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Spring 5-2-2019

Artificial Intelligence and the Future of Supply Chain Management

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Introduction

In any business, a supply chain is used to manage the flow of goods and services, money, or information from the start of a product to the end consumer. As new technology is developed, the way companies transfer information and goods, both intercompany and to partners along the supply chain, changes constantly. Artificial intelligence, or AI, is one of these emerging technologies that is reshaping the supply chain for every industry, specifically manufacturing within the automotive industry.

What is artificial intelligence? It's a huge buzz word in all types of businesses, but it can be hard to pin down an exact definition because of the many interpretations used in the business world today. According to IBM, artificial intelligence, or AI, is known as, "... systems that can actually understand, reason, learn and interact. They use natural language processing and machine learning to learn about and analyze data – and do so at tremendous scale and speed. AI can … be taught to correlate this data and extract insights, augmenting the intelligence of the operator" ("The AI Journey: Artificial Intelligence and the Supply Chain"). AI is being used in businesses to analyze large amounts of data very quickly, to give insights and make conclusions that any human would miss. As AI is used more and more within companies, the software continues to learn and adapt to its environment to make more informed decisions with the additional data collected or provided.

In a supply chain, AI can be used to improve efficiencies and customer service. These goals are at the forefront of any company's strategy, as they help the company save money and

keep customers happy. In a manufacturing environment within the automotive industry especially, AI can use the data collected by the machines and staff to reduce bottlenecks, improve supplier and customer relationships, and improve delivery, all while learning, refining, and streamlining the process.

In the automotive industry, the use and transfer of data is crucial during the manufacturing process. Many automotive Original Equipment Manufacturing (OEM) companies, or companies that manufacture a product for the end consumer, rely on data transfers both within the company and with other firms along the supply chain to manufacture products on a pre-arranged schedule. Most of these automotive OEMs use a Just-In-Time (JIT) manufacturing process where the manufacturing plant keeps minimal inventory on hand and relies on regular deliveries from the suppliers throughout the day. The OEMs tell the suppliers how many of each design of car they will be manufacturing and in what order, so the suppliers deliver the exact number of needed parts in the proper order to match the production schedule. Much of this process is data driven, and AI can be a huge tool to help OEMs manage inventories and continue to improve the manufacturing process. AI can be used to perfect the JIT process by collecting data about late shipments from suppliers, manufacturing delays at the OEM level, and provide delivery information for the customer (car dealerships). JIT manufacturing can fall under lean manufacturing, or the process of limiting waste in various processes. Toyota is known for starting the lean manufacturing process, and it has spread to the other OEMs. Much of lean manufacturing is reducing inventory, time, labor needed, and other inputs, all of which AI can help to limit. After implementing a JIT system, AI can help by identifying problem spots, improve efficiencies, and other cost saving measures.

At the supplier level, AI can be used in a variety of ways to improve delivery performance, save money that can be passed along to the OEM, and better forecast the demand

of products. There is much overlap with AI features between what can be utilized at the OEM level and at the supplier level, but it is critical suppliers are able to consistently deliver on time, especially with a JIT process. Manufacturing plants are chaotic; thousands of different parts are moving into, through, and out of each facility daily. Every order must be accurately filled in a timely manner, or the supplier may have to pay astounding expedite shipment fees to ensure the OEM gets the product on time. AI can help smooth this process out, pinpoint inefficient processes, schedule production to optimize resources, and improve demand forecasting.

Current Implementation of Artificial Intelligence

A large part of any supply chain is to streamline processes and save money throughout, and AI can be used to greatly improve this. In a manufacturing setting, all the machinery creates large amounts of data which can be very hard to analyze. AI can collect this data and make observations about it, such as when machines are malfunctioning, when processes are out of control, or which processes take the most time and need improvements. A human can make these conclusions, but it would take lots of time to collect all the data, interpret it, and draw conclusions. In addition to manufacturing scenarios, process streamlining can be used for any procedure that humans are involved in. Oracle, a cloud and database management system, is using AI to streamline business processes for its users. Oracle ERP Cloud systems offer its customers "... intelligent rules-based processing enable[ing] the automation of labor-intensive tasks and allow[s] organizations to redeploy employees to more strategic and rewarding work" (Montgomery, "How to Streamline Your Business Operations with Artificial Intelligence"). With the use of Oracle and automation, companies can shift the focus from people completing very repetitive and tedious tasks to considering the bigger picture, while saving time and money along the way. Any process that can take away human error will greatly improve the process flow and will save money for the company.

