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The Connected Machine Shop: Steps to Successful Digitalization

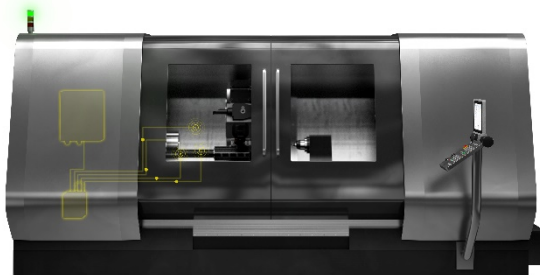
A look into the importance of Industry 4.0, breaking past the barriers of digitalization, and developing a culture of change

What if someone told you that your manufacturing company would be out of business within five years if you neglected to invest in a certain machine tool, a newfangled cutter, or the latest and greatest software package? Skeptical or not, you'd listen, and then make the best decision based on the available data.

What if the risk to your company wasn't the failure to adopt one of these new manufacturing technologies, but rather the failure to embrace that which you just based your decision on, the data itself? It may seem farfetched, but a number of industry leaders are predicting that machine shops and manufacturing companies that ignore the writing on the Industry 4.0 wall might be scratching their collective heads in a few years, wondering what hit them.

Step One: Think Big

"Whether your business is small or large, you should know that digital manufacturing is coming, and it's coming really quickly," says Sean Holt, president of Sandvik Coromant for the Americas. "You have to assess how it's going to affect the sustainability of your business, what are its risks, its benefits, and most importantly, how to take the first steps towards digitalization."



Holt is just one of many industry experts who agree that there's plenty of talk nowadays about the Industrial Internet of Things (IIoT), Industry 4.0, and smart manufacturing, and he admits it can be a confusing topic. That doesn't mean, however, that shops should avoid it. "The scope is admittedly quite large when we talk about digital manufacturing, with

many aspects to consider, but I think the early adopters of this technology are the ones who will win the race," he says.

I'd rather be machining

"Who cares?" you might be thinking. "I just want to make good parts, on-time, and for a fair price. That's what's most important to me."

You're not alone. Every shop aims to achieve the most cost-effective way to manufacture their products, and for most this means focusing on removing as much metal as they can in as short a time as possible. But before you turn around and head back to the production

floor, let's at least discuss what digitalization is, and what it might mean to you and your manufacturing processes.

Consider this: any seasoned machinist or programmer can walk up to a machine and know instantly if something is awry. It might be the sound of the cutting tool as it plows through a chunk of steel or the vibration coming through the floor that tells her the chip load per tooth is too low, the spindle speed too high, or that she'd better hit the emergency stop, right now.

These and many other machining conditions are readily picked up by our human senses, and when coupled with a few years of experience, are often what make the difference between a shop's success or failure. There's just one problem: finding those qualified people is increasingly arduous, never mind finding ones that like working nights—most humans would rather stay home and watch Judge Judy reruns or go to their kid's ballgame than take the vampire shift. Who's going to be there at 2:00 AM to listen?



Worse, most shops need their operators to manage multiple machines, making the telltale signs of tool wear or imminent tool breakage more challenging to hear and feel. Even when things are rolling along like the proverbial well-oiled machine, the processes predictable, the parts seemingly making themselves, it would be a huge advantage to know that the spindle bearings on VMC #2 will fail in three days, or that the parts being made on Machine 5 right now are about to go out of tolerance.

Capturing tribal knowledge, digitally

Wouldn't it be great if manufacturers had a way to replicate or at least augment a machinist's senses with a set of digital eyes, ears, and steel-toed boots? If a computer could watch and listen to manufacturing processes and machine tool health, then report back the findings to its human masters?

The path to those capabilities is data. Cutting tool data, machine data, quality data, operator productivity data. It may sound simplistic, but that's the essence of Industry 4.0 and the Internet of Things—the collection and analysis of data, followed by better decision-making as a result of these data-related efforts. To the shop of the future, data will be everything.

That's why many equipment builders and now tooling suppliers are making their products "smart," giving manufacturers the ability to not only listen to what the shop floor is telling them but present the huge piles of data thus collected in a way that even the non-analytical among us easy to understand.

"Our machines have over 9,000 data points that you can extract information from right out of the box," says Wade Anderson, manager of product specialists and technical centers at Okuma America Corporation. "Beyond that, there's a host of peripheral devices you can use to gather additional information."

Are you connected?

