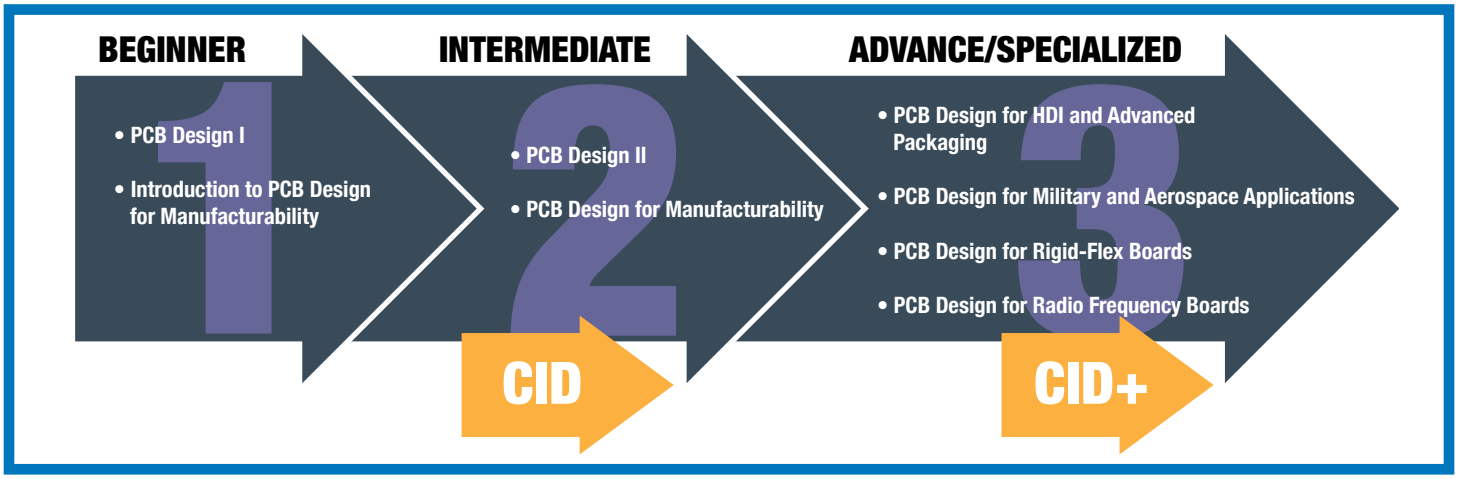
IPC learning specialists also employ a highly effective approach called scaffolding. Scaffolding involves the judicious application of instructional techniques such as modeling, concrete examples, timely feedback, the division of complex tasks, and the gradual reduction of support. These methods are used to gradually increase the complexity of tasks as learners become more competent. By enabling learners to master each step before moving on to more complex tasks, scaffolding helps students experience success regularly. These achievements, even if small, boost confidence and motivate learners to continue engaging with the material. Scaffolding is particularly valuable when a specific step is crucial for understanding an entire process, or when a concept is among several needed to fully comprehend a broader subject or idea.

Finally, it's important to note the critical role that practice activities and assessments play in IPC training. Formative evaluations and real-life application foster learning, engagement, and self-efficacy. Most importantly, they significantly enhance the transfer of learning, ensuring that learners are not only knowledgeable but also skilled in applying their learning in practical, real-world contexts.

IPC is employing the collaborative processes and instructional techniques described above to develop and launch training programs for each of the essential roles that make up the operator, technician, and engineer job levels. Several thousand participants have already taken *Electronics Assembly for Operators, Wire Harness Assembly for Operators,* and *Electronics Assembly for Engineers* to obtain the competencies required to perform these entry-level roles. These onboarding courses serve as the starting point for a series of stackable training programs that allow participants to advance along a given career path.

For example, a budding engineer new to PCB design can take PCB Design I, Introduction to Design for Manufacturability, PCB Design II, Design for Manufacturability, and PCB Design for Military and Aerospace Applications to progressively acquire the knowledge, skills, and experience required to perform the role of PCB Design Engineer at an aerospace or defense electronics manufacturer.

This career path might also include a Certified Interconnect Designer (CID) or advanced CID+ certification. Certification validates an individual's ability to apply the criteria or processes specified in a standard at an industry-defined level of proficiency. Industry-recognized certifications like those offered by IPC provide a range of benefits to individuals and employers alike, enhancing career prospects, professional credibility, organizational performance, employee retention, risk management, and competitive advantage.



