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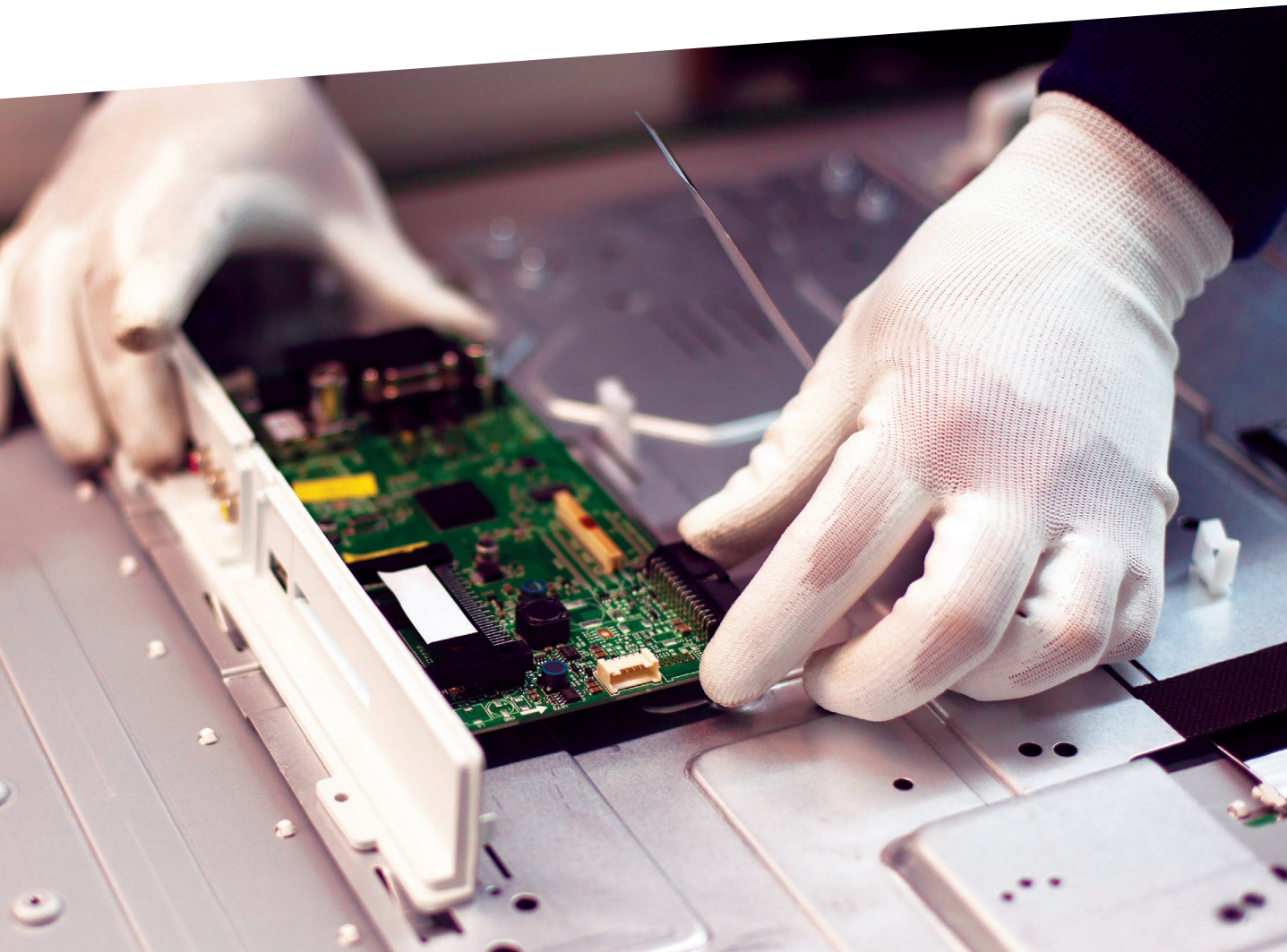
The State of Human Factory Analytics

While Industry 4.0 is firmly focused on machines, humans still perform nearly three in four tasks on the factory floor—while remaining almost invisible to factory analytics. How would your digital transformation strategy change if you could generate as much data from your people as you do from your machines?



Introduction

Automation is sexy. Robots are cool. Cobots are cooler. Companies such as Tesla, which have relied almost completely on automation to assemble their vehicles, dominate the conversation about the future of manufacturing.

What's missing from the conversation—though not from the factory floor—is humans.

