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ADVANCED MANUFACTURING MARKET ASSESSMENT

Use of New Technologies &
Workforce Needs Among NYC Manufacturers

December 2018



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INTRODUCTION

PURPOSE

- ITAC recently partnered with Empire State Development to survey small- and medium-sized New York City manufacturers about their hiring expectations and workforce challenges, as they consider and adopt new technologies for Industrial Transformation.
- **Survey Focus:** understand utilization of new technologies and define workforce needs.
- **Survey Goal:** reduce barriers to skilled employment by informing training programs around Industrial Transformation.

FORMAT

This report is divided into three parts:

1. A quantitative analysis of existing New York City manufacturing data
2. The design, execution and analysis of an opinion survey of over 100 manufacturing leaders
3. Comprehensive qualitative interviews used to inform survey findings

SUMMARY OF FINDINGS

- More than 8,000 small- and medium-sized manufacturing companies in New York City employ over sixty thousand people and occupy nearly 40 million square feet of real estate. Together, they generate \$7.75 billion dollars in revenue.
- Printing, Apparel, Fabricated Metal, Food, Jewelry, and Electronics provide more than 50% of all manufacturing jobs in New York City. Most of those jobs are in Manhattan, Brooklyn and Queens.
- About 85% of companies employ less than 10 people; the median size is 3. Similarly, about 85% of manufacturing companies generate less than \$1 million dollars in revenue each year; the median is \$193,000 per year. 70% of companies have been in business 20 years or less.
- 70% of companies occupy 4,000 square feet or less; the median is 3,200 square feet. An uncertain real estate market is the biggest barrier to adopting hardware and machine tools. Without knowing the future of where the business will be located, business owners are unwilling to make a large investment which may either be too costly to move, or not be functional in a new space.
- 40% of respondents reported having at least one Industrial Transformation initiative in progress or completed. 75% of the respondents that completed an initiative reported them to be either extremely or very effective.
- Most of the Industrial Transformation has been in automation tooling like CNC, or software tools like Computer-Aided Design and Manufacturing that have both a lower barrier of entry and higher impact on the bottom line.
- Nearly two thirds of respondents saw their workforce as important in achieving successful Industrial Transformation, yet less than half are satisfied with the skills needed to drive Industrial Transformation, which they perceive as lacking among their current employees.
- Available vocational and technical programs are extremely limited; as a result, employers seek the most experienced employees possible, and do internal training or job shadow programs to fill the knowledge gaps.
- Less than 50% of respondents reported working with state or local organizations, community colleges or private universities to recruit or train staff.

FRAMING THE ISSUE: IF THEY CAN MAKE IT HERE...

In many respects, New York City is a great location to operate a business. The unparalleled concentration of residents, economic activity and wealth creates a tremendous market for goods and services. As the business capital of the world, New York City offers many companies the unique opportunity to thrive as part of value-chains in sectors such as media, publishing and fashion. The size and diversity of New York City are important advantages for local companies, creating broad supplier networks and fostering strong local clusters. Employers often praise New York City's:

1. Proximity to a large, diverse, affluent market
2. Good transportation systems that draw talent from many locations, including outer boroughs and suburbs
3. Support for small businesses, including tax incentives and an active SBS agency that helps with training and recruitment



It's a very dynamic market place to be in, but specifically for what we do, addressing and targeting the top one percent layer and they are right here. Proximity to the clients is key for what we do...

— **Simon Hansen**, *Erik Bruce Company*



In our industry, we are within a one- or two- or three-block radius of anything that we need, whether it's zippers or anything you need for manufacturing.

— **Carolyn Ferrara**, *Ferrara Manufacturing*



If we had this business anywhere else in this country, I don't think it would be as successful. We do very, very high-end work, and where else in this country do you have such a concentration of wealth in such a small area? We can see a lot of clients in one day and are not spending tons of time traveling. You've got the Hamptons, Upstate, Manhattan. I live in Brooklyn. I just think it's the perfect place.

— **Kelly Ault**, *Stitch NYC*



There is such a community of like-minded entrepreneurs doing really cool things. I grew up in the area and having my company in a place where I like to live is very helpful. I would also say that making everything in New York, having direct control over our product, being able to quickly turn things around and innovate, and not necessarily have all this time sunk in working with manufacturing companies abroad is really helpful. There are a lot of companies designing products here and sending everything to get produced abroad. I get direct control over the products, and benefit from short lead times to ship to clients. Those are definite advantages.

— **Ashley Platt**, *Lux Holdups*



There's only really one thing and it's the labor that we have. If we ever decided to move, that would be the most difficult thing to replace; almost every employee has been with us at least 10 years. I would say a third of our people have been here 20 years or more.

— **Fred Schneider**, *Volckening*

However, New York City is faced with some pressing issues including the scarcity of affordable real estate, the cost of labor and a growing lack of skills required to fill new production roles.

Expanding and relocating within the City is difficult. Over 60 percent of manufacturing companies lease their space. Most of them occupy less than 10,000 square feet. In addition, while more than half of the companies have near-term expansion plans, less than half of them plan to expand at their current location.

Manufacturing space in the five boroughs comes in short supply, at high costs, and with little security of tenure. Owners of industrial space can get as much as three times the rent from offices, residences, and retail as they can get from manufacturers. Manufacturers in all sectors have experienced escalating rents and, even more unnerving, uncertain leases.

A 2014 study conducted by the Independent Budget Office of New York City reported that industrial businesses with fewer than 20 employees provide employment to a significant number of residents with lower skill levels. Given the pressures on New York City manufacturing companies to remain competitive and improve productivity, tasks that require manual labor are targeted for automation or outsourcing. The nature of the work that remains requires technical training and certifications beyond what is expected today. Small companies lack the resources to provide training themselves, and individual employees lack the funds to secure the training if it's available. These conditions lead to what is referred to as the "Middle Skills Gap". In previous generations, large companies provided on-the-job training, and unions offered apprenticeships to provide the skills and experience required.



The cost of doing business in New York, it's very expensive. This office is very expensive. Payroll is going to be more expensive because of minimum wage increases. And just in general, the cost of living is high here. So, we have to be able to pay our workers an actual livable wage.

— **Roseanna Kilts**, *Catbird*



Being in such tight quarters really does impact your labor costs because it's like living in a tight space, you're always moving in, moving out, rearranging. You have no room to really breathe.

— **Paula Rimer**, *Crepini*



With the minimum wage increase, we're really trying to automate and squeeze out as much as we can per worker. We don't want to have to let people go, and we haven't yet.

— **Oleg Zoan**, *EzInk*



The tough part is access to skilled labor — the right labor

— **Simon Hansen**, *Erik Bruce Company*

MANUFACTURING IN NYC BY THE NUMBERS

Much has been written about the cost of doing business in New York City, and the dramatic impact on manufacturing employment. While the numbers vary from one source to another, most reports indicate approximately a 50% drop in manufacturing employment in New York City over the past two decades. There are a few bright spots in the data. First, the trend has remained stable and even very slightly up since 2010; and second, the food and beverage sector appears to be growing.

MANUFACTURING EMPLOYMENT IN NYC (THOUSANDS), 2001-2016

2001	158.6
2002	140.7
2003	128.2
2004	120.8
2006	114.9
2007	101.8
2008	96.8
2009	82.3
2010	76.5
2011	74.9
2012	75.9
2013	76.2
2014	75.8
2015	77.7
2016	78.8

Source: New York State Labor Department, Current Employment Statistics. Data is for April of every year.

MANUFACTURING SUBSECTORS

This report divides manufacturing establishments into 9 clusters comprised of manufacturing's 21, three-digit subsector NAICS classifications. These clusters have individual trends that both define and illuminate the path of the sector as a whole.

TRENDS KEY

2012
2002-2012
Percent of total NYC Manufacturing Sector by Employment
NYC Employment

>5%
-10%
-20%

↑
= (three horizontal lines)
↓

CLUSTER¹



Food and Beverage

Transformation of livestock & plants into products for consumption, including alcohol and tobacco



Textile, Apparel & Leather

Production of apparel or materials for apparel, including weaving, tanning, cutting and sewing



Wood, Paper & Printing

Production of wood products, converting pulp to paper products & printing, such as newspapers



Petroleum, Chemical, Plastic & Mineral

Transformation of raw materials such as petroleum, minerals & rubber into usable products



Metals & Machinery

Transformation of ore into metal products by way of refining, smelting, heat treating, assembly et al.



Computers & Electronics

Production of computers and electronics or their components



Transportation Equipment

Production of equipment for transporting people and goods, including cars, trains and trucks



Furniture & Related Products

Production of furniture and related articles, including design and development of such products



Misc

Production of items such as sports goods and jewelry that require specialized manufacturing processes

TRENDS IN NYC



WHERE YOU'LL SEE IT IN NYC²

Highest concentration in Brooklyn

Concentrated in Manhattan's Garment Center

Commercial Printing concentrated in Manhattan & Long Island City, Queens

Concentrated in Brooklyn

Light concentration in Long Island City, Queens

Highest concentration in Downtown Manhattan

High concentration in Queens

Historically concentrated in Brooklyn

Found scattered throughout the five boroughs

¹ Clusters appear in the numerical order of their corresponding NAICS codes

² Concentrations are based on a combination of sources, including InfoUSA and observations of authors and are provided for reader reference only.

Source: State of Local Manufacturing, October 2013, A NYCEDC Special Report.

Government agencies, such as the US Census and Bureau of Labor Statistics, are the most common sources of data for this type of research. In this instance, we chose to use data from D&B Hoovers, a publicly held company that provides commercial data, analytics, and insights from over 300 million business records curated from tens of thousands of sources. This data set provided greater depth and breadth of business information than what was available through publicly available government sources. While some readers may question discrepancies between this information and reports based on government data, we believe that the added insights compensate for the differences.

According to D&B Hoovers data, more than 8,000 privately held companies with 500 or less employees in New York City meet the North American Industry Classification System (NAICS) definition for manufacturing. The statistics and graphs in this section are generated from a data set pulled in February 2018 from 85 million company profiles. The data was filtered by the following dimensions:

- NAICS code = Manufacturing (31 to 33)
- Full Time Employees = 500 or less
- Location = Bronx, Kings, New York, Queens or Richmond counties in New York State (the 5 metropolitan boroughs of New York City)
- Importer = No (this excludes companies where manufacturing activities take place in another country)
- Location = Single (this excludes branch offices and headquarters where only or mostly selling and/or administrative functions are in New York City)

NEW YORK CITY MANUFACTURING BY INDUSTRY

The graphs on this page are based on NAICS 3-digit industry codes.

INDUSTRY	COMPANIES	EMPLOYEES	FACILITIES (SQ FT)	REVENUE (\$MM)
Fabricated Metal	542	5,741	3,513,877	\$819.828
Printing and Related Activities	1,025	7,281	4,762,382	\$812.805
Jewelry and Precious Metals	578	5,033	1,971,872	\$789.205
Apparel	796	6,630	3,455,359	\$777.632
Computers and Electronics	492	4,225	2,690,108	\$709.887
Food	607	5,392	2,999,400	\$612.525
Chemical Manufacturing	498	2,813	2,116,133	\$393.130
Electrical Equipment, Appliances, Components	320	2,425	1,368,055	\$390.818
Misc Manufacturing	868	2,875	3,332,872	\$362.473
Machinery	377	2,105	1,700,814	\$304.617
Textiles	408	2,250	1,793,653	\$257.492
Paper Products	141	1,564	1,598,953	\$253.916
Furniture and Related Products	316	2,407	1,958,273	\$228.373
Nonmetallic Mineral Products	193	1,841	1,051,153	\$182.875
Plastic and Rubber	121	1,483	1,099,093	\$166.129
Transportation Equipment	112	1,227	614,736	\$162.601
Beverage and Tobacco	146	1,046	574,911	\$120.340
Wood Products	244	1,001	1,366,402	\$113.704
Leather and Allied Product	192	761	653,095	\$91.157
Medical Product	146	825	531,620	\$86.274
Primary Metals	102	570	439,631	\$76.304
Petroleum and Coal Products	23	166	121,664	\$34.627
Grand Total	8,247	60,661	39,714,056	\$7,746.711

Manufacturing companies in New York City employ more than sixty thousand people and occupy nearly 40 million square feet of real estate. Together they generate \$7.75 billion dollars in revenue.