A perfect example of how AI is being used to streamline processes in a manufacturing setting is looking at production scheduling. It can be very difficult to schedule which parts need to be manufactured when and requires lots of information to make those decisions. A scheduler must consider inventory levels, demand for hundreds of different parts, when deliveries must be made, how to recover from line down time, and many other data inputs. If a production schedule is incorrectly done, it will lead to the wrong parts being manufactured, driving up inventory carrying costs and causing shortages of other parts, which will require expensive expedited shipping to deliver on time. With the JIT manufacturing process, it is critical that the needed parts are manufactured on time and in full, or else expedited shipments will be needed. With AI managing the scheduling process, the system schedules the order of manufacturing "... based on rules and parameters set by the production manager. This eliminates the need for managers to continually answer those 'What do I work on next?' questions" (Green, "Artificial Intelligence for Real-Time Manufacturing Execution and Operations Management"). AI can also "... predict when inventory shortages will occur in response to a continual inflow of new customer orders. The AI-based system can then alert managers when these problems are about to occur" (Green, "Artificial Intelligence for Real-Time Manufacturing Execution and Operations Management"). Between setting the manufacturing plan and ensuring it can be completed based on inventory levels, AI considers all facets of the production schedule more efficiently than humans could.

One big struggle many companies have today is how to handle supply risk. Looking at the automotive industry, there are suppliers around the world that provide unique parts for each OEM, which increases the supply risk. Getting parts from around the world may cause problems within the supply chain because of shipping delays caused by customs, long lead times, weather around the world, or political differences. Looking at all companies, either international or continental, there are many additional factors that can cause shipping delays including labor

shortages, robustness of processes within a plant, machine failure, production capacity, and many others. Because of the JIT inventory process in the industry, if one shipment is late it could cause the whole OEM manufacturing process to shut down, costing thousands of dollars. Once manufacturing lines are shut down, the whole production schedule must be adjusted to accommodate the necessary changes. But how can AI help to reduce this supply risk? Let's consider Watson, an AI tool that can be used to reduce supply chain risk.

Digging deeper into some of the international supply risk factors, customs, long lead times, or international weather all can play a factor in supply chain risk. When shipments go through customs, lots of paperwork is needed and it is relatively common for the shipments to be delayed or even held overnight (inspections or wrong/missing paperwork are the biggest causes). When looking at the long lead times, it is standard for shipments to take up to 6-8 weeks to get from Asia and other regions of the world. If these parts are needed sooner because of quality issues or increased production at the OEM, additional parts must be airfreighted because of the long standard shipping process. Weather is also a huge factor in this supply risk: because many of these parts are being sources from Asia, there can be lots of weather disruptions, anything from typhoons to hurricanes to flooding that can shut down production or shipping.

Looking at some factors that can be considered in supply risk, there's labor shortages, the effectiveness of the processes within a plant, machine failure, and production capacity to name a few. There are many opportunities for labor shortage to cause problems along the whole supply line. At the supplier level, many companies struggle finding staffing to run their facilities, and it takes time to train new employees which can also slow down production. Staffing is also a concern in the trucking industry, so it may cause problems in the shipping process as well. Looking at a supplier's processes, there should be procedures and plans in place for what to do if there are quality concerns, a machine breaks down, or there isn't enough staffing to run shift. If

these plans are not in place or not robust enough, any small problem can have the potential to shut down production. Looking at machine failure, there must be preventative maintenance (PM) planned to limit unscheduled down time. PM is known to decrease the number of unplanned machine breakdowns, which helps plants stick to the production schedules. If machines still break down with regularly scheduled PM, there should be procedures in place to minimize down time. Finally, production capacity must be considered when looking at supply risk. It is critical a supplier is able to be somewhat flexible in supplying parts above the required amount. If a supplier will be struggling to meet the typical demand, if there are any production delays or additional parts requested because of quality or higher demand than forecasted, the supplier may not be able to keep up with the demand. All of these factors, for both international and continental suppliers, must be factored in when considering supplier risk. AI can help monitor these when considering new and existing suppliers to make the best, informed decisions possible.