Goldman Sachs says there are 345 million workers in factories around the world; the International Federation of Robotics estimates there are 1.7 million robots working alongside them. But while the popular press has been wringing its hands over job-stealing robots, simple math tells a different story: the robot population is still decades away from displacing the human workforce. And that's assuming that, unlike today, robots will be able to actually do what humans do.

Meanwhile, humans on the factory floor continue to contribute the majority of the value in manufacturing operations. And while Industry 4.0 has ushered in an explosion of tools to create data from machines, the tools used to measure human activity have remained effectively unchanged since 1908.

A.T. Kearney and Drishti partnered to hear from approximately 100 manufacturing leaders about their efforts to measure tasks performed by humans, and the challenges they face in collecting reliable metrics. We also sought to quantify the amount of time and effort they spend on trying to gather this data, as well as how they use it to guide strategic operational decisions—even when they know the data is not completely accurate.

Our research was conducted in September and October 2018 and combined quantitative (survey) and qualitative (one-on-one interviews, individual commentary) methodologies. We uncovered illuminating statistics about the state of human analytics in manufacturing today and have condensed those findings into this report.

Executive Summary

Despite the hype around factory automation, humans still dominate the manufacturing labor force. More than 72 percent of factory tasks are performed by humans, and humans create an almost equal proportion of value: 71 percent.

But there's no easy or accurate way to capture data that represents these actions (see sidebar: 110 Years of Stopwatches in Your Factory on page 4). Therefore, analytics and resulting insights on human tasks are scarce. And without sufficient analytics on tasks performed by humans, it's exponentially harder to mitigate variability and trace defects to the source.

In fact, with no effective methodology for gathering data derived from tasks performed by humans, manufacturers rely on outdated and inexact measurement techniques. For example, 71 percent of survey respondents identified time and motion studies as very or fairly important data sources—despite their obvious limitations. The data from these techniques is flawed, but it's the best most factories have got, and is thus used to drive strategic decisions anyway.

Better data can be used to drive direct labor improvements. But it's important to note that the benefits of having this data extend deep into the ecosystem around the operators. According to the survey respondents, engineers spend 37 percent of their time conducting and analyzing time and motion studies. Imagine if more than a third of your engineers' time was suddenly freed up for more strategic purposes because the data they needed was already available to them: your indirect labor force grows by a third, making more time for improving efficiencies, optimizing operations, and protecting your often razor-thin margins.

Luckily, new technology is driving better human factory analytics, with the potential to improve manufacturing metrics across the board.

Part I

The Human Touch: Still Crucial in Manufacturing

72 percent

of tasks in the factory are performed by humans.

Humans Provide Your Competitive Advantage

The contribution of humans in manufacturing is indisputable. According to survey respondents, 72 percent of the tasks in a factory are performed by humans, and 71 percent of the value created by the operation comes from human actions. Given what we know about both humans and machines—and the cognition, adaptability, and dexterity that humans bring to the factory—that figure isn't surprising.

"Machines don't innovate anything," said Doug Neely, director of advanced *monozukuri* research at Yazaki North America. "Our people are the source of all of our competitiveness. There isn't a machine out there that we could buy that would make us more competitive."

Humans are and will remain integral to the manufacturing process. Not just because robots require significant capital, skilled resources, long installation periods, and attendant programmers and engineers, but because of the fundamental qualities that make us human. We can logically reason. We can adapt. We are dexterous beyond anything robots are capable of today. And as manufacturers increasingly strive for lot sizes of one to satisfy customer demands for personalization and customization, these qualities are more valued than ever before.

According to Anik Bose, general partner at Benhamou Global Ventures, "Whether you're a contract manufacturer or a captive manufacturer, differentiation is no longer about cost and capacity—it's about time-to-market and productivity." In this environment, your human workforce can become your biggest differentiator.

68 percent

of defects are caused by humans.

Human Imperfection and the Assembly Line

Despite their clear value, humans have one significant disadvantage when compared to robots: they introduce variability, and a lot of it. A robot's attention doesn't wander. Robots don't take bathroom breaks or sick days. A robot never stays out late the night before work. But our survey respondents have felt the pain of inconsistency caused by human workers: they told us that 73 percent of the variability on the factory floor comes from human workers, not machines.

Variability opens the door to another issue: defects. Survey respondents noted that 68 percent of defects are caused by humans. Unfortunately, without having data to indicate anomalies, tracing defects to their source is a largely manual and time-consuming process that can be impossible to execute with certainty.

