White Paper

The Industry 4.0 Talent Pipeline:

A Generational Overview of the Professional Competencies, Motivational Factors & Behavioral Styles of the Workforce

AMHUB: A Partnership Between the World Economic Forum and Automation Alley

Abstract

This research seeks to identify emerging trends, pinpoint challenges and gain data-driven insights into the forces shaping the technical talent pipeline of Industry 4.0 in the United States, specifically Southeast Michigan, which has one of the largest concentrations of engineers and technicians in the country. The rapid advancement of digital technology has revolutionized engineering and industry. It is dramatically shaping the technical talent landscape. Simultaneously, major cultural changes are being forced by generational transition and leadership succession.

To prosper in the Industry 4.0 ecosystem, individuals and organizations will be required to develop 21st century skill sets. The talent pipeline is failing to provide sufficient quantities of workers and calls for stepping up Industry 4.0 reskilling have become ever more urgent. Five themes have emerged:

1. The Workforce Must Embrace Frequent and Constant Change.
2. Teams Must be Flexible, Adaptive and Collaborative.
3. Companies Must Create Cultures of Inclusion and Transparency.
4. Workers Must Become Life-long Learners & Dynamic Thinkers.
5. Education Must Accelerate Workforce Development Reform.

An empirical investigation, focused on Southeast Michigan was conducted with the support of local industry, educational institutions and government agencies. Three key segments of upcoming generations, currently advancing in the talent pipeline, were investigated: 1) future technical leaders, 2) future engineers and 3) future tradespeople. Based on responses to a series of questions using the TTI TriMetrix® DNA assessment suite, a data-driven, validated assessment instrument, this research presents an overview of the development of 25 professional competencies that contribute to superior performance. Individual motives and behavioral styles are also explored. These findings provide some valuable insights and direction into what educators, industry and policy makers should address to upgrade the technical talent pipeline in the age of Industry 4.0 in order to protect and ensure the United States' global leadership position.

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Overview of the Industry 4.0 Talent Landscape

The rapid advancement of digital technology is revolutionizing engineering and industry. The term "Industry 4.0" is now commonly used to reference this revolution. Industry 4.0 is a result of the convergence of digital, biological and physical technologies. Industry 4.0 dynamics are dramatically shaping the technical talent landscape. Simultaneously, cultural changes are being driven by generational transition. As the Baby Boomer generation (1946-64) exits the workforce, the Millennial generation (1981-96) and the Generation Z'ers (1997-2012) rise up as the majority of the technical workforce. The combination of technological and cultural change has made the transformation to Industry 4.0 difficult to manage, especially for legacy companies and small and medium sized enterprises.

Socio-cultural transformation has become a challenge confronting industry. Knowledge and experience are exiting the workforce in mass through the retirement of the Baby Boomer generation. A shortage of qualified talent has emerged, in part due to the smaller numbers of Generation X'ers (1965-80), who now make up 51% of the management and leadership positions. With an average of 20 years of workplace experience, Generation X'ers are assuming the top executive roles [1].

Socio-cultural transformation is complicated due to each generation's radically different views on work-life balance. Millennials make up the largest segment of the working population. Not far behind, the Gen Zers are now entering the workforce in entry level positions. Both generations have their own unique attributes. For example, a common attribute of Gen Z is that they tend to be very inclusive in nature and willing to rally around causes.

The technologies of Industry 4.0 coupled with generational transition are driving the need to step up workforce development efforts. Industry 4.0 skills have become critical components of labor markets [2]. Developing and retaining an Industry 4.0-ready workforce demands that industry and educators go beyond traditional reskilling and upskilling initiatives. Organizations must focus on career strategies, talent mobility and re-engineering ecosystems to drive organizational reinvention and new business models.

Objectives of this Research

This research seeks to build on the work of Pistrui and Kleinke et al. [3] [4] and Petrick, and McCreary [5] to identify emerging trends, pinpoint challenges and gain data-driven insights into the forces shaping the technical talent pipeline and Industry 4.0 in the United States, and in particular Southeast Michigan.

Research objectives include:

1. Building on previous and ongoing research findings to provide a deeper and more comprehensive understanding of the talent pipeline in United States.
2. Evaluating three key segments of the talent pipeline: 1) next-generation leaders, 2) undergraduate engineering students and 3) skilled trade apprentices.
3. Defining the fundamental DNA of the talent pipeline in terms of the professional competencies, motivational factors and behavioral styles of the three groups.
4. Producing data-driven insights that industry and education collaborators can use to modify and strengthen the talent pipeline in United States.
5. Developing new knowledge and strategies to attract, develop and retain top Industry 4.0 talent in the United States.

Emerging Workforce Themes and the Talent Horizon

To prosper in the Industry 4.0 ecosystem, individuals and organizations will be required to develop 21st century skill sets. The talent pipeline is failing to provide sufficient quantities of workers and calls for stepping up Industry 4.0 reskilling have become ever more urgent [2]. The factories of the Industry 4.0 digital age are very different from the legacy operations of the automation-age of Industry 3.0. In 2015 alone, nearly 100,000 robots were deployed in automotive factories and a further 65,000 were installed in electronics factories as automation continues to reshape the size of the labor pool [6]. With the advent of Industry 4.0, each robot installation is also a digital installation as the robots are equipped with technologies such as machine learning, cloud computing and big data. The work of the labor pool must evolve.

