JULY 2024

tire TECHNOLOGY INTERNATIONAL

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Contributors this issue:
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Feature your company's expertise in the next issue and on the website and weekly e-newsletter by contacting **olivia.campbell@ukimediaevents.com**

EDITOR'S NOTE

It's extremely easy to overthink things when working on an issue of *TTI*. At the outset, you're pulling together content ideas, figuring out if there are any common elements that you might like to weave together as a theme across the issue. Then, as material starts to come in, you're on the lookout for anything that may have been thrown up by features going off in unexpected directions (that evolution of what you expect versus what you get is, in my opinion, still the best thing about working on magazines).

Then, as that content goes from words in a text document to a living, breathing article with images and graphics, you're watching out for anything that's visually striking and worth highlighting, while also being aware of what the main issues are in the tire sector in the days and weeks leading up to publication and making sure you're at the cutting edge of the industry's latest developments.

Then, you may have a personal anecdote from the last three months that you want to share (I bought a new car last month, so you were very nearly reading an editor's note about mismatched replacement tires...), which may affect the way the issue comes together when you're signing off those final pages.

Or, you might notice when doing the contents page just how many times the topics of artificial intelligence, machine learning and automation are coming up and realize that, without even meaning to, these areas have managed to weave themselves throughout the entire issue. It's another example of just why magazines like *TTI* are so important. In fact, it's something I've noted in the past when compiling our *Annual Review*, which features the latest white papers, research and case studies from tire makers, academics and R&D institutes around the world. More often than not, a publication such as this one will guide you to what its theme should be – you only have to make sure you're ready to listen. Enjoy the issue.

A publication such as *TTI* will often guide you to what its theme should be

Matt Ross
Editor-in-chief

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ROCKWELL AUTOMATION

Mithun Nagabhairava, senior manager of data science and AI, reveals how manufacturers can benefit from the latest advances in artificial intelligence and machine learning

With over 15 years of experience in digital transformation, Mithun Nagabhairava possesses a wealth of expertise in industrial internet of things (IIoT), artificial intelligence and machine learning (AI/ML), advanced process control, computer vision and energy optimization.

TTI sat down with him during Tire Technology Expo and Conference in Germany in March to discuss the latest developments in advanced AI/ML capabilities to improve efficiency and quality in tire manufacturing.

Tell us about your presentation – why did you feel this topic was important?

The tire industry is at an inflection point, with many key trends posing unique challenges and presenting opportunities to innovate and differentiate among growing competitive pressures. Take the demand for growing tire sizes, with 22in, 24in and even bigger tires now needed to meet market demand. This poses many unique challenges for manufacturing.

There is also a growing requirement for all-season tires, and requirements for performing in demanding environments like mining, agriculture and construction.

Manufacturers must also apply the latest material science, engineering and technology to harness the most eco-friendly, sustainable and recycled materials to meet sustainability goals, without any compromise in tire performance.

Vehicle electrification requires tires that can handle extra weight and instantaneous torque while delivering low rolling resistance to improve battery range. There's also a demand for smart tires featuring IIoT sensors and digital capabilities that provide insights to save fuel and optimize battery charging, uptime and safe driving.

Meanwhile, evolving business models such as Tire as a Service contracts for fleets, and specialty tires, coupled with digital capabilities and services, continue to proliferate.

All of these trends provide many opportunities to leverage automation, digital and AI solutions throughout the lifecycle of a tire.

How can AI best help plants, machinery and people?

With the evolution of tires, the manufacturing plants have evolved extensively by utilizing automation capabilities, standardizing equipment and adding sensors and data platforms for real-time analysis and a variety of systems supporting operations.

However, there are still many challenges. With hundreds of material compositions, intricate compound interactions and stringent quality control requirements at every step, variations in raw materials, production conditions and rheological properties across the overall process can lead to inconsistencies in tire quality. Plant managers are continually challenged to consistently maintain KPIs in terms of scrap, rework, quality and energy. Operators, despite their extensive knowledge of the machine, are having to make repetitive adjustments to the processes to achieve target goals.

The advancements we find particularly compelling are those that synergize the power of AI/ML with the well-established bedrock of optimal control theory. The optimal control theory has evolved over centuries, and its enduring principles have consistently delivered value to manufacturing. Now AI is playing a pivotal role in advancing automation to autonomy for tire makers, akin to the transformative impact autonomous vehicles have had on the automotive realm.

Enabled by the advancements in technology, leading tire manufacturers are overcoming these challenges by leveraging advanced closed-loop optimization and machine vision capabilities to optimize production processes. This includes developing process models and optimization capabilities to achieve optimal Mooney viscosity at mixing, consistent weight measurements closer to the setpoint at extrusion, reducing out-of-tolerance events at tire building machines, achieving optimal vulcanization properties at curing, and automated defect detection at final inspection.

50-70%
reduction in reworkable scrap by using an AI-enabled control solution

Can you share some real-world examples with us?

