Industry 4.0 Demands the Co-Evolution of Workers and Manufacturing Operations

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ABOUT THIS RESEARCH

Industrial IoT (IIoT) is transforming how humans work, operate and interact with manufacturing technologies and operations. As Intel seeks to drive these technologies more broadly into manufacturing, understanding today’s factories, their inhabitants, and the obstacles to further digitization will be critical to making intelligent factories reality.

As we undertook this project, we wondered what workers from the factory floor to the boardroom expected in the intelligent factory of the future. Likewise we also wanted to uncover pain points, desires, concerns, and expectations of these individuals as they and their companies pursue the promise of the intelligent factory.

These research-based findings and insights will help Intel’s technology and solution development. But we also recognize the value of these insights to manufacturing leaders as they transform their operations and create the digital culture that will be so important to successful implementation and deployment of IIoT.
WALKING THE WALK

The promise of the intelligent factory is of particular importance and interest to Intel. As a manufacturer ourselves, we have factories all over the world, each precision-tuned for efficiency and quality. Our traditional automation systems are augmented with IIoT-enabled capabilities, such as data-driven materials handling and advanced analytics.

Examples of how Intel is using IIoT include (a) big data analytics helps us detect the potential failure of critical testing units before they can begin wrongly categorizing "good" devices as "bad", (b) image analytics speed up the once hours-long manual task of segregating true rejects from marginal units by verifying them moments after they pass through an inspection module, and (c) machine learning is helping us visualize and automate the control of equipment performance, confidently validate product quality and conformity to specifications, and achieve accurate, verifiable process diagnostic.

These and many other IIoT-enabled efficiencies are teaching us how to use our data to increase uptime, accelerate output, generate higher yields, and lower mean time to repair—typical benefits of the journey toward a fully intelligent factory.

"For Intel, manufacturing serves as the underpinning for our business and allows us to provide customers and consumers with leading edge products in high volume. The unmatched scope and scale of our investments in manufacturing helps Intel maintain industry leadership and drive innovation."

INTEL CEO, BRIAN KRZANICH
THE EVOLVING FACTORY

Transforming into an intelligent factory is neither easy nor quick. Successful adoption of the underlying IIoT-enabled technologies requires comprehending the co-evolution of the many systems in manufacturing environments and the motivations, concerns, and practices of the people who work with them in order to anticipate how to successfully design this transformation.

By sharing the research-based findings in this document, Intel is hoping to accelerate progress towards the intelligent factory. This document shares insights that

1. Extend current technology-centric models of the intelligent factory to include the people involved in the transformation now and into the future.

2. Provide a shared framework and language for thinking about the accompanying co-evolution of workers and operations.

3. Help companies think about where they are in their journey toward the intelligent factory, enabling them to better anticipate implementation and communication needs.

4. Highlight accelerators and potential threats to adoption of IIoT and progress toward the intelligent factory.

5. Provide foundational information to help leaders accelerate their company’s transformation to the intelligent factory.

“If I have to advise my company how to make changes in new technology, then I would ask them to discuss the idea with everyone, and especially with those who are associated with that technology. In the past, it happened that new machine was set up and, uh, the workers could not understand how to work with it, and it did not add off any advantage.”

QUALITY CONTROL INSPECTOR WORKING ON THE FACTORY FLOOR
THE RESEARCH APPROACH
145 MANUFACTURING PARTICIPANTS, 1323 DATA SETS, 11 HOURS OF SENIOR LEADERSHIP INTERVIEWS

As part of the research, we looked to identify key groups of leaders and workers with similar behaviors, goals, motivators, and needs—aka personas of potential “users” that will facilitate adoption of IIoT capabilities, both today and in the next 3-5 years. We focused on discovering the problems important to this audience, not the technology. So while this work was done in the context of intelligent factories, what we learned should have broad generalizability to introducing technology in manufacturing settings.

We recruited individuals from a broad range of manufacturing settings for this project, with 76% of participants between 18 and 40 years of age and who represent the population of manufacturing professionals that will likely still be working when the vision of Industry 4.0 is realized in the coming years. We used a mobile ethnography app to capture real moments in the factory combined with one hour phone interviews with senior manufacturing leaders. The app allowed participants to share their everyday experiences as they went about the factory. Responses included free-form commentary, traditional survey questions, and videos or photos relative to the topics shown to the right. Photos found in this document, like the ones below, were shared by research participants.

NOTE: Percentages in this document are a measure of the relative strength of the trend among participants, not a measure of statistical significance.
OVERALL PARTICIPATION AT A GLANCE

43% MANUFACTURING FACILITIES IN MULTIPLE COUNTRIES
73% CHANGEOVERS OR SETUPS VERY OR SOMEWHAT FREQUENT
19% USE NO AUTOMATION OR CONTROL SYSTEMS
68% WORK OR SUPPORT PREDOMINANTLY DISCRETE MANUFACTURING PROCESSES

TOP INDUSTRIAL MANUFACTURING SECTORS
27% PETROCHEMICAL
29% METAL FABRICATION
17% ELECTRICAL MACHINERY & COMPONENTS
9% FOOD & BEVERAGE
7% WOOD & PAPER PRODUCTS
6% TRANSPORTATION EQUIPMENT

32% OPERATIONS
26% INDIVIDUAL WORKER
26% SUPERVISORS
13% SENIOR LEADERS
3% OWNER / CEO

COMPANY SIZE
36% SMALL (1-249 EMPLOYEES)
15% MEDIUM (250-999 EMPLOYEES)
49% LARGE (OVER 1000 EMPLOYEES)

UNITED STATES
SOME COLLEGE

AGE
MALE

69%

32% 46% 13% 11%
18-29 30-39 40-49 >= 50

78% COMPUTER
46% CAMERA / VIDEO RECORDER
44% SMART PHONE
39% TABLET
34% 2-WAY RADIO
32% ROBOTS

78%
46%
44%
39%
34%
32%

61% OFFICE SOFTWARE
26% COLLABORATION
13% DATA COLLECTION + MANAGEMENT

61%
THE DIGITAL CONTINUUM
DIGITIZATION IN TODAY'S WORK ENVIRONMENT

WHY THIS MATTERS

Transforming into an intelligent factory is neither quick or easy. You start the journey where you are at today. By understanding where you are on the DIGITAL INTENSITY spectrum to the left you can better set course and strategize on your journey to the intelligent factory.

In this project, participants gave us their subjective perception of workplace DIGITAL INTENSITY to (a) assess the degree of progress towards the intelligent factory vision and (b) understand its impact on what participants perceived relative to the opportunities and threats of further digitization. The concept refers to the degree to which computer-based technologies (e.g. machines, equipment, services) do the work, and often substitute, for humans when it comes to tasks in a particular manufacturing environment.

LOW DIGITAL INTENSITY

Work is primarily manual with semi-automated or automated technologies the exception not the norm.

MEDIUM DIGITAL INTENSITY

Computer-based technologies are common, but humans are still required to complete manufacturing tasks (e.g. human feeds machine). Fully automated processes may be exist but are the exception not the norm.

HIGH DIGITAL INTENSITY

Automated processes that accomplish manufacturing work without human intervention are common. But workers also indicate that manual or semi-automated elements of the work are common with humans often acting as the glue to string together more automated elements of the work.

FUTURE INTELLIGENT FACTORY

Powered by IIoT, generalized compute technologies, complex data analytics, and distributed, virtual manufacturing, the future intelligent factory will operate with agility and intelligence to improve their functioning with little or no human intervention through autonomous decision making and self-optimization.
DIGITAL INTENSITY ACROSS WORK ENVIRONMENTS TODAY

Today every company is at a unique position in this digital intensity continuum. The key is to develop your vision and to scout your environment for projects that move you towards your vision, that you can start implementing immediately, that deliver value in the near term, and lay the groundwork for your long-term vision. Our respondents indicate that medium-digital intensity companies want their high-digital intensity counterparts to lead the way to the intelligent factory and hope to draft off their efforts. Regardless of the level of digital intensity participants report humans still perform important functions. Participants shared worlds where intelligent technologies existed side-by-side with human operators.

25% LOW DIGITAL INTENSITY

“Technology isn't the worker here ... operator has to do majority of the work.”