IBM is a large computer software company that has developed a very modern AI system called Watson. Watson is being used to track disruptions to a supply chain by monitoring weather trends, social media, and other data sources to monitor the risk of a supply chain. According to IBM's website, AI (and Watson) "… can provide an instant forecast of the potential time, financial and other impacts of a disruption, so businesses can prioritize which areas to act upon first. With these capabilities, AI can enable automation of risk and event monitoring to the fullest extent possible-and provide supply chain professionals with powerful capabilities to intelligently monitor, assess and mitigate disruptions and risks" ("The AI Journey: Artificial Intelligence and the Supply Chain"). Risk mitigation is key in any supply chain, and AI can be used as one of the best lines of defense against unforeseen difficulties.

If there is a situation with some sort of supply chain disruption, AI can be used to find the best solution to get production back up and running. Based on a company's past actions, AI can

advise the company on the best way to proceed, considering outside sources of data and past experiences. Using these past experiences, "...the system develops internal supply chain 'playbooks' to provide guidance on how to react to specific events based on similar conditions and institutional experience.... The system, at the operator's direction, can collaborate with partners, such as logistics providers, and provide analysis and recommendations in advance of a meeting" ("The AI Journey: Artificial Intelligence and the Supply Chain"). A big struggle many companies face is how to fill in the informational gaps when employees leave. If one employee is responsible for multiple supplier relationships and hundreds of parts, it can be very difficult to remember all the ins and outs of each part and supplier, let alone train an incoming employee on it. When considering technology, each company uses different systems and processes. If a system expert leaves the company, it is very difficult for the remaining employees to get their questions answered, and lots of time is wasted. One way companies try to minimize this information loss is to document all processes and information, but AI can be used to fill in the gaps. If there are problems or questions, AI can advise staff on how best to proceed and preemptively start the decision-making process, so time and money is saved, not to mention many headaches.

Because of the increase in international sourcing, language barriers can be a huge problem in many companies. Considering the Japanese car manufacturers, a translator is almost always required when meeting are held between the Japanese and the United States branches, as well as with many of the Asian or Mexican suppliers. AI can be used to help eliminate many of these language barriers. According to a Forbes article, it seems to be a fairly easy and straightforward process to 'train' AI on translating between two languages. The process "... requires nothing more than feeding a large quantity of material, in whichever languages you want to translate between, into the neural net algorithms" (Marr, "Will Machine Learning AI

Make Translators an Endangered Species?"). Once the information is uploaded, AI can step in and help during meetings and translate documents.

An additional way AI is being used to benefit the supply chain in any company is through customer service. A large part of a supply chain is working with customers to ensure on time delivery, questions are answered in a timely manner, and managing supplier to customer relationships. Companies can start using chatbots, or automated communication systems that answer questions and provide other customer service to a customer. According to an article that discusses how chatbots will be used in various customer service applications, it is estimated that chatbots will save companies billions of dollars every year by 2022. Many of these cost savings are from minimizing the customer service budget by allowing the machine to handle simple queries. Chatbots also create customer engagement with the consumer, which also improves company sales overall (Sunthar, "How Chatbot Helps Businesses Improve Customer Service?"). In addition to chatbots, AI helps to offer superior customer service by always giving staff access to the status of all orders, the location of parts, and machinery. This information can then be easily passed along to the customer when requested, which provides the customer service staff an easier way to pull requested information. They can then focus their time and energy on more critical issues (or they will be alerted if an order is running into any processing issues that may delay shipping). It also helps to reduce "... the amount of time everyone spends trying to make sure customer orders get shipped on time" (Green, "Artificial Intelligence for Real-Time Manufacturing Execution and Operations Management").

