THE ADAPTIVE MACHINE

Cultivating a 'green patch' in your brownfield

An Interview with John Kowal, Director, Business Development,
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John Kowal is Director, Business Development, for B&R Industrial Automation, a global supplier of advanced machine control solutions, where he is responsible for North American marketing, standards proliferation, vertical market development and customer specifications. John is co-chair of the Industrial Internet Consortium's Smart Factory Task group and serves on the Board of Directors of the Organization for Machine Automation and Control (OMAC). He also serves on the Dean's executive council for Purdue University Calumet's school of technology and is active in AMT, PMMI, BMA, IoPP, ISA and ISPE.

What are the benefits to manufacturers of transitioning to IIoT/connected factories?

Most of the emphasis on manufacturing IIoT has been placed on increasing operational efficiencies in brownfield factories through the sensorization, networking, analysis and optimization of existing manufacturing assets.

The principles are similar to familiar OEE, TPM and lean initiatives, only with data acquisition and analytics on a much larger scale than would have been practical without correspondingly greater processing power, bandwidth and analytics software. The benefits also relate well to OEE attributes: quality, availability, performance.

Makers of capital equipment such as earthmoving machinery and turbine engines are also using IIoT connectivity to offer their customers 'power by the hour' and predictive maintenance services. This has largely not taken place in manufacturing.

But consider the order of magnitude competitive advantage that may be gained by pairing advanced manufacturing technologies with IIoT technologies. This combination has the potential to implement disruptive business models, such as mass customization shipping direct to the consumer. By leveraging adaptive machine technologies, mass customization can now apply not only to high value goods like automobiles, but to packaged goods as well.

Video: *KRONES Bottling on Demand*

One recent example is 'bottling on demand,' in which a consumer can order any combination of beverage flavors and bottle sizes online, and the 'batch size one' order fulfilled and shipped from a highly flexible bottling line.

The traditional concept of a conventional greenfield factory has been surpassed by a few factors. This has included pairing the technology for machines to adapt to individual products, instead of products to adapt to sequential manufacturing constraints, along with the ability of IIoT to connect manufacturing to customer inputs.

Do manufacturers have to rip and replace existing equipment in order to make this transition or can they retrofit existing equipment?

It is absolutely feasible to obtain incrementally improved performance from older equipment. This does not necessarily require retrofitting, outside of adding systems to monitor and report on operations.

Nor are all products conducive to mass customization.

However, developing a new business model demands new technologies. This is where the adaptive machine concept comes into play. And because this is a new category of machinery, it does require investment in new capital equipment.

What are some challenges manufacturers with legacy equipment face when trying to transition to manufacturing IIoT or smart factories?

Brownfield IIoT strategies generally accept that existing control hardware and software should not be changed – because this is a costly and risky exercise that is the equivalent of commissioning a new machine, only without the latest mechanical design attributes. This is a built-in constraint.

Analytics must be interpreted by individuals with an intimate knowledge of the process to be optimized. In Overall Equipment Effectiveness analysis, for example, sometimes line speed is actually reduced to increase throughput, based on the bottleneck process or machine, to prevent downtime and scrap.

The hope is for that process knowledge to become the basis for artificial intelligence and for machine learning to expand on that body of knowledge. Today, most manufacturing processes depend on knowledgeable workers, many from a generation that is itself in transition to retirement.

If analytics do lead to process optimization, there is a question whether older control systems have the performance to execute, and whether old mechanics have the tolerances to produce faster or better.

In Asia, and among transplants entering the U.S. market, greenfields with advanced automated manufacturing systems have become the norm. For example, robot industry statistics now show that China has become the world's largest user of industrial robots.

IIoT-enabled adaptive machines leapfrog these greenfield manufacturing technologies, even if IIoT-enabled. Rather than producing in a fixed sequence, an adaptive machine controls products individually, sending them to the required process stations for that product, moving in multiple directions, and batching finished goods together for shipment.

Tell us about the concept of the 'green patch' -- is this like a pilot project, using all new equipment?

