AUTOMATION AND THE CHALLENGES FACING CAR MAKERS IS A FLEXIBLE MANUFACTURING SYSTEM THE ANSWER?

INSPHERE

Whitepaper

EXPLORING

THE EVOLVING DEMANDS ON CAR MANUFACTURERS OF TODAY

WHY FLEXIBLE AUTOMATED MANUFACTURING IS THE ANSWER – IN THEORY

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GET IN TOUCH AND DISCOVER HOW IONA CAN UNLOCK THE POTENTIAL FOR FLEXIBLE AUTOMATION

Electric vehicles, autonomous vehicles, and industry 4.0 are just some of the key trends and technologies that are shaping the automotive industry today.

With automation playing a key role in manufacturing, this paper is going to explore the challenges faced by traditional automated manufacturing when it's met with modern-day dynamic requirements.

It will conclude with how automated processes could adapt and evolve with the support from new technology entering the market, so car manufacturers can stay up to date with modern-day demands and realise the full potential of flexible automation.

THE **EVOLVING DEMANDS ON CAR MANUFACTURERS** OF TODAY

Electric Vehicles (EVs)
Governments worldwide are implementing stricter emission regulations, and consumers are increasingly demanding more sustainable transportation options, putting pressure on the automotive industry to make a major shift towards the production of electric vehicles. Traditional automakers and new entrants are investing heavily in EV development and production. This shift requires huge changes in manufacturing processes, including the integration of battery production lines, electric drivetrain assembly, and specialised EV components.

Autonomous Vehicles
Self-driving cars represent another transformative trend in the automotive industry. While fully autonomous vehicles are still in the testing phase, manufacturers are working on advanced driver-assistance systems (ADAS) to improve safety and convenience. Manufacturing processes will need to adapt to accommodate the integration of sensors, cameras, LiDAR systems, and other technologies required for autonomous driving. Additionally, the development of robust software systems and AI algorithms will become increasingly important.

Advanced Materials and Lightweighting
Automakers are exploring new materials and manufacturing techniques to reduce the weight of vehicles. Lightweighting is crucial for improving fuel efficiency in internal combustion engine vehicles and extending the range of electric vehicles. Advanced materials such as carbon fiber composites, aluminum alloys, and high-strength steel are being adopted to achieve weight reduction while maintaining structural integrity. Manufacturing processes like 3D printing and composite molding are being employed to enable cost-effective production of lightweight components.

Industry 4.0 and Automation
The integration of Industry 4.0 principles, such as the Internet of Things (IoT), robotics, artificial intelligence (AI), and data analytics, is transforming automotive manufacturing. Smart factories are being developed where interconnected systems and machines communicate, monitor, and optimize production processes in real-time. Automation plays a significant role in enhancing efficiency, precision, and productivity. Robotic systems are being used for tasks like assembly, welding, painting, and quality control, while AI and data analytics help optimize production planning, maintenance, and supply chain management.

Sustainable and Circular Manufacturing
As sustainability becomes higher on the agenda for consumers and manufacteres, automotive manufacturers are turning their focus to environmentally conscious manufacturing practices. Efforts are being made to reduce waste, energy consumption, and water usage throughout the production process. Circular economy principles are gaining momentum with a focus on recycling, reusing, and remanufacturing materials and components. This shift towards sustainable manufacturing is driven by both environmental concerns and the potential for cost savings.

Supply Chain Resilience
Recent disruptions like the COVID-19 pandemic and semiconductor shortages have highlighted the importance of building resilient supply chains. Automotive manufacturers are reassessing their supply chain strategies to mitigate risks and ensure uninterrupted production. This includes diversifying suppliers, improving visibility through advanced analytics and tracking systems, and exploring local sourcing options to reduce dependencies on distant suppliers.

But does it stop there? The future of automotive manufacturing is dynamic and now more than ever, subject to continuous evolution as new technologies, demands and regulations emerge. The industry needs more flexibility to be able to rapidly evolve and meet the demands of a changing world.

WHY FLEXIBLE AUTOMATED MANUFACTURING IS THE ANSWER – IN THEORY

Manufacturers are increasingly turning to flexibility and customisation to remain competitive, offer tailored consumer preferences, and meet market demands. Automation plays a significant role in enabling this in the following ways:

Reconfigurable Production Lines
Automation can support the creation of reconfigurable production lines to quickly adapt to different vehicle models or variations with the use of robotics and automated systems, vehicle designs and specifications. This flexibility reduces the time and effort required to switch between different production setups, enabling faster model changeovers and reducing downtime.

Modular Assembly
Automated systems facilitate modular assembly, where components are pre-assembled or pre-tested before being integrated into the final product. This modular approach allows manufacturers to mix and match components, subsystems, and options more easily, resulting in greater customisation possibilities. Automated systems can handle the integration of different modules efficiently and precisely, enabling a wide range of configurations without sacrificing production speed or quality.