46% MEDIUM DIGITAL INTENSITY

“I would take human element out of it however I can't because you have to do research <outside process> to discover <root cause>. It's the reason why you can’t automate ... there has to be human involvement here.”

29% HIGH DIGITAL INTENSITY

“... ends with the robot checking every part.”
THE MANUFACTURING CONTINUUM AT A GLANCE

The table below summarizes the human aspects of differences in digital intensity. As you consider your next steps on your journey toward the intelligent factory, you need to understand what we have learned about the impact of digital intensity on factory inhabitants’ concerns and pain points that may facilitate or hinder adoption of IIoT and progress on your factory’s journey.

<table>
<thead>
<tr>
<th>DIGITAL INTENSITY</th>
<th>LOW</th>
<th>MEDIUM</th>
<th>HIGH</th>
<th>FUTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOP CHALLENGES</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>1.</td>
<td>Process includes too many manual tasks and too much paper</td>
<td>Information challenges – (a) not collecting needed data and (b) not trusting as inconsistent information coming from different sources</td>
<td>Information and communication challenges – do not collect data I need or collect it but can not easily use it as (a) not available real-time or (b) difficulties making sense of it</td>
<td>Technology changes faster than company makes decisions or can keep up with skill-wise</td>
</tr>
<tr>
<td>2.</td>
<td>Equipment upkeep and maintenance</td>
<td>Wasted labor time due to poor planning or insufficient information</td>
<td>Old equipment still in use</td>
<td>Increased transparency of work and communication may make visible information workers or company don’t want shared</td>
</tr>
<tr>
<td>3.</td>
<td>Information challenges – (a) not trusting as too many people touch during collection or processing, (b) not in an easy to use format, and (c) information hoarding by others</td>
<td>Labor variability (e.g. staffing differences, or quality differences for the same work)</td>
<td>Unpredictability of technology and equipment maintenance</td>
<td></td>
</tr>
<tr>
<td>IMPACT TECH ON WORK IN NEXT 3-5 YEARS</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>1.</td>
<td>Work faster and more efficiently</td>
<td>Work faster and more efficiently</td>
<td>Work faster and more efficiently</td>
<td>Increased work transparency</td>
</tr>
<tr>
<td>2.</td>
<td>Work is increasingly automated</td>
<td>Work is more strategic</td>
<td>Work is more strategic</td>
<td>Less manual work</td>
</tr>
<tr>
<td>TOP CHANGE OBSTACLES</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>1.</td>
<td>Limited tech financial resources.</td>
<td>Cost of technology</td>
<td>Cost of technology</td>
<td>Our pace of change is too slow to achieve envisioned transformation in a competitive time frame for our industry</td>
</tr>
<tr>
<td>2.</td>
<td>No commitment to change in the organization</td>
<td>Skill gap among today’s workforce</td>
<td>Insufficient training investment</td>
<td></td>
</tr>
<tr>
<td>CHANGE MOTIVATOR</td>
<td>Reducing time to complete a task</td>
<td>Increasing productivity</td>
<td>Increasing effectiveness and overall productivity</td>
<td>Improved quality especially process &amp; information</td>
</tr>
</tbody>
</table>

Our pace of change is too slow to achieve envisioned transformation in a competitive time frame for our industry.
TODAY - TRANSITION - FUTURE

THE DIGITAL JOURNEY
TODAY

What is important to know about where leaders and workers are NOW.
How does our current experience influence the perceptions of “the possible”?
What drives a hunger for change?

Biggest Pain Points Today
Insufficient Coordination = Opportunity
Motivators of Change

“When our machines are not running, we are losing money. If we could reduce downtime even by 10% to 20%, we would improve profitability by $1M to $2M annually.”

FINANCE PERSON, MEDIUM DIGITAL INTENSITY
**Biggest Pain Points Today**

Manufacturing pain points came in all shapes and sizes—product rework or damage, physical discomfort or injury, inefficiency or just basic communication breakdowns. The most frequent types of problems are shown below.* These are the problems that participants were looking to solve—with or without technology.

<table>
<thead>
<tr>
<th>Percentage of Data Sets</th>
<th>Issue Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>26%</td>
<td>Information Challenges (around getting what I need for my work—can't find it, too many versions of the truth, too manual, too much paper, too many information silos)</td>
</tr>
<tr>
<td>24%</td>
<td>Equipment Maintenance and Upkeep</td>
</tr>
<tr>
<td>19%</td>
<td>Communication Challenges (related to the lack of effective coordination across factory (e.g. between teams, sites, or functions))</td>
</tr>
<tr>
<td>18%</td>
<td>Safety Hazards (with environment air quality, temperature, noise levels, and ergonomic issues (e.g. lifting heavy object) top of mind)</td>
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</tbody>
</table>
| 17%                     | Equipment Not a Good Fit for Work (whether the complexity of changeovers, age of equipment, or not using for intended purpose)

*Percentage of data sets where participants raised this issue

"<I need> the ability for this macro level tool to drill down further to give the information that's needed. You can't build an exponential view to everything that could go wrong in a factory, you got to build it for the biggest problems or biggest areas of issues first, then you can maybe build out from there. Let's get something that helps you in the shorter term. That's the types of conversations I've had."

CTO, HIGH DIGITAL INTENSITY
Insufficient Coordination = Opportunity

Participant pain points reflect an underlying lack of coordination on many levels, whether within one factory or between factories and other sites both nationally and internationally. For some, this lack of coordination is a communication problem. There may be a lack of effectively communicating requirements to overseas factories. There may also be a gap between their technology and the digital intensity of these overseas factories, leading to a failure to create and ensure the quality of product designs. In addition to a widespread desire to standardize quality across sites, there is also concerns around ensuring data security across sites. These many coordination obstacles are ideal problems to potentially solve with Industrial IOT solutions.

“One of the biggest challenges between departments and even within departments is clear communication. All too often when a work order is given to us it has not been reviewed to see if the work is even possible. Other times there are no clear instructions or locations for the work. Makes for longer planning times and less efficiency.”

FLOOR WORKER, LOW DIGITAL INTENSITY
Motivators of Change

47% of the entries suggesting digital improvements to today’s factory were motivated by the desire for increased efficiency or productivity. That was true regardless of overall digital intensity or persona. However, quality was the primary driver of expected changes to the factory in the next 3-5 years with quality surging to the front before efficiency and productivity. Other motivators for further digitization were as varied as the participants, but could generally be categorized either as minimizing manufacturing variances or benefiting the bottom line, which was particularly important to manufacturing leadership.

“Now when you look at manufacturing metrics, there’s safety, quality, delivery cost. So with a highly automated workforce, safety becomes less of an issue when you don’t have the hands and fingers touching processes. Right now, direct labor efficiency… is a huge manufacturing metric and really is sort of passé in a fully-automated world where you want to know uptime and what to do when downtime is happening.”

MANUFACTURING LEADER, MEDIUM DIGITAL INTENSITY
TRANSITION

What is important to know as leaders and workers transition from today's reality to their desired future vision?
What questions do we need to be asking about our factories?
What questions do we need to anticipate from our workers?

The Understanding Gap
Magical Thinking around Technology
Biggest Obstacles and Enablers of Change
The Operational Chasm
The Skill Gap

“We were able to save a million dollars over two years through implementing the automation with the robotics because you had the volume. You have to have the volume and you have to have standardization. Those are the two key factors. You can't take the cost out unless the process is consistent, unless there's labor standardization. Then you're able to do it. If you have a lot of changeover, if you have a lot of non-commonality, you have to have the labor in place. You can't automate. The cost structure doesn't allow you to.”

FACTORY MANAGER, HIGH DIGITAL INTENSITY
“Industry 4.0.” and “Manufacturing 4.0” were at best buzzwords for most participants, with leadership response to these terms during interviews mixed. Overall, participants demonstrated a widespread lack of awareness about using a 4.0 framework for conceiving and planning changes in their factories. Despite that, many demonstrated awareness of and interest in solving today’s problems in ways evocative of 4.0 technologies. However, they framed their interest in terms of piecemeal changes, process changes and improvements to particular work, not large-scale manufacturing transformation. So when taking the journey to the intelligent factory, we must be able to translate the grand vision into changes that workers care about, namely solving the problems they face today.