As Anderson explains, leveraging this requires little more than a free download of MTConnect or a comparable communications protocol, some network cable or a wireless connection, and a computer. Hooking it all up for the first time might mean spending a few hours at the shop on a Saturday afternoon, after which you'll have more data than you know what to do with.

So why aren't more people doing it? Excellent question. "A very small percentage of shops are connected, never mind those that actually collect and analyze the data," says Anderson. "If I had to guess, I'd say it's just a few percent, maybe less."

Part of the problem is the perceived cost. With all due respect to Okuma and other tech-savvy machine builders, not everyone can afford a top-notch machining center or lathe. Even those who can might be asking themselves, "What the heck am I going to do with 9,000 data points. Multiply that by five or fifty machine tools and I'll have to hire a crew of people just to understand it all."

And what about the large percentage of manufacturers chugging along just fine on decades-old equipment, or those that must fight for every nickel and have no room to spare for all this techno mumbo jumbo—are these companies really going to be out of business in five years, just because they're not interested in going digital?

Keeping the doors open

Maybe not, but the fact remains that the shops that embrace digitalization will have much better information with which to operate their businesses:

- Because their machines and cutting tools will be able to identify chatter (even when it can't be heard), part quality and tool life will be better.
- Understanding what's going on inside spindle bearings, axis motors, and other machine components will prevent unexpected equipment failures.
- Knowing exactly how hard to push cutting tools will increase production levels.
- The ability to more easily spot trends in part quality and tool wear will help machinists and engineers develop better processes.

Simply put, the manufacturing leaders who want to elevate their game, who want to make their companies the very best that they can be will be the ones that thrive. Everyone else? They'll eventually be like those who still lament the loss of paper tape and high-speed steel tool bits, wondering how the shop down the street can possibly make parts at such ridiculously low prices.

Next, we'll look at what it takes to get started with Industry 4.0 and the IIoT. As you'll see, it's easier than you might think, and won't cost an arm and a leg besides.

Step Two: Start Small



you do business.

Now you know what a "smart" production floor and why it's important. Assuming your curiosity was at least piqued by that discussion, it might be time to dip your toes into the Industry 4.0 waters. Don't worry, though—you won't need a big budget (\$1000 or so should do), or the technical skills of a computer scientist (any teenager can probably figure it out). A little patience, a network connection to your machine tool, and an open mind is all it takes to begin harvesting the data that may just change the way

“I tell people to start small,” says Andy Henderson, vice-president of engineering at industrial technology firm company Praemo. “Hook up one machine, start collecting some data, and then let the value you’re receiving from that effort pay for the next one, and the next, scaling upwards as you go.”

Where to begin?

Anyone who’s developed a value stream map to identify a production floor constraint will have no problem telling you which machine or cell to begin with: it’s the one that causes you the most grief. If said machine has an Ethernet connection (most newer ones do) and is connected to the corporate network, gathering basic data should be no more difficult than programming the remote control for your TV. And for those with older, less garrulous machine tools, adapters are available to make even the most reticent CNC into a digital Chatty Cathy.

At the very least, making your machine tools “connected” will let you check production status from anywhere, whether you’re in a meeting, sitting in line at a fast food restaurant, or lying sleepless in bed at night, wondering if you’ll win the big job you just quoted.

Taken to the next level, you might gather hundreds or even thousands of data points from a modern machine tool, including in-process metrology data, machine maintenance information, production output, scrap levels, cutting tool usage, job status...the list goes on and on.



Don’t do that. At least, not yet. Better to pick a pilot machine, choose one or two of whichever production values or machine metrics are most important to you, and start watching the data flow in. You’ll soon spot causes of downtime that are expensive to the shop but simple to cure. Areas for continuous improvement will become abundantly clear. Unexpected failures will eventually become a thing of the past.

Counting the beans

“I’d start with simple things like the execution state of the machine—whether it’s active, idle, ready, or in alarm status,” says Will Sobel, co-founder and chief strategy officer of advanced manufacturing analytics software company VIMANA. “From there I’d look at speeds and feeds, and whether the overrides are at 100-percent or some other setting. These values help to paint a fairly comprehensive picture of current production status and Real OEE.”

Worried about the cost? Don’t be. Sobel says the ROI can be “amazingly ridiculous,” sometimes as short as a few weeks. “If you look at a typical manufacturing processes in a typical shop, equipment utilization is often around 30-percent,” he points out. “It doesn’t take much to improve that figure.”