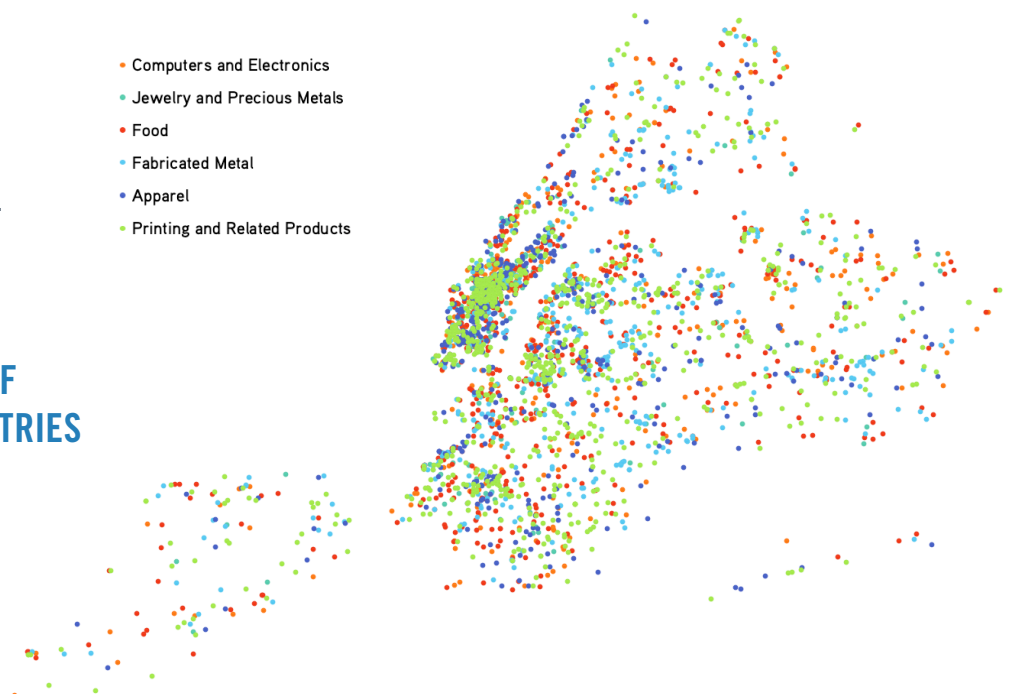
NUMBER OF EMPLOYEES BY INDUSTRY AND BOROUGH

INDUSTRY DESCRIPTION	STATEN ISLAND	BRONX	QUEENS	BROOKLYN	MANHATTAN	GRAND TOTAL
Printing and Related Activities	174	183	2,229	1,425	3,270	7,281
Apparel	70	169	988	979	4,424	6,630
Fabricated Metal	135	928	1,876	2,257	545	5,741
Food	150	440	1,267	1,795	1,740	5,392
Jewelry and Precious Metals	11	7	297	227	4,491	5,033
Computers and Electronics	51	136	676	1,064	2,298	4,225
Misc Manufacturing	106	108	878	1,397	1,386	3,875
Chemical Manufacturing	71	247	316	896	1,283	2,813
Electrical Equipment, Appliances, Components	22	96	457	697	1,153	2,425
Furniture and Related Products	73	186	770	860	518	2,407
Textiles	53	63	514	563	1,057	2,250
Machinery	56	352	643	551	503	2,105
Nonmetallic Mineral Products	78	152	459	409	743	1,841
Paper Products	50	13	581	513	407	1,564
Plastics and Rubber	15	168	161	540	599	1,483
Transportation Equipment	280	29	297	161	460	1,227
Beverage and Tobacco	18	45	464	198	321	1,046
Wood Products	54	128	246	374	199	1,001
Medical Products	17	169	144	126	369	825
Leather and Allied Product	4	9	52	159	537	761
Primary Metals	12	34	153	186	185	570
Petroleum and Coal Products	31	69	40	12	14	166
Grand Total	1,531	3,731	13,508	15,389	26,502	60,661



The top six industries, Printing, Apparel, Fabricated Metal, Food, Jewelry, and Electronics provide more than 50% of all manufacturing jobs in New York City. Most of those jobs are in Manhattan, Brooklyn and Queens.

GEOGRAPHIC DISTRIBUTION OF COMPANIES IN TOP SIX INDUSTRIES

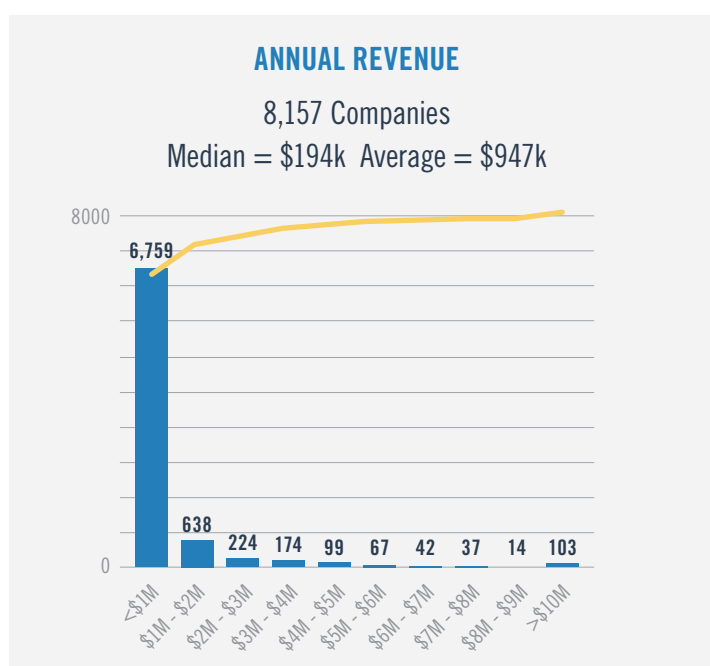
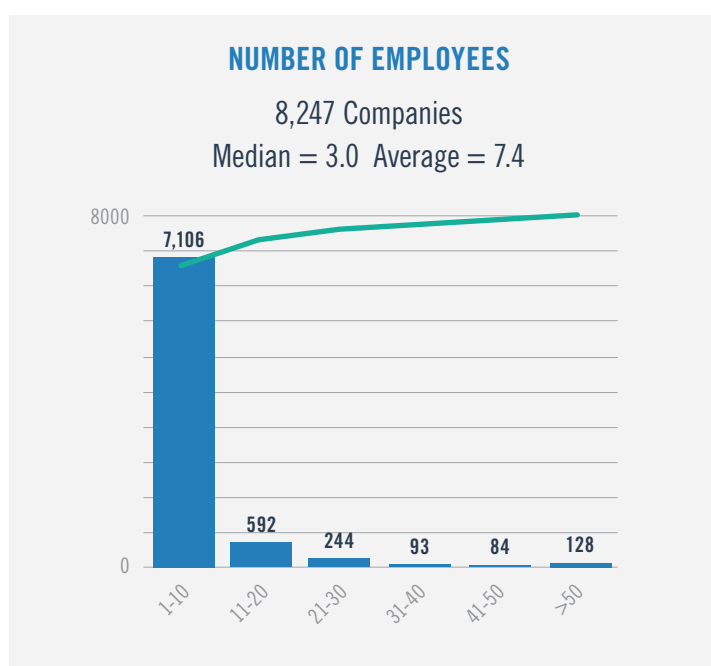


NYC'S "TYPICAL" MANUFACTURING COMPANY

Averages are easy to calculate and provide useful insights about a group, with the simplicity of a single number. However, to be accurate, averages require data distributed in a bell-shaped curve, with most results clustered around the middle and a much smaller group of outliers at the high and low ends.

When data distributions are skewed, a small number of unrepresentative outliers pull the average in their direction. For example, in 1984 the University of Virginia's Department of Communication announced that the starting salary for their graduates was \$55,000 (\$135,000 in 2018 dollars) however, the previous year's class contained NBA first-round draft pick, Ralph Sampson. While UVA's announcement was factually correct, it was at best misleading.

For this reason, each of the following attributes will contain a histogram which displays the distribution of data, as well as reference to the median, a measure of central tendency which is far less influenced by outliers.

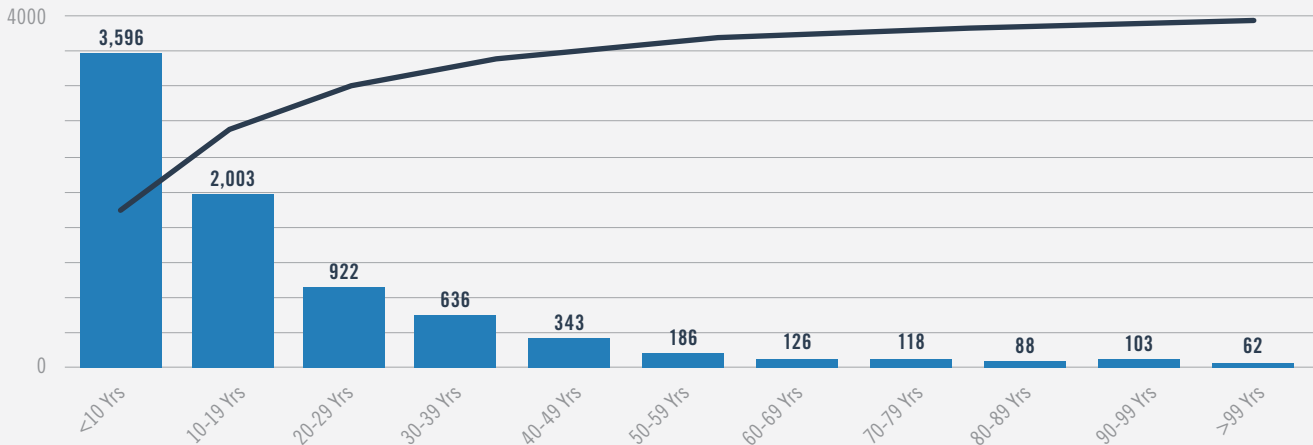


Most small manufacturers in New York City are very small. About 85% employ less than 10 people, the median is 3. Similarly, about 85% of manufacturing companies generate less than \$1 million in revenue, with the median being \$194,000 per year.

While 10% of companies have been in business for over 40 years, 70% of companies have been operating for 20 years or less. The median is 11 years.

YEARS IN BUSINESS

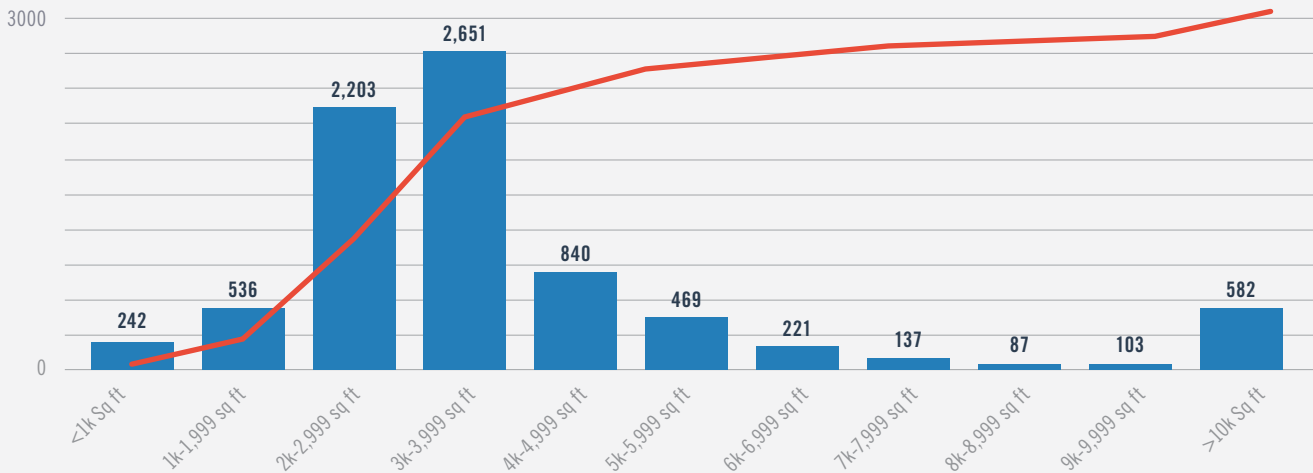
8,183 Companies
Average = 18.7 Years



IMPACT OF REAL ESTATE ON BUSINESSES

SIZE OF FACILITY

8,071 Companies
Median = 3,197 Average = 4,941



In aggregate, 70% of all companies occupy 4,000 square feet or less. The median is 3,200 square feet. The table below provides insight on the differences between companies that own and rent their workspaces.

	# OF COMPANIES	YEARS IN BUSINESS	REVENUE	FACILITY SIZE (SQ FT)	EMPLOYEES	REVENUE PER SQ FT	REVENUE PER EMPLOYEE
Owns	435	39	\$1MM	6,000	10	\$167	\$100k
Rents	2,248	25	\$500K	2,728	5	\$183	\$100k
Variance	-81%	56%	100%	120%	100%	-9%	0%

- About 1 in 5 companies reported owning their facility
- Owners occupied more than twice as much space as renters – median of 6,000 vs. 2,728 sq. ft.
- Owners employed more people – median of 10 vs. 5
- Owners have been in business considerably longer than renters – median is 39 vs. 25 years
- Renters tended to be slightly more efficient in terms of Revenue per Square Foot

An uncertain real estate situation is the biggest barrier to adopting hardware and machine tools. Without knowing the future of where their business will be located, business owners are unwilling to make a large investment which may be costly to move, or may not be functional in a new space.



The biggest concern for me is that one of the machines I want to get is so large that getting it here is a real problem. And the instability of not knowing if my building will be here in a few years obviously creates a lot of apprehension on my part to commit to purchasing an expensive piece of equipment; if I have to move, I'm basically out of business because I can't afford to move all this heavy machinery.

— **George Kalajian**, *International Pleating*

THESE FINDINGS ARE IN LINE WITH THOSE OUTLINED IN THE 2017 SURVEY CONDUCTED BY THE GARMENT CENTER SUPPLIERS ASSOCIATION:

Of the 157 owners that were interviewed, few felt they had long term real estate security.

- 67% of factories have fewer than 2 years remaining on leases
- 96% of factories have fewer than 5 years remaining on leases
- 4% of factories have leases with 5+ years remaining
- 99.8% of participants not moving are interested in long-term leases (only one participant was not interested)

With the majority of manufacturers on short term leases, there is little to no security in real estate.

Source: www.gcsa.org/survey



ABOUT THE SURVEY & ITS PARTICIPANTS

ITAC partnered with Empire State Development to survey small- and medium-sized New York City manufacturers about their hiring expectations and workforce challenges, as they consider and adopt the new technologies for Industrial Transformation.

For the purposes of this survey, the term Industrial Transformation refers to technologies such as Digital Manufacturing, Robotics, Advanced Materials and Additive Manufacturing.