“As somebody that sources several hundreds of millions a year and works continuously with all scales of suppliers—large to small—Manufacturing 4.0 isn’t even on the radar. I know that’s not what you want to hear. The term Manufacturing 4.0 on the ground floor doesn’t exist in my world and I touch a lot of industry.”

SUPPLY CHAIN LEADER, HIGH DIGITAL INTENSITY
Magical Thinking about Technology

While participants rarely referenced wanting a specific technology in their free-form musings about needed changes, they did do plenty of magical thinking regarding smart 4.0 technologies. While it demonstrates the participants’ openness to these technologies, it also demonstrates a lack of concrete information about how these technologies work, what they are, and what they can or cannot do. Magical thinking is clear in how people believed that this technology was out of reach (“unobtanium,” to use one participant’s language). An all-in-one, out-of-the-box solution to their problems is desired. The technology remained a black box to participants, despite a hunger for “smart” technologies to solve a variety of today’s problems.
Biggest Obstacles and Enablers of Change

Whether from workers concerned with the pace of change at their factories, or leadership concerned with resistance to change from their workers, participants repeatedly discussed the obstacles to change in their factories today. Some described distrust of new technology and resistance at the C-Suite-level to technology adoption despite the fact that it would increase efficiency for their companies. Others focused on the technical hurdles. Overall, 56% of the raised obstacles related to the culture and leadership of the parent organization, with the remaining obstacles primarily technical. When describing the enablers or accelerators of digitization, 46% focused on benefits to themselves or what they brought to the process, 40% on the larger organization, and only 14% related to technology.
Despite their identification of obstacles in their environment and in part due to their magical thinking about technological possibilities, participants struggled with how to operationalize new technology possibilities. They often had concerns about the new technology fitting in with existing equipment and lacked the time to learn more. They saw themselves as being at risk potentially if they failed to navigate the transition, but need help learning to make transformation concrete through practical, proven steps.

Their difficulties were exacerbated by the need for there to be multiple paths to 4.0 since there is such variety in digital intensity in contemporary manufacturing. How do they start with today’s context of skills, technology, and process, and develop concrete steps to prepare for their change?

“We have a tendency to move as quickly as we can <when introducing technology> because maybe we want to get something on the market or we want to start working as quickly as we can, and we don’t put enough time and effort into validating that this technology or equipment or whatever-it-is process is going to be reliable. A lot of times, things seem like they’ll work fine and then we’ll put something into production, and then all of a sudden, we have all these new issues.”

OPERATIONS COORDINATOR, HIGH DIGITAL INTENSITY
Many expressed concerns about skill gaps for existing let alone new manufacturing technologies, especially at the lower levels of digital intensity. Some leaders do not want to invest in training because they are worried that they might lose their workers and thus their investment. Managers are worried about the increasing inability to find and keep skilled labor, particularly as the skills required for manufacturing keep changing. Workers are worried that their factories will leave them behind because while the industry changes they are not getting a chance to learn newer technologies. And other workers are operating robots without adequate training or understanding of their machines, raising security and quality concerns.

"It's all about change management. Ensure the people that will touch the new tech have the training, knowledge and skill set to be successful. Look for ways to integrate the tech into everyday work."

CUSTOMER SUPPORT MANAGER, HIGH DIGITAL INTENSITY
FUTURE

What is important to know about the envisioned manufacturing future 3-5 years out? What is most desirable in the envisioned future to workers and leaders? What do they fear? What new challenges do they expect the intelligent factory to bring?

No Change is the Worst Plausible Future
Fundamental Shift in Factory Work
Distrust of the Intelligent Factory
Potential Fragility of the Intelligent Factory

“I do see a lot of digital changes and changes for the better that are happening, especially in the next three to five years. But I think a big problem is that once we implement something new, we kind of keep the old stuff around and don’t make, like, that hard cutoff.”

OPERATIONS COORDINATOR, LOW DIGITAL INTENSITY
For many participants, the worst future is no change at all thus demonstrating a sense of fear about their future or that of their company. Worker participants who embraced technology and coming changes were often motivated by the desire to adapt as a way to stay relevant and employable over the long-term. Likewise, they want their factories to change in order to stay in business before they do not have enough capital to adopt new technology. Leadership participants who embrace technology are often concerned about the potential financial losses from poor adoption and delays from implementation. As a result, there is clearly a subset of leaders who appear to be more risk averse when considering new technology changes than workers on the floor.

"The worst and most extreme thing would be that nothing changes <in the future>. That we don’t move forward with technology. That we don’t try and be more technologically savvy. That we don’t invest in new machinery that will keep us in line with our competitors. That would be the worst thing---a day in my life wouldn’t change at all and it would be me running around trying to get everything done as I am now and not using technology in order to do that.”

OPERATIONS MANAGER, MEDIUM DIGITAL INTENSITY
FUTURE

Fundamental Shift in Factory Work

Participants’ free-form imaginings of the future included not only re-invented technology, but also the re-invented nature of their work. They expected the more onerous aspects of their job to disappear (e.g., physical labor, paper wrangling). Many relished the thought of being able to focus more on value-add tasks that were uniquely human and having freedom from today’s constraints of manufacturing. They expected transparency in work and communication, where they could access information about anything from anywhere leading to an organization that was more in-sync and data driven decision making ruled. Whether that transformation was good or bad depended largely on the extent to which they saw (1) humans leading versus serving the technology, and (2) felt that they had talents outside of ones easily automated.

“For a worker like me, everything would be easier. There would be high-tech machines and devices to help do our job faster. <Technology> will save time, energy, and mind power. The relationship with other employees and regulation of the production may stay the same, but everything will be controlled in advanced way. The challenge would be to know well the high-tech in the production line and when something is wrong as if you didn’t notice right away then that would cause a lot of <issues>.”

MANUFACTURING TECHNICIAN, MEDIUM DIGITAL INTENSITY
Participants at times exhibited distrust when it came to 4.0-like technologies. It may be partially driven by AI fear mongering in mainstream media that some participants mentioned. Even if participants do not have a clear understanding of 4.0 technologies, they have seen and heard about the dark potentials of it becoming difficult to control, from losing control over quality or data, to losing the ability to respond flexibly to volume fluctuations, to losing control of personal information, or even fully losing control over the factory itself. Even those who are the closest to/most ready for 4.0 seem afraid of letting go of human control in manufacturing processes. In fact, one intelligent factory persona exists largely because of the participant sentiment that the future factory, even if run by robots, still needs humans on premise---just in case.
The system when running is like watching an industrial ballet. It’s graceful and mesmerizing when it’s running. However when it’s down, it’s extremely difficult to troubleshoot and pinpoint exact deficiencies. When it goes down, it’s a huge ordeal in the facility. I wish it attempted to reduce downtime or ideally be able to proactively respond to an issue before the entire machine is down. We’re moving towards more robotics in the future, so I worry.”

FACTORY SUPERVISOR, HIGH DIGITAL INTENSITY

Participants had a lot of concerns about what happens to the 4.0-like technologies once they are installed. Even with current tech, regardless of digital intensity, there are widespread concerns around preventative maintenance lapses and that repairs that take too much time away from production due to hard to come by parts or need for specialized support. Tech today is often adopted without any plan in place to keep it updated. Several factories have ended up with new machines and old computer interfaces, new data streams and old servers, or other combinations due to a lack of systematic planning. With the increase in automation, this concern becomes even more pressing as many participants feel that they would need to rely more on tech with less human intervention and potential lack of needed skills in-house.