QUALITY TRAINING **ALWAYS HAS A POSITIVE ROI**

Quality training produces substantially more value than cost. Perennial problems such as the lack of effective training programs, post-training performance support, and career pathways have led many electronics manufacturers to view new hire training and even veteran worker upskilling as a waste of time and money. Having seen recently trained employees take positions with rival companies, they henceforth "refuse to train their competitors' workforce." These employers often fail to consider other retention factors such as pay, fringe benefits, and company culture. They may also fail to consider how deficiencies in the timing, delivery, or quality of their training solution may have contributed to negative outcomes.

The reality is that effective training works. Multiple case studies from industries as diverse as finance and manufacturing demonstrate that training programs that approach onboarding and performance improvement from the perspective of the worker, the work, the workplace, and the world drive significant increases in performance and productivity as well as employee morale and retention.

It also bears noting that a lack of investment in effective training eventually leads to a loss of revenue and market share. Companies with quality training programs simply outperform those that must bear the costs of rework, scrap, increased lead times, and other inefficiencies that are the inevitable result of trying to get by on one- or two-day knowledge dumps and trainee shadowing. Companies that invest in effective training programs like those that IPC has created in collaboration with industry experts and learning specialists see positive returns in the form of:

- Reduced time to proficiency
- Reduced attrition
- Reduced training costs
- Reduced rework, repair, and scrap
- Increased product quality, reliability, and consistency
- Increased productivity
- Increased employee morale

TRAINING DELIVERY AD SCALABILITY

IPC workforce training courses currently come in two formats: online self-paced and online instructor-led. All IPC programs are delivered through the IPC EDGE learning management system, allowing any user with an internet-enabled device to access their courses at anytime from anywhere in the world. These course formats and delivery system allow users to employ IPC training at a time and in a manner best suited to meet their needs. Academic and corporate trainers do not have to introduce new training programs or support. The IPC EDGE learning management system provides full visibility of student activity, allowing trainers to monitor students' progress and access results from practice activities and tests.

The standardization of essential roles, career pathways, and training programs effectively addresses industry-wide needs and captures the savings that accrue to economies of scale. For example, the foundational IPC assembly and wire harness programs developed in collaboration with industry has saved hundreds of companies hundreds of thousands of dollars in otherwise individualized onboarding costs. However, standardization does not imply rigidity. Various features of the career pathways development process and IPC training programs provide the flexibility that companies require to address sector- or company-specific training and performance needs.

For example, the IPC workforce programs developed in collaboration with the industry are based on universal competencies. They provide the knowledge and skills that most employers across the various sectors of the electronics manufacturing industry would expect an assembly operator, PCB designer, manufacturing engineer, or other essential category of worker to have. Therefore, most IPC programs provide optional, hands-on activities that trainers can use to reinforce general principles within the context of the specific materials, tools, and processes used in their facility. Moreover, by focusing most of the learning experience online, trainers obtain the time to give the personalized attention that some learners need to learn and perform company-specific tasks.

IPC workforce training courses currently come in two formats: online self-paced and online instructor-led.

IPC onboarding programs provide another good example of how courses can be tailored to afford the flexible implementation required by a diverse industry. Onboarding courses such as Electronics Assembly for Operators are divided into mandatory and optional modules. The mandatory modules encompass the knowledge and skills that all assembly operators must acquire to perform their job. These modules cover topics such as Safety, ESD, and Drawings, Specifications, and Measurements. The optional modules provide more specialized skill sets that an operator may need to work in a specific area. These modules cover topics such as hand soldering, SMT technology, and wire and cable preparation. An employer who needs to quickly scale operations can have their operators take the mandatory modules and only those optional modules that directly relate to their immediate tasks. In contrast, another company that has had success with cross-trained generalists may opt to have their new operators take all the modules.

BUILDING THE PIPELINE: **AN ONGOING ENDEAVOR**

IPC is working with industry experts to develop turnkey workforce training programs that companies can use to help new employees rapidly acquire the requisite knowledge and skills. As noted above, some of these programs may serve as the first in a series of courses that will allow individuals to achieve the competencies required to perform the essential roles that make up a career pathway.

At the same time, IPC is working with academic institutions, industry members, government agencies, and other non-profit agencies to implement IPC workforce training programs in schools, training centers, and other academic institutions. Full career paths will emerge as IPC completes the training courses for each essential role and specialization. For example, the career path for an electronics assembly manufacturing engineer includes an onboarding training program as well as separate courses that focus on specific areas such as surface mount technology and through hole assembly.

There is no single switch that activates a talent pipeline. The electronics manufacturing pipeline will emerge over the coming years as high schools, community colleges, and universities adopt IPC workforce training programs and begin producing operators, technicians, engineers, and designers ready to join the electronics industry.