Agile Production Planning
Automation, coupled with advanced data analytics, allows for agile production planning and scheduling. Real-time data from automated systems and sensors provide insights into production line performance, inventory levels, and customer demand. Manufacturers can use this information to make data-driven decisions and adjust production whilst remaining in motion. By continuously optimising production based on demand fluctuations, manufacturers can better meet customer requirements and reduce the risk of overproduction or shortages.

Mass Customisation
Automation supports the concept of mass customisation, where individualised products can be produced efficiently at scale. Through the integration of automation, manufacturers can offer a wide range of customisation options to customers without significantly increasing costs or production time. Automated systems can handle the assembly of unique features, components, or colour choices, ensuring that each vehicle meets the specific requirements of the customer.

Customer Interaction and Personalisation
Automation technologies are also being employed to enhance the customer experience and personalise vehicles. For example, interactive digital interfaces and configurators allow customers to visualise and customise their vehicles in real-time. These interfaces connect directly to the production systems, enabling seamless integration of customer choices into the manufacturing process. Automation facilitates the efficient translation of customer preferences into the final product, ensuring accurate customisation and reducing the possibility of errors.

By incorporating automation into the manufacturing process, automotive manufacturers can achieve a higher level of flexibility and customisation while maintaining efficiency and quality. Advanced automated systems enable rapid adaptation to changing market demands, agile production planning, and the efficient integration of diverse components and options.

As a result, manufacturers can offer a broader range of personalised vehicles to better align with customer preferences and enhance customer satisfaction.

WHY FLEXIBILITY IS A CHALLENGE FOR CONVENTIONAL AUTOMATION

Programming and Setup Time
Configuring automation systems for new product variants or customisation options can be time-consuming. Programming robots and other automated equipment to handle different tasks or assembly processes may require specialised expertise and extensive programming time. Additionally, reconfiguring production lines and tooling setups can involve substantial downtime, impacting overall productivity.

Limited Scalability
Some existing automation technologies may lack scalability, making it challenging to adapt to fluctuating production volumes or rapidly changing customisation requirements. Traditional fixed automation systems are designed for specific tasks or product variants, and modifying them to accommodate new configurations can be complex and time-consuming. Scaling up or down production levels may require significant reconfigurations or investments in additional automation equipment.

Lack of Flexibility in Handling Varied Parts
Automation systems may struggle with handling a wide range of parts with different shapes, sizes, and characteristics. Traditional robots and automated equipment are typically optimised for specific tasks or specific parts, and adapting them to handle a diverse range of components can be challenging. This limitation can hinder the ability to offer extensive customisation options or efficiently integrate a wide variety of components.

Adaptability to Changing Customisation Demands
Rapid changes in customer preferences or customisation requirements can pose a challenge for existing automation technology. If the automation systems are not designed to handle frequent changes or variations, reprogramming, or reconfiguring the systems may take time and disrupt production. Agile and adaptable automation solutions are necessary to meet evolving customisation demands effectively.

Maintenance and Repairs
Automation systems, like any complex machinery, require regular maintenance and occasional repairs. Ensuring the uptime and reliability of automated equipment is crucial for maintaining production flexibility. Timely maintenance and the availability of spare parts are essential to minimise downtime and avoid disruptions in the customization process.

HOW A METROLOGY SYSTEM CAN UNLOCK THE FULL POTENTIAL OF AUTOMATED FLEXIBLE MANUFACTURING

As outlined, automation and flexibility have become crucial elements in modern manufacturing, enabling companies to adapt to changing market demands and achieve higher levels of efficiency.
However, trying to solve modern demands with traditional robot technology alone is riddled with pitfalls.

One way to fully capitalise on the benefits of automated flexible manufacturing, is to integrate a robust metrology system into the blueprint of the production line to monitor robot performance and make alignment and positional corrections based on the configuration at any given time, rather than relying on an accurate, fixed configuration that doesn't change. This can therefore increase the flexibility and performance of the manufacturing system.

IONA is a scalable network of sensors providing metrology-grade data for industrial robots. It is a critical enabler of flexible manufacturing, adding value to the process at three key stages,
Commissioning, Process Performance, Process Monitoring.

1 COMISSIONING

A flexible manufacturing solution is by its nature being reconfigured more frequently than a conventional production line. An automated or even autonomous commissioning process is therefore critical to reduce the time and manual intervention typically associated with introducing new parts or programs.

Using IONA, a new program or re-configured automation cell, can be run with IONA checking and correcting any mis-alignments or deviations from program nominal.
This has the following advantages.