FUTURE

Potential Fragility of Intelligent Factory
# A JOURNEY, NOT A JUMP

**TODAY**
What to know about them NOW

<table>
<thead>
<tr>
<th>TOP PAIN POINTS</th>
<th>PEOPLE AND PROCESSES ARE THE BIGGEST HURDLES (not technology)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Challenges getting the information I need for my work</td>
<td>• 56% raised hurdles to transforming with technology related to the culture and leadership, particularly the lack of commitment to change / improve, not involving workers in the change process, and the pace of change in the organization</td>
</tr>
<tr>
<td>• Equipment maintenance &amp; upkeep</td>
<td>• Remaining hurdles related to the technology cost and the challenges of implementation (example: 25% saw need for connectivity as a obstacle to change or necessary change to achieve vision)</td>
</tr>
<tr>
<td>• Communication challenges related to lack of effective coordination</td>
<td></td>
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</tbody>
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**FUTURE**
What they envisioned 3-5 years out

<table>
<thead>
<tr>
<th>CHANGE WANTED AND NEEDED</th>
</tr>
</thead>
<tbody>
<tr>
<td>• No change is the worst plausible future across the board</td>
</tr>
<tr>
<td>• Expect (and want) fundamental shifts in nature of their work</td>
</tr>
<tr>
<td>• Technology takes on the onerous</td>
</tr>
</tbody>
</table>

**TRANSITION**
What to know to help them navigate the transition

<table>
<thead>
<tr>
<th>TOP DRIVERS OF INFO CHALLENGES</th>
<th>AN UNDERSTANDING GAP AND A SKILLS GAP (and they are not the same)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Do not collect needed info or data</td>
<td>The Understanding Gap</td>
</tr>
<tr>
<td>• Collect it but cannot easily use as not in needed format, too much work to get, or not available when/where need it</td>
<td>• Manufacturing 4.0 is at best a buzzword despite participant awareness and interest in solving today's problems in ways evocative of 4.0 technologies</td>
</tr>
<tr>
<td>• Collect it but do not trust it as too much manual input or inconsistent info from different sources</td>
<td>• Magical thinking around technology despite an openness to “smart” technologies to solve problems</td>
</tr>
<tr>
<td></td>
<td>• Need for good examples both in the real world and the virtual (e.g. skype tours, VR) to get potential users “hands-on” and to help counter magical thinking</td>
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<tr>
<td></td>
<td>The Skills Gap</td>
</tr>
<tr>
<td></td>
<td>• In addition to the technology, also need soft skills (e.g. adaptability, data-driven decision-making)</td>
</tr>
<tr>
<td></td>
<td>• Start with problems that leaders and workers care about in words they understand</td>
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<tr>
<td></td>
<td>4.0 capabilities and IIoT solutions demonstrate effectiveness and increase resilience, but ...</td>
</tr>
<tr>
<td></td>
<td>• Increased transparency brings new risks (e.g. factory “tattles” on worker)</td>
</tr>
<tr>
<td></td>
<td>• The potential fragility of intelligent factory could mean potentially bigger consequences</td>
</tr>
</tbody>
</table>

**TOP CHANGE MOTIVATORS**
AN OPERATIONAL CHASM

<table>
<thead>
<tr>
<th>TOP CHANGE MOTIVATORS</th>
<th>HIGH INTENSITY expected to lead with less digitally intense counterparts hoping to draft off their efforts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary: Efficiency</td>
<td>• But need concrete help on making vision real (it’s not magic!)</td>
</tr>
<tr>
<td>Secondary: reduce variances, costs</td>
<td>• Looking for practical steps that help them systematically plan to avoid unwieldy mix of old and new</td>
</tr>
<tr>
<td></td>
<td>• Need proven examples and operational learnings from those that have been there in their industry</td>
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<td></td>
<td>Medium Intensity (with their feet in both worlds) struggle the most</td>
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<td>• Focus on return on investment and accompanying efficiencies</td>
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<td>• Robotics may not be the Trojan horse that pulls adoption unless they tie into larger environment</td>
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<td>• We need deeper understanding of day to day tasks to guide implementation and adoption</td>
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<tr>
<td>Primary: Quality</td>
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<td>Secondary: Responsiveness</td>
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FACTORY INFLUENCERS

Our daily work is all about the big picture of the organization – from maintaining our reputation to planning our strategy. Even when we are drawn into more day-to-day matters, the larger picture is never far from our minds.

CUSTOMER CHAMPIONS

Our relationship to manufacturing is all about the customer. We aim for happy and satisfied customers every day whether we are providing technical support, creating new markets, or designing products that customers will love.

Why This Matters

As part of the research, we looked to identify key groups of leaders and workers with similar behaviors, goals, motivators, and needs --- aka personas of potential "users" that will be critical for successful adoption of IIoT capabilities, both today and in the next 3-5 years. On the journey to the intelligent factory, these personas are the people that you should get input from, design for, do change management for, and create communications for.

Now, as you continue reading, you will notice that the “name” of the persona and a position are different --- and they both matter. As we found that the same job title may have different roles and responsibilities in different companies, referring to a persona by title might be misleading, so instead we gave each a name representing their role. Later in this document, we link the most frequent job titles back to personas.
THE PERSONA TRANSFORMATION

As the vision of the intelligent factory is realized, the personas are expected to transform with their taglines reflecting this transformation.

1 HARDCORE DOERS

Factory Supervisor
If it ain't broke don't fix it! We've got way too much to do!

Hands-on Risk Spotter
Quality matters here! Do it right even when I am not looking.

Hands-on Worker
I know my little corner of the factory really well.

Operations Coordinator
Data believer! I want data silos and dark data out of my operational area.

IT Doer
I keep all the enterprise things running!

OT Doer
I maintain a mishmash of equipment and machines to keep the factory running!

IT Doer
I keep all the enterprise things running!

Manufacturing Leader
I want data-driven insights to lead the organization!

OT Doer
I maintain a mishmash of equipment and machines to keep the factory running!

IT Doer
I keep all the enterprise things running!

2 FACTORY INFLUENCERS

Risk Exposer
Risk is bad! I'm always looking to expose it before it trips the company up.

Customer 1st Responder
I am here for the unhappy customer. Always!

Customer Chaser
I spend my days chasing the data that lets us find customer opportunities!

Customer 1st Responder
I am here for the unhappy customer. Always!

Customer Chaser
I spend my days chasing the data that lets us find customer opportunities!

Customer Anticipator
Emerging customer opportunities come to me automatically.

Product Innovator
I exploit new visibility into use and new adaptability of manufacturing to make previously impossible products possible!

3 CUSTOMER CHAMPIONS

I want data-driven insights to lead the organization!

Risk Exposer
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I exploit new visibility into use and new adaptability of manufacturing to make previously impossible products possible!

REGARDLESS OF DIGITAL INTENSITY

TODAY

INTELLIGENT FACTORY

FUTURE
THE HARDCORE DOER FAMILY TRANSFORMATION

**Factory Supervisor**
If it ain't broke don't fix it! We've got way too much to do!

**Hands-on Worker**
I know my little corner of the factory really well!

**Hands-on Risk Spotter**
Quality matters here! Do it right even when I am not looking.

**Factory Pit Boss**
Machines may dominate the factory floor, but you still need me here just in case.

**Minimally Manual Laborer**
There are still a few things that only I can do, for now at least!

**Operation Coordinator**
Data believer! I want data silos and dark data out of my operational area.

**IT Doer**
I keep all the enterprise things running!

**OT Doer**
I maintain a mishmash of equipment and machines to keep the factory running!

**Factory Optimizer**
My factory is a well-oiled machine where real-time data lets me proactively solve problems.

**DevOps Doer**
I am hands-on with tech and on the front lines of transforming how work gets done here.

REGARDLESS OF DIGITAL INTENSITY
TODAY

INTELLIGENT FACTORY
FUTURE
I supervise shifts on the production line or in shipping and receiving. I may be walking the floor or in my office scheduling, monitoring, or reporting. I look for new efficiencies that can help us meet our quotas while minimizing scrap and wasted time. I try to find enough workers for my shifts and make sure they have materials and working equipment they need. My goal is getting us working as efficiently, high quality, and safely as possible.

**TOP PAIN POINTS**

1. Not knowing if we are going to be able to meet our quotas is a constant stress
2. I struggle to schedule and plan effectively—not knowing upstream delays and too much manual tracking—so I may unknowingly plan with out-of-date or incorrect info
3. We need consistent quality and quantity, but it's hard to find workers to invest the effort—I worry about what goes on when I am not on the floor
4. Just takes one machine unexpectedly down or malfunctioning for us to miss quota

**TOP OBSTACLES TO CHANGE**

1. The lack of communication between functional groups is a real barrier to change
2. Our efforts at change fail when we don't put enough money into training our people
3. We lose out on effective change when we don't bring our operators to the table

**WHERE TO FIND ME**

- Factory Floor
- Warehouse
- Office
- Cleanroom
- Assembly

"My main focus is keeping all my people safe. I measure plenty of metrics, making sure that our people are doing the right things ergonomically, we're using the right tool, and that we're safely getting the results we want every time."