110 Years of Stopwatches in Your Factory

In 1908, Henry Ford's mass production line rolled out its first Model T. That same year, Frederick Taylor, along with Lillian and Frank Gilbreth, showcased the science of time and motion studies. This methodology, which they'd been developing for several decades, enabled factories to standardize the data they collected on activity by human workers; effectively, the trio laid the groundwork for mass production to succeed.

Armed with nothing more than stopwatches, legions of engineers transformed craft manufacturing into mass production, one task at a time.

Thanks to Toyota, lean production replaced mass production, but time and motion studies remained a constant. Fast forward to the 1980s: at General Motors' Hamtramck plant, among others, robots began their ascent into the factory, and the narrative about machines taking over the factory floor started to take hold. Predictions about fully automated factories ran wild. Expectations for lights-out factories ebbed and flowed (in the 1990s, manufacturers started talking in earnest about human performance enhancement and man–machine interactions). Maybe they peaked in 2012 when, as "Industry 4.0" became the go-to phrase to define the next phase in manufacturing, Foxconn declared that 1 million robots would replace its 1.3 million human workers by 2014.

In 2016, Foxconn reported that only 40,000 robots had been deployed—just 4 percent of its 2012 target. But the manufacturing community remains unperturbed, and the Industry 4.0 buzz is still firmly centered around automation, robotics, and IoT—that is, the machine workforce—with expectations of machine learning powered by cage robots rising ever faster.

As for the human workforce, well, there are two things that haven't changed since 1908. First, they remain the primary contributor of value in the factory. And second, the manual time and motion study remains as the primary source of data about humans.

And that's where those time and motion studies fall short. This 110-year-old methodology is incomplete and inaccurate. Incomplete, because it requires manual labor to perform, and thus cannot be deployed at scale; and inaccurate, because it's subject to both the observer's biases and the fact that the act of observation invariably disturbs the person being observed.

Time and motion studies provide mere samples of what's happening across multiple moments in time, moments that might hint at a trend … but also might not. Time and motion studies offer some data, but require a lot of investment from skilled personnel to harvest and assess that data.

But beyond time and motion studies, what choice is there? For the most part, manufacturers we talked to are making do without being able to clearly and definitively measure activities performed by humans. Whenever we discuss Industry 4.0 with manufacturing leaders, they cite the massive architectures they have in place to extract data from machines in the factory, but very little by way of capturing data on tasks the human workforce completes.

The vast majority of Industry 4.0 initiatives focus on measuring tasks done by machines—leaving manufacturers facing a blind spot in the shape of a human.

Think back to the flammable Samsung Galaxy Note 7 incidents in 2016. On top of its own internal investigation, the company hired three independent consulting agencies, tested 200,000 devices and 30,000 batteries, and had 700 of its own engineers dedicated to root source investigations—and it still took four months from the initial recall for Samsung to announce what caused the phones to catch fire.

Recalls are used to mitigate the extreme consequences of defects, including injuries or deaths. Recalls cost the manufacturing industry billions of dollars each year. In 2016, the automotive sector alone was hit with $22.1 billion in recall costs. The Samsung Galaxy Note 7 recall mentioned above cost the company $5.3 billion (not to mention the collateral damage to the brand).

"Think about the last time you got a recall notice for your car," said Bose. "The automaker is recalling thousands or millions of cars for what's likely a narrow problem. But since they have no way of tracing it back to particular factories, stations, particular shifts, particular VINs, they have to cast a wide net—and the costs are astronomical."

What this all means is that the human workforce presents both opportunities and challenges to manufacturers. On the one hand, humans create more value than machines, but on the other, they create more variability.

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This is where data comes in. Improving visibility into tasks performed by humans empowers manufacturers to find opportunities to improve productivity; to lift the ceiling on the perceived limits of human quality standards; to measure the magnitude of the variability of human labor; to identify and measure defects; and to prevent isolated failures from snowballing into recalls.

In other words, the key to maximizing the potential of the human workforce is not tools or training, it's data. In greater quantities, with higher accuracy. Taylor and the Gilbreths had it right the first time. More than a century later, it's time to update the collection techniques.

Part II

Data (or Lack Thereof) Drives Manufacturing Operations

Manufacturers must constantly make decisions to drive their organizational strategies forward. Lacking holistic and reliable data, they instead rely on a multitude of data sources overlaid on top of each other, each one telling an incomplete (and sometimes conflicting) story, with many holes left at the end (see sidebar: Human Data Resources: How Reliable Are They?).