Another way companies can benefit from implementing AI is through quality control. According to an article studying how AI is being used in the manufacturing process, AI can learn the characteristics of a "bad" part, can identify these bad parts through cameras, and can remove them from the production line (Savidge, "AI in Supply Chain: 6 Reasons Executives Should

Invest in AI in 2018"). This process can save both a supplier and an OEM lots of money over time, as the parts can quickly be removed and reworked if possible. The bad parts are sorted out immediately, so the parts aren't processed any more than necessary and part quality is greatly improved. With this collection of data from the machines picking out the bad parts, the AI software can pick up patterns in the quality of parts to notify staff if a process is yielding too many bad parts or if a process is out of control. Once someone is alerted, corrective measures can be taken to fix or replace the machinery needed for production.

AI can also be used to more accurately forecast demand by using historical data, as well as factoring in outside data sources. Many of the future sales can be predicted based on historic data using data mining and predictive analysis, all of which AI can help us with. According to the Vice President of Hitachi Insight Group, predictive analysis through machine learning is expected to increase supply chain efficiencies by 10% (Savidge, "AI in Supply Chain: 6 Reasons Executives Should Invest in AI in 2018"). A large cost many companies must face on a regular basis is inventory carrying costs, or the cost of holding inventory in warehouses and other locations. Oftentimes some of this inventory gets damaged or becomes obsolete, which also adds cost to the process. On the other hand, if companies underestimate the amount of sales they expect and stock out of product, they are missing out on a large chunk of the market and can greatly reduce profits. In the automotive industry specifically, it can be very difficult to forecast sales, especially on newer technology like electric vehicles.

Many sources cite that OEMs are losing money with each electric vehicle being produced. According to Investors.com, GM was losing at least $7,000 on each Chevy Bolt sold, so forecasting accurately can mean the difference between having a profitable quarter or not (Narayanan, "How to Make Electric Vehicles Profitable as Tesla, GM Look to Build Millions"). With the use of AI and more accurate predictive analysis, the amount of money lost to inaccurate

forecasting can be minimized, saving the company lots of money. As the industry continues to evolve into newer technologies, this forecasting of newer technology is going to be critical for the success of many car manufacturers.

In addition to electrification, many companies in both the automotive and trucking industries are researching autonomous driving, or the vehicle being programmed to drive itself. This is one of the biggest emerging technologies, majority of which is AI driven. These new autonomously driven cars would need to be pre-programmed with human-like "judgement" to be able to make decisions while driving, just like a human would. Once the vehicle starts to drive on unfamiliar roads, it must be able to apply its programming to the information brought in from the sensors placed around the car to safely arrive at the destination. This would redefine many facets of the automotive industry, between limiting human-driven taxis/Ubers and greatly improve safety. Within the trucking industry, there is a huge driver shortage which is driving up logistics costs across the board, which autonomous vehicles would address.

Challenges

As we are moving into the digital age, we are creating more and more data. The sheer amount of storage needed for all this data, not to mention the analysis, computations, and algorithms needed for AI, is a problem we are having to face in today's modern world. This lack of computing infrastructure in place has already become a problem, but there are short-term solutions available like cloud computing and parallel processing systems. As AI continues to evolve and grow, so will our need for these computing systems (Marr, "The Biggest Challenges Facing Artificial Intelligence (AI) In Business and Society"). The best way to move forward past this limitation is to encourage all data technology growth, even if it isn't directly related to AI.

As AI develops and continues to evolve, it will require much more technological support that what we can offer right now.

When a company is considering AI implementation, cost may be a large factor. AI software has a huge upfront investment cost, which may be a big negative factor for AI. After the initial investment, companies must also continue the development and updating of this new software. Because AI is such a new technology that is still rapidly changing in the market today, there will be lots of research costs tied in with this new technology, just like any new software project. To help cover some of these investment costs, many companies agree that AI helps to increase sales, productivity, and efficiencies within the company, all of which make up for the initial investment and continued development. Depending on the initial investment, it still may take years for companies to make up the investment money on this new technology. Just looking at the cost of implementing a chatbot, estimates range from a few thousand dollars up to $340,000 depending on if companies choose to build their own chatbot or pay for a service to provide a pre-made framework (Ismail, "How Much Does it Cost to Build an Enterprise Chatbot?"). A large factor in determining the cost of a chatbot (and any sort of AI implementation) is the features the software can offer. Investing in just a basic AI software is going to be a shorter process and less expensive, but it's critical companies base their decisions on their individual needs, as well as the industry needs. A company must also consider the level of customer service it wants to offer its customers. If a company implements a very cheap chatbot with very limited features, customers will likely be unhappy with the service they are offered and may stop buying those products. On the other hand, if a company would prefer prioritizing other things instead of customer service, a cheaper and less involved chatbot may be enough for the company needs.