**HARDCORE DOER**

Family
I know my little corner of the factory really well!

I operate equipment, monitor machines, or assemble parts. Wearing personal protective equipment is mandatory every day because machines can be dangerous. I follow specs from a tool sheet or procedure diagram to produce products in the right way. I also inspect my work for any defects. I know how to monitor my equipment, often by sight or sound, to make sure it is working correctly. I take pride in producing quality products for our customers.

**TOP PAIN POINTS**

1. It's hard for me to do work that is both high quality and efficient
2. I waste time when management is disorganized or doesn't give me what I need
3. I use old, out of date equipment to do my job and it makes it hard to produce quality
4. I can't get the information I need to know how to do my job better and safer
5. Our equipment breaks frequently and it can be difficult to fix

**TOP OBSTACLES TO CHANGE**

1. Management keeps saying that the new equipment we need is too expensive
2. My company doesn't make sure changes actually stick and make things better
3. Our leadership always ignores operators when considering changes to the line

**WHERE TO FIND ME**

Factory Floor, Machine Shop, Cleanroom, Lab, Test Area

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“I make sure that the machine doesn't buckle and that it makes the right and correct parts to the correct length and correct size. These tasks are essential because whenever I make a single mistake, it's gonna be a huge problem. We have to satisfy our customers.”

**HARDCORE DOER**

Family

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Machines may dominate the factory floor, but you still need me here just in case.
Today, HANDS-ON RISK SPOTTER

Quality matters here!
Do it right even when I am not looking.

COMMON TITLES: Quality Assurance, QA Specialist, Quality Control Specialist, QR Technician

I make sure that the products we send out meet my company’s standards. I spend my day in the factory doing quality and compliance checks for products and processes. I jump in to help the line workers when needed. I do a lot of reporting to document the problems I find. I stress and worry about accidentally missing a problem. When new workers start, I am often responsible for training them to meet our standards of work.

TOP PAIN POINTS
1. It’s hard to find the accurate information I need about our products and standards
2. I try to catch all the problems with our products but sometimes things slip through
3. I have to pull a lot of bad product because people are not doing quality work
4. Our equipment causes us problems because it is old and out of date
5. Our equipment breaks down frequently and downtime is a productivity killer

TOP OBSTACLES TO CHANGE
1. I can see what change can help us but I’m not allowed to do anything about it
2. We don’t invest enough in training on new equipment, and that leads to quality issues in our products and processes

WHERE TO FIND ME

Machines may dominate the factory floor, but you still need me here just in case

“I think anyone can really identify something uncommon or wrong. A worker could tell easily if the machine product is not working as normal. If the worker misses any sort of technical problem then I can point out that problem as I would be inspecting the products. So, it is not usually a single person who can spot a problem.”

HARDCORE DOER
Family

Future, Floor Pit Boss
Machines may dominate the factory floor, but you still need me here just in case.

We see technology benefitting, not replacing people. Work will be more about monitoring machines than today. We’ll have more advanced, automated technologies which will lead to better security, safer working conditions, and more efficient production. Our machines will fix themselves so there will be less downtime and manual maintenance. From drones to smarter systems, tech will make our life easier. But you will still need people like us around in the factory just in case something goes wrong, although likely fewer of us.

**TOP OBSTACLES FOR IMAGINED FUTURE**

1. Leadership is too slow to make decisions. Anyway, workers here do not want to change how they do their jobs. They like the status quo.
2. The company doesn’t bring workers to the table, even though we do the actual work. We don’t understand or buy-in to the change.
3. Change efforts fail when the company doesn’t put enough money into training those of us working in the factory who have to implement the change.
4. We may be inconsistent in use of new technologies and other changes. We can fall back to old ways of doing things, and may not follow new SOPs.

**TOP ENABLERS OF IMAGINED FUTURE**

1. Changes will improve my efficiency, increase safety, and makes my life easier.
2. We have a strong focus on staying competitive, which helps.
3. We learn from our failures and try again.

“People in my position would have more time to actually do a little analysis and try and improve processes overall rather than sitting there and combining parts constantly or manually writing out sequential serial numbers and giving <papers> to associates.”

**COMMON TITLES:** Production Manager, Shift Supervisor, Team/Group, Materials Supervisor Technician, Production Associate

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**HARDCORE DOERS**

**Family**

**Today, FACTORY SUPERVISOR**

**Today, HANDS-ON WORKER**

**Today, HANDS-ON RISK SPOTTER**

**PREPARING FOR FUTURE**

1. We need to start embracing the value of tech for our company.
2. We need to build/rebuild/shore up morale in our company. By working on our morale and building engagement with our direction, we will create a foundation for change.
FUTURE, MINIMALLY MANUAL LABORER

There are still a few things that only I can do, for now at least!

Everyone here thinks this will be someone else, but we all expect there will be some manufacturing tasks that are just not worth the cost of automating or where human-made outputs be more marketable. Good news is that even if I get stuck in this role (fingers crossed that I won’t), I will have new technologies like smart wearables and augmented reality to serve up the information I need when I need it, wherever I need it, so I should be able to work more effectively. Now if I can just keep all the robots whizzing around this place from running me over....

HARDCORE DOER

Family

Today, HANDS-ON WORKER

PREPARING FOR FUTURE

My biggest fear is that I will become this person. I look to training, alternative jobs, and sometimes retirement to keep me from ending up here. I know the factory will need this person (at least for a little while), but I don’t want a dead-end job like this is sure to be.
Today, OPERATIONS COORDINATOR

I want data silos & dark data out of my operational area.

COMMON TITLES: Operations Manager, Logistics Manager, Planner, Process Engineer, Mfg. Support

I monitor operational machines and try to avoid downtime as much as possible. While preventative maintenance is ideal, I sometimes just have to help my technicians troubleshoot on the spot and physically fix equipment. When there are defects in our production, I conduct root cause analysis and work with my team to prevent its reoccurrence. My work is about continuous monitoring and improvement of our processes.

TOP PAIN POINTS
1. Difficult to find the information to determine if we are meeting our efficiency goals
2. I get inconsistent data because it is manually entered by different people
3. Implementing ways to increase efficiency is hard when labor performance is variable
4. The age of our equipment makes it difficult to introduce efficiencies
5. When procedures are not followed accurately we waste a lot of labor time.

TOP OBSTACLES TO CHANGE
1. When we are considering a change for efficiency, financial cost can be a huge barrier
2. My organization isn’t data driven and so hard to make a long-term case for change
3. We adopt new tech without any plan for getting rid of the old equipment

WHERE TO FIND ME

My factory is a well-oiled machine where real-time data lets me proactively solve problems

Future, Factory Optimizers
I see us going completely digital and automated with less human error and more efficiency. We will eliminate the human factor and instead use robotics or other automation. My day will be partly monitoring systems and partly be driving efficiency at a more strategic level. We must phase out older systems so the new tech can really take hold and bring efficiency to how we do things. This tech will also give us more visibility and remote access to our operations. I will keep evolving myself to stay valuable.

"Someone in my role would be working more with a higher skilled work force on the factory floor. New procedures and training will have to be implemented with regard to working with more automation equipment, maintenance plans, etc."

"My factory is a well-oiled machine where real-time data lets me proactively solve problems."

TOP OBSTACLES FOR IMAGINED FUTURE
1. We are inconsistent in the use of new technologies and other changes. We can fall back to old ways of doing things, and may not follow new SOPs.
2. Leadership is too slow to make decisions. Anyway, workers here do not want to change how they do their jobs. They like the status quo.
3. The technology is complex and there is the perception that it will add complexity to the work or possibly replace workers.
4. Perception that technology may negatively impact the quality of output, or at least not be as good as when humans do it.

TOP ENABLERS OF IMAGINED FUTURE
1. Changes will improve my efficiency, increase safety, and makes my life easier.
2. I have a can do attitude, the tech skills, and flexibility needed for change.
3. My company wants to be innovative in our industry. We are very open and supportive of change to stay ahead. We are focused on staying competitive.
4. We learn from our failures and try again.

COMMON TITLES: Operations Manager, Logistics Manager, Planner, Process Engineer, Mfg. Support

PREPARING FOR FUTURE
1. We need to conduct studies on current process limitations so we know what most needs optimization.
2. I need to embrace new technologies and get the skills needed to succeed in the future and help my company do same.
3. We must carefully plan implementation including rollout.
Today, OT Doer

I maintain a mishmash of equipment and machines to keep the factory running!