Andy Henderson agrees. The vice-president of engineering at industrial technology firm company Praemo, Henderson says even the oldest equipment—even those without computers on board—can be tapped for important information.

“I was with General Electric before joining Praemo and we were rolling out a lot of IIoT technology to their factories but encountered a number of machines that we were unable to communicate with,” he says. “What we found was that, by tapping into various relays within the electrical cabinet, we were able to identify whether the machine was running, whether there was a tool change was taking place, that sort of thing. The point here is that there’s a good deal of information that you can obtain without investing large amounts of capital.”

Keep calm, and data on

The difference between a machine that comes ready-made to serve up 9,000 data points is admittedly a far cry from one that must more or less be hotwired for its secrets. Yet both of these examples illustrate that, no matter which end of the spectrum your shop and its equipment are on, it's a straightforward exercise to extract relevant data.

The output could be as simple as “is my machine running” or detailed enough to predict when the Y-axis drive motor will need to be replaced. Either way, there's plenty of low hanging fruit to be picked, regardless of the size of the shop, its technical prowess, the age of its equipment, or how much money is available to invest.

Perhaps the most challenging part of Industry 4.0 and shop floor digitalization is the need to don a fresh set of eyes, starting with your own. Many shops wring their collective hands over simplistic questions such as whether to try out a new grade of carbide or adopt a tool presetting strategy—how difficult will it be to convince them they should not only yank on the digital thread, but keep pulling until they see results?



It probably won't be that difficult, actually—anyone with a smart phone in their pocket would find it hard to go back to their old rotary dialers, so why should it be so arduous to embrace digitalization, especially as Millennials and Generation Z workers make up an ever-larger percentage of the workforce? And to the old-timers in the group? Industry 4.0 might finally mean never again saying, “Because that's the way we've always done it.”

Opportunities abound

Industry 4.0 and the IIoT also opens new doors. Drura Parrish, President at the web-based manufactured parts sourcing company Xometry, says digitalization does two things. The first and most obvious is that it helps to maximize a manufacturer's efficiency. OEE is increased, part quality improves, customer satisfaction rises. Aside from that, digitalization also makes companies more flexible, ready to take on new opportunities and markets.

“When your shop is wired, and your machines connected, you're no longer a nondescript building at the end of a cul-de-sac in the middle of a small town in Kentucky,” he says. “You now exist in the broader world, and because you're much better able to compete, you don't care whether part orders come to you from across town or from Shenzhen, China. That's power.”

Buyer beware

Powerful or not, be careful. Just as you wouldn't connect your home computer to the Internet without a firewall and antivirus software, connecting machine tools to the World Wide Web without a well-planned security strategy and the appropriate hardware is asking for problems, possibly ones the size of a T-Rex.

That's why Industry 4.0 must be approached with caution, despite its potential benefits. Always consult with a network security specialist before embarking on a digital journey; be sure to pull the machine tool or equipment builder into the discussion. Make sure all employees are trained on IT housekeeping practices. And if you don't already have an IT person, hire or contract one to keep software and operating system up to date. There are a lot of bad

dudes out there, ready to hack, ransom, and infect your corporate computer network. Don't be their next victim.

Next, we'll look at ways to leverage what you've learned and where to go next with your Industry 4.0 initiative.

Step Three: Move Rapidly

Now you've connected your first machine, identified a few key data points to collect, and begun reviewing the resulting information. Congratulations. You're not yet on the Industry 4.0 superhighway, but you're definitely on the entrance ramp, accelerating towards greater productivity and more stable processes.

By now, however, you might be wondering what you've gotten yourself into. Will we have to hire a data analyst? What other metrics should we be tracking? What's this whole thing going to cost us, and will it really bear the fruit promised by IIoT pundits? Those are just a few of the questions even the least skeptical, most technically-minded among us might be asking.

The answer in each case is predictable: it depends.