A recent study conducted by the Ralph C. Wilson, Jr. Foundation reports that in Southeast Michigan 30% of the middle skilled labor pool will be displaced by automation by 2030 [7]. There will also continue to be a shortage of workers with the skills industry is seeking. Many people will need to transition from "traditional careers" where they have trained to do specific tasks, (i.e. mechanical engineer) to "multitrack careers" where they will have multiple simultaneous jobs such as engineer, data analyst and network administrator [4] [8].

To successfully navigate the Industry 4.0 environment (and beyond), organizations will need to integrate four (and soon five) different generations into their workforce. This will be no easy task given the generational differences coupled with the shortage of qualified talent.

Table 1 presents an overview of the emerging themes shaping the workforce environment. Four central themes are having dramatic impact on the Industry 4.0 work environment:

Insights into 21st Century Industry 4.0 Skills, Mindsets and Cultures of Performance

Research conducted by Pistrui et al. (2018; 2019) provides insights into three categories and specific types of skills that industry and educators view as critical for the 21st Century [3] [4]. Their research identified three categories of skills that are important to develop and employ in an Industry 4.0 environment including discerning skills, people skills and purposeful skills (see Table 2). These findings parallel the work of Petrick and McCreary (2019), Bawany (2019), Schwab (2019), and Arena (2018) who all identified similar skill sets, common trends and empirical findings [5] [9] [10] [11].

The need to develop discerning skills is a result of the disruption and uncertainties associated with Industry 4.0. This applies to both companies and educational institutions. People need to be able to identify patterns and make new connections in ways never imagined

Table 1 - Emerging Workforce Themes

1. **The Workforce Must Embrace Frequent and Constant Change** - Industry 4.0 is expected to significantly increase the pace of change. Companies need to be aware of the implications of disruption to their workforce [2] [3] [8].

2. **Teams Must be Flexible, Adaptive and Collaborative** - Team agility, an entrepreneurial mindset and the ability to persist through failure are fundamental to creating and sustaining networks of interrelated teams [4] [5] [23].

3. **Companies Must Create Cultures of Inclusion and Transparency** - This requires breaking down traditional hierarchies, implementing agile methodologies and embracing the changing nature of work tasks [11] [8] [9].

4. **Workers Must Become Life-long Learners & Dynamic Thinkers** - Dynamic thinking requires empathy, collaboration, experimentalism and a focus on solving problems and creating value for other humans [2] [3] [8].

Sources: Schwab, 2016; Pistrui and Kleinke, 2019; Arena, 2018; Pistrui and Kleinke, 2018; Brachman, 2018.

before. Moving forward, they must envision and create new products, efficient services and better user experiences.

The research of Petrick and McCreary (2019) included 404 manufacturing companies directly involved in creating and implementing smart technologies. The findings were similar to the work of Pistrui et al., reporting that creativity and innovation, the ability to be forward looking and having an improvement mindset are all required to successfully navigate the digital transformation [5, p. 9]. Bawany (2019) contends that a digital leader in an Industry 4.0 environment must build teams, keep people connected and drive a culture of innovation [9, p. 107] which aligns with both Pistrui et al. (2018, 2019) and Petrick and McCreary's (2019) findings [3] [4] [5].

Good people skills impact organizations at all levels from the executive suite to the shop floor. People are the key to success, and today there is a shortage of individuals to fill the jobs available in the marketplace. People skills can mean the difference between survival and failure. Communicating, listening, understanding and embracing diversity along with

Table 2 - 21st Century Industry 4.0 Categories and Skill Types [3] [4] [5] [9] [10] [11]

Discerning Skills Perceptive, astute and discriminating aptitudes	**People Skills** Individual, team and group effectiveness	**Purposeful Skills** Determination, aim and need for achievement
Creativity and Innovation Creating new approaches, designs, processes, technologies and/or systems to achieve the desired result.	**Interpersonal Skills** Effectively communicating, building rapport and relating well to all kinds of people.	**Self-Starting** Demonstrating initiative and willingness to begin working.
Conceptual Thinking Analyzing hypothetical situations, patterns and/or abstract concepts to formulate connections and new insights.	**Understanding Others** Understanding the uniqueness and contributions of others.	**Continuous Learning** Taking initiative to regularly learn new concepts, technologies and/or methods.
Futuristic Thinking Imagining, envisioning, projecting and/or creating what has not yet been actualized.	**Teamwork** Cooperating with others to meet objectives.	**Negotiation** Listening to many points of view and facilitating agreements between two or more parties.

building trust are critical to both the success of companies and educational institutions.

In their 2016 report "The Future of Jobs," the World Economic Forum identified core people skills as critical for success in the workforce including people management, coordinating with others and negotiation [12]. The research of Petrick and McCreary (2019) report comparable findings with Pistrui et al. identifying similar people skills as vital (see Table 3) including trust, empowerment, networking and collaboration as central to developing a 21st Century workforce.

Strong purposeful skills that include the need for achievement and self-initiative are essential to navigating the integration of learning new concepts, methods and employing new technologies. Arena (2018) described the need to carve new paths towards breakthroughs within existing business models [11 p. 203]. In their work with 404 manufacturing firms, researchers Petrick and McCreary (2019) reported that leaders believe that there is a need for risk taking and operating as "mavericks" in the transition into an agile digital enterprise [5 p. 7].