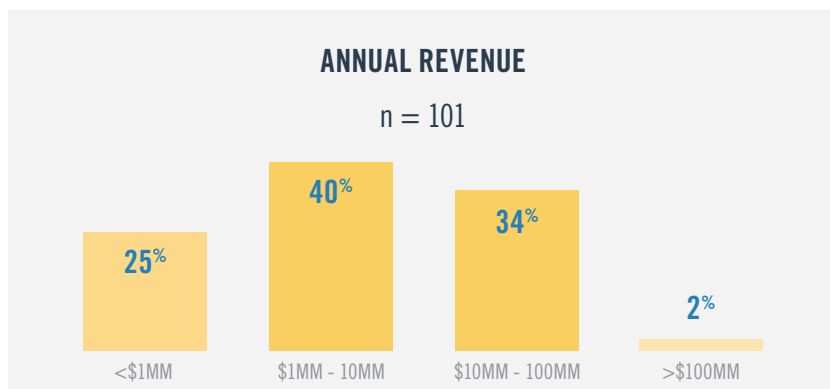
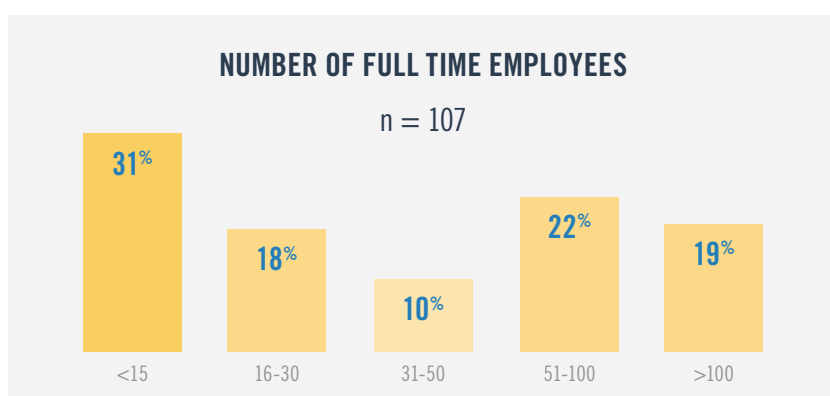
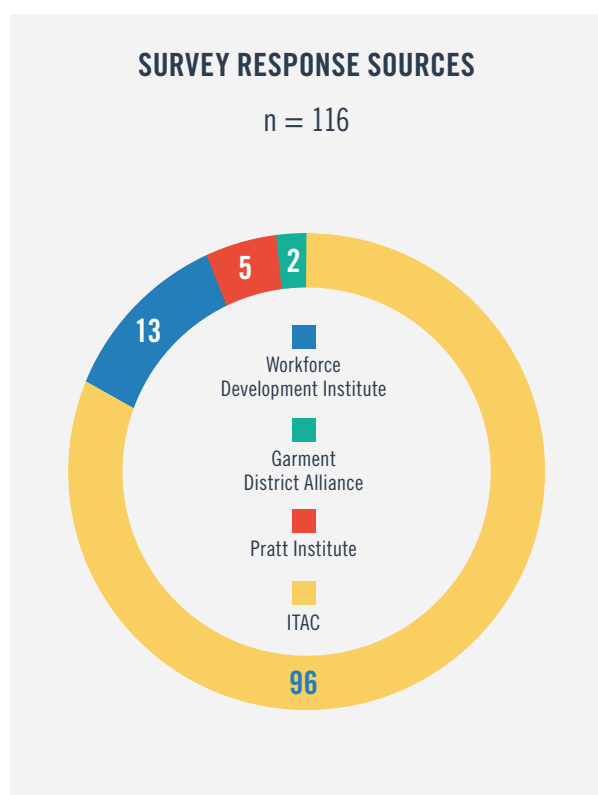
Digital Manufacturing is the use of electronic sensors and tools that collect and analyze data to improve product design or manufacturing process.

Robotics are automated tools that perform tasks deemed tedious, difficult, repetitive or dangerous for people, including collaborative robots, which are intended to work side by side with humans in shared workspaces.

Advanced Materials are new or modified manufacturing inputs such as metals, polymers, ceramics, glass, textiles, nanostructures, biomaterials and food ingredients that have better performance attributes than traditional counterparts.

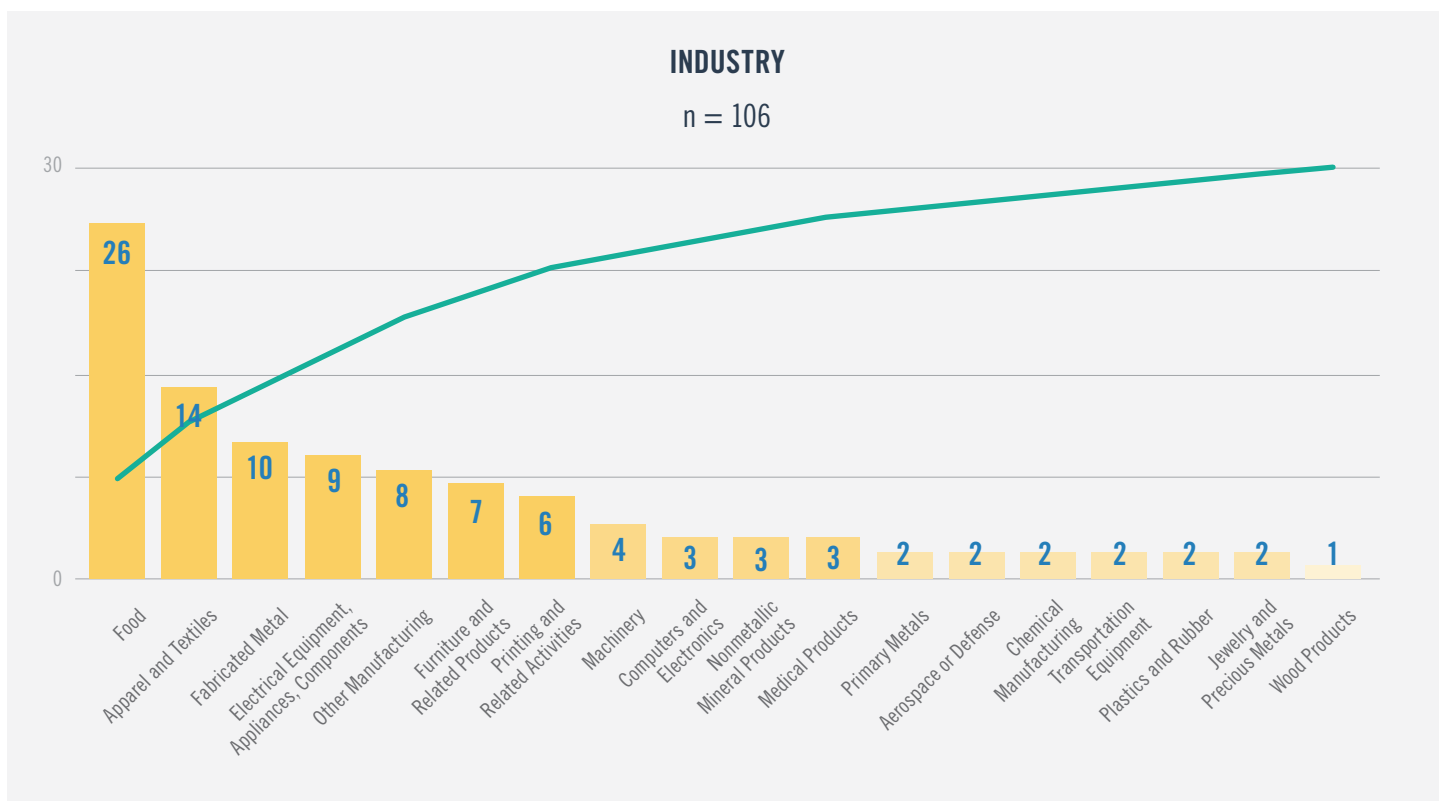
Additive Manufacturing describes technologies that build three dimensional objects directly from digital design files using materials like plastics, metal powder or concrete.

The electronic survey consisted of 26 questions focused on perception and utilization of new technologies as well as workforce hiring, retention and training. The survey was open between May 31, 2018 and November 16, 2018. It was delivered primarily through email invitations to ITAC and partner organization contacts. The demographics of survey respondents skewed towards larger, more established companies.

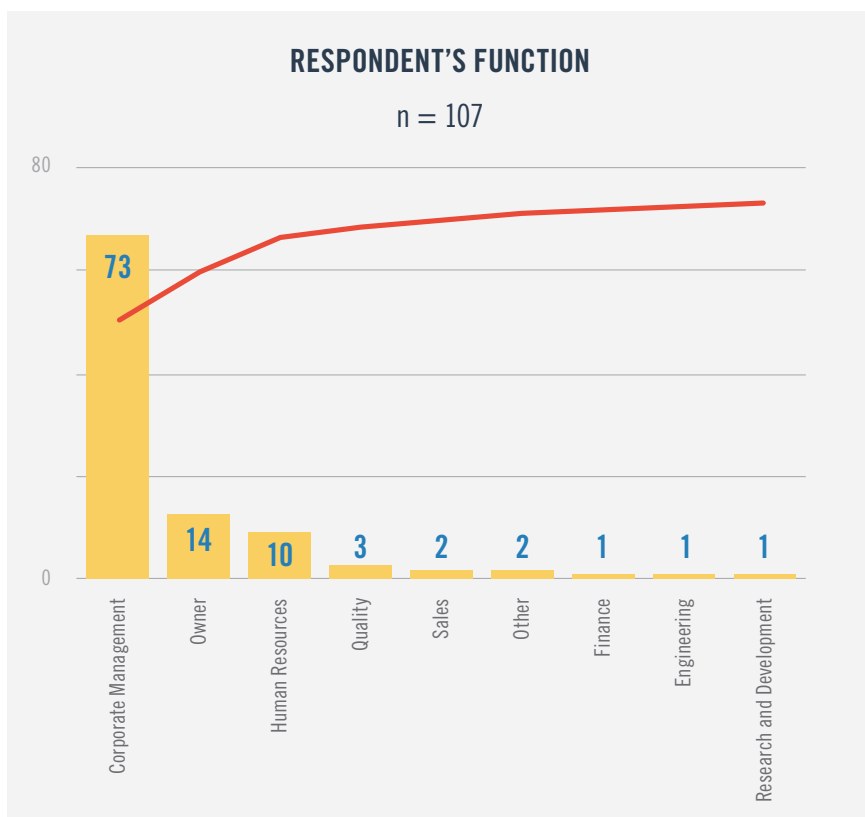
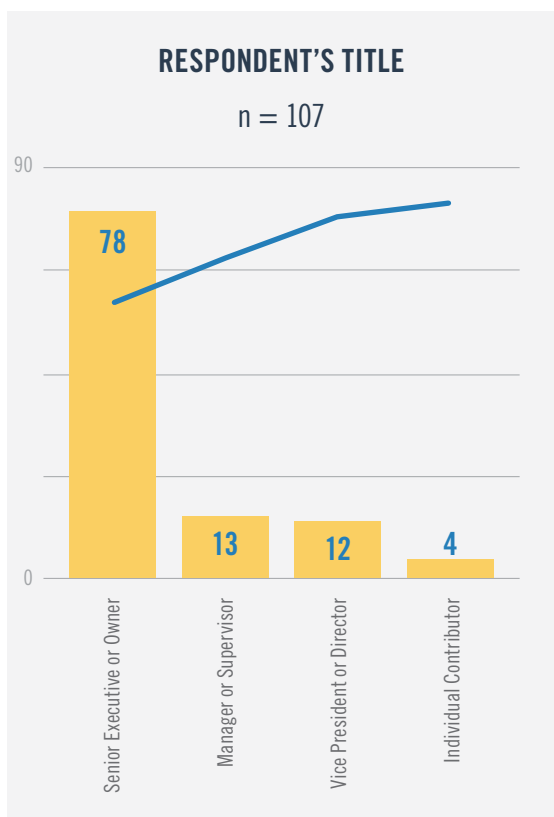


Over half of respondents employed less than 50 people and 65% generated less than \$10 million.

Q: Which of the following best describes your Industry?



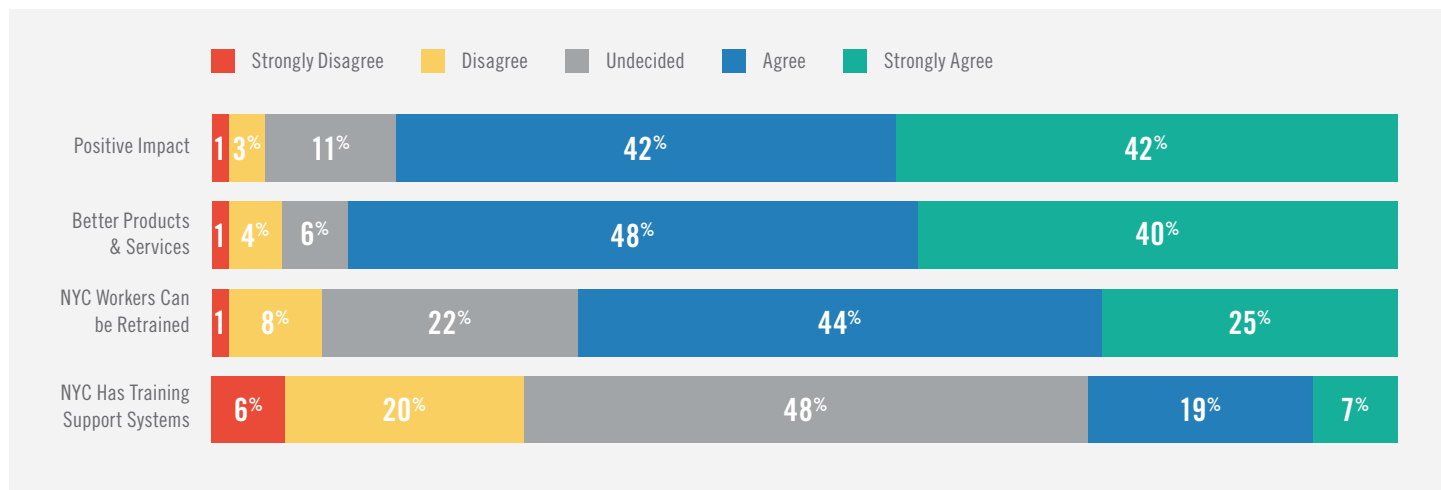
Q: Tell us about yourself and your company:



Most respondents are owners or senior decision makers within their businesses.