A great example is our differentiating closed-loop optimization capabilities with co-extrusion processes in tire manufacturing. Extrusion processes, such as simplex, duplex, triplex, quadruplex and quintuplex, are inherently complex with repeated challenges to consistently achieve the target weight and width. This resulted in significant reworkable scrap during startups, and variations in product quality impacting downstream processes and tire uniformity metrics.

To solve this, we designed and developed AI/ML capabilities using process knowledge to predict expected weight ahead of in-line measurements. Furthermore, we designed and deployed

"The tire industry is at an inflection point, with many key trends posing unique challenges and presenting opportunities to innovate"

Mithun Nagabhairava, senior manager, data science and AI, Rockwell Automation

Above: With the evolution of tire design and technologies, manufacturing facilities have had to adapt. AI and machine learning will prove key to this ongoing trend

an AI-enabled industrial control solution with adaptive control capabilities, which made real-time adjustments to line speeds, proactively correcting for weight and dimensional accuracy. This has resulted in a 50-70% reduction in reworkable scrap across various tire codes and mixes, and energy savings as a part of avoiding the remilling process. It has also contributed to the reduction in product-to-product variations by 50% standard deviation, thereby improving the strength and performance characteristics of the overall tire quality.

Another great example is how we have helped tire manufacturers achieve superior levels of product quality based on advanced sensory feedback derived from machine vision capabilities combined with advanced control strategies to minimize and prevent potential defects. Traditional inspections relied on manual methods and sampling techniques to monitor product and material flow in extrusion, calendering, tire building machines and final inspection.

To solve this, we utilized a combination of 2D/3D cameras and sensing strategy to capture product characteristics in real time. Furthermore, we developed convolutional neural network (CNN) models to detect defects accurately and more quickly than human inspections. This has helped tire manufacturers achieve a 50% reduction in inspection cycle time. It has also helped achieve accuracies in determining the precise product characteristics and surface defects with extrusion, and detecting fabric wrinkles, skewness, perforations and joint lengths at tire building machines.

What advice would you offer to companies considering investing in artificial intelligence?

'Start small and scale fast' is a good approach to establish tangible proof points and accelerate investments to capitalize on the gains that move the needle for the organization. Depending on the maturity of the current infrastructure and capabilities, we recommend taking a phased approach.

First, discover. During this phase, we recommend constraining the scope to a single-unit operation or asset within the plant and one product type. The purpose of this phase would be to closely collaborate with the plant teams and conduct exploratory data analysis to determine the technical feasibility and economic viability within four to six weeks.

Then, develop and deploy. The focus here would need to be to develop and deploy robust adaptive control methods that can adjust the production process autonomously in the real-time production environment in a timeframe of about 8-12 weeks. The before and after results would enable further investment decisions to minimize risk and accelerate the proliferation of the capabilities.

Next, scale. With the tangible proof points established in the previous phases, the focus would then be to expand the capabilities at a rapid pace to all product types on the existing machine and scale the capabilities to similar machines across all the plants within the manufacturing network, while supporting competency development to enable the organization to be self-sufficient.

Last, maintain. Collaborate with the plant IT-OT teams to provide cost-effective support for the maintenance of capabilities to derive sustained performance over time.

Where do you see the next breakthrough with regard to AI and tire manufacturing?

Automation has long helped make tire plants safer and improve overall productivity. As a result of recent advances, manufacturers can now leverage data to develop autonomous manufacturing capabilities that are capable of automatically learning various situations and scenarios and self-adapting to changes in uncertain environments during operation – all without any manual intervention. 'Autonomous' means the manifestation of 'self-governing' systems at every step of the tire manufacturing process. How could these capabilities help advance your tire manufacturing processes and help you develop strategic advantages over your competitors?

Rockwell Automation | KALYPSO

Empower your people, plants, and machines with AI/ML superpowers

Kalypso collaborates with leading tire manufacturers, applying AI/ML technologies to advance automation towards autonomy, solving complex production challenges with precision and innovation.

START SMALL, SCALE FAST:
Our unique phased approach ensures a rapid payback on investment.

TIRE SPLICE OPTIMIZATION:
Predict out-of-tolerance splices and use closed-loop control on tire building machines to reduce splice length variation. This achieved a 50% reduction in standard deviation and improved overall tire strength and performance.

EXTRUSION OPTIMIZATION:
Predict the weight of extruded products and use closed-loop control on extruder settings to minimize weight deviations. This reduced scrap by over 50%-70% across various tire codes and mixes.

PREDICTIVE MAINTENANCE:
Use digital reliability tools to safeguard assets, establish proactive maintenance schedules, and prevent catastrophic anomalies.

MACHINE VISION AI:
Implement a Machine Vision AI solution to enhance detection precision and speed up Final Inspection. This resulted in over 95% accuracy and 50% reduction in inspection time.

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