Researchers Petrick and McCreary (2019), Bawany (2019) and Pistrui et al. (2018; 2019) reported that determination, challenging the status quo and persistence through failure were traits, skills and mindsets that are vital to effectively navigate an Industry 4.0 environment [5] [9] [3] [4]. While eminent Industry 4.0 scholar Schwab (2016) advocated that people must be continuous learners in order to create and sustain innovative and collaborative organizations and cultures during the Fourth Industrial Revolution and beyond [2], Pistrui et al. (2018; 2019) documented that listening, openness to new ideas and respecting different points of view are vital to working effectively across generations (consider Baby Boomers, Gen Xers and Millennials) [3] [4].

Generational Transition and Leadership Succession

Socio-cultural transformation is a challenge confronting both industry and education due to each generation's radically different views on work-life balance, the loss of knowledge through Baby Boomer retirement and a global shortage of qualified talent. Generation X now holds 51% of management and leadership positions. With an average of 20 years of workplace experience, they are primed to quickly assume nearly all top executive roles [1]. Not far behind are the Millennials, who represent the largest segment of the working population.

Gen Zers are now joining the workforce in entry level positions. They are a generation with their own unique attributes that include being very inclusive in nature, they are also found to rally around causes. They believe profoundly in the efficacy of dialogue to solve conflicts and improve the world. Gen Zers make decisions and relate to institutions in highly analytical and pragmatic ways [18]. Their world is rooted in mobility and multiple realities. In 2017, O'Boyle, et al. reported that many Gen Zers expressed concern that technology is weakening their ability to maintain strong interpersonal relationships and develop people skills. This is a shortcoming that organizations should be aware of as they enter the workforce [19].

Figure 1 - Generational Birth Years, Trait Strengths and Challenges [13] [14] [15] [16] [4] [17]*

Baby Boomers 1946-1964	**Generation X** 1965-1980	**Millennials/Gen Y** 1981-1996	**Generation Z** 1997-2012
Strengths:	**Strengths:**	**Strengths:**	**Strengths:**
Work-centric/career driven	Results and efficiency focus	Excellent technical skills	True digital natives
Independent and self-reliant	Metrics and data driven	Can-do attitude	Radically inclusive
High level of competitiveness	Conventional leadership style	Excellent multi-taskers	Mobilizes around causes
Challenges:	**Challenges:**	**Challenges:**	**Challenges:**
Support hierarchical thinking	Forgotten generation	Lacking professional loyalty	Requires constant feedback
Believe in face time at office	Works to live vs. live to work	Quickly bored and frustrated	Little delineation between work and home
Aggressive & confrontational	Lack of process focus/skills	Enjoys working remotely	Can be focus challenged

Empirical Investigation of Three Sectors of the Talent Pipeline

This empirical investigation focuses on Southeast Michigan and was conducted with the support of local industry, educational institutions and government agencies. A consortium of ten colleges and universities, two and four-year focused on Industry 4.0 and workforce readiness supported this work. The intention is to expand this research nationally as part of the further development of a larger consortium of institutions from a cross section of U.S. regions.

This research represents a snapshot of one region of the U.S. that is being intensely disrupted by both the technical and cultural forces associated with Industry 4.0 and a multi-generational workforce.

Research conducted by the University of Detroit Mercy in partnership with TTI Success Insights, Oakland Community College, Macomb Community College and Walsh College investigated three key segments of the talent pipeline:

1. Next-Gen Leaders (NGLs): Engineers from OEMs and Tier 1 suppliers who have been identified by their companies as emerging leaders in their organizations. This group is composed primarily of Gen Xers and Millennials who have Masters degrees.
2. Next-Gen Engineers (NGEs): Undergraduate engineering students who are in their freshmen and junior years in mechanical and electrical studies. This group represents Gen Zers.
3. Next-Gen Skilled Trades (NGSTs): Individuals enrolled in two-year skilled trades programs such as robotics, cybersecurity and welding. They represent a cross section of generations but are primarily Millennials and Gen Zers.

Methodology and Research Instrument

To collect data, our academic team partnered with TTI Success Insights, a 30-year-old Scottsdale, Arizona-based firm that serves clients in 90 countries and 40 languages. The firm is the global leader in providing research-based validated compliant assessment and coaching tools that enable organizations to meet their talent management needs. Their client base includes Fortune 500 companies, government agencies and educational institutions around the world.

For data collection, the TTI TriMetrix® DNA assessment suite was used. The TTI TriMetrix® DNA assessment suite is comprised of three self-reporting assessment instruments that are administered via an online portal. Each of the three self-reporting assessment instruments are independently validated. The authors have administered over 10,000 TTI TriMetrix® DNA assessments relating to engineering education and professional development. There have been a series of peer reviewed research papers published using the TTI TriMetrix® DNA assessment suite that investigate engineering education and professional development.

Drawing from a data sample of 4,965 undergraduate students, and 313 entrepreneurially minded engineers, the work of Pistrui, et al. employed the TTI TriMetrix® DNA in a combination of descriptive and multivariate methods and techniques that quantified specific behavioral attributes and professional competencies found in entrepreneurially minded engineers [20]. The doctoral dissertation research of Dietrich (2012) was able to quantitatively distinguish between engineers and entrepreneurially minded engineers in both behavior and mastery of professional skills in the workplace [21]. Research by Pistrui et al. used the TTI TriMetrix® DNA assessment suite to define and establish a measurement model of undergraduate engineering education learning outcomes associated with professional competencies (soft skills) development [22].