THE STATE OF INDUSTRIAL TRANSFORMATION

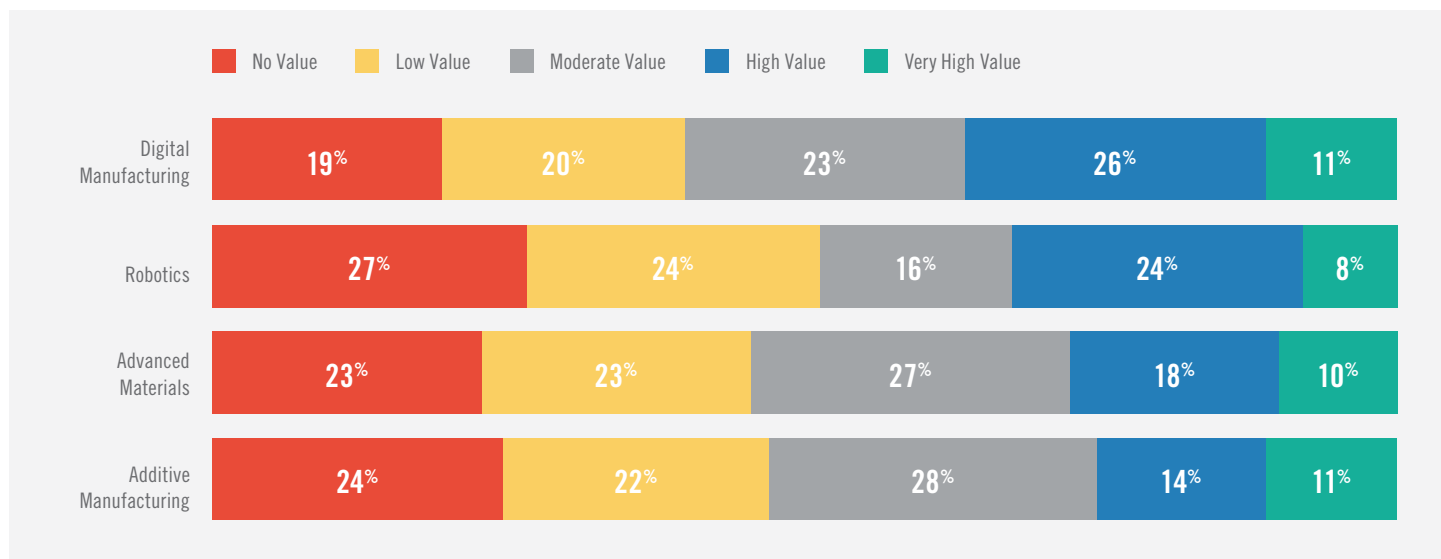
Q: To what extent do you agree or disagree with the following statements about Industrial Transformation in New York City over the next three years?



The overwhelming majority of respondents was optimistic about the potential for advanced manufacturing; however, retraining workers to meet the challenges associated with new ways of working remains a concern.

Nearly all the people interviewed (please see redacted interviews at the end of this report) praised the ecosystem of New York — the transit options and proximity to a large hiring pool. They were less optimistic about the cost of doing business, and ever-increasing taxes and minimum wage. Improvements in products and services resulting from Industrial Transformation initiatives were not considered significant. Non-domestic competition linked to the increased costs of doing business in NYC was also mentioned as a challenge because companies elsewhere were not subjected to such strict regulations and high costs. While challenges were varied, they generally had to do with the cost of business, hiring issues or not being able to grow the business in a healthy and prescribed manner.

Q: How much value will the following Industrial Transformation technologies contribute to your business over the next three years?



While respondents were enthusiastic about the idea of Industrial Transformation in theory, they were not as focused on the four specific technologies covered in the survey. In each instance the proportion of respondents seeing no or low value was larger than those seeing high or very high value. The quotes below outline what some of the manufacturers considered exciting in terms of future advancements, as mentioned to ITAC during the interviews we conducted.



Custom fit. We're going into this world of immediacy and 'just for me', and what could be better than that? As part of custom fit, we need an agile system to support the manufacturing process. Sustainability also — you're not making a bunch of inventory that you have to burn.

— **Carolyn Ferrara**, *Ferrara Manufacturing*



Zero waste. We generate a lot of waste because of the round shape of our crepes. Now we can do a square crepe, but we needed to have certain systems in place so that our line can have a continuous line of crepe and a guillotine system. We can probably bring our waste down to virtually zero, and that will save a lot of money. I don't know if it's necessarily robotics, but it's definitely automation.

— **Paula Rimer**, *Crepini*



There is a company right now that is automating sewing tee shirts, but the physical dexterity required to sew a gown is not something that can be easily done by a robot. 3D printing is something that would help me tremendously and [...] would allow me to be less involved in every single project.

— **George Kalajian**, *International Pleating*

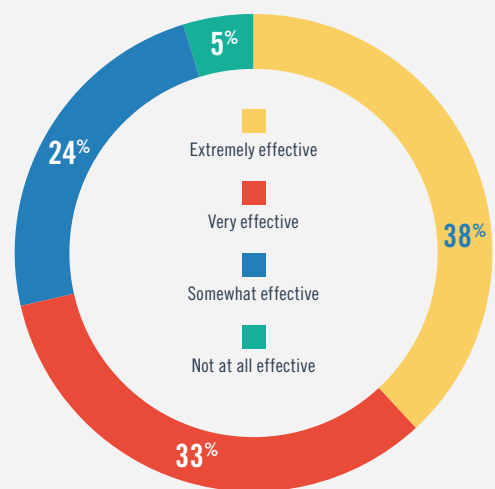
INDUSTRIAL TRANSFORMATION ADOPTION

n = 99



INDUSTRIAL TRANSFORMATION EFFECTIVENESS

n = 21



40% of respondents reported having at least one industrial transformation initiative in progress or completed. In addition, 75% of the respondents that completed an initiative reported it to be either very or extremely effective.



We just hired a retail systems support specialist to manage all of our software and tech needs, and partner with the different departments to see what kind of tech can support them. For ecommerce, we use a software tool that acts as our POS, OMS, CRM, it's used across all the business departments.

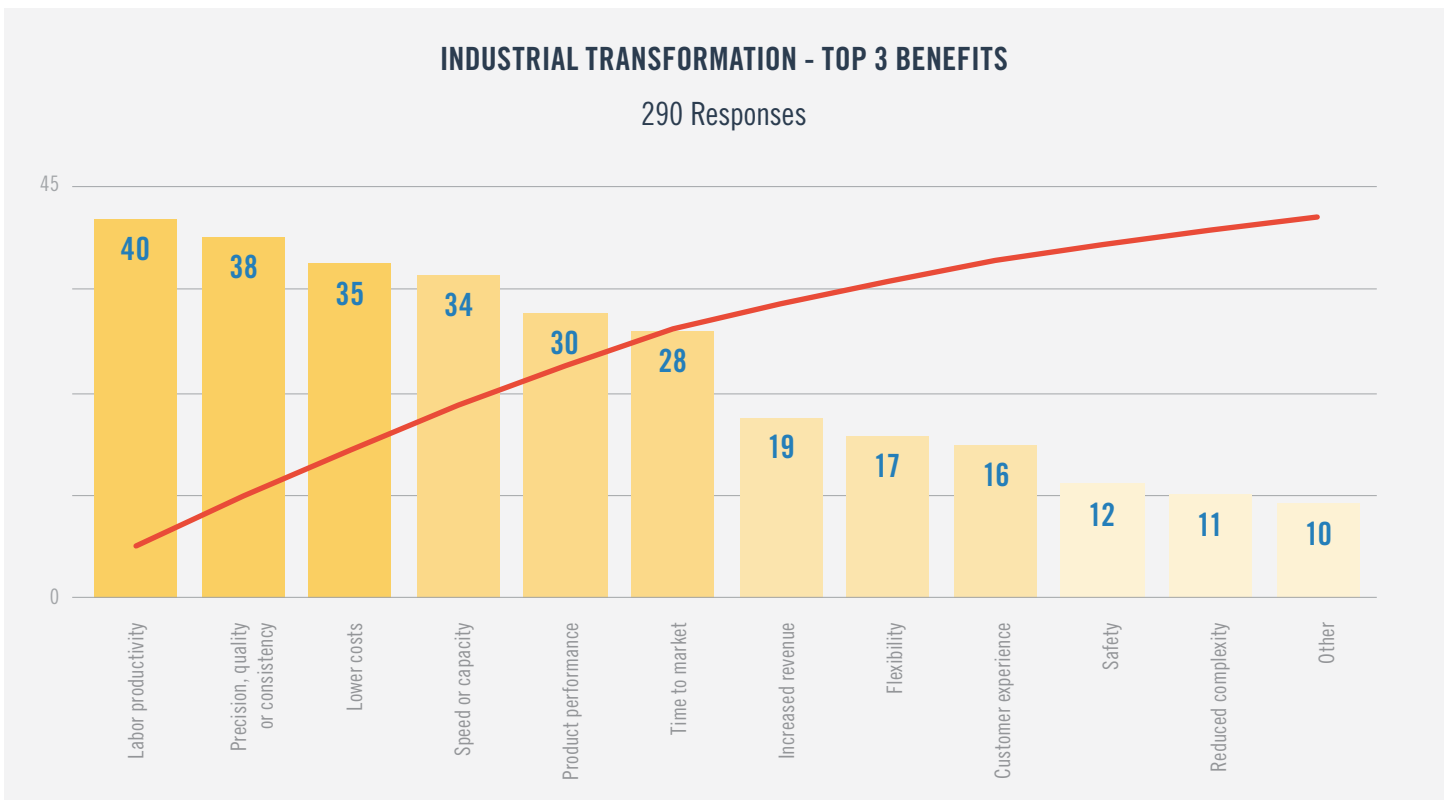
— Roseanna Kilts, *Catbird*



Our production line has the automated lines run through, and we've made things more official. The engineer that we hired worked for the biggest ink manufacturer in the world. He came from there and he's helping us automate, make everything much more manageable, current, productive and efficient.

— Oleg Zoan, *EzInk*

Q: What are the top 3 benefits your company expects from industrial transformation?



The top 4 categories, representing nearly 50% of all responses focused on benefits that accrue to the company (labor productivity, precision, costs and speed) rather than customer-focused benefits, such as time-to-market or customer experience.



There are probably three main factors that would drive implementation:

1. The capability to do something not previously possible with a corresponding business case. For example, if we could design and build a product that was otherwise previously not possible *and* there was a suitable market.
2. An economic business case; generally the litmus test, as I mentioned, is whether the applied technology is safer, better (quality), faster and cheaper. The technology would need to be all of these things; simple trade-offs would not necessarily satisfy this criterion (i.e., faster, but not better).
3. Human interface. Sometimes, and more and more so, people simply prefer to work with newer technologies even though there may not be any other specific advantage.

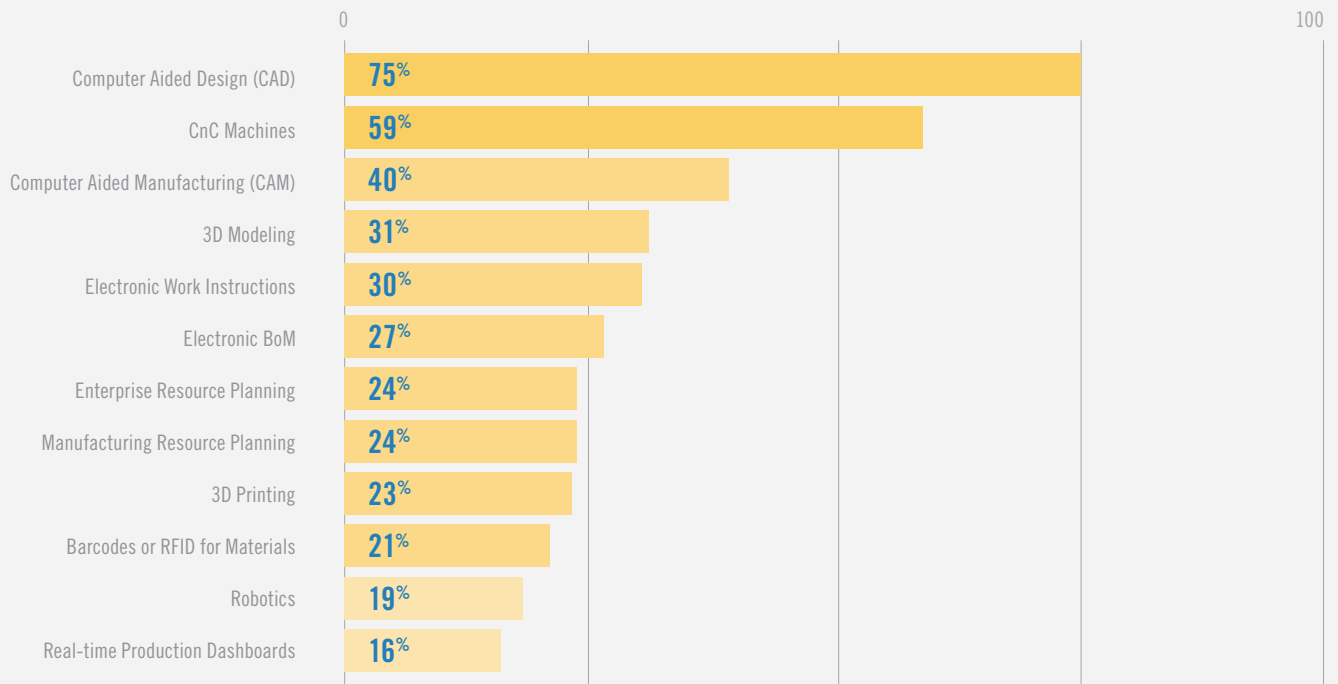
— Al Mangels, *Lee Spring*



I have seen gigantic changes towards faster and better production, thanks to technology. Take grinding for instance, not too long ago, it would have taken hours, maybe days to grind a particular part; now it takes minutes.