COMMON TITLES: Maintenance Technician, Factory Programmer, Maintenance Mechanic

I work closely with operations and am the person that gets sent out into the plant to maintain equipment, diagnose problems, and may even be responsible for changeovers. I program my company’s operational machines or even robotics, and make sure they work smoothly. I may be assigned to work with one machine that needs constant monitoring or work around the factory keeping multiple machines up and running.

TOP PAIN POINTS

1. Whenever a machine is down and I don’t know, I’m losing time. Unexpected downtimes are the worst, I have everyone screaming at me and no one seems to understand diagnosing the problem takes time
2. I can’t find the information I need to be able to better optimize a machine
3. Changeovers are a pain even if I don’t do them as I am always fixing the problems that others caused. Not everyone respects the machines when they use them

TOP OBSTACLES TO CHANGE

1. Without training, we can’t support new equipment as well as we need; it’s learn as you go
2. Management always puts off updating our equipment and they blame it on cost
3. There is a real gap between the skills we need and the new equipment coming online

WHERE TO FIND ME

MACHINE SHOP
FACTORY FLOOR
OFFICE
WAREHOUSE
TEST AREA

Future, DevOps Doer

“I am hands-on with tech and on the front lines of transforming how work gets done here.”

HARDCORE DOER

“My tasks are basically to make sure that all the machines and all the processes are OK. I usually do things like set parameters, fix damaged devices, and troubleshoot <issues>. In order to avoid loss of production, when some machine or some process have an unexpected stop, I need to find and fix the trouble as fast as I can.”

Family
Today, IT Doer

I keep all the enterprise things running for the factory!

COMMON TITLES: Manufacturing IT, Enterprise Architect, IT Specialist, IT Programmer, Software Engineer

I maintain our terminals, servers, software, and the other IT we rely on. When any of this goes down, I receive a call and will get it going again. Sometimes I have to rely on outside vendors for maintenance. I may have to maintain separate server environments or configure software specific to my company or a particular department. I try to make sure our software and architecture is current and up to date and meets the requirements for the system.

TOP PAIN POINTS

1. It takes too long for me to repair our tech, particularly when I need to rely on outside vendors for parts or assistance
2. I’m not always in the loop on new tech adoptions even though I need to support them
3. We always need more bandwidth and server capacity than we have
4. I have to provide support for older equipment that can be difficult to maintain

TOP OBSTACLES TO CHANGE

1. Leadership will often put off adopting the new tech we want because of cost
2. In IT, we are not high up enough to have a say in change decisions but we still have to support when they don’t work well and deal with the unhappy users

WHERE TO FIND ME

WAREHOUSE  OFFICE  FACTORY FLOOR  OPS CENTER  TEST AREA

Future, DevOps Doer

I am hands-on with tech and on the front lines of transforming how work gets done here

“IT work with the tool owners on their special projects. I have computer expertise and they are mostly mechanical engineering types so I help them set up their equipment on the networks and that kind of thing.”

HARDCORE DOER

Family
Our job will become more skilled and interesting. Instead of just monitoring equipment or fixing systems when they break, we will be able to solve more complex problems and explore ways to use new technologies in the factory. The line between IT and OT will blur resulting in a single organization to keep all this intelligence running. We will partner with the technologists outside the factory to see what changes really work here. Whether it’s doing custom code or repairing smart systems, we will still be the hands-on, go to tech people in the factory.

**TOP OBSTACLES FOR IMAGINED FUTURE**

1. I worry about the long-term outlook for my job. If our machines and equipment can tell us what is wrong, will being able to fix themselves be far behind?
2. We lack the skills needed for these new technologies.
3. The company doesn’t bring us to the table, even though we keep the systems running. We don’t understand or buy-in to the changes we need to implement.
4. People here are aware that change is needed, but passive about making it happen. Most people are not active change makers. Combined with insufficient investment in training workers, it’s not clear the changes will succeed.

**TOP ENABLERS OF IMAGINED FUTURE**

1. Changes will improve my efficiency, increase safety, and makes my life easier.
2. I have some tech skills to build-on, and desire to enable the right changes.
3. My company wants to be innovative in our industry. The company is supportive of change to stay ahead and reap monetary benefits. We are focused on staying competitive in our industry.

**COMMON TITLES:** DevOps Specialist, Factory Programmer, Maintenance Mechanic

“My typical day would change. Instead of just running the robot, which is what I do now for a repair job, I’d be probably developing things and trying to solve bigger problems. And with a good digital assistant or a robot with an AI, I’ll always be able to find answers to what I’m looking for.”
THE FACTORY INFLUENCER FAMILY TRANSFORMATION

Manufacturing Leader
I want data-driven insights to lead the organization!

Transformative Leader
I put data at the heart of my organization to empower my employees.

Tech Opportunist
Isn’t technology grand!!!

Next-Generation Technologist
Innovative technologies help me solve big business problems!

Risk Exposer
Risk is bad! I’m always looking to expose it before it trips the company up.

Risk Controller
Greater visibility into the factory lets me proactively assess and manage risk.

REGARDLESS OF DIGITAL INTENSITY
TODAY

INTELLIGENT FACTORY
FUTURE
Today, MANUFACTURING LEADER

“My role is that I have to be open minded, and even though I’ve got a lot of experience in industry and different types of manufacturing, I always have to be looking for that next edge and stay competitive so that I stay equal to or better than my competitors.”

FACTORY INFLUENCER

Family

I want data-driven insights to lead the organization!

COMMION TITLES: Owner, CEO, President, VP, Director, Factory Manager, General Manager

I lead my company strategically and always with attention to the bottom line. My job includes building capacity, negotiating with customers, contracting out work with other companies, deciding on capital investments, and forecasting our future. While the day-to-day is important, I try to never lose sight of the bigger picture, the macro view, the long-term goals. I want to stay competitive, and need hard numbers to commit to any change.

TOP PAIN POINTS

1. I struggle to work with those who value gut-level decisions over being data driven
2. We don’t always have the data we need to plan and operate in strategic ways
3. We need better, easily accessible information – on our customers, competitors, and the larger market
4. Stressed by the potential for things to go wrong without me knowing and potentially damage company reputation

TOP OBSTACLES TO CHANGE

1. The cost of new tech can be prohibitive
2. We are often operationally dependent on our old equipment even after new adds.
3. We are not really using data to drive the entire organization, just pieces of it

WHERE TO FIND ME

OFFICE  CUSTOMERS  FACTORY FLOOR  HOME OFFICE

Future, Transformative Leader

I put data at the heart of my organization to empower my employees
I put data at the heart of my organization to empower my employees

FUTURE, TRANSFORMATIVE LEADER

I see tech giving me more control and visibility over our facilities. I want smarter, more connected, automated, and maybe autonomous equipment so I can reduce human errors, wasted labor time, and inventory issues. It’s going to save us money and increase our efficiency at a high rate. But, I am worried about the data security risks and know that tech can only help us stay competitive if we can keep our information from getting exposed.

TOP OBSTACLES FOR IMAGINED FUTURE

1. Our culture doesn’t support change let alone transformation. Workers are happy with the status quo which is a hurdle to achieving my imagined future.
2. The cost of new tech is prohibitive, unless I know for sure the benefit is there.
3. We don’t ever really phase out our old technology, which makes our systems more fragile and makes integrating new technology harder.
4. People here distrust change, technology, and sometimes each other. Implementing programs across functional areas can be challenging.

TOP ENABLERS OF IMAGINED FUTURE

1. I am in a position to enable change and have the skills needed to be a change agent in my organization.
2. We have a strong focus on staying competitive, which helps.
3. Technology that is right for this industry and fits the environment.

FACTORY INFLUENCER

Today, MANUFACTURING LEADER

I need to learn more about the options for my company’s needs in the tech market. We want to change but we need to start diving into the options.

1. I need to help my company start embracing the value of tech for our competitive future.

Common titles: Owner, CEO, President, VP, Director, Factory Manager, General Manager

“I think manufacturing in the future is gonna get more and more robots or smart machines running machines. We’ve really got an aging workforce that we’ve got to overcome somehow, and also you get free run time and free parts when you don’t have to have labor involved.”
**Today, TECH OPPORTUNIST**

**Isn’t technology grand!!!!**

Enough said.