TTI TriMetrix® DNA assessments are used by organizations for professional development and social science research. The TTI TriMetrix® DNA assessment suite is designed to increase the understanding of an individual's DNA in three distinct areas: competencies, motivators and behavioral styles. Understanding strengths and weaknesses in each of the three areas will lead to personal and professional development and a higher level of personal satisfaction. For this research, the TTI TriMetrix® DNA assessment was administered online between the fall of 2017 and the winter of 2019, with 473 individuals participating in the study, 66 NGLs, 182 NGEs and 225 NGSTs. The sample is comprised of 349 (74%) males and 124 (26%) females.

Females play an important role in the talent pipeline, representing 29% of the NGST and 26% of NGEs. However, when it comes to NGLs, females trail off to 17%. There is cause for concern that perhaps either in perception, or reality, there are fewer opportunities for females to advance into management positions. This is an area worthy of further investigation and analysis beyond the scope of this work.

The TTI mean is a sample of all the individuals who have taken the TTI TriMetrix® DNA assessment suite. This is a national sample across all job sectors and allows for a general comparison.

Professional Competencies

Based on responses to a series of questions, this section presents an overview of the development of 25 professional competencies that contribute to superior performance in many types of jobs. For many jobs, professional competencies, often referred to as "soft" skills, are as important as technical skills in producing superior performance. Professional competencies are developmental and transferable to a variety of professions, whereas technical skills are usually job specific.

Figure 3 presents a comparative visual overview of the 25 professional competencies of each segment of the talent pipeline as compared to the TTI mean, a sample of all the individuals who have taken this survey across all job sectors. As expected, the Next-Gen Leaders exhibit the greatest level of professional competency development. They also have the greatest level of experience and highest level of education. They have very well-developed interpersonal skills combined with a strong customer focus.

Next-Gen Engineers are young and in their formative years and their level of professional competency development reflects this. They are found to be goal oriented and demonstrate some level of interpersonal skills. The Next-Gen Skilled Trades people comprise multiple generations and thus represent a more eclectic and diverse set of individuals. They demonstrate strong interpersonal skills and show appreciation for others.

Figure 2 - TTI TriMetrix® DNA Assessment - Competencies, Behavioral Style and Motivators

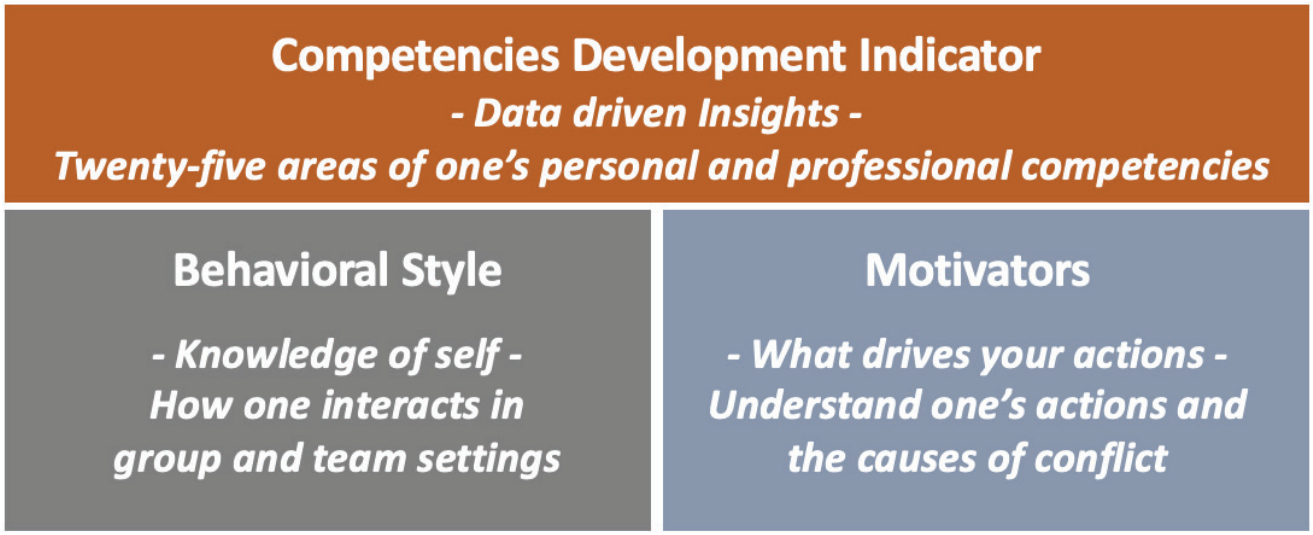
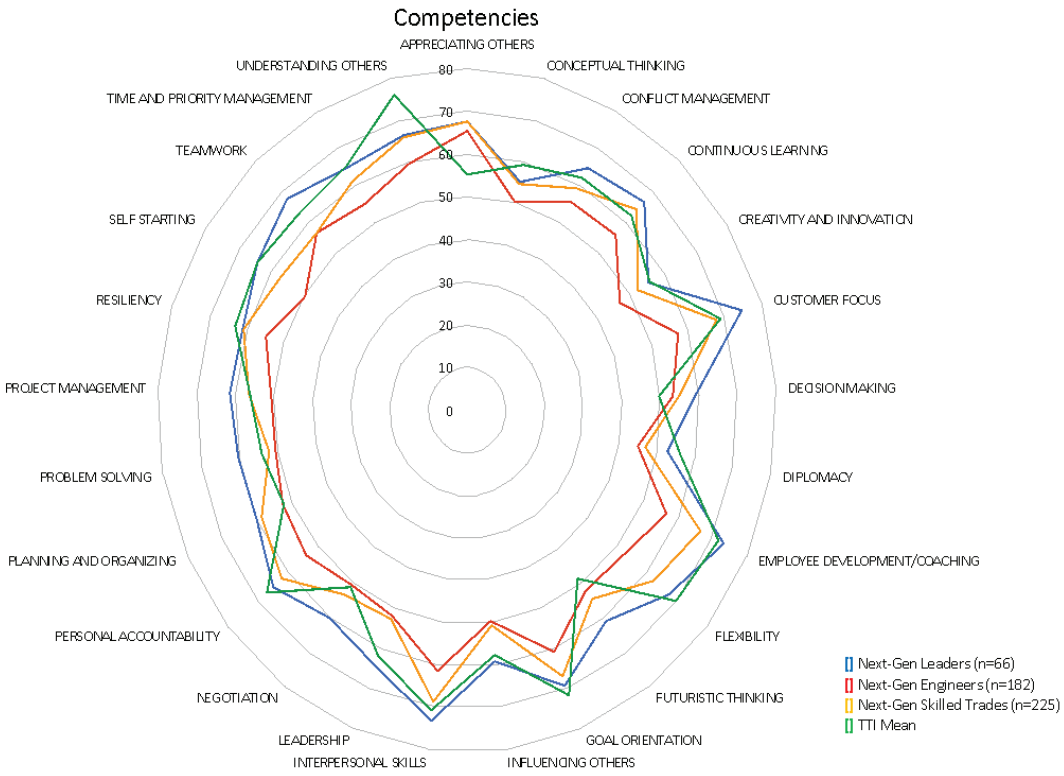