— **Dinos Avlonitis**, *Magellan Aerospace*

UTILIZATION OF TECHNOLOGIES



What are the technologies most frequently utilized? The top four responses are design (CAD, 3D modeling) to manufacturing (CNC and CAM) technologies. Most of the technological advances have been in automation and CNC tooling. Software tools have a lower barrier of entry, but can be more difficult to implement, because of the learning curve. Software tools also have a higher impact on bottom line and functionality, allowing for the business to operate efficiently and for the owner/employees to focus on their product and customer delivery.



One of the biggest changes is a shift to 3D modeling as a pre-visualization. That didn't exist so much and it was rudimentary in 2004. Now it's expected and fast. People have this expectation that one can build an almost photorealistic three-dimensional representation of a concept, not even a finished idea.

— **Paul Olmer**, *Hewn Bros.*



The biggest thing is that we could get the repeatability of the parts we are making and taking the human element of error out of running the machine. We also find out over time that what we used to have 30 manual machines doing, we could do on four CNC machines.

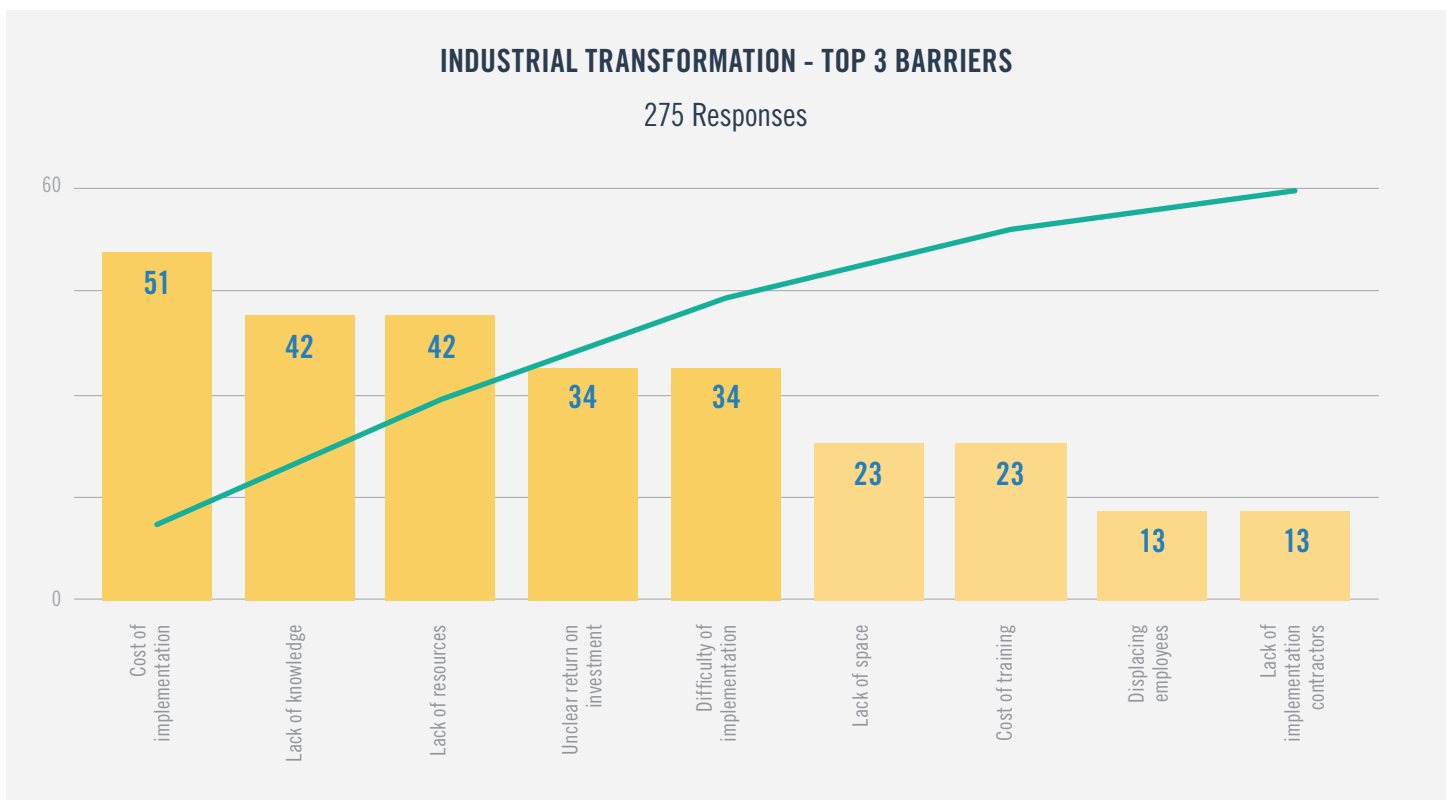
— **Fred Schneider**, *Volckening*



In the last four years that I've been in business, the number of "software as a service" provider companies tailored to manufacturers, small businesses, and e-commerce companies has grown exponentially. There is always something coming out. The biggest developments in that area are actually systems that we started using that have just added on their offerings and the API integrations. All of these systems are talking to each other now; in the past, I would have had to put together a custom API.

— Ashley Platt, *Lux Holdups*

Q: What are the top three barriers to successfully implementing industrial transformation in your organization?



The most common concerns reported by respondents were related to the costs and risks of implementing new technologies, in addition to the uncertain return on investment. Compounding these concerns was a reported lack of knowledge about the new technologies. Most companies don't have the means or ability to adopt the newest technologies at the rate they would like to. Software technologies are easier to adopt and generally have a bigger impact – however, there is often a higher learning curve to adopting new software tools which can be distracting from the daily operation of the business.



Cost of automation would probably be in the millions to get fully automated machines. I don't know if we're set on having this be our facility for the next 10 years. If we're going to divert those resources [to create automated lines], we would need to be sure it makes financial sense.

— **Oleg Zoan**, *EzInk*



I started having conversations with people in the industry who are doing 3D technology and the cost was just crazy... and then I probably would have to hire a person who could maintain that, because I'm not going to be able to do it.

— **Katie Sue Nichols**, *Wing + Weft Gloves*

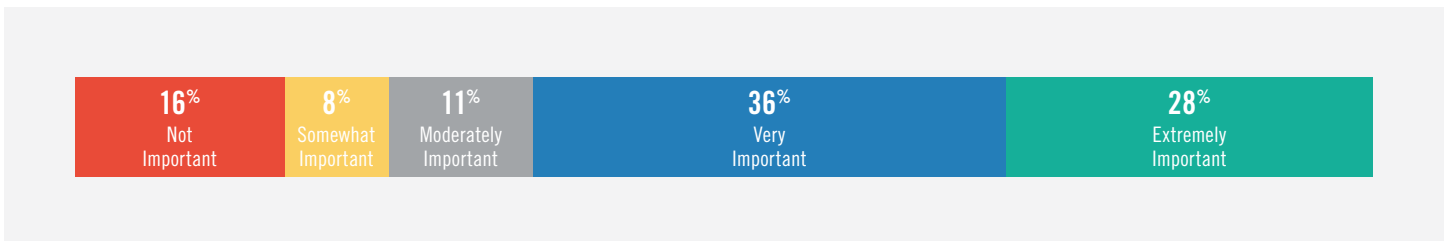


You're saying that's 50K a year that you could send on either a tool or a person. And my pitch would be that if you had 50K, it's better to hire a designer or somebody who could get new business before we got a CNC machine.

— **Chris Tilden**, *Hewn Bros.*

OVERVIEW OF WORKFORCE NEEDS

Q: How important is your workforce in industrial transformation?



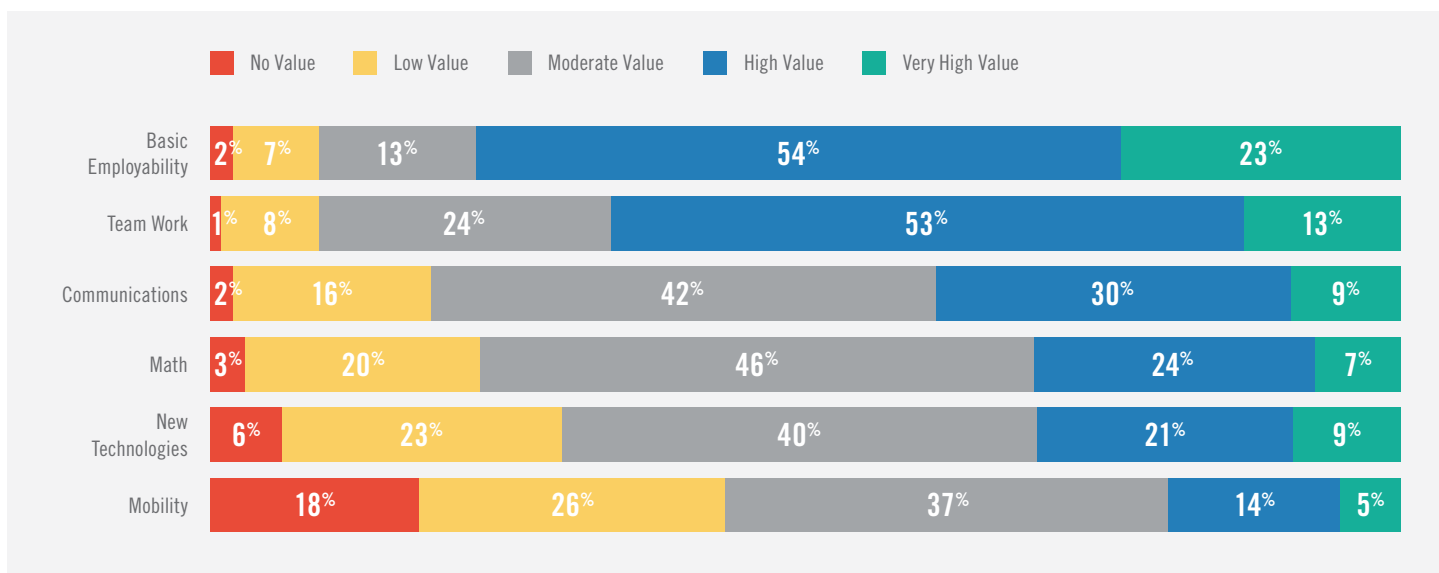
Nearly two thirds of respondents saw their workforce as either very or extremely important in successful industrial transformation.



As soon as they got the technology in their hands, whether they got it 10 years ago or 15 years ago depending on the area, the production and productivity went up and it stayed up. People want to be productive, they want to keep things moving. One of the greatest challenges in the last few years is when you don't have enough work for people - that's just bad for 100 reasons. It's bad for the culture, you need to be proud of turning out so many parts in a day. It doesn't matter how much work we have, we still have to get the level of quality, and the level of productivity is not changing at all. I'd rather you be idle for two hours a day than stretch the work out.

— **Fred Schneider**, *Volckening*

Q: What proportion of your workforce meets your expectations for:



While many respondents report that most of their employees meet their expectations for traditional skills (basic employability, working in teams, etc.), less than half are satisfied with the skills that drive industrial transformation such as math and new technologies.



It's incredible how many people don't know how to read a proper tape measure. They'll say that they have experience working in a shop and they don't. When it comes down to it, the precision that we expect and being able to follow simple instructions on how to manufacture something is lacking.

— **Ashley Platt**, *Lux Holdups*



As technology has evolved, the skillset required to utilize this technology has also changed. But it's very important to note that in many cases, the new technology is not instead of the old technology, it is in addition to the older technology.

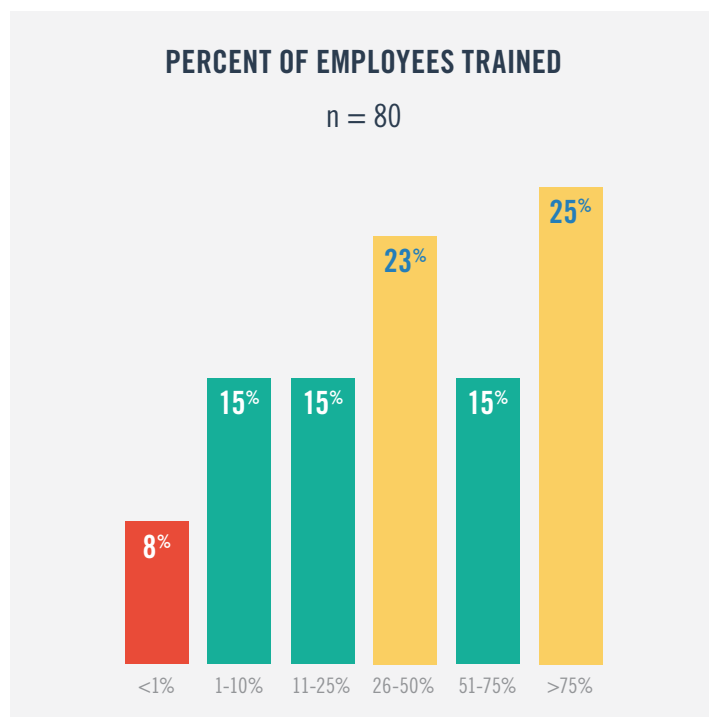
— **Al Mangels**, *Lee Spring Company*



Just stick with the basics: understanding speeds and feeds as far as machining is concerned, and understanding simple mathematics, simple algebra and trigonometry, and being able to read a blueprint. Blueprint reading is a big issue in itself. Those are the basic skills that somebody needs to enter a workplace, and we are missing that.

— **Dinos Avlonitis**, *Magellan Aerospace*

SMALL MANUFACTURING COMPANIES AND TRAINING



Nearly 90% of respondents are providing some type of training to staff, and 40% of respondents train the majority of their employees. However, the disconnect may be in what kind of training delivers value. During the interviews that ITAC conducted, several manufacturers expressed a preference for experience over certification, and a bias for “show/do” on-the-job training, which is an important consideration for policymakers. While “portable skills” and “micro-certifications” may sound attractive, respondents are saying that they want to know that people are capable and productive (“reading a book is a lousy way to learn how to dance”, as the saying goes).



The required skillsets may have changed over time, but the truly skilled workers are those that are experienced, and the younger generation isn't arriving to the workforce with enough skills to even be hireable.