We wanted to get a sense of the tactics manufacturers are using today in an attempt to complete the picture. And what we learned tells us just how much manufacturers depend on imperfect patchworks of data and insights.

Human Data Sources: How Reliable Are They?

"When a manufacturer wants to resolve a production issue, they gather the workers and the managers to brainstorm ideas," said Bose. "If they want to improve asset utilization, they bring in lean experts for time and motion studies or rely on twice yearly visits by engineers in their headquarters. For new product introductions, they shut down the line to run experiments. It's all manual and ad hoc, because they have no alternative—they have no real-time data that enables any other type of approach."

Manual time and motion studies	More than a century old, the mechanics of these studies have evolved very little over time. They're still driven by stopwatches and humans observing other humans, which limits the amount of data available while introducing observation bias.
***Poka yoke* systems** (for example, light curtains, touch globes)	*Poka yoke* systems such as touch globes or light curtains are meant to guide human behaviors and reduce errors. These systems can be repurposed for data collection—for example, capturing information when a light curtain is triggered—but that's not their primary purpose.
Manual processes (for example, scanning)	Barcode scanning can be a quick and easy way to digitize certain manufacturing operations, and the practice can help companies effectively track and capture data about products on the line. However, every scan adds time to the cycle. In fact, anecdotal plant floor data from Drishti shows that as much as 14 percent of cycle time is spent scanning labels.
Automatic means (for example, RFID, computer vision)	Technologies such as RFID tags and computer vision are nonintrusive, and therefore don't hinder activity on the line. But the data they capture is passive: you may know where the unit was, but you won't know what happened to it while it was there.
HR methods (for example, clock-in/ clock-out data)	Human resources data, such as clock-in, clock-out time, provides a high-level understanding of who was where and at what time, but little else in terms of task data and insights.

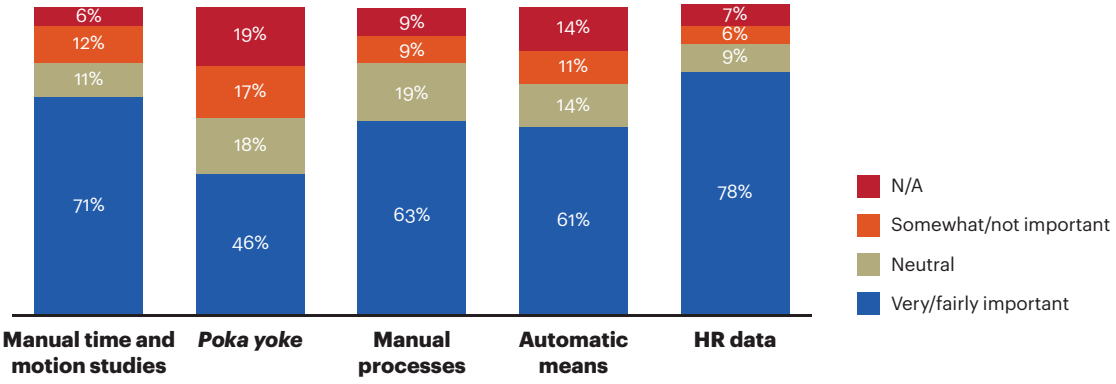
Time and motion studies:

71 percent say they're important; **43 percent** aren't confident in the data they yield.