Figure 3 - Professional Competencies vs TTI Mean



Next-Gen Leaders

Table 3 provides a deeper look into the professional competencies associated with each segment of the talent pipeline. Table 3 compares the average competency by segment to the mean of all people who have taken the same suite of TTI TriMetrix® DNA assessments (hundreds of thousands of people across all professions). The intention is to get a benchmark comparison of each segment against an aggregate mean of all professions. This is directional in nature and will be used to guide more deep and rigorous analysis of the data sets in the future.

The Next-Gen Leaders were found to be well positioned to lead their organizations into the future. This group, which is comprised of a mix of Gen Xers and Millennials, is customer centric and demonstrates the ability to help others develop and grow. As one might expect, they have well developed communication skills and possess the ability to interact and relate with others.

Turning to the three least developed skills, it is eye opening to learn that this group, the future leaders, score low on creativity and innovation. Being able to effectively create new approaches, designs, processes, technologies and systems will be imperative for companies to navigate the disruption associated with Industry 4.0. The same can be said for conceptual thinking. Electrification and autonomous vehicle development (not to mention new business models) requires analyzing hypothetical abstract concepts and formulating connections and new insights.

These findings provide insights for educators and industry leaders to review, refine and reform educational practices to address these deficiencies both in the schools and respective companies. These findings suggest that topics such as design thinking, creativity, social science and systems engineering should be integrated into all levels of education and across engineering curriculums.

Table 3 - Competency Strengths and Weaknesses of the Talent Pipeline vs TTI Mean

Next Generation Leaders (NGL)		Next Generation Engineers (NGE)		Next Generation Skilled Trades (NGST)	
Top 3		**Top 3**		**Top 3**	
Customer Focus:		**Appreciating Others:**		**Interpersonal Skills:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
75	63	65	55	69	71
Employee Development:		**Interpersonal Skills:**		**Customer Focus:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
73	72	62	71	68	69
Interpersonal Skills:		**Goal Orientation:**		**Appreciating Others:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
74	67	61	72	68	72
Bottom 3		**Bottom 3**		**Bottom 3**	
Creativity & Innovation:		**Self-Starting:**		**Problem Solving:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
56	56	50	64	52	54
Conceptual Thinking:		**Creativity & Innovation:**		**Influencing Others:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
55	59	47	56	51	58
Diplomacy:		**Diplomacy:**		**Diplomacy:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
53	56	45	56	47	56

Two or more standard deviations above the mean

One standard deviation above the mean

One standard deviation below the mean

NGL n = 66, NGE n = 182, NGST n = 225

Next-Gen Engineers

Next-Gen Engineers, composed of Gen Zers who are all undergraduate engineering students, represent the next generation of engineering talent. Table 3 indicates this group has their own set of unique strengths. The top two professional competencies they have developed at this stage in their lives seem to align with their generational tendency to be radically inclusive. This includes identifying with and caring about others. They exhibit the abilities of building rapport and relate well to different kinds of people. It is not a surprise that this group is goal orientated, given the intensity and rigor associated with earning an engineering degree.

There is some cause for concern when reviewing the least developed professional competencies in the Next-Gen Engineering segment. The data suggests that they lack the ability to demonstrate self-initiative. Today's work environment with rapid change and disruption demands an opportunity-seeking mentality and self-drive. This is also a point of potential conflict between Gen Zers and Gen Xers. Just as the Next-Gen Leaders segment scored low on creativity and innovation, the Next-Gen Engineers do as well. The fact that both groups score so poorly in this area should be a wake-up call for both educators and industry leaders to begin to address these needs.