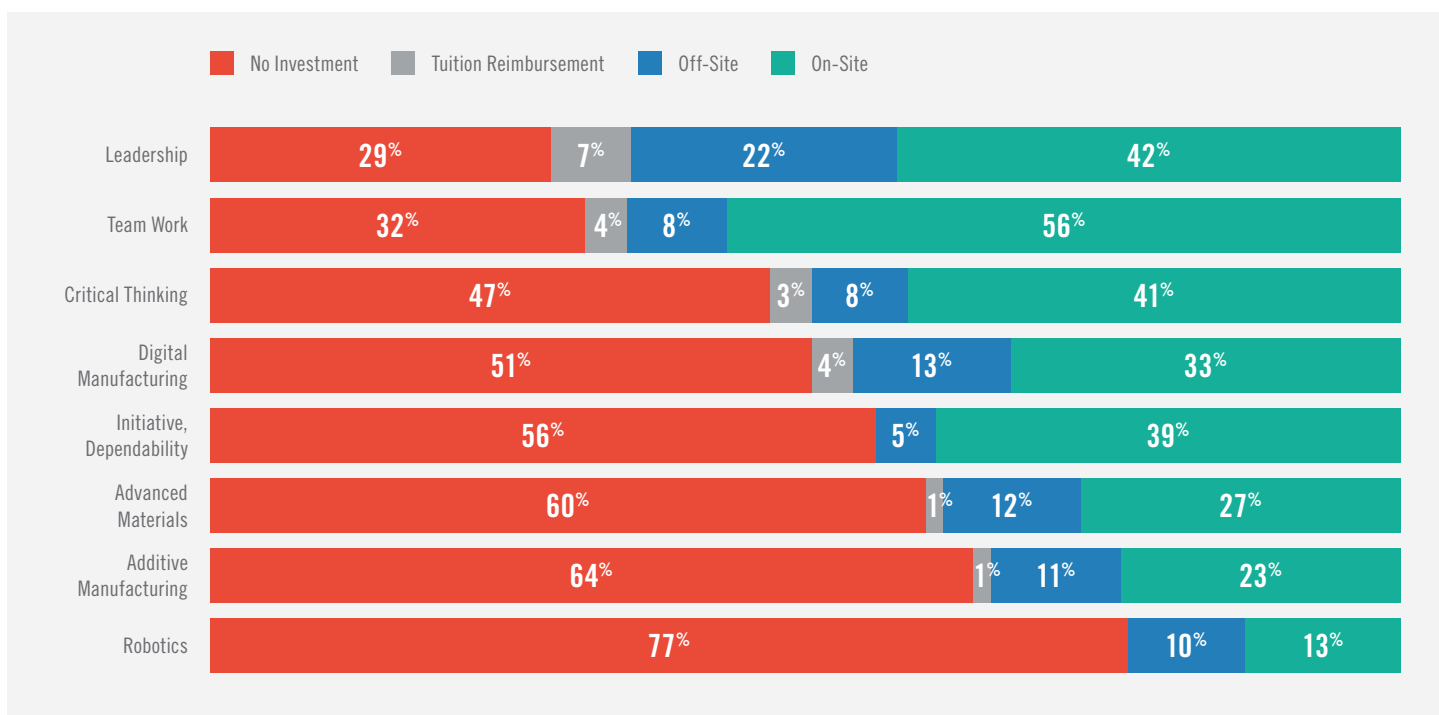
— **Simon Hansen**, *Erik Bruce Company*



I have the same problem as everybody else in this industry is that nobody knows how to do anything. And suddenly it turns into our job to teach them, and it really is a drain.

— **Katie Sue Nichols**, *Wing + Weft Gloves*

Q: Are you investing for the following skills and competencies over the next three years?



It is relatively uncommon for companies to pay for Industrial Transformation skills training for employees. A few executive staff or owners take managerial or other business-oriented training. Most on-site training is geared towards assembly or manufacturing skills for floor workers.



What would be interesting is tax credits for employers to just train new people in house and not necessarily impose requirements such as having to hire the person afterwards.

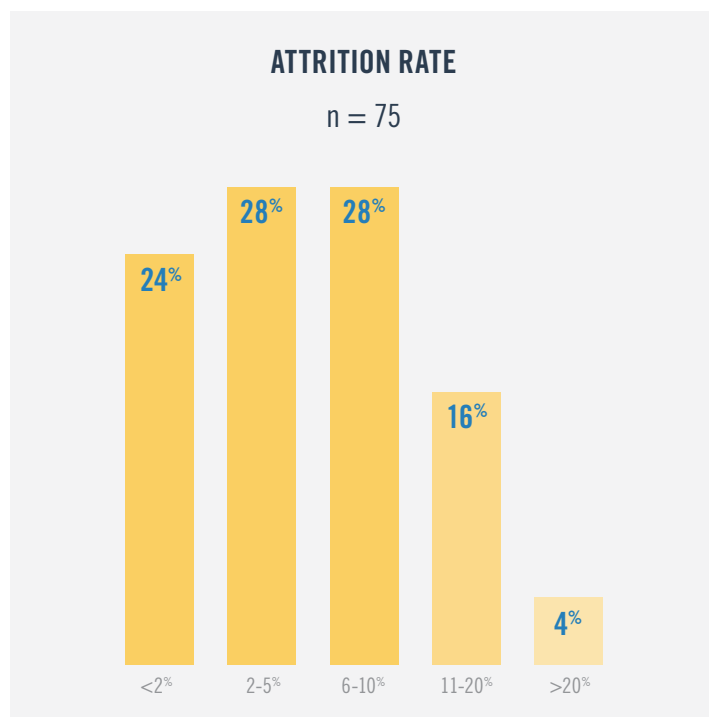
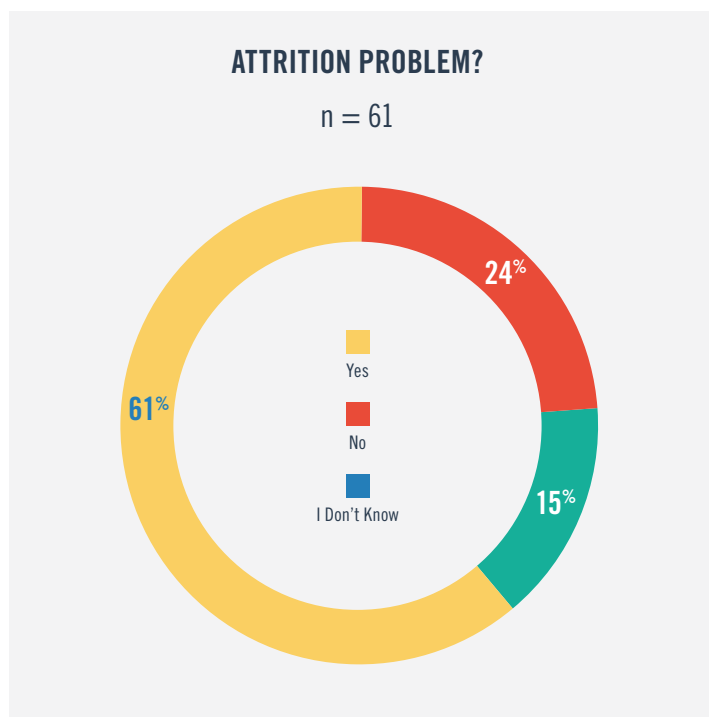
— **Gabrielle Ferrara**, *Ferrara Manufacturing*



We have hired quite a few people and started training them from scratch — from simple math to blueprint and instrument reading.

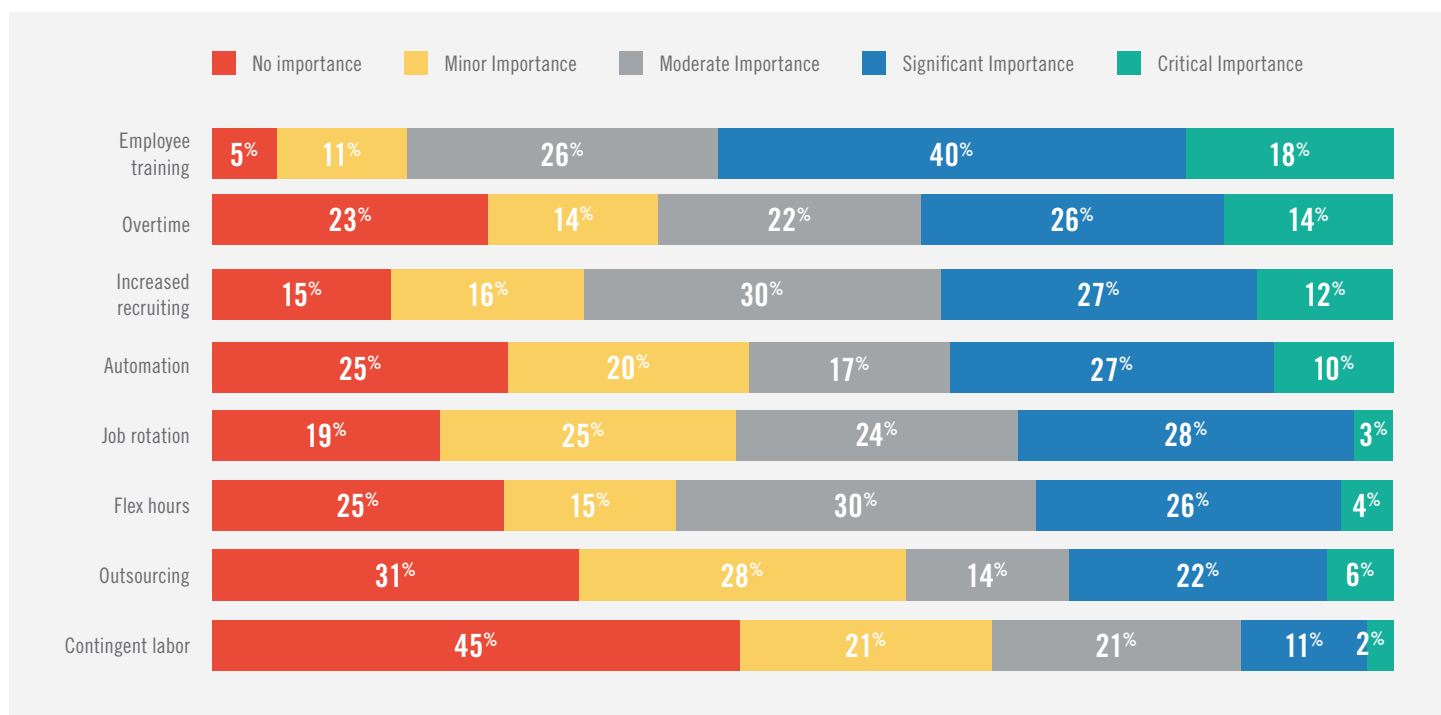
— **Dinos Avlonitis**, *Magellan Aerospace*

HIRING AND ATTRITION



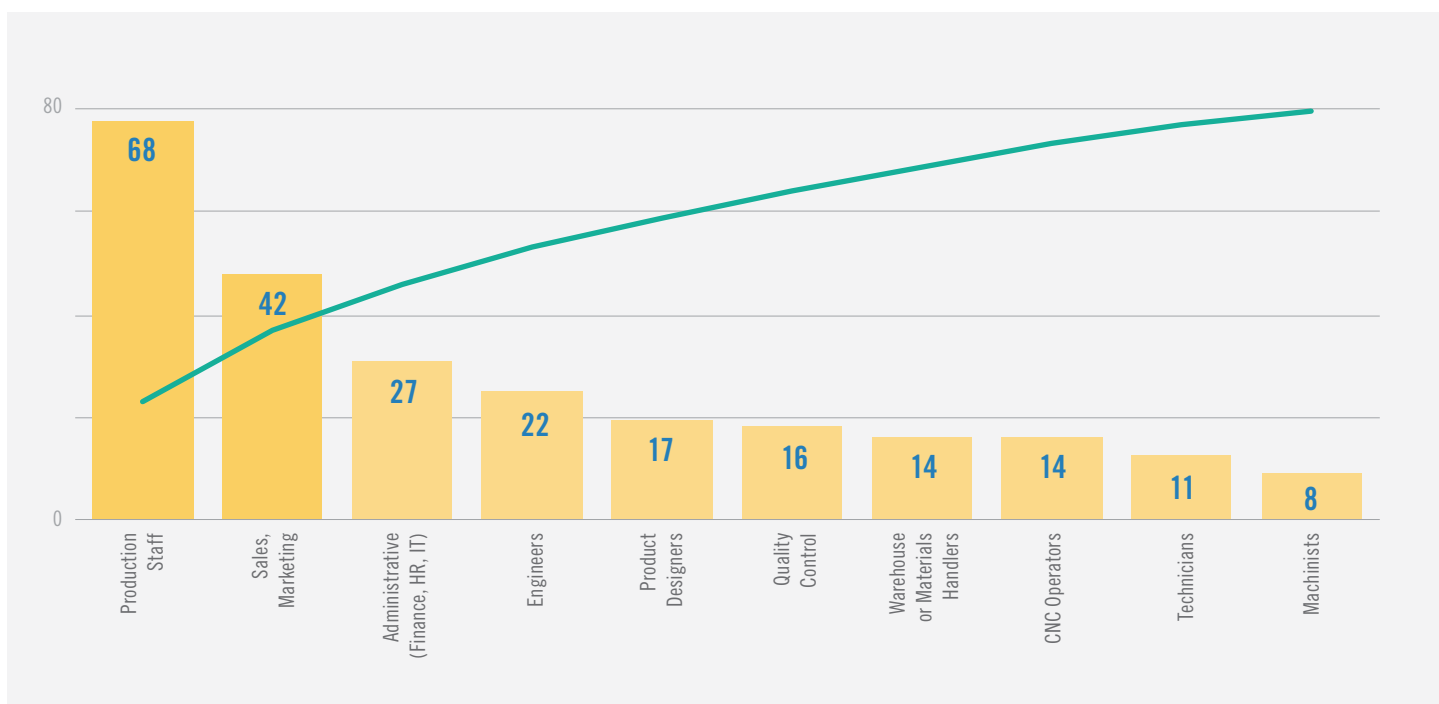
80% of companies reported attrition rates below 10%. Roughly one quarter of respondents reported having an attrition problem, typically at rates above 10%

Q: How important are the following techniques for mitigating skills shortages?