Accurate Robot Alignment to Cell Datum and Part Fixture:
- Improved precision and alignment of robots within the manufacturing cell.
- Enhanced product quality due to precise positioning of parts during assembly or production processes.
- Minimised errors and misalignments, leading to higher efficiency and reduced rework.

Increased Consistency and Traceability of Program Updates:
- Streamlined program updates across robot systems, ensuring consistency in manufacturing processes.
- Enhanced traceability of program modifications, making it easier to identify and track changes for quality control and auditing purposes.
- Reduced errors and discrepancies resulting from inconsistent programming, leading to improved overall production reliability.

Reduced Commissioning Downtime:
- Decreased setup and commissioning time required for robots within the manufacturing cell.
- Optimised production efficiency by minimising downtime associated with initial system configuration.
- Faster deployment of robots, allowing for quicker start-up and production ramp-up

Less Scrap from Commissioning Activity:
- Reduced waste and scrap materials resulting from commissioning activities.
- Enhanced efficiency and cost-effectiveness by minimising the need for rework or disposal of faulty products.
- Improved resource utilisation and sustainability by minimising material waste during the commissioning phase.

2 PROCESS PERFORMANCE

Improving Process Performance is clearly critical to quality and becoming more demanding as products increase in complexity and expectations on product quality increase.

With a permanently embedded metrology system continuously streaming data, process performance can be maintained by determining and correcting process variables. Process variables exist in any manufacturing process, but this is exacerbated in a flexible manufacturing line. Changing robot end effectors, payloads, robot poses and orientations, dynamic loading etc all have significant influence on the robot accuracy and performance. Being able to correct for this, in-process has can have significant performance benefits.

In-Process Correction of Robot Errors:

- Real-time identification and correction of robot errors during the manufacturing process.
- Minimised production disruptions and downtime by addressing errors immediately.
- Improved product quality and consistency by ensuring accurate robot movements and operations.

Update Fixture Alignment Each Process Cycle:

- Continuous optimisation of fixture alignment throughout the manufacturing cycle.
- Enhanced precision and alignment of parts during each stage of production.
- Improved accuracy and reliability in the assembly or manufacturing process, resulting in higher-quality products.

Enhanced Process Accuracy - Increased Potential to Automate Challenging Tasks:

- Increased automation capabilities for complex or challenging manufacturing tasks.
- Expanded possibilities for automating previously manual or difficult processes.
- Improved efficiency, productivity, and repeatability by leveraging the accuracy of robot automation.

Improved Robot-to-Part Alignment Accuracy - Consistent Product Quality:

- Enhanced alignment between robots and parts, ensuring precise positioning and assembly.
- Consistent product quality and reduced variations in finished products.
- Minimised defects, rework, and scrap due to improved robot-to-part alignment accuracy.

Reduced Cycle Time - Fully Automated Alignment:

- Accelerated production cycles through fully automated alignment processes.
- Decreased time required for manual adjustments or alignment checks.
- Increased overall production efficiency and output by minimising alignment-related bottlenecks.

3 PROCESS CONTROL

In a flexible manufacturing context, process control is essential. Processes must be monitored to ensure they continue to operate within defined tolerances to maintain quality of output.

Keep Processes Running Within Control Limits

- Continuous monitoring of processes to ensure they stay within control limits.
- Early detection of process drift or deviations, allowing for timely intervention.
- Minimised scrap and waste by addressing issues before they result in defective products

Process Feedback

- Live feedback from the manufacturing process integrated with Manufacturing Execution Systems (MES).
- Real-time verification and validation of the digital twin model against actual production data.
- Improved process control and decision-making based on up-to-date information.

Data for Predictive Maintenance

- Collection of real-time data for predictive maintenance of equipment and robots.
- Proactive identification of maintenance needs, preventing unexpected breakdowns.
- Reduced maintenance costs and minimised downtime by scheduling maintenance tasks more efficiently.

Evidence of Process Capability

- Data-driven evidence of process capability, demonstrating its ability to consistently produce high-quality products.
- Enhanced confidence in process performance and its ability to meet specified requirements.
- Facilitates continuous improvement efforts by identifying areas for optimisation and quality enhancement.

SUMMARY

The expectation on car manufacturers to be more dynamic and flexible to meet market demands is only set to increase.

When new technologies are embraced, the full potential of automated, flexible manufacturing can be realised, providing the solution to many of the challenges faced by car manufacturers of today.

With IONA built into the blueprint of a production line, the pitfalls otherwise found with trying to automate commissioning, process performance and process control, can be mitigated enabling car manufacturers to stay competitive, efficient, and adaptable.

CONTACT US

Get in touch with us here to discuss your manufacturing requirements and discover how IONA can unlock the potential for flexible automation.

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