These findings suggest that educators and industry leaders should join forces to review current curriculum methods and develop an action plan to strengthen the creativity and innovation skills in both students and faculty.

Next-Gen Skilled Trades

Next-Gen Skilled Trades people demonstrated strong development of three primary professional competencies. First, they exhibit solid interpersonal skills associated with effectively communicating, building rapport and relating to a diverse group of people. Second, they were found to have developed a customer focus with the skills to anticipate and meet customers' needs, wants and expectations. Third, Next-Gen Skilled Trades people were found to be appreciating of others, having the ability to identify with and care about others. These findings reflect that this segment of the talent pipeline is often working and attending school part time. They represent a cross section of generations and socio-economic strata and are a vital part of the talent pipeline.

In terms of least developed professional competencies, three items emerged. The Next-Gen Skilled Trades group lack problem solving skills associated with defining, analyzing and diagnosing key components of a problem to formulate a solution. Although they have strong interpersonal skills, they have underdeveloped abilities to influence others. Personally, they are weak at affecting other's actions, decisions, opinions or thinking. Lastly, is their lack of diplomacy as they struggle with the ability to effectively and tactfully handle difficult or sensitive issues.

These insights suggest that community colleges have both the need and opportunity to review, recalibrate and redirect programs to improve Industry 4.0 skillsets. As skilled trades continue to transform around Industry 4.0 technologies, the workforce will most certainly need better problem-solving competencies. Further, as skilled trades become more collaborative in nature (think robotics, the Internet of Things (IoT), cloud computing and Big Data intersections) the workforce will be confronted with a different set of human interaction. New types of working relationships will require the ability to influence others with diplomacy, especially across and between generations.

Professional Competencies Below the National Mean

There are five professional competencies that the Southeast Michigan data set scores below the TTI mean. Three noteworthy themes emerge out of the data (see Table 3). 1) They score below the mean as it relates to understanding the uniqueness and contributions of others. 2) They score lower on conceptual thinking. Conceptual thinking relates to identifying patterns and formulating connections and concepts. 3) They score lower on personal accountability. These findings suggest that our emerging talent pipeline is more rigid, light on sensitivity (empathy) and less focused than the mean. These are important distinctions in an Industry 4.0 environment and cause for educators and industry leaders to address these important needs.

These findings provide some valuable insights and direction into what educators, industry and policy makers should begin to address. For example, how can our educational system begin to develop measurable ways and methods to improve the conceptual thinking skills in their graduates? As the workforce proceeds through generational leadership succession, how can both industry and educators help people empathize and embrace the uniqueness and contributions of others? This is vital to strengthening the talent pipeline.

These finding suggest that instilling broader goal orientation and personal and professional development must become core components of strengthening the quality of the workforce. With these new-found insights, educators, industry leaders and government officials should review existing workforce development programs and initiatives to determine if these deficiencies are being addressed; and begin immediately to formulate strategies and secure funding to support Industry 4.0 skill development.

Behavioral Styles

For this research, we utilized DISC, a behavior assessment tool based on the theory of psychologist William Moulton

Table 4 - Behavioral Strengths and Weaknesses of the Talent Pipeline vs TTI Mean

Next Generation Leaders (NGL)		Next Generation Engineers (NGE)		Next Generation Skilled Trades (NGST)	
Top 3		**Top 3**		**Top 3**	
Competitive:		**Persistent:**		**Consistent:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
59	49	67	61	68	61
Customer-Oriented:		**Consistent:**		**Persistent:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
59	64	66	61	68	61
Persistent:		**Following Policy:**		**Following Policy:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
59	61	64	60	66	60
Bottom 3		**Bottom 3**		**Bottom 3**	
Organized Workplace:		**Urgency:**		**Urgency:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
53	51	41	43	37	43
Urgency:		**Frequent Change:**		**Competitive:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
54	43	48	52	46	49
Analysis:		**Versatile:**		**Frequent Change:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
55	53	48	54	46	52

One standard deviation above the mean

One standard deviation below the mean

Marston. DISC centers on four different behavioral traits: Dominance, Influence, Steadiness and Compliance. There are no best styles and all people exhibit some level of intensity of all four components.