Beyond the last mile

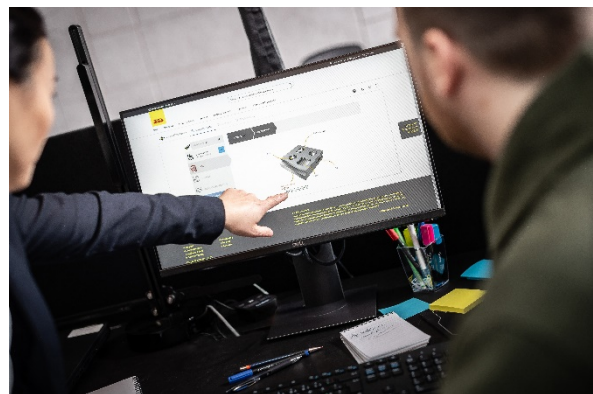
Stas Mylek, Mastercam developer CNC Software's senior product marketing specialist, says those looking for a quick win should consider purchasing monitoring software. "There are plenty of applications out there that you can get for minimal investment, and that make the traditional green, yellow, and red indicator lights obsolete. Using such an application to col- late and make sense of data allows you to better understand your processes and where each machine is making money. At the end of the day, it's about measuring data and ex- tracting real information from it, information that can move your business forward."

Like the other experts who contributed to this article series, Mylek says he's seen custom- ers achieve ROI on their digitalization initia- tives in days or weeks, not years. That's great news for shop owners and production man- agement alike, but as Andy Henderson points out, achieving success in an Industry 4.0 world requires much more than capitalizing on the quick wins.

Henderson is the vice-president of engineer- ing at data science company Praemo. He says "getting digital" requires three things—a safe, secure, and robust connection to the shop's machine tools (something he calls the last mile), an equally robust IT infrastructure to support it, and the data analytics and visualization software needed to make sense of the in- formation.

That means investing in the tools needed to convert the raw machine data into reports and dashboards that anyone in the company can understand, whether it's the CEO, the program- mers and operators, or the person responsible for maintaining the equipment. Taken one step further, the same software system should have the ability to sift through and archive data—lots of it—quite possibly to a cloud-based server, making it feasible to spot trends over weeks, months, or even years.

Gather data softly, and carry a big stick



Of course, it's all well and good to see problems, but if personnel don't have A) the knowledge and experience to formulate a solution, followed by B) the authority to implement that solution, then what's the point?

This is the fourth thing needed for success with Industry 4.0, and it's easily the most important. Once the IIoT wheels have begun turning and the digital train is primed to leave the station, a data evangelist (or team, depending on the size of the company) must be appointed to chase down improvement opportunities. This person will work with suppliers, report back to management, and work to spread the good word of digitalization throughout the organization.

"There goes the budget," you say. And while it's true that taking your IIoT data collection pilot project to the next level will cost the company some cash—in infrastructure, hardware and software, and additional labor costs—it's important to remember that the additional visibility to production and machine tool data, and the benefits derived from both, will greatly outweigh any investment costs.

Hey, partner!

That's not to say that the appointed data evangelist should pound people on the head with his or her findings. For one thing, this person will typically have less manufacturing skill and experience than the machinists, programmers, and engineers responsible for part production each day—a talented but technically-oriented machine operator is a good choice for such a role, one able to communicate effectively while recognizing that the people he or she is working with may be reluctant to change their ways.



In that same vein, all continuous improvement projects—especially those dealing with new, somewhat scary technology—call for support from everyone in the company. It must be a team effort, one embraced by all, and championed from the very top.

It should also be supported externally. Says Henderson: "It's an excellent idea to work with a technology company that knows the manufacturing industry and is able to help guide you through the initial project and beyond."

This shouldn't just be "any old software company," he notes, but rather someone experienced in machine tools and the idiosyncrasies of your particular type of manufacturing, whether that's machining, fabricating, stamping, or 3D printing. "They need to understand your particular problems."

GIGO

Digitalization success largely comes down to a simple maxim that any computer geek knows intimately: garbage in, garbage out. That, and the fact that computers themselves are stupid—they need good data, and a human to do any meaningful work. "Humans are good at judgment, and decision-making" says Will Sobel, co-founder and chief strategy officer of VIMANA. "Advanced manufacturing analytics software? Not so much."

Software doesn't make great choices when comparing different solutions, he points out. That's why humans will always be better (for the foreseeable future, at least) about when to shut a machine down, for example, or the best way to adjust feeds and speeds when chatter occurs. This is why involvement from the entire manufacturing team is crucial to any Industry 4.0 implementation. "The software can only go so far, only give us so much capability," says



Sobel. “You’re always going to need humans to go in there, figure things out, and come up with the creative ways of solving problems.”

Ready to pull the trigger? Any of the people named in this article are ready to help, as is Sandvik Coromant. All it takes a connected machine tool, a little data, and willingness to change. Properly implemented, the results will be greater throughput and higher profit margins, never mind corporate survival for well beyond the next five years. Get going. Industry 4.0 is waiting.

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