With any new software being installed at a company, there is a long implementation process in addition to the transition stages. During these transition stages, lots of time is spent on training employees with the new software and staff productivity decreases. It can be very hard to estimate how long it takes for an AI software system to be custom built and integrated within the company, but the process will most likely take months or even years. It can be frustrating for the staff involved to learn the new processes, and there is oftentimes a long learning curve to these very involved systems. Different generations may be able to adapt to this new technology quicker than others, which may affect the transition process as well. One problem a company must consider is that the technology continues to change as the changes are being made, so by the time an AI system is fully implemented it could be relatively outdated. Companies must plan for the continually updating technology by being flexible in their implementation process. If the company stays in a very rigid schedule with set goals without room for growth or improvement as the technology improves, the company won't be very much further along at the end of the project than when they started. One additional thing to consider with such a long implementation process is that many processes and data sources can change, so companies must adjust accordingly. For example, if an employee fills out a form every time there is a quality concern but halfway through the AI implementation process the employee is now required to type the information into an Excel spreadsheet, it is critical the system is kept up to date with any process changes.

Another factor that may cause problems for AI is the complex language and social cues of customer service and other applications. With any sort of customer service, the language used will have many language nuances that AI will not pick up on unless programmed to do so. Without understanding these, the ability to offer the necessary service will be greatly diminished. Outside of customer service, if AI is asked to find a solution for a manufacturing problem (such

as an inventory shortage or an incorrect production schedule), AI must be able to understand what criteria must be met to make a potential solution the "best" solution. According to an article that looks at the challenges of language in AI, "language is the mechanism for sharing information and connecting to those around us, but machines need to understand the intricacies of language and how we as humans communicate in order to make use of it" (Socher, "AI's Next Great Challenge: Understanding the Nuances of Language"). Just understanding the technical side of language is one thing, but being able to interpret it, identify possible actions and outcomes, and choosing the best outcome is something totally different. Once the language is understood, AI must be able to interpret the question, make connections with data already collected and stored, and advise accordingly.

It's one thing to theorize about AI, but it's something totally different to actually code and implement this new technology. It's very difficult finding people with data backgrounds who have the skills to analyze the ever-growing flow of data, not to mention finding staff who have the technical skills to develop and implement AI as well as manage its dynamic abilities. According to an article from a supply chain magazine titled *Supply Chain Quarterly*, "Supply chain organizations are already struggling to find enough data scientists to analyze the data that they are collecting. Organizations that adopt AI will be challenged to make sure they have the right people to develop, implement, and maintain those applications" (Gooley, "AI Adoption in Supply Chain in Accelerating, but Barriers to Success Abound, Analyst Says"). An AI system is only as good as its developers, so finding the best people to create and maintain these tools are critical for any organization or software developer. Looking specifically at the number of data analysts and scientists, there is a growing shortage of these skilled employees. According to an article discussing this growing problem, "The January report from Indeed, one of the top job sites, showed a 29% increase in demand for data scientists year over year and a 344% increase

since 2013 -- a dramatic upswing. But while demand -- in the form of job postings -- continues to rise sharply, searches by job seekers skilled in data science grew at a slower pace (14%), suggesting a gap between supply and demand" (Holak, "Demand for Data Scientists is Booming and Will Only Increase"). Without the staff needed, companies will not be able to implement these new technologies as fast as they would like, and companies will lack some of the analytical information they could gain from the data collected.