More than half of respondents cited employee training as significant or critical to mitigating skills shortages.

Q: What are the top three roles you plan to hire over the next three years?



Nearly half of responses were focused on hiring production or sales & marketing staff. Given the economic pressures of being in New York, employers were looking for greater experience, as well as commitment from potential new hires.



It's not specific to us. It's New York in general. Our minimum wage rates are increasing, which is a good thing, but it's keeping up with all the laws that are destined to get us to \$15 an hour. Making sure that we have people who want to work. I think it's challenging for everybody. Getting a good workforce that is committed and that wants to grow with the company. We're competitive, but at the same time we have to manage our costs as well.

— **Avi Bromberg**, *Russ & Daughters*



The required skillsets may have changed over time, but the truly skilled workers are those that are experienced, and the younger generation isn't arriving to the workforce with enough skills to even be hireable.

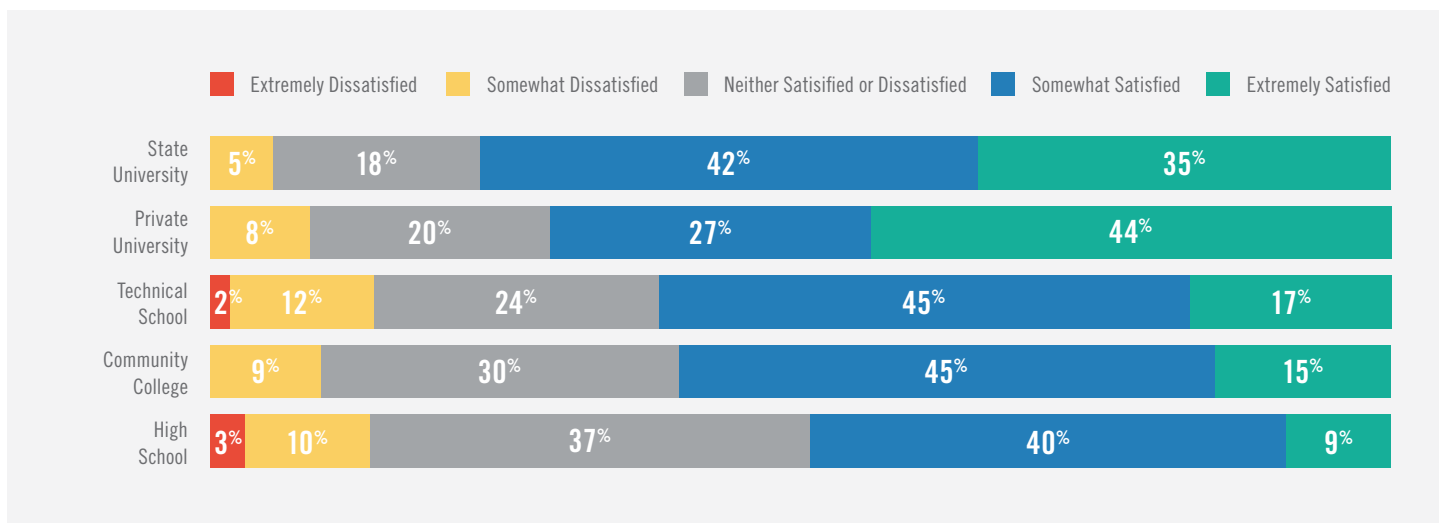
— **Simon Hansen**, *Erik Bruce Company*



In the past, older employees helped the business and had impact. They had families and needed the work to survive. The young interns are so difficult to train, their common sense is different.

— **Akiko Mukae**, *Atelier Atsuyo & Akiko*

Q: How satisfied are you with your new hires from the following educational institutions?



While most survey respondents reported being satisfied with new hires, the largest problem is finding candidates with the minimum skillset required. There was a consistent thread of finding new college graduates that had studied in the appropriate field but didn't have the fundamentals required to perform in the work environment. This imbalance strains the resources of the employer, in order to find the best candidate and invest in training before the employee brings them value.



Hiring has been very difficult because there is a gap between academia and the real world. People coming out of university or college are not prepared to take on production roles. Plus, we do not have vocational schools. Up until a few years ago, there were a number of vocational schools around New York City, which no longer exist.

— **Dinos Avlonitis**, *Magellan Aerospace*



The students that we've hired from Pratt, some of them are from industrial design and some of them are from interior design. Some of them are Grad students or Undergrad and have a huge range of skills. I'm almost always asking them to dumb things down. I just need them to work fast; they're used to working better and slower, and I need them to be worse and faster until we get the right idea.

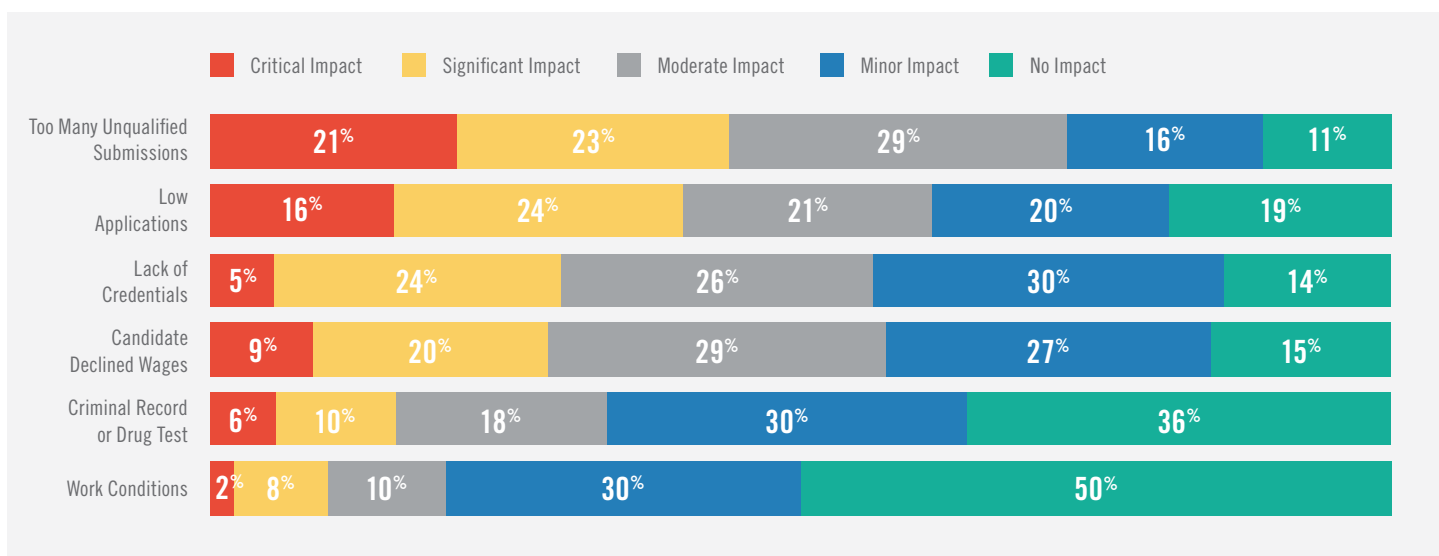
— **Paul Olmer**, *Hewn Bros.*



There are some great schools like Carnegie Mellon and UNC teaching really good technical skills; but does a kid who just graduated from Carnegie Mellon who really knows how to sew, want to go be a stitcher in a factory for their life?

— **Katie Sue Nichols**, *Wing + Weft Gloves*

Q: Which factors have the most impact on your company's ability to fill open roles?



The three factors that have the most impact on hiring are all related to the imbalance of skills required by respondents, and the capabilities of applicants. Hiring tests are standard, but there weren't consistent checks, quotas or certification requirements. Small businesses can be in touch with the operations of the business so as to observe employees' abilities.



Just the mere number of applications, or just finding people that more than need a job, is a rough ride. And finding people that have some kind of basic sewing experience. Because we can train them, they go through four to eight weeks of internal training before we let them loose.

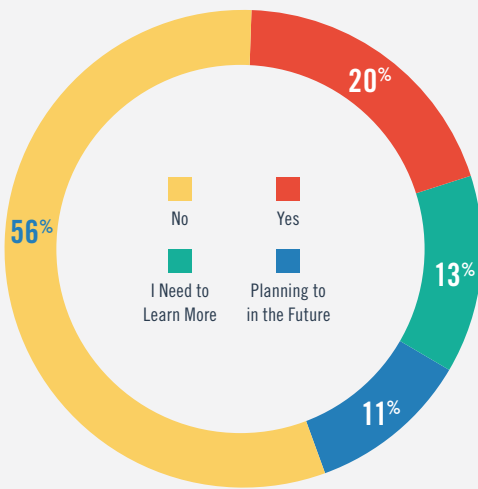
— **Simon Hansen**, *Erik Bruce Company*



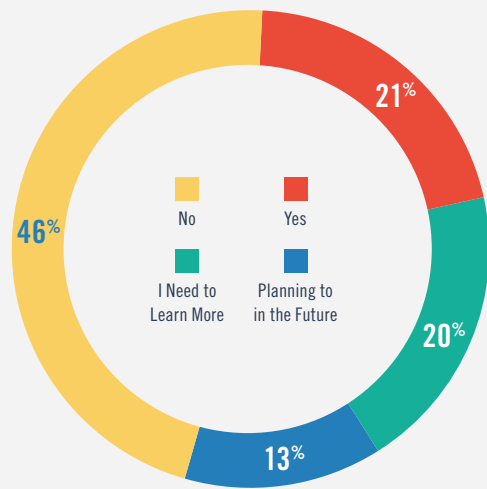
For years and years, people would send in their resume stating they were first class machinists and they practically didn't know anything. How could you put first class machinist, on a resume? To the point we felt it became completely meaningless.

— **Fred Schneider**, *Volckening*

SUPPORT FROM STATE OR LOCAL ORGANIZATIONS FOR TRAINING OR RECRUITING?



WORK WITH COMMUNITY COLLEGES OR UNIVERSITIES TO IMPROVE RECRUITING OR TRAINING?



The vocational and technical programs available are extremely limited. Most employers seek to hire the most experienced employee, and conduct internal training or job shadow programs to fill the knowledge gaps.



From what I have seen in South Carolina or Washington State, there is a close connection between the local government, federal government and the industry. They all communicate and cooperate, and have much better apprenticeship and vocational training programs, something that doesn't exist in New York.

— **Dinos Avlonitis**, *Magellan Aerospace*



There are a lot of great intentions coming up with training program to bring people into the workforce, and teach them how to sew. That's not really going to support the industry here, because we cannot afford to hire beginners. Our industry is highly competitive, we are competing with Italy and our costs are higher; so we need to hire people that work quickly. Training programs tend to attract people who are slower, or not confident enough as opposed to more aggressive personalities and faster workers who just don't need such programs. The people we need are those who have the gusto to just go in and sew. They will catch the attention of the manager and will get trained in-house.

— **Carolyn Ferrara**, *Ferrara Manufacturing*



Unfortunately, there are very few external resources available for training the specific skills required for our industry. There are some generic skills (“transferable skills”) training programs available, for example in safety, quality and lean manufacturing, and we have utilized many of those. Lately, however, in response to this shortage, our industry organizations are starting to develop more industry specific programs, but it’s still relatively early days for these.

— **Al Mangels**, *Lee Spring Company*

NYC MANUFACTURING IN THE 21ST CENTURY

According to a 2018 skills gap study¹ from Deloitte and The Manufacturing Institute, the widening manufacturing skills gap is expected to grow from about 488,000 jobs left open today to as many as 2.4 million manufacturing jobs going unfilled between now and 2028. This workforce crisis, the study found, could put at risk \$2.5 trillion in manufacturing GDP over the next decade. It is worth noting that a recent paper² by Alicia Sasser Modestino (Northeastern University), Daniel Shoag (Harvard University) and Joshua Ballance (Federal Reserve Bank of Boston) shows the well-documented skills gap being a consequence of high unemployment, rather than its cause: “with workers plentiful, employers got choosier”. Instead of investing in training workers, they looked for significant experience and credentials, whereas a healthy labor market incentivizes employers to provide workers with some training. Regardless of the cause (whether insufficient skills among workers, or high unemployment leading employers to only hire the highly skilled employees – because they can), research shows that five out of ten open positions for skilled workers in the U.S. manufacturing industry remain unoccupied today due to the skills gap crisis. These positions require specific training or skillsets and often take months to fill.

In New York City, manufacturing companies face even stronger pressure to remain competitive and improve productivity, given the heightened costs of living and operating. Straightforward tasks that require manual labor are being targeted for automation or outsourcing. The nature of the work that remains requires technical training and skills beyond what was expected just a few years ago, in fields as diverse as 3D printing or garment manufacturing. In previous generations, large companies provided on-the-job training and unions offered apprenticeships to provide the skills and experience necessary. Today, approximately 85% of NYC manufacturers generate under \$1MM in revenue per year while employing less than 10 people (the median is 3 employees). These very small companies lack the resources to provide training themselves, and many individual employees lack the funds to secure training if it is available.

New York City is faced with two issues: the decline of the institutions that develop in-demand manufacturing skills; and a rapid increase in the variety and complexity of skills required to fill new production roles. In an effort to respond to these challenges, Governor Cuomo recently announced a plan to double the number of apprenticeships statewide by 2025, in high-demand fields including advanced manufacturing. We applaud this initiative as our research shows that training should in fact be experiential and focus on skills most needed in the City’s top manufacturing industries -- think “Hot Bread Kitchen” model for fabricated metal. For reference, the organization cited as an example, Hot Bread Kitchen, provides an intensive, earn-while-you-learn culinary training program for women seeking economic mobility. Six industries -- printing, apparel, fabricated metal, food, jewelry, and electronics -- provide over 50% of the City’s manufacturing jobs, mainly across three boroughs. Any policy actions should focus there first. The less prescriptive these training programs are (e.g. minimal paperwork, no obligation for employers to hire trainees), the more manufacturers will be inclined to associate with them. Of course, many questions that are outside the scope of this research will need to be carefully tackled, including funding for any training programs, content creation, choice of training providers, venues etc. Another key question will be the cost, if any, to participants and whether hiring companies should pay a premium or finder’s fee for workers with known, possibly credentialed skills.