**COMMON TITLES: CIO, CTO, Director of Systems & Intelligence, GM IOT Analytics & Digital Enterprise**

I design new, technology strategies for manufacturing. I make sure that the right data is being collected, accessed, and analyzed so that the company can make the proper decisions. I know that there is a technological solution to every problem in contemporary manufacturing. The challenge is communicating the value of my solutions persuasively and without bogging down leaders in technical information they may not understand.

**TOP PAIN POINTS**

1. Organizations cannot keep competitive when they rely on old equipment
2. Trying to keep older tech secure takes too much time and money
3. Unreliable tech causes major bottlenecks for the organizations I consult with
4. Constantly worried about new threats when it comes to the security of data

**TOP OBSTACLES TO CHANGE**

1. Organizations will try delaying new tech adoption because of upfront cost
2. Today’s workers often do not have the skills we need for nextgen manufacturing
3. Leadership is cautious and slow with change even if they are falling behind
4. Even when we commit, execute successful POCs, and deploy a solution, my partners often jump ship at the first sign of real trouble.

**WHERE TO FIND ME**

**FACTORY INFLUENCER**

Family

“I try to get the industrial user to buy into the concept of digital not just because everyone is doing it but because it makes sense. We make sure that they understand what we are trying to address.”

**OFFICE**

**OPS CENTER**

**FACTORY FLOOR**

**HOME OFFICE**

**Future, Next Generation Technologist**

Innovative technologies help me solve big business problems!
In the future, the factory will be more automated, integrated, with a merging of technology and operations. General managers of manufacturing facilities are going to be able to look at productivity from anywhere through mobile dashboards. There will be more integration of existing systems and new tools. The challenge will be staying ahead of the curve, from IoTization and digital analytics to keeping debugging tools current. I'll be at the center of it all, and always on the lookout for the next big thing that will solve a big problem here.

**TOP OBSTACLES FOR IMAGINED FUTURE**

1. Leadership is so cautious and slow with change that we are falling behind.
2. My company isn’t really interested in industry trends and what our competitors are doing especially when it comes to technology.
3. My company tries to delay new tech adoption because of upfront cost, and is to slow on moving forward on the technologies being considered.
4. Implementation goes to fast, is not typically well thought out. My partners often jump ship at the first sign of real trouble.
5. My arguments of tech value do not always resonate with the business.

**TOP ENABLERS OF IMAGINED FUTURE**

1. I am in a position to enable change and have the skills needed to be a change agent in my organization.
2. I have a solid knowledge of what technology is on the market and understand how we might implement it here.

"Maybe in the future there’ll be a Chief Operations Technology Officer, one individual to drive both manufacturing operations and IT, merging the organizations."

**COMMON TITLES:** CIO, CTO, Director of Systems & Intelligence, GM IOT Analytics & Digital Enterprise

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**FACTORY INFLUENCER**

**Family**

**Today, TECH OPPORTUNIST**

**PREPARING FOR FUTURE**

1. I want to lead change in my organization and am focused on building awareness of the potential of new technologies here.
2. I try to make sure that we adapt the pace of change to the time it takes to make sure we have chosen the right tech and that everyone understands its value.
Today, RISK EXPOSER

Risk is bad! I’m always looking to expose it before it trips the company up.

COMMON TITLES: Compliance Officer, Financial Manager, Safety Manager, Supply Chain Manager

I am responsible for risk oversight in my company. I believe that exposing risk is ultimately all about the bottom line – if we don’t catch a problem before it becomes public, we could lose customer trust and market share. I may work across my company on improvements to enhance profitability and efficiency or I may be responsible for one category of oversight. I make sure our reputation as a company is strong, competitive, and trustworthy.

TOP PAIN POINTS
1. I have to search for information to ensure we are putting out safe, quality products
2. I worry about even one missed standard causing irreparable damage to our reputation
3. There are too many possibilities for human error in our production process
4. We can’t always plan well and this can cause quality steps to be missed
5. The information I need is not real time because I have to wait on manual entry

TOP OBSTACLES TO CHANGE
1. We know what tech we need to improve our risk profile, but the cost is a barrier
2. Some of our workers do not have the skills for the change we want
3. Leadership does not sufficiently invest in training on new equipment to avoid potentially problematic use

WHERE TO FIND ME

Greater visibility into the factory lets me proactively assess and manage risk

Future, Risk Controller

“I walk through our facilities and make sure that they’re streamlined, make sure that there’s not any environmental issues. And I also work with the people at our facilities to understand how we can recycle products more efficiently when we get them back from the consumers.”

FACTORY INFLUENCER
Family

OFFICE
FACTORY FLOOR
CUSTOMERS
Greater visibility into the factory lets me proactively assess and manage risk.

I think we will see more automating of risk control and product customization. Machines will collect, analyze and act on data without human involvement except for supervision. I will feel a lot more confident about data that I use for decision-making now that we have removed the human element! I will have visibility to be more preventative then reactive. As a company, we sell more quality and customizable products because of automation. We will need much more technology support and I worry about the cost.

"We would have a fully automated plant with fully integrated controls where all of our systems are monitored and regulated on a real-time basis. If there were any problems with the specifications being met we would have a real-time feedback loop. That would be the ideal system."

**TOP OBSTACLES FOR IMAGINED FUTURE**

1. Many of the people in our company do not have the skills for the changes we want to make in the next 3-5 years.
2. Leadership is too slow to make decisions. People here distrust change, technology, and sometimes each other which slows progress.
3. The cost of new tech is prohibitive, and we don't invest sufficiently in training workers on the changes so may not see a return on our tech investment.
4. My company isn't really interested in industry trends and what our competitors are doing especially when it comes to technology.

**TOP ENABLERS OF IMAGINED FUTURE**

1. I am in a position to enable change and have the tech skills needed to be a change agent in my organization.
2. We have a strong focus on staying competitive and reaping the monetary benefits of change, which helps.

**COMMON TITLES:** Compliance Officer, Financial Manager, Safety Manager, Supply Chain Manager

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**FACTORY INFLUENCER**

**Today, RISK EXPOSER**

**PREPARING FOR FUTURE**

1. I try to get my company to start embracing the value of tech for our competitive future.
2. I am trying to seed data-driven change here and am trying to get my company to conduct studies into the limitations in its current processes.
THE CUSTOMER CHAMPIONS FAMILY TRANSFORMATION

**Customer 1st Responder**
I am here for the unhappy customer. Always!

**Customer Chaser**
I spend my days chasing the data that lets us find customer opportunities!

**Product Designer**
I design for producibility often at the cost of creativity.

**Customer Proactive Problem Solver**
I solve problems before customers encounter them!

**Customer Anticipator**
Emerging customer opportunities come to me automatically.

**Customer Chaser**
I exploit new visibility into use and new adaptability of manufacturing to make previously impossible products possible!

**Product Innovator**
I exploit new visibility into use and new adaptability of manufacturing to make previously impossible products possible!
Today, CUSTOMER 1st RESPONDER

"Sometimes our customers aren’t forthcoming with information because they just don’t realize how significant it might be. We are good at asking the right questions with limited information to make quick assessments based on experience."

CUSTOMER CHAMPION
Family

I am here for the unhappy customer. Always!

COMMON TITLES: Customer Support, Field Operations Support, Regional Technical Specialist

I provide direct support to our customers to make sure that they get the products they need and that everything functions the way it was meant to. I spend my day answering calls and emails, and making sure our service technicians are installing the equipment properly. I may visit our customers and test and optimize their equipment. I keep an eye out for customer requests that have fallen through the cracks and dive in to address them.

TOP PAIN POINTS

1. We can’t get back to customers as fast as they need us to
2. I worry about losing customers to the competition
3. Customers want information quickly but it can be hard for me to find
4. We struggle to get a real time look on what is going on with a customer’s equipment
5. We can’t change our work practices even if they are bad for customers

TOP OBSTACLES TO CHANGE

1. Management thinks new tech is too costly even if it is better for our customers
2. We are too slow when it comes to making changes our customers need
3. People in my organization don’t want change even if it will be an improvement

WHERE TO FIND ME

CUSTOMER, CALL CENTER, SERVICE VEHICLE, OFFICE, MACHINE SHOP

I solve problems before customers encounter them.
We will have more automation and better traceability. I’ll be able to be more proactive and reduce the amount of human error, because customer orders and requests will be seamlessly connected to our systems. AI may assist me in offering certain forms of support, while IOT will let me see how our products are actually used. I just don’t want to completely lose direct, human connection to our customers so that we can still keep those relationships strong.