As is the case with all radical technology, it's to be expected that there will be problems in the development and implementation process. Because this is such new technology, there is no "rulebook" to reference when things go wrong. If a serious problem arises, companies will be forced to make up the rules as they go along, which means the implementation process will take that much longer and be that much more expensive. As this technology continues to develop, it will continuously need to be updated at the company level; technology is like a never-ending cycle you can never get ahead of. With each new stage, critical thinkers and problem solvers will be needed to work their magic before the newest system can be fully functioning. AI will be a very expensive process, but by making good decisions and using the best resources companies should be able to gain lots of improvements from this technology.

Many software systems put in place are made to collect data and send it somewhere else, not necessarily share data. With AI, the machines must allow for collaboration and decision making based on the shared data. According to an article in the Harvard Business Review,

"...software developers have long since figured out how to export data from one application to another.... If the goal is to tie together all the pieces in the production process so that for example quality defects can immediately feed back to the design, enabling quick changes to everything including the bill of materials and the automation

design, one needs to *share* data so that every participant in the design, production, distribution, and selling process is operating off one integrated data model, what product life-cycle management (PLM) professionals call a 'single source of truth'" (Shih and Ludwig, "The Biggest Challenges of Data-Driven Manufacturing").

If machines are to truly share data, any changes made must be made all along the manufacturing process in every source of data to ensure accurate and consistent data sources. If the data isn't kept consistent through all sources and locations, any analysis run off that data will be inaccurate. This challenge goes hand in hand with the next challenge many companies face, or the integration of old software with new software.

There are always going to be levels of technology in any system: the newest technology must be made to communication with the oldest technology, or else there won't be the necessary sharing of data. Many of these old systems were developed before the current software engineers started working for the company, so some of the information about the software and what it can do is lost over time. This wave of new technology is "not about starting from a clean sheet of paper but integrating efficiently within the existing design and manufacturing environment" (Shih and Ludwig, "The Biggest Challenges of Data-Driven Manufacturing"). If companies can't connect all these pieces of technology, then there's very limited capacity for what AI can accomplish for a company. Another factor that needs to be considered is that AI systems need a base level of technology to communicate with. These new AI systems will not be able to communicate with all types of old technology, so those old systems may need to be updated before the new AI technology can be implemented. Because of these challenges, it is very plausible that the company will have to do multiple implementation processes to get all the old technology up to date before the AI system can be fully implemented, which can be very expensive as well as time consuming.

As we move into the digital age, security is a priority for every company. When looking specifically at OEMs, security is critical for any new technology being developed, new features being put on cars, supplier relationships, financial information, and even sales forecasts. Looking specifically at the automotive industry, new technology could range from autonomous driving, fuel efficiency technology, electric vehicle power, or new model features that haven't been applied in the industry before. As more and more software is being developed and integrated into a company's processes, there are more and more opportunities for data to be stolen, software to be hacked, and security to be breached. All companies along the supply chain will need to spend more money promoting and monitoring security within their company. Hackers are more likely to target the suppliers along the SC, because they oftentimes don't have the security practices set in place like the OEMs do. But who are these potential hackers? Some of these possibilities include foreign governments, people who want to gain access to consumer information (such as social security numbers for customers using the company sponsored loans or employee SSNs), or even malicious hackers who just want to wreak havoc on a company's processes and information. With this AI technology being implemented, it is critical the security is developed enough to protect every company along the supply chain.

Data Management and Artificial Intelligence

A manufacturing process creates millions of pieces of data, including anything from part measurements to cycle times. Without analyzing this data and looking for trends to draw conclusions from, there's no point in recording all this data. AI gives companies an opportunity to manage this data to save the company money, produce products more efficiently, and be more effective. Because AI can continue to develop past just the data analytics piece, "AI-enabled systems continue to grow ... where they can automatically weed through large amounts of data to quickly product insights and forecast events" ("The AI Journey: Artificial Intelligence and the

Supply Chain"). It's one thing to be able to describe the trends in the data; it's another thing entirely to have a system that can continue to progress and learn, moving past forecasting and towards the different applications discussed above, including analyzing supply chain risk, scheduling production, and countless others.