When Inexact Data Drives Operations

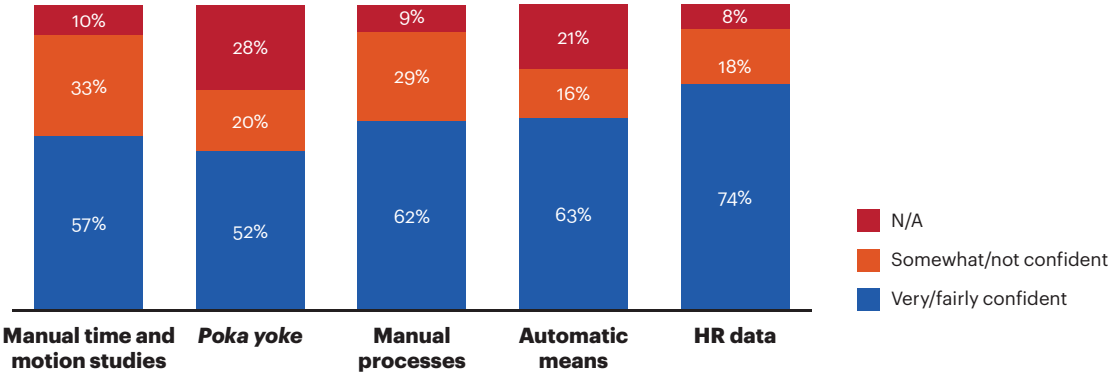
Despite the lack of clarity around tasks performed by humans, manufacturers still rely heavily on the data these methods provide to drive business decisions. More than 71 percent of survey respondents said manual time and motion studies were either very or fairly important sources of information about human labor; 78 percent said the same for data derived from HR methods—as inexact as that data is. HR methods may provide the least actionable data of all the methods mentioned in the survey; despite that, respondents had more confidence in them (74 percent) than they had in time studies (57 percent), a far more relevant source of data on tasks performed by humans (see figures 1 and 2).

Figure 1
Importance of data sources



Sources: Drishti; A.T. Kearney analysis

Figure 2
Confidence in data source accuracy



Sources: Drishti; A.T. Kearney analysis

Historically, manufacturers haven't had much more data to work with than what's here, which means this data has influenced nearly every aspect of the organization: staffing plans, production scheduling, the cost of heating and cooling, planning for the future, and more.

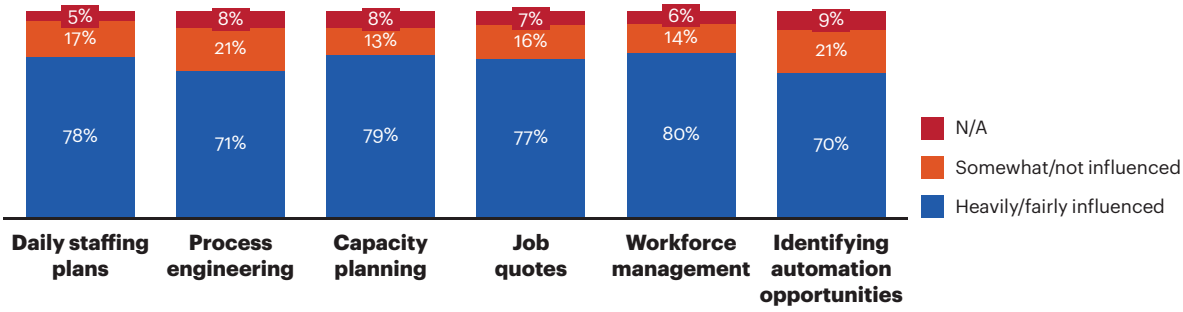
Survey respondents said that data on human tasks harvested through these methods heavily or fairly influenced initiatives such as daily staffing (78 percent); workforce management tasks such as hiring and training (80 percent); capacity planning (79 percent); job quotes (77 percent); process engineering (71 percent); and identifying automation opportunities (70 percent) (see figure 3).

"Human factory analytics is a topic that has been challenging to deal with since it depends on human observations and requires a lot of effort to maintain," said Hector Larrion, lean manufacturing director at Sanmina. "It will require significant technological and cost evolution to reach the point where AI and manufacturing automation can fully replace manual labor. So human-related labor data analytics tools are required to expedite continuous improvement in a 4.0 era where human and automated labor will co-exist and are sometimes in dispute."

But what happens when this data isn't accurate, or simply doesn't exist (see sidebar: Accurate Data Drives Better Decisions)?

Figure 3

Operations decisions that are influenced by human factory analytics



Sources: Drishti; A.T. Kearney analysis

Accurate Data Drives Better Decisions

Leslie is trying to maximize the efficiency on a line, and through the use of time and motion studies, Leslie determines that the cycle time is 360 seconds. The industry benchmark for efficiency is 90 percent, so that's the number Leslie uses to determine that the line should produce nine units per hour.

Unfortunately, Leslie has a lot of lines to monitor, and the time and motion studies on this line only lasted 45 minutes every day for a week. Because of their limited scope, those studies didn't capture that, for every 20 units, the operator has to walk across the floor to source more parts—which takes about four minutes. Realistically, due to this requirement, the efficiency level is closer to 83 percent, which means the line is only producing eight units per hour.

With a system for harvesting continuous data on tasks performed by humans, Leslie would have eliminated those blind spots and could have seen that adjustments needed to be made to reach the targeted productivity rate. Leslie can justify moving the part source area closer to the line or consider adding an automated step that moves the parts to the humans without requiring periodic four-minute breaks.