Yes, it is. This approach is outlined in the Industrial Internet Consortium's white paper 'Cultivate a Green Patch in your Brownfield.'

The concept isn't new. It dates back to the 1970's and 1980's with the 'focused factory' and 'factory within a factory.' Simply put, to overcome the constraints of existing manufacturing practices, when capex for a new product or process is required, the new line or cell is isolated from the existing manufacturing systems.

It's bigger than a pilot project, because it is a full scale production system. It's a smaller investment than a greenfield. But it benefits from advanced automation platforms that can deliver on the full potential of IIoT, and from that perspective it is a pilot for cost justification of additional investment in new technologies.

'Green patch' applies to both conventional and adaptive machine types.

How would you start with this green patch – what is the ideal environment? Would it be one production line?

Typically, project scope would call for one line or cell. Using conventional manufacturing equipment, batches can be run and fast changeover technologies used to maximize efficiency.

An example would be a manufacturer of beverage can seamers. These machines have been in use for many decades and there is a large installed base in the world. Manufacturing of new seamers is a low volume, fabrication intensive activity that is hard to automate.

But manufacture of replacement wear parts consists of a relatively small number of part types, with a high degree of variability. These parts orders are time critical to beverage plant operators to avoid downtime, and they reward the machine builder with favorable margins and a known market. This lends itself to a dedicated manufacturing cell, one that is automated up to the level of the adaptive machine, and one that is connected via IIoT to predictive maintenance systems at the beverage plants.

The core of an adaptive machine is track technology. Multiple tracks can be laid out to interact with each other without one product waiting for another to be processed, serve as parallel processes, as queueing areas, to sort and collate, whatever is required to achieve small batch or batch size one production. This configuration makes the adaptive machine ideal to circumvent physical constraints such as building columns in the existing facility, as there is no need for a long, uninterrupted space to install a sequential production line.

Ideally, the green patch will operate autonomously – with its own ERP (cloud) system talking directly to the production machinery (edge), with the raw materials

warehouse treated as a supplier, its own OEE and predictive maintenance systems, and a flattened network hierarchy.

What are some supporting factors within the company you need to get a green patch project in place?

Clearly, even though the green patch has a relatively narrow focus, it absolutely requires top-down commitment and a multi-disciplinary team. That team involves not just OT and IT, but in reconfiguring to a batch size one implementation, that team must include product design engineering, sales, marketing, logistics and finance.

Another lesson learned from past 'focused factory,' lean and quality improvement processes is that the factory floor personnel need to play a fundamental role, because they understand the manufacturing processes – and workarounds – that need to be addressed. This is also true of a brownfield IIoT project.

What data/knowledge will manufacturers take from this green patch project that will help guide future decision making? How do you measure the success of this project?

Comparing green patch IIoT to brownfield IIoT performance will yield a valuable metric to prioritize future manufacturing investments.

Both brownfield and green patch metrics will sound familiar, such as OEE or other measures of equipment availability, quality and performance.

In a direct-to-consumer business model enabled by adaptive machine technology, metrics become even more interesting because they include a streamlined supply chain, expanded e-commerce integration, strengthening brand loyalty, expanding in growing demographic categories (millennials), and capturing market share from both direct and indirect competitors.

What is the next step after a successful green patch project? How do manufacturers then roll this out across their whole facility?

Of course, there is no one right answer.

Not all products are suited to mass customization. In the case of mature and declining product categories, squeezing more efficiency out of brownfield assets may be all that's realistic, so new manufacturing technology does not roll out across the facility.

Perhaps the green patch scales up to greenfield for a major new product line introduction.

Perhaps to reduce shipping time and costs, successful green patches are duplicated at other brownfields in different regions to better serve local markets.

And perhaps, with unprecedented levels of performance and flexibility achieved, it will be practical for manufacturing machine suppliers to finally adopt a manufacturing-as-a-service model, similar to the turbine makers.

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"The Adaptive Machine: Achieving Batch Size One"

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