All these uses are based on the availability of accurate data, which is critical in any AI enabled system. A large problem many organizations face is determining how to collect the necessary data and keep it accurate enough to draw correct conclusions. AI can help keeping data clean by pulling data "...from internal and external sources .... The ability to draw data directly and analyze in real-time accelerates insights and time to value for AI-enabled systems, and provides confidence in those insights and in decision-making" ("The AI Journey: Artificial Intelligence and the Supply Chain"). For a company to make decisions, the data being analyzed must be recent. It is pointless to make predictions and decisions on obsolete information, and AI can help companies with this type of data management. As mentioned above, it's also critical that data from multiple sources are drawn together for making conclusions. To just consider data from one source is a one-sided approach, which won't provide the best answers possible. AI is very good at being able to analyze thousands of different pieces of data, from many different sources, to come up with the best solution. At this level of complexity, a human would have to rely on intuition to a degree, which decreases the effectiveness of the decisions.

By collecting data directly from various machines and processes, this helps to ensure the cleanliness of the data as well. With less automated processes, it's very easy for users to insert incorrect data, delete data, or even misinterpret data. That concern can be managed with the involvement of AI and data management. Because AI is involved in all the different processes within the system, it can help to minimize human-data interaction, not to mention understanding all the different relationships between the processes. For example, if a plant is tracking the cycle

times of a process and comes up with a way to reduce the time by a minute, that affects almost every part of the system. Inventories need to be increased because the plant can produce more every day, suppliers must be contacted to get more parts, and new efficiency rates must be calculated. If the new cycle times aren't updated everywhere, the whole plant could shut down because of a lack of inventory. AI cuts out many of the middle processes between saving time in the process and producing more every day.

Continuing with the example discussed above, it would be a very long process for a manufacturing plant to be able to shorten the cycle time of a part. Considering plants must identify the weakest point in a system, determine the best way to improve it, find the needed data to support the conclusions made, and then actually sell the idea to management, it can be a very long and difficult process. AI can step in and identify process improvements, assign monetary value to these improvements, and crunch all the needed numbers to save time and effort for everyone involved. AI follows a similar process to the human mind, but "AI's capability to be educated and then correlate and interpret data ... can enable greater supply chain insights and visibility" ("The AI Journey: Artificial Intelligence and the Supply Chain"). To put it in layman's terms, AI can do almost everything a person can do, but better and faster and with better outcomes.

Case Study: An Automotive OEM

Because much of my discussion thus far has been largely theoretical, I did an interview with a large automotive manufacturer to discuss how AI is being used within their processes and with their suppliers. While this company hasn't implemented any advanced AI, they are starting to rely heavily on data visualization and have had internal discussions on how responsibility AI will hold.

One large system the company is currently using is an inventory management system that allows the buyers to predict part shortages and give advanced warning for delayed parts. The system also prioritizes the part shortages, which allows staff to spend their time the most effectively in the time of a crisis. As this tool is continuing to develop, there have been discussions on how much responsibility these machines will get compared to the buyers of the company. Upper management firmly believes that at the end of the day human senses will always be more important than machines, but machines will start taking over more menial work.

One large challenge this OEM is facing is data cleanliness. Depending on the department, this can be a large problem because of the sheer amount of data being used and uploaded. Because this company is so large, it can be very challenging for the different branches to communicate with each other and share accurate data, which is critical for any sort of data analysis. To counteract this challenge, the OEM is in the process of creating a "data ecosystem" that will be a storage location for clean data that can be used to run reports and as a point of reference across all departments. Another large challenge is facing the bureaucracy of such a large company. It can be very difficult getting approvals and new projects initiated because of the long and challenging process, but by identifying that problem the company is able to start prioritizing speed. One more challenge faced by this company is determining how to grow into these technologies without having to outsource. It is very important for this company to grow organically and have systems that are unique to their processes, but as the new AI technology becomes more widespread this will become easier to face. Finally, a large challenge this OEM is facing is finding the employees who are interested in working with data. Data analysts and scientists are in great demand, and this company is feeling the strain of this staff shortage.