Part III

Digitizing the Indirect Human Element

More than 1/3

of an engineer's time is spent on time and motion studies.

What's the Best Use of Your Engineering Staff's Time?

Survey respondents noted that, on average, their engineers spent 37 percent of their time conducting manual time and motion studies. Over the course of a month, this translates to more than 59 hours, or nearly a full work week and a half, all devoted to time and motion studies that tend to yield inaccurate data anyway.

"A significant portion of our industrial engineers' time is spent on non-value-added work—specifically, gathering and analyzing data through manual means. This is overhead, and it does not add value," said Raja Shembekar, director of process and research development at Denso.

What could your engineers do if they recovered 37 percent of time that's currently being spent on manual data collection and entry into Excel? Not only could he or she conduct additional plan-do-check-act (PDCA) cycles, but each cycle would be shorter, because the engineer wouldn't have to put one PDCA cycle on hold to gather data for another. Quicker PDCAs lead to faster innovation, quicker results, and more attention available to give to the next problem, creating an accelerating spiral of optimization.

39 percent

of an engineer's time is spent on root cause analysis.

Data Equips Direct Labor to Manage Defects

Assembly issues that result in defects have to be recognized and addressed quickly to minimize subsequent cost and reputation damage. According to our survey respondents, root cause investigations take 39 percent of staff time—more than 62 hours a month. That's time that is currently spent observing the line, hoping that the problem being hunted recurs while the line is being watched, with the engineer contributing no value, generating no revenue.

"From my conversations with manufacturers, it's evident that a large percentage of factory tasks are still performed manually, and there's clear opportunity for optimization," said Peter Marcotullio, SRI International's vice president of commercial R&D. "What's less evident—but perhaps more significant—are the manual, repetitive tasks being performed by indirect labor that add no value: supervisors trying to find areas of improvement, engineers performing root cause analysis, even plant managers on their walks of the factory floor. This area has been nearly impossible to address in the past, but presents a great opportunity for the next generation of factory technology."

More importantly, lack of visibility into the "bill of process" negatively impacts the OEM–supplier relationship. While you're conducting your root cause analysis, your customer is waiting impatiently, wondering why your operation is so far out of your control.

Human Factory Analytics for the Digital Era

We've arrived in the Industry 4.0 era, but we're still relying on a methodology to measure and analyze tasks performed by humans that was state-of-the-art in 1908.

It's time for new technologies to improve the way we gather human analytics. We need better data to make informed operational decisions.

"Human factory analytics are still in their infancy, primarily deriving from time studies performed manually, for example, observation on the shop floor and construction of work cycle diagrams," said Eric Tordjeman, senior vice president of manufacturing, Faurecia. "The most valuable advantage I would expect from an AI solution would be the analysis of variability of human tasks, to highlight issues to be addressed."

A.T. Kearney believes that digital transformation strategies must extend to the last analog frontier: humans. Drishti makes this possible using a combination of artificial intelligence, machine learning, and computer vision to create massive datasets on tasks performed by humans. Together, A.T. Kearney and Drishti are creating and realizing ambitious digital transformation strategies that arm manufacturers with more insights on their human labor force than has ever before been possible.

"If you're not accurately measuring human tasks, you're at risk, but the advent of new methods presents manufacturers with great opportunity," said Sean Monahan, chief operating officer at Stone Brewing. "We don't yet know what's possible. We may be putting more labor on a task than is truly necessary. With that data, we would be able to standardize activities, push for better performance, improve quality. The risk is that you don't address it, and therefore miss out on the opportunities."

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About A.T. Kearney

A.T. Kearney is a leading global management consulting firm with offices in more than 40 countries. Since 1926, we have been trusted advisors to the world's foremost organizations. A.T. Kearney is a partner-owned firm, committed to helping clients achieve immediate impact and growing advantage on their most mission-critical issues. For more information, visit www.atkearney.com.

About Drishti

Drishti's mission is to extend human capabilities in an increasingly automated world. Its action recognition and AI innovations automatically digitize tasks performed by humans inside the factory to create a massive new dataset. Manufacturers use Drishti to drive true digital transformation, advancing sweeping improvements in productivity, quality, and traceability. And operators rely on Drishti to be more consistent and efficient, becoming even more valuable on the factory floor. For more on Drishti, visit www.drishti.com.