The current company adoption of IPC onboarding programs is particularly effective because it helps alleviate the monetary and opportunity costs associated with simultaneously high attrition and growth rates. These costs will gradually shift to academic institutions as they begin to implement IPC programs. However, some company-driven onboarding will remain even after the talent pipeline is fully operational. This is because not all potential job candidates will flow through the talent pipelines. Examples include students that do not avail themselves of formal educational opportunities; adult workers migrating from other industries; and military service veterans transitioning to civilian life.

THE GROWING ROLE **OF APPRENTICESHIPS**

In some cases, companies can use apprenticeship programs to fulfill their onboarding and upskilling needs. An apprenticeship program is a structured training system that combines on-the-job training with classroom instruction in a specific trade or profession. It is designed to equip participants with practical skills and knowledge directly relevant to their chosen field. Apprentices are often paired with experienced professionals who mentor them through the learning process, allowing them to earn while they learn by working on actual job sites or in real-world business environments. Upon completion, apprentices often receive a certification or credential recognizing their proficiency and are prepared to work independently in their trade or profession.

In November 2023, IPC received approval from the U.S. Department of Labor (DOL) for IPC's National Program Standards of Apprenticeship, the first-ever in the U.S. electronics manufacturing industry. The DOL's action paves the way for IPC's Registered Apprentice programs to be recognized in all 50 states and confirms that they align with the industry's highest standards of proficiency in electronics manufacturing. IPCs first two registered apprenticeship programs cover the roles of Electronics Assembly Operator and Printed Circuit Board Fabricator. These will be followed by the other essential roles identified in collaboration with our industry partners.

Each apprenticeship program is composed of an industry-defined set of courses that cover the competencies required to perform the role. Upon completion of the courses, apprentices can sit for one or more certification exams. Candidates who attain a passing score receive a certificate that attests to their ability to perform the role at a level of proficiency defined by the electronics manufacturing industry.

As noted above, IPC Registered Apprenticeship programs can be adopted by employers to cover job candidates that may not reach them via the talent pipeline. In the near future, academic institutions will also be able to incorporate IPC Apprenticeship programs into their talent pipeline curriculums. IPC is currently piloting pre-apprenticeship programs with high schools in Colorado, Texas, and Massachusetts, which will work directly with local electronics manufacturers to prepare qualified job candidates. The results of these pilot programs will be published to inform the policy and practice of secondary schools across the country that will eventually form part of the electronics manufacturing talent pipeline.

COURSE TOPIC	HOURS
Apprenticeship Employer Onboarding	16
ESD Control for Electronics Manufacturing	1
Safety for Electronics Manufacturing	1
Foreign Object Debris/Damage	1
Electronics Assembly for Operators	40
IPC Soldering Fundamentals I	20
IPC J-STD-001 for Operators	8
IPC J-STD-001 Certification (CIS) Training	40
IPC A 610 for Operators	8
IPC A 610 Certification (CIS) Training	40
Total	175

Electronics Assembler Apprenticeship Program Required Instruction

CONCLUSION

The electronics manufacturing industry stands at a critical juncture, faced with the dual challenge of a growing skills gap and workforce shortage made worse by demographic shifts and evolving worker expectations. The creation of an industry-driven talent pipeline and career pathways system is essential to cultivating the pool of qualified candidates that the industry requires to ensure its competitiveness and growth into the next decade and beyond.