"I think the way of the future is the connectivity, the internet of things. My industry is industrial heating, ventilation, and air conditioning. Having buildings and equipment connected, it allows real-time monitoring, real-time data, to allow buildings to be monitored and to be the best building it can be."

**TOP OBSTACLES FOR IMAGINED FUTURE**

1. We are too slow when it comes to making changes our customers need. Some don’t want change even if it is an improvement.
2. The company doesn’t bring us (and workers in general) to the table, even though we are the people dealing with customers and know what is needed.
3. We lack the skills needed for these new technologies and our company doesn’t invest enough in training us on any new technologies.
4. Many people here are aware that change is needed, but passive about making it happen. Most people are not active change makers.

**TOP ENABLERS OF IMAGINED FUTURE**

1. My company leadership wants to be innovative in our industry. They are supportive of change to stay ahead and reap monetary benefits.
2. I have the right attitude when it comes to change, tech skills to build-on, and desire to make things better for my customer.
3. We learn from our failures with technology.

**PREPARING FOR FUTURE**

1. I need to help our company start embracing the value of tech for our competitive future and grow an internal culture of change.
2. I need to embrace the new technologies and get the hands-on skills needed to succeed in my envisioned future.
Today, CUSTOMER CHASER

I spend my days chasing the data that lets us find customer opportunities!

COMMON TITLES: Sales Leader, Marketing Manager, Event Coordinator, Marketing Strategist

I connect current and potential customers to our products. I spend a lot of time on the phone or email with customers or sales people in the field. I help communicate information about our products to help make sales. I may have to change my language to explain complicated processes and products to different people. I may work in close proximity to the factory, which helps with communication but is not always the most comfortable work environment.

TOP PAIN POINTS
1. I can't get the information I need on sales or inventory
2. It can be very hot where I work, especially in summer
3. Our products take too long to get to market because our production is too slow
4. Too much information is manually entered and people forget or make mistakes
5. When we are not on the same page with manufacturing our customers are confused

TOP OBSTACLES TO CHANGE
1. We don't communicate well across teams and departments
2. The cost of the tech we need most is too expensive for our organization
3. Our organization doesn't keep making improvements to help us attract customers

WHERE TO FIND ME

Emerging customer opportunities come to me automatically

Future, Customer Anticipators

“Our salesmen go out to different customers, all day long, every day. It is important to help them perform better by seeing missed opportunities and teaching those sales people how to better close deals and help the customers.”

CUSTOMER CHAMPION
Family
In the future, I expect to have technology that will help me communicate better – with customers, departments, sites, salesmen in the field. We'll use more video which will help us avoid the communication problems with email and other text forms. I also think technology will help us get the information we need for reaching out to customers, from inventory to measurements, without having to spend time searching. AI and other technologies will proactively combine data and generate insights that take me forever to discover today.

**Emerging customer opportunities come to me automatically**

**Future, CUSTOMER ANTICIPATOR**

“Everything’s gonna be automated, work through the computer, it’s going to be amazing. No more manual having to go through and checking or converting the footages. Humans will be double checking just to ensure that the computer is doing what it’s supposed to do and counting correctly.”

**TOP OBSTACLES FOR IMAGINED FUTURE**

1. The people here are resistant to change due to the potential of these technologies eliminating jobs and the complexity that they bring to the environment.
2. Our communication is very functionally and geographically siloed which will be a significant obstacle to transformative changes like I envision.
3. The cost of the technology is prohibitive for our organization. I worry if the company doesn’t keep making improvements we will lose customers.

**TOP ENABLERS OF IMAGINED FUTURE**

1. I have the right attitude when it comes to change, persuasive influence skills, and desire to make things better for my customer.
2. Changes will improve my efficiency, make my life easier, and let me spend the valuable time I waste chasing information today doing more strategic and useful activities.

**CUSTOMER CHAMPION**

**Family**

**Today, CUSTOMER CHASER**

**PREPARING FOR FUTURE**

1. I need to help our company start embracing the value of tech for our competitive future and grow an internal culture of change.
2. I need to ensure the human is part of the process, whether encouraging inclusion of those closest to the work or ensuring the human is considered during implementation.

COMMON TITLES: Sales Leader, Marketing Manager, Event Coordinator, Marketing Strategist
**TOP PAIN POINTS**

1. It’s hard to get the information I need to make innovative and feasible designs
2. It can be hard to get my vision for the customer into the final design
3. I can waste a lot of time working on a design that can’t even work
4. There are challenges with our overseas factories translating designs into products
5. It takes too long for factories to run my initial designs and send the samples back

**TOP OBSTACLES TO CHANGE**

1. There is great, new tech for design but my company is put off by the cost
2. Sometimes we try to go too fast with change and don’t manage the process
3. I’m nervous about any change that could slow down the design process

**WHERE TO FIND ME**

- Office
- Factory Floor
- Lab
- Home Office
- Test Area

**CUSTOMER CHAMPION**

“My dilemma is, as a designer, to constantly have to pick or choose: Design something that people will love, that’s good quality, or make it at cost so the company can make the margins it needs.”

**I exploit new visibility into use and new adaptability of manufacturing to make previously impossible products possible!”**

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**WHERE TO FIND ME**

- Office
- Factory Floor
- Lab
- Home Office
- Test Area
I want tech to make my work easier, more efficient, and innovative without reducing my ability to be creative. We will have better, more efficient ways of communicating with our factories across multiple languages and time zones. We'll eliminate inefficiencies and reduce cost through automation in our factories and spend that money on better designs and materials for our customers. More and more 3D tech will help us save time modifying physical prototypes.

**TOP OBSTACLES FOR IMAGINED FUTURE**

1. We are too slow when it comes to making changes our customers need. Some don't want change even if it is an improvement.
2. My company overvalues technology and neglects the importance of the human element needed to guide it. I worry about overly relying on tech as it may cause people to forget their knowledge of products and processes and potentially lose a place in the production process.
3. I worry that all the envisioned technology will add complexity to the work and slow down the design process.

**TOP ENABLERS OF IMAGINED FUTURE**

1. I have the right attitude when it comes to change, tech skills to build-on, and desire to create great things for our customers.
2. My company leadership wants to be innovative in our industry. They are supportive of change to stay ahead and reap monetary benefits.
3. We introduce technology that fits the way I work and is easy to use.

“*If machines or automation or 3D continues to grow then the hours and hours of conversations we have about cost and efficiently will basically cease to exist and free up so much more time for innovation or creativity.*"
TAKING YOUR NEXT STEPS
YOUR JOURNEY TO THE INTELLIGENT FACTORY

Your journey to the intelligent factory begins with a vision – one that you can incrementally implement over time. As you learn more along the way, the vision matures. Our work here suggests that this vision should consider the co-evolution of manufacturing environments and the people that work within them.

Current manufacturing workers at all levels have expressed a hunger for change and believe that they can and should play an important role in that change. Harnessing this enthusiasm, coupled with their deep hands-on manufacturing expertise, will lead to solutions that are powerful, that have buy-in, and that can be communicated in a way which presents the changes as solutions to the problems workers care about today.

Our study respondents believe that change is necessary to stay competitive, both for themselves and for their companies. The personas shared here will help you better understand your workforce, consider how your workforce may experience the transition, and craft communication that explains the value of operational transparency.

No single company makes this journey alone. Intel seeks to be an advisor, solution provider, and co-traveler on this journey.

PARTNERING WITH INTEL

In sharing these research findings with the broader industrial community, Intel hopes to help refine the dialog about what it means to operate in an Industry 4.0-like environment. We wanted to focus a spotlight onto the organizational and worker concerns that often are overlooked (or underplayed) in wide-sweeping technology changes.

We intend that this work should be ongoing and look to grow our understanding of this transformation by actively partnering with those engaged in the journey. We envision active partnerships taking many forms including workshops, management roundtables, individual company engagements, and sharing learnings thru industry forums. You can contact us directly as follows:

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