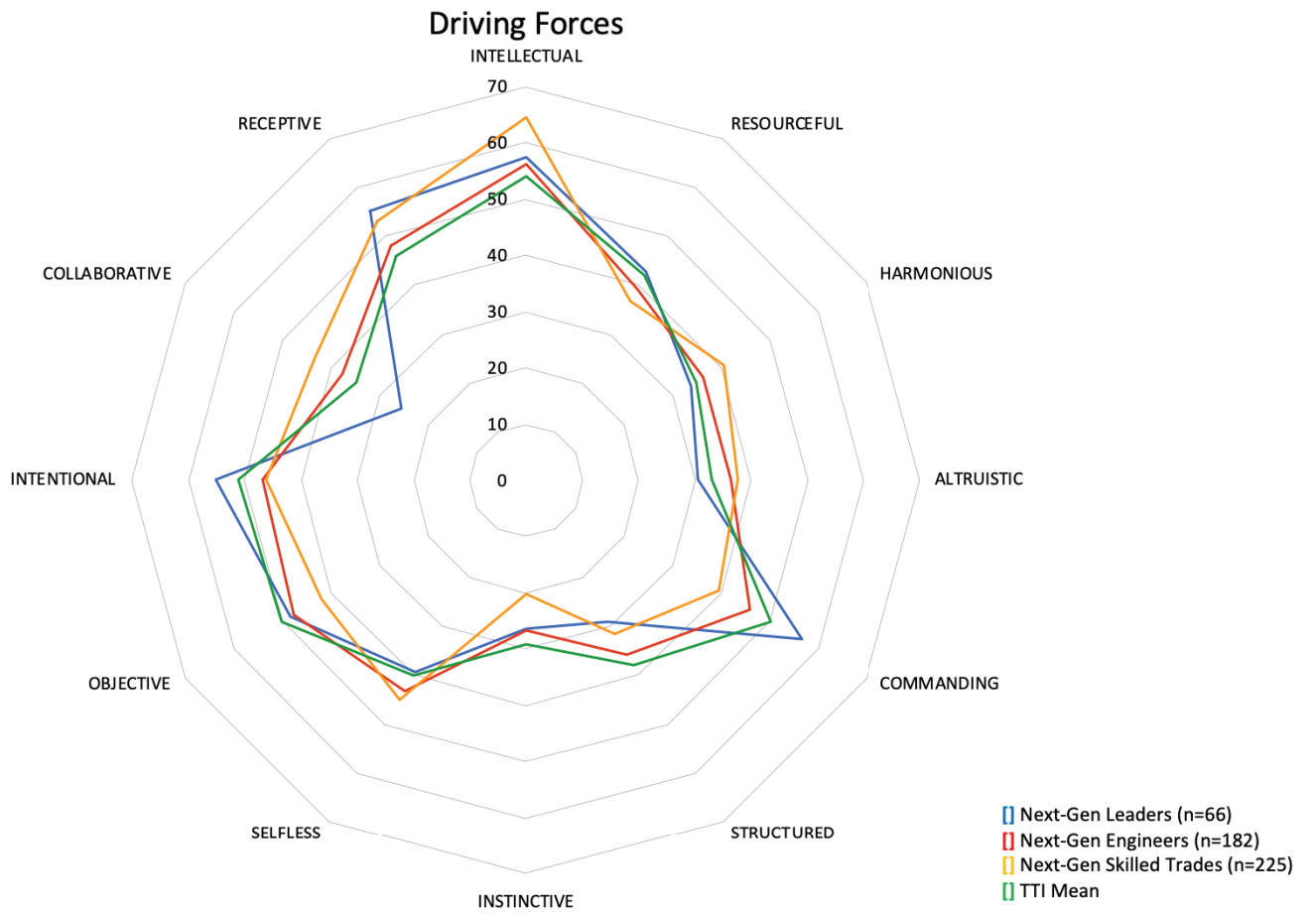
Understanding behavioral styles can help in gaining the commitment and cooperation of others, resolve and prevent conflict, build effective teams and enhance awareness and personal performance. People exhibit both natural behavioral styles (the ones we wake up with in the morning) and adapted behavioral styles (the ones related to our environment, level of stress and job requirements). Table 4 presents an overview of each segment's behavioral styles.

One common theme is that all three groups lack a sense of urgency to take immediate action. Both the engineering and skilled trades segments are resistant to frequent change, including rapidly shifting between tasks. Another surprising finding is that Next-Gen Leaders scored low in analysis. This seems counterintuitive given the nature of their work and is worthy of further examination.

Motivational Factors

Motivators are the driving forces or the "why" of what we do. Understanding motivators provides insights into what drives people's actions in personal and professional settings. Primary motivators can be referred to as the aspects of life for which one is passionate and perceived as important, or the thoughts that provide one with purpose and direction in life. This research defines 12 motivational factors (see Figure 4).

Figure 4 - Motivational Factors vs TTI Mean



Next-Gen Leaders

Table 5 provides a comparative overview of the motivational factors shaping the talent pipeline in Southeast Michigan. The Next-Gen Leaders are found to be commanding but not very collaborative. They are driven by status, recognition and control over others. They are not motivated to play a supporting role if given a choice.

Next-Gen Engineers

As one might expect, the Next-Gen Engineers, who are undergraduate engineering students, are driven by the functionality and objectivity of their surroundings. They are in a rigorous, structured and demanding environment so this driving force is critical to achieving their degree. This group is also receptive to new thoughts and ideas but are driven only by practical results. They are driven to assist others for a specific purpose, not just for the sake of being helpful or supportive. It is also not surprising that Next-Gen Engineers do not score higher in resourcefulness. This is a result of being in an academic environment that has yet to adopt new methods that fall outside a defined system for learning.

Table 5 - Motivational Strengths and Weaknesses of the Talent Pipeline vs TTI Mean

Next Generation Leaders (NGL)		Next Generation Engineers (NGE)		Next Generation Skilled Trades (NGST)	
Top 3		**Top 3**		**Top 3**	
Intellectual:		**Intellectual:**		**Intellectual:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
57	54	56	54	64	54
Commanding:		**Receptive:**		**Receptive:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
56	50	58	46	53	46
Intentional:		**Objective:**		**Intentional:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
55	51	47	50	46	51
Bottom 3		**Bottom 3**		**Bottom 3**	
Collaborative:		**Instinctive:**		**Instinctive:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
26	35	27	29	20	29
Instinctive:		**Structured:**		**Structured:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
26	29	36	38	31	46
Structured:		**Altruistic:**		**Resourceful:**	
Average	TTI Mean	Average	TTI Mean	Average	TTI Mean
29	38	37	33	37	42

One standard deviation above the mean

One standard deviation below the mean

Next-Gen Skilled Trades

The Next-Gen Skilled Trades group has some surprising and insightful motivators. First, they were found to be intellectually driven by opportunities to learn and acquire knowledge and had the highest level of motivational intensity. This may be due to the fact that they could be working fulltime while pursuing their education. Counter to this, Next-Gen Skilled Trades people were also found to be much less instinctive, whereby they can utilize past experiences and intuition.