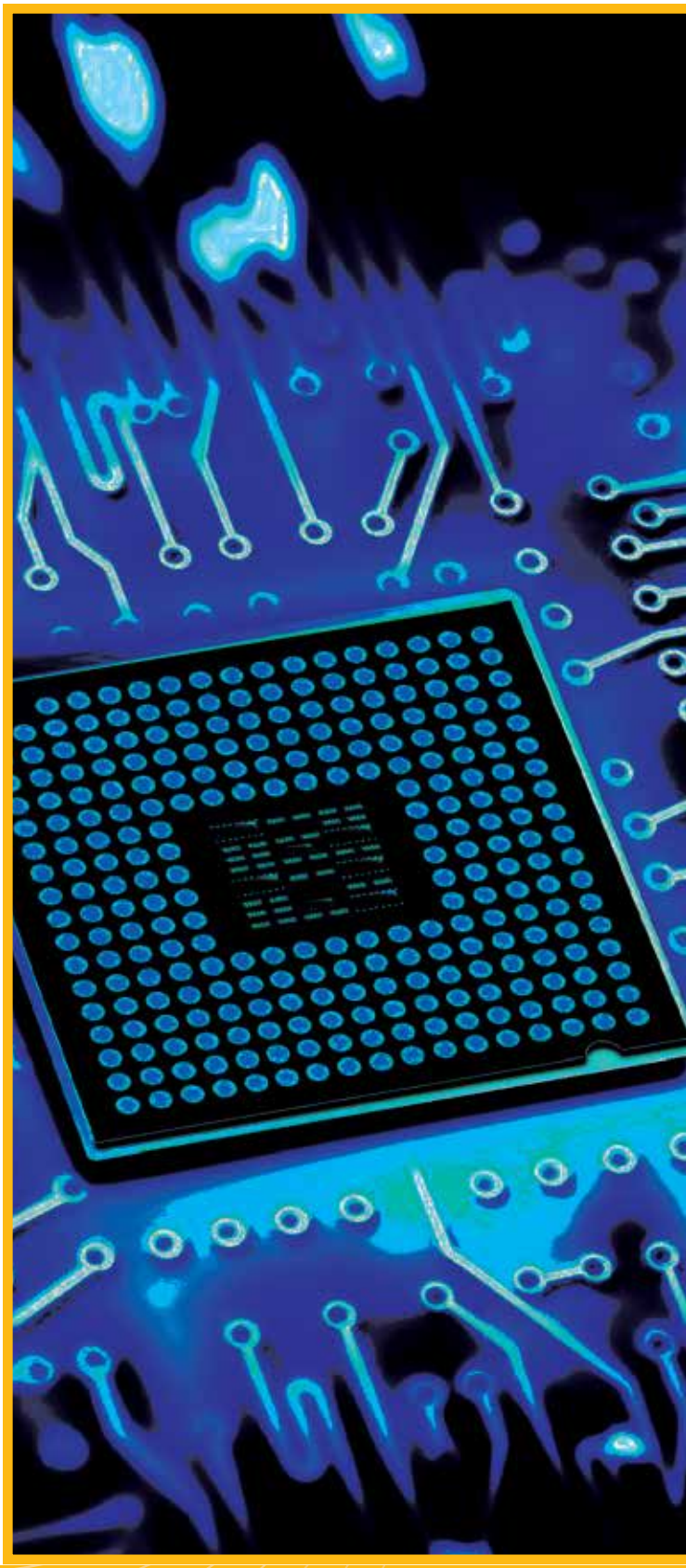
An effective talent pipeline and career pathways system entails significant investments in training and education initiatives to prepare individuals for immediate employment and ongoing professional development. This approach not only mitigates the industry's current workforce challenges, but also contributes to a more dynamic, skilled, and resilient labor market capable of adapting to the demands of a rapidly evolving global economy.

IPC has enacted the first phase of a comprehensive plan to make this vision a reality. By offering courses like Electronics Assembly for Operators, Wire Harness Assembly for Operators, Electronics Assembly for Engineers, and PCB Design I & II, IPC enables electronics manufacturers to expedite the onboarding of new employees. Additionally, the adoption of the first DOL-approved IPC apprenticeship programs allows companies to provide the instruction that employees need to perform their jobs to industry-defined levels of proficiency.

At the same, IPC is building partnerships with Career and Technical Education (CTE) high schools, vocational colleges, universities, veterans' organizations, recruitment centers, and other institutions that can employ IPC workforce training and apprenticeship programs to channel qualified job candidates into the electronics manufacturing industry. As the number of organizations that provide these programs increases, the emerging career pipeline will reach a tipping point, at which time the industry will have secured a stable supply of labor.

Clearly, the workforce challenges facing the electronics manufacturing industry cannot be solved by traditional educational pathways and paradigms. A multifaceted approach to recruitment and training is essential if we are to turn current socioeconomic, demographic, and cultural trends into opportunities for growth.

The federal CHIPS and Science Act will play a critical role in overcoming these challenges for a national semiconductor industry. Yet, addressing the semiconductor labor shortage alone will merely transfer the problem to other companies downstream in the manufacturing process. Comprehensive solutions must include efforts to train the PCB and wire harness designers, fabricators, and assemblers who create the circuit boards that house and connect semiconductor devices. Adopting a holistic silicon-to-systems strategy is essential for the United States to maintain its technological leadership, national security, and economic competitiveness amid growing global challenges.



BUILDING ELECTRONICS BETTER:

A PLAN TO ADDRESS THE WORKFORCE CHALLENGES FACING THE ELECTRONICS MANUFACTURING INDUSTRY

For more information about the IPC Workforce Initiative visit education.ipc.org.

BUILD ELECTRONICS BETTER

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IPC is the global association that helps OEMs, EMS, PCB manufacturers, cable and wiring harness manufacturers and electronics industry suppliers build electronics better. IPC members strengthen their bottom line and build more reliable, high quality products through proven standards, certification, education and training, thought leadership, advocacy, innovative solutions and industry intelligence.