On the supplier side, some of this company's business partners have been implementing much more AI and automation to their processes. For example, one supplier has created a

process almost fully automated (with some human support still) that starts with the raw materials, moves them to each processing location, and at the end of the manufacturing process even sequences the parts based on the order from the OEM. A large consequence of all this automation is that if the technology stops working (a software problem, a broken-down machine, a possible quality problem), the plant is largely unable to manufacture parts any more. The staff doesn't have the tools or may not be trained to be able to step in and manually complete the process, which causes many delays and is very costly. As the AI and automation become more and more integrated into a system, this problem will continue to grow.

Future of Artificial Intelligence

As technology is getting more and more advanced, AI is going to become more and more ingrained in every company's processes. It is estimated that "… 60% of all business software will incorporate AI" ("The AI Journey: Artificial Intelligence and the Supply Chain"), and it's arguable that statistic is very conservative. AI can change everything we know about the supply chain today, it's just a matter of continuing to develop the technology and implementing it within company processes. Moving forward, AI can help companies shift from reactive planning to proactive planning, shift employee responsibilities from manual to more managerial duties, a huge increase in automation, and much more data visualization.

In today's supply chain, many of the plant's actions are reacting to what is happening around them. For instance, if a machine breaks down, the production schedule must be re-made to accommodate this stop in production. This is very reactive; employees must quickly determine the best solution to minimize delays and money lost. On the other hand, proactive planning allows employees to start planning for potential problems before they occur, so a recovery plan is finalized and can be set in place much sooner. With an increase in AI implementation in the

supply chain, manufacturing firms are going to be able to shift from very reactive planning to proactive decision making.

As AI is being developed and further implemented, employee's duties and responsibilities are being shifted to help accommodate this. "Artificial intelligence technology serves as an advisor that can make connections based on all relevant data, from internal systems and external like social and news feeds, weather, traffic, and other sources, from learnings caused on prior resolutions, and from any notes your collaborators may choose to upload for future reference" ("The AI Journey: Artificial Intelligence and the Supply Chain"). As AI starts to take over more of the manual or tedious tasks, staff are going to be responsible for more managerial responsibilities. Staff will rely on the recommendations from the AI systems, and as the system learns more things will continue to change.

Automation is going to play a large part in the future of the automotive industry, and many companies have been and continue to implement more machine-based processes to support manufacturing. With an automated process, there is much smaller room for error for critical steps. Human error is a large concern for many manufacturing settings, so if the process is created to rely on automation to ensure the correct procedures are being followed consistently, the overall part quality will greatly improve. In addition to quality, speed is another big benefit of automation in a manufacturing setting. If a machine can do the same five steps over and over again even a second faster than a human, think about how much time can be saved on a daily or weekly basis. Automation is becoming more and more fundamental in any automotive process, which will only continue as robotics continue to advance.

Data visualization is also going to play a large role in the future of AI, especially in the beginning stages of AI implementation. Data visualization includes any sort of diagram, chart,

graph, or picture that displays information in an easy to understand form. For the AI system to display results easily and effectively for a human to quickly understand a situation and what needs to be done, faster and more educated decisions can be made within a company. Some examples of these visualization tools could include trend lines, heat maps to show target areas or problem spots, or even forecast graphs. In the case of a critical situation like part shortages or supply disruptions, data visualization can alert staff to the highest priority parts to minimize consequences.

Conclusion

In conclusion, artificial intelligence is redefining the supply chain, especially within the automotive industry. AI is helping companies streamline processes, schedule production, manage supply risk, minimize supply chain disruption, reduce language barriers, improve customer service and quality control, and improve demand forecasting. With these benefits, there will be quite a few challenges companies will have to face to get the most out of the new technology. The biggest challenges being faced today include a lack of computing power, high cost, the long implementation process, the complexities of language and social cues, the lack of data scientists and other analysts, sharing data, legacy systems, and security concerns. As this technology continues to evolve and grow, more applications of AI will be developed, while the challenges will continue to progress. The sooner automotive companies start implementing AI, the sooner they can start improving processes, produce more efficiently, and save money from a range of different areas of the business. Companies will improve customer service, which strengthens the relationships between the consumer and the OEM, which encourages repeat customers. Stronger bonds can be formed between the OEM and their suppliers, which encourages joint development and overall growth. Every aspect of a business will be affected by this new technology, so sit back, grab some popcorn, and get ready for the newest technological evolution!

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