As students, they are seeking new knowledge and skills that can be used to improve their everyday lives and those of their families. Another interesting insight from this group is that they are not driven to achieve practical results through maximizing both efficiency and returns for their investments of time. This suggests that this group may be searching for opportunities that are not clear or well defined.

Motivational Factor Common Threads

Patterns emerge between the three groups when looking closely at motivational factors. All three segments are driven by an intellectual quest. They are motivated by opportunities to learn and acquire knowledge. This is encouraging as the integration of Industry 4.0 technologies demand intellectual curiosity and engagement. The Industry 4.0 disruption and rapidly changing environment requires continuous learning and the development of new skills.

Another commonality is that both the Next-Gen Engineers and the Next-Gen Skilled Trades groups are receptive to new ideas, methods and opportunities that fall outside a defined system. This would seem logical as both groups are in school. The same logic holds true for the Next-Gen Leaders who are driven by status, recognition and control over personal freedom. Conflict could arise between Next-Gen Leaders, who have a drive to command and control, and the Next-Gen Engineers and Next-Gen Skilled Trades people who are motivated to pursue new ideas, methods and opportunities.

Another common thread is that all three segments are indifferent to traditional approaches, proven methods and a defined system. Perhaps this is the result of the Industry 4.0 environment where change is constant, and people are being forced to adopt new methods and adapt to a changing work environment. This may also reflect generational differences where certain groups want to "do it their way."

A Call for Education Workforce Development Reform and Additional Research

To successfully navigate the Industry 4.0 environment (and beyond), organizations will need to integrate four different generations (soon to be five) into their workforce. Next-Generation Leaders were found to be lacking in creativity and innovation and conceptual thinking, critical skills required in navigating an Industry 4.0 environment. This should serve as a wake-up call to educators tasked with overhauling an antiquated system, particularly at the graduate level.

Next-Generation Engineers (currently in the higher education system) are trending low in the categories of resourcefulness, creativity and innovation. They were also found to not be self-starting and not instinctive. This may be a result of an education system (K-12 and higher education) that has yet to fully appreciate, embrace and adapt to the rate of Industry 4.0 technology change and generational differences.

Next-Generation Skilled Trades is a group that is vital, yet often overlooked. They were found to be greatly lacking when it comes to problem solving skills and the ability to influence others. They were also found to be lacking competitiveness which suggests that educators need to rethink how they create dynamics between individuals, teams and groups, and how industry rewards performance. These findings provide some direction to community colleges and labor organizations as they calibrate for an Industry 4.0 world.

Findings suggest that educators, industry leaders and policy makers need to collaborate and initiate immediate and sweeping educational reform. Table 6 presents a suggested framework that recommends a transdisciplinary approach that will fundamentally change the focus, learning outcomes and education of university and community college students in the U.S.

Engineering and science need to incorporate contemporary Industry 4.0 subject matter, such as advanced software skills

Table 6 - Industry 4.0 Education Workforce Development Reform Framework

Engineering and Science

- Systems engineering & architecture
- Advance software skills & programming
- Artificial intelligence & machine learning

Business Acumen

- **Entrepreneurial thinking & leadership**
- **Industrial economics & data analytics**
- **Financial management & decision making**

Social Science

- **Sociology & anthropology**
- **Industrial psychology**
- **Research methodologies**

Creative Studies

- **Design thinking methods**
- **Innovation in society**
- **Creativity & opportunity identification**

and artificial intelligence at the reduction of some Industry 2.0 subject matter, such as differential equations with linear algebra. This is not to say students should not be exposed to understanding differential equations, but they should do so in Industry 4.0 applied ways. Students should also be skilled in the areas that promote the development and application of business acumen including the intersections of entrepreneurial thinking and leadership, as well as data analytics, decision making and financial economics. This will be essential as new business models unfold and are created.

Industry 4.0 workforce development reform also needs to re-incorporate the social sciences.

Sociology, anthropology, psychology and the research methodologies these fields employ are other important areas in need of re-integration. Some of these topics could be one or two-credit offerings that blend human engagement, online modules, reading and field experiments. The data suggests that students could benefit from better understandings of human beings and culture.

Design thinking, which is currently a topic of much discussion in industry, should play a more distinctive role in Industry 4.0 educational experiences. The history and roll of innovation in society, developing creativity and identifying, qualifying and quantifying socio-economic opportunities need to become core principals of our educational frameworks at all levels.

This work serves not as an “end all, be all,” but rather as a preliminary step, in one of many, to look at both the technical dynamics associated with Industry 4.0 and the human dynamics associated with generational transition and leadership succession in conjunction with the talent pipeline. While this research is centered on Southeast Michigan, we advocate for an expansion of this work nationally, employing additional and more rigorous research methods, larger data sets and transdisciplinary collaboration and analysis.

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