As for the curricula, our findings suggest that efforts around scaling and industrial transformation should focus on extremely low-cost, easy-to-implement solutions that have rapid paybacks (automation tooling, such as CNC, or software tools, such as Computer-Aided Design or Manufacturing, were among the most cited solutions given low barriers to entry and a tangible Return on Investment). While programs around advanced technology are certainly valuable, they mostly benefit larger companies. In order to help New York City’s manufacturing sector, we must focus on assisting the majority of smaller players to scale, focusing on those making high value-add, niche products as they are the ones that can compete with those manufacturers outside of NYC that are subjected to lower costs and less regulations. Finally, while hiring workers with a specific skill set is viewed as necessary by most, it is not sufficient. In addition to both technical and soft skills, it is malleability -- the willingness and eagerness to adapt and learn -- that matters most.

¹ <https://operationalsolutions.nam.org/mi-skills-gap-study-18/>

² http://scholar.harvard.edu/files/shoag/files/modestino_shoag_and_ballance_012114.pdf

IN THEIR OWN WORDS....

ITAC conducted in depth interviews with 17 businesses across a wide range of industries. Quotes from these interviews have been included throughout this report. Two interviews stood out as particularly noteworthy. We have included them, in their entirety below.

FELIX STORCH INC



Felix Storch Inc. (FSI) manufactures and distributes specialty major appliances to the residential, professional, commercial, hospitality, and scientific markets. They carry over 600 models of refrigerators, freezers and cooking appliances including the industry's largest collection of built-in undercounter and ADA compliant models. FSI's focus is on crafting innovative products to meet the unique needs of customers who might not find their appliance solution in a big box store.

From their beginning in 1969, FSI has been a New York based company. Their location in NYC has inspired many of their distinct product lines and their focus on smaller appliances with the functionality and quality of larger ones. They take great pride in their homegrown workforce and strive to keep much of their production and value-added manufacturing in-house and in the USA.

Paul Storch, Chief Executive Officer of FSI, has worked there for 35 years. Under his direction, the business has diversified and grown considerably, moving into value-added manufacturing and expanding into medical and commercial refrigeration.

Q: How long have you been in business?

FSI has been in business since 1969 (49 years), always in New York City.

Q: What's great about being a business in NYC?

The advantages of NYC changed in sequence over the decades, but all the reasons remain.

1. Proximity to a large market – and one with great diversity.
2. Geographically, it is central to the urban population centers from Boston to Washington, DC, within one day's trucking radius. To a company specializing in appliances for small kitchens, it is an ideal location.
3. NYC has more small apartments than the rest of the US combined. As housing trends change, NYC provides design inspirations that roll out nationally over time.
4. In total, and with some exceptions, NYC has been welcoming to small business, with tax incentives and an active SBS that helps with training and recruitment.
5. The transportation system allows recruitment from many directions, including outer boroughs and suburbs.

Q: What changes have you seen over that time?

Like most businesses, we have undergone several reinventions of ourselves. Chain retail consuming independent stores has been a factor in our business, requiring a shift in marketing and sales. Certainly, the growth of online impacted every business. The urban real estate market, with replacement of middle-income apartments with luxury buildings forced us to change our product mix (for the better).



Changes with negative consequences for us have been the disappearance of educated and skilled blue-collar labor, the consolidation of manufacturing in Asia, and the high cost of labor. The NYC \$15 minimum wage – with its cascading effect on experienced staff at similar wages will put much staff at a level where their output is not commensurate with their salary. This will have longer term negative consequences for unskilled workers, as automation will increasingly have lower break-even points, and will reduce employment for the less educated and less skilled.

The biggest change we've endured has been the multitude of regulations that impact our products (appliances) on energy consumption and refrigerant choices, requiring massive time investment. Increased regulations on employment and HR affect all businesses by lowering productivity and making it harder to screen and select appropriate candidates.

Our business has changed over time from a regional to a national business – as the internet allowed us to find the more diffuse niche markets we serve at lower cost. We have stayed in NYC because the larger market here helps us achieve critical mass. Another reason is our stable and veteran workforce which offsets high cost with better productivity.

Q: Tell us about some of your biggest challenges. How did you manage?

Our biggest challenge over the years was the dramatic consolidation of both retail and manufacturing – making it difficult for those in the middle of the chain. Our solution was to invest and move heavily into value added manufacturing, creating niches that large manufacturers could not afford to economically make, and large retailers would not want to stock. Over 49 years we've seen many competitors with low cost business models go out of business as their customers became competitors, and we've seen other customers merge or consolidate into larger companies. New competition arises as larger appliance manufacturers offer products like ours as some niche markets (such as smaller kitchens) become more mainstream.

Q: What technology advances have you seen in your industry over the years?

Our business is somewhat low tech – and still depends on creating products for niche markets and marketing intensively to create customer awareness. Certainly, the availability of digital controls at lower cost than mechanical controls has benefited our customers and us. In the appliance industry the connected appliance is the new buzz. . .your refrigerator is on the phone telling you to pick up milk and cheese on the way home and your washer called to tell you the load of towels is done and needs to go in the dryer. But in our niches, it is not yet a big thing.

Q: Did your business benefit from adopting new technologies?

We have not utilized much new technology, except in the IT world, where hardware and software (such as remote meetings, webinars and cloud storage) have greatly increased the productivity of the professional and office staffs. Today, we are not utilizing robotics, 3D printing or other related technologies.

Q: Do you see any new technologies on the horizon for your industry?

We don't see fundamental changes in our two key businesses – food preservation and cooking. Connected appliances improve some communication with appliances, but the functional technologies are likely to remain the same. In time, induction cooking will replace radiant electric cooking (it has in Europe) but that is not very fundamental as the technology is 60 years old. Ultrasonic (no water) dishwashers and washers are in final stage development, but public acceptance may be a generation off.

In time, self-driving trucks will take over much of the fleet we operate. We are also a candidate for robotics for much of our packaging (it is already under study) and eventually some of the simpler assembly operations. We are eagerly awaiting the next generation of 3D printers to replace rows of spare parts with parts manufactured on demand.

Q: How likely are you to implement? Why?

We are likely to implement all three ideas above as soon as they are demonstrated to be reliable and economically justified.

Q: Do you have difficulty hiring?

Yes, in some positions. The most difficulty is in blue collar positions requiring some skills and basic education (reading and math). The millennial workforce as professionals is the same challenge to us as every other business in America. On balance, despite the usual complaints, we've not been held back from growing by staff issues. We have turned largely to recruiters to fill positions, driving costs up greatly. Repeating myself, the \$15 minimum wage, which dominoes all workers higher to adjust for experience and skill levels is hugely inflationary and will make many marginal businesses move or fail.

Q: Have the skills you require of your employees changed over the years?

Skill needs have not changed for the blue-collar force, but the office and professional staff certainly need much higher-level computer, communication and writing skills than previously. In our business, we have a greater need for most of the office staff to have a small bit of technical knowledge to deal with customers.

Q: How do employees in your industry gain the skills required?

We rely on in-house training for almost all the skills we need to teach. There are not many appliance companies in the Northeast at all. So, we cannot find experienced workers from our industry. Any outside training has been accomplished largely in conjunction with NYC SBS. We absorb the costs of all training.

Q: How do you assess competency?

We, like most, hire for attitude and train staff for the specific skills they might need. We use tests for all candidates for hourly jobs (math, Excel and writing) and rely on education and experience for professional positions.

Q: Are your people more productive than 20 years ago? Why, why not? How much more productive?

In manufacturing, it is impossible to answer because the magnitude and complexity of what we do has changed too much. In the office, with the advances in web and computers, we certainly use fewer people per dollar of revenue than we did 20 years ago.

Lee Spring is a global manufacturer of mechanical springs, wire forms and related products. It has had its headquarters in Brooklyn since 1918. Lee Spring serves thousands of customers every year in virtually every manufacturing segment.

Al Mangels is President of Lee Spring Company. He started in 1983 and has held roles in production control, manufacturing engineering, design engineering and management system integration until ultimately becoming President in 1999. Since then, Al has become well versed as a champion of continual improvement activities such as total quality management, lean manufacturing and business process re-engineering, and has seen the company grow to five facilities in the United States as well as having locations in Mexico, China, India and the United Kingdom.

Q: How long have you been in business?

Lee Spring has been in business for 100 years, founded in Brooklyn in 1918. Now with 12 locations around the world, New York remains our headquarters and our largest location by employee count.

Q: What's great about being a business in NYC?

Historically, we have had opportunities to leave New York, but retaining our core staff has always been the deciding factor. New Yorkers are apparently a unique breed: simultaneously aggressive and tough, yet cooperative and friendly. The word courageous also comes to mind.

Q: What changes have you seen over that time?

The strategy and structure of Lee Spring has transformed over the last 35 years in response to the changing landscape of American manufacturing. Our customers are almost exclusively other manufacturers, but in virtually every industrial segment. As they have sprawled out across the world, especially the larger organizations now referred to as multi-nationals, so have we. Yet we continue to operate as one integrated system and continue to court and respect even the smallest clients.

Q: Tell us about your biggest challenges over the years. How did you manage?

I guess you can say we've seen it all, with the worst single day in recent history being undoubtedly 9/11/2001.

Competition in our industry has been aggregating more so than expanding. Some of the larger companies have been swallowing up some of the smaller, generally family owned and operated shops.

The key throughout has been to sustain our core principles no matter what the challenge. We study best practices but only take what fits. We have been blessed in having ownership that has been patient with our plans and in having a workforce that puts their hearts into everything we do.

Q: What technology advances have you seen in your industry over the years?

Manufacturing technology has been advancing since the beginning of humanity, and it will probably continue to do so, perhaps at accelerated pace. The most notable nowadays would be digital technology and materials science. Things are possible today that would not have been possible or practical some recent years ago. The key, however, lies in how the technology is applied – can products be made that are safer, better, faster and cheaper, all things considered?



Q: Did businesses benefit from adopting new technologies?

Some competitors have invested heavily in the latest technology; some not so much. For technology adoption, in some areas we're leading and in some areas we're more in the middle of the pack. It would be hard to argue that new technologies, such as CNC machinery and the use of barcodes, did not play a part in the success. But not all the breakthroughs were technology based. And some important ones were simply a change in the way of thinking.

Q: How did the implementation of new technologies impact your business?

No one wrought products out of the earth with their bare hands. New technologies have brought new tools; and some of them are quite miraculous. But the tools need to fit the job.

I need to mention information and communication technology –things that put everyone in the Lee Spring organization on the same platform. These are things like ERP, websites, email, cloud-based systems and home-grown integrated applications in product design, quality control, shop floor control and lean-style inventory control. Without these tools, it's hard to imagine establishing a global footprint.

Q: What new technologies do you see on the horizon for your industry?

We are now looking at advanced technologies. Some or most of the things I already described were considered “advanced” in their day. Currently we are investigating Digital Manufacturing, Automation/Robotics, Augmented/Virtual Reality, Additive Manufacturing (3D Printing) and Advanced Materials, such as superalloys and composites.

Q: How likely are you to implement? Why?

There are probably three main factors that would drive implementation:

- The capability to do something not previously possible with a corresponding business case. For example, if we could design and build a product that was otherwise previously not possible *and* there was a suitable market.
- An economic business case; generally the litmus test, as I mentioned, is whether the applied technology is safer, better (quality), faster and cheaper. The technology would need to be all of these things; simple trade-offs would not necessarily satisfy this criterion (i.e., faster, but not better).
- Human interface. Sometimes, and more and more so, people simply prefer to work with newer technologies even though there may not be any other specific advantage.

Q: Do you have difficulty hiring?

We have had difficulty hiring for several years. It's been more difficult in factory positions than in office positions, especially in those positions requiring higher levels of skill.

Q: Have the skills you require of your employees changed over the years?

As technology has evolved, the skill set required to utilize this technology has also changed. But its very important to note that in many cases, the new technology is not instead of the old technology, it is in addition to the older technology. As a simple example, I wouldn't describe reading and writing as new technology. But email is not of much use if one can't read and write. Because the scope of knowledge has extended to include new technologies, it takes longer for employees to absorb it all.

Q: How do employees in your industry gain the skills required?

We have, and still do, rely on institutional education and on-the-job training. Learning by doing remains the best way. The educational community has in some sense failed, and the pool of qualified manufacturing workers has shrunk. We are relying on other methods to supplement workforce development. This includes apprenticeships, on-line learning, industry seminars / webinars and internships.

Q: How do you assess competency?

We rely on multiple supervisor reviews of performance to verify competency. Each employee has a direct supervisor, a functional supervisor and an executive supervisor. They are reviewed by all three. These reviews occur more frequently when an employee is first hired (for example, every couple of months) and then on an ongoing basis (generally annually or if there is a change in job). Test results, and other credentials such as diplomas and certificates, are currently used more to qualify employees to be hired in the first place.

Q: Is it common for companies in your industry to pay for skills training?

Unfortunately, there are very few external resources available for training the specific skills required for our industry. There are some generic, transferable skill training programs available, for example in safety, quality and lean manufacturing. We have utilized many of those. Lately, however, in response to this shortage, our industry organizations are starting to develop more industry specific programs, but it's still relatively early days for these.

Q: Are your people more productive than 20 years ago?

This is hard to gage. We have seen both top line and bottom line growth without a corresponding increase in the number of workers. Yet, in some ways, we were more capable 20 years ago than we are today. The marketplace has significantly changed in 20 years, so it could be more a question of adaptation than progress.