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Digitizing Automotive Semiconductor Supply Chains to Optimize Performance in Conditions of Constrained Supply

The automotive sector is experiencing chip shortages with no end in sight. In this paper we will discuss the reasons to implement a real time collaborative supply chain network to solve for the current situation, as well as strategically position your future supply for resilience, continuity, and operational readiness.

By Joe Bellini, EVP, One Network Enterprises

CHALLENGING MARKET CONDITIONS

The automotive sector is experiencing chip shortages with no end in sight. In this paper we will discuss the reasons to implement a real time collaborative supply chain network to solve for the current situation, as well as strategically position your future supply for resilience, continuity, and operational readiness.

The 2021 global semiconductor shortage is projected to reduce automotive sales by 20% or more, costing OEM's billions of dollars. Semiconductor manufacturing requires long lead times and thus as demand increased across all channels it proved impossible for semiconductor manufacturers to react to increased demand in the short term. Limited and sporadic part availability is affecting the assembly lines for products like automobiles, trucks, phones, smart devices, appliances etc., which are operating on an intermittent basis.

In a recent article in the Detroit Free Press, GM estimated they had over 15,000 "build shy" trucks stuck in the lot and Ford estimated about 22,000 vehicles awaiting parts. Similar stories have been written about all major OEM's with Toyota cutting global production by as much as 40%. Certain OEM assembly plants slated to reopen before Labor Day will now stay down until fall.

The hit the industry is taking is cyclical, but one that is different than past cycles and represents more of the "new normal" for the industry moving forward. This hit started with the -related global downturn in automotive demand, with sales dropping anywhere from 50 to 80% depending on the country. Given that a vehicle can take 100 or more semiconductors, this led to a significant drop in demand as automotive assembly plants were systematically closed.

MULTI-TIER VISIBILITY WITH CONSTRAINED MATERIAL/CAPACITY SYNCHRONIZED TO FINISHED GOODS DEMAND

Today's constrained chip supply requires a real-time supply chain network control tower which enables multi-party collaboration and transaction execution from the OEM upstream through semiconductor manufacturing. Understanding upstream capacity and the related vehicle volume and mix options to maximize revenue and margin is of critical importance. Increased semiconductor capacity is at least a 6-month (and most likely more than 12-month) window. The ability to plan and execute in real time with multiple parties simultaneously is the only way to deliver on the best business scenarios given the current circumstances.

One Network powers war rooms for many top global corporations today. Dashboards provide full transparency around global demand and supply, sharing the intelligence with trading partners across the ecosystem (those granted permissions to see the data). Using the network capability for demand translation, full bill of material and bill of process is translated upstream across trading partners. Semiconductor capacity commitments can then be used to constrain the order forecast, and the best-case volume/mix scenario can be executed. In this many-to-many, hub-to-hub network, all omnichannel and segment demand can be aggregated on the front end and supported by distributed

The Digital Supply Chain Network™ and NEO analytics architecture with its integrated data model, is ideally suited to meet the automotive semiconductor challenge. It provides a communication foundation across all trading partners in the network ecosystem.

order management and dynamic sourcing on the backend, depending on the node in the network. NEO, One Network's proprietary machine learning and analytics technology, drives the analytics either autonomously or interactively, removing the current error-prone efforts supported by spreadsheets or other manual and non-integrated means.

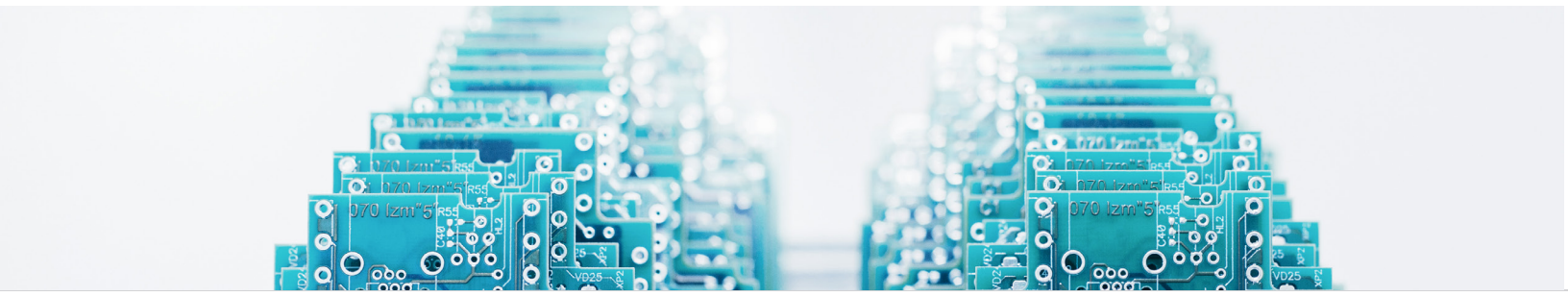
Visibility will be key and the war room dashboard display should include KPI's designed to reflect the demand for automotive components, the built-in semiconductor technology, and the available production capacity for specific semiconductor products. Using this KPI dashboard, the capacity situation for each product group and semiconductor technology can be displayed. This dashboard is accessible in real time across multiple parties in the network (based on permissions), to drive capacity alignment meetings, leverage for investment decisions by the semiconductor suppliers, and to drive risk mitigation actions (such as alternate source) of the automotive OEM and subsystem suppliers.

Moving forward, industry consortiums are being considered to create network leverage through aggregate buying, enabling them to secure more capacity. One Network's NEO Platform that powers its Digital Supply Chain Network™, is the natural platform to enable these capabilities.

SUPPLY CHAIN NETWORK AGILITY

The semiconductor manufacturing process is divided into two primary stages which include the chip manufacturing (front end) and the assembly, packaging and final testing (back end) stage. Both stages may be performed by one manufacturer or can be outsourced to subcontractors or foundries. All tiers in the trading partner ecosystem would benefit from a many-to-many, hub-to-hub based network platform, since the semiconductor manufacturer could be supplying a tier 2, a tier 1, a subsystem provider, or even an OEM.

One Network's Industry 4.0 compatible Digital Supply Chain Network™ and analytics architecture (NEO), is particularly applicable to the automotive semiconductor problem. The integrated data model capability within the platform provides the communication foundation across all trading partners in the network ecosystem. NEO enables seamless transaction flow from planning through execution. IBP/S&OP scenarios are collaboratively planned across the network operating model and once a scenario has been selected, it seamlessly transitions state and is forecasted, planned, scheduled and executed in real time across all trading partners to deliver on the best-case business scenario.



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NEO AI/ML analytics are powerful - from creating best case IBP/S&OP scenarios to establishing capacity and inventory policies through analytics like rolling and capacity/budget-constrained Multi-Echelon Inventory Optimization (MEIO). Constrained order forecasts based on material, capacity and logistics availability, as well as downstream execution visibility and control, are enabled through the platform.

Given that yesterday's systems are providing very little (if any) applicable capabilities based on the problems we are seeing with the current situation, innovation through NEO is an absolute requirement moving forward. Value generation reaches a whole new level with NEO, because the platform is seamless from planning through execution, managing all exceptions to flow, which result from variances in demand and supply along with lags in information sharing.

Automotive OEM's are already suffering from the lack of visibility and collaboration supported by their current IBP/S&OP, planning and execution systems. Their issues only get worse as they are bombarded by exceptions due to variances in supply and demand when they attempt to execute their plans across their supply chain network operations.

Automotive and semiconductor sectors differ significantly in terms of product and manufacturing strategy, which is an important consideration from a capacity planning perspective.

Semiconductor is characterized by frequent changes in manufacturing technology, along with high planned production utilization in the 90-95% range. This high-capacity utilization is necessary due to investment costs and market price competition.

The automotive sector on the other hand is characterized by relatively long product life cycles and very little vertical integration in today's marketplace. The typical vehicle is manufactured for four years, followed by a service life cycle of up to twenty years. Guaranteed long-term availability of electrical components is a requirement.

Another consideration for collaborative capacity planning is the agility of the supply chain network. The automotive industry processes a great number of variants in small lot sizes, while the efficiency of chip manufacturing depends on large lot sizes. And an important requirement in production and assembly for the automotive sector is short lead times, as compared to the longer lead times found in a semiconductor operation.

From an agility perspective, automotive manufacturers are able to increase production capacity even at short notice, for example through extra shifts or the rapid ramp-up of additional production resources. Thus, the automotive industry is designed to respond quickly to demand fluctuations (some of which are self-inflicted).

In contrast, the lead times in the semiconductor industry span 10-16 weeks, given the manufacturing of chips (front end) is very complex and often includes more than 500 process steps. The long lead times in the semiconductor industry require long-term planning horizons and stable planning figures, especially given the full capacity operating practices in place. Typically, semiconductor sector production orders are scheduled up to six months in advance.

NEO provides correlation-based AI/ML to improve predictions. But uniquely also provides causal-based ML to enable prescriptive analytics based on root cause. This enables it to provide options to resolve virtually any exceptions.

With these sector realities, every variance is critical, given the relationship of short supply and planned market mix/volume. Being able to run plans on a daily basis by running prior day execution back up through the network, and resolve exceptions across all trading parties in real time with multi-party collaboration and transaction execution, is the only way forward in the short term.

SUPPLY CHAIN NETWORK ANALYTICS

NEO provides correlation-based AI/ML to improve predictions. But where it is really unique, is in its ability to provide causal-based ML to enable prescriptive analytics based on root cause. This enables it to provide options to resolve any exceptions, along with the expected outcomes based on the potential resolutions.

Workbenches provide an interactive UI framework for users to interact with NEO to resolve exceptions, rather than have to trust a "black box." NEO is the only system in the world with causal-based supply network ML, given a real-time network grid is the only platform capable of providing the right data and representation to the ML algorithm, and the NEO platform is the only platform of this design in the market. NEO ML studies decision patterns that generate improved outcomes and applies that knowledge to future guided resolutions. Users have the options in how NEO operates. They can invoke NEO to solve part of an exception, let it solve the entire problem as part of an RPA, or invoke NEO agents which run autonomously on a continuous basis using targeted KPI's. If the exception runs outside the KPI's (or guardrails as we call them), the problem is elevated to the workbench for user input and guidance.

The automotive sector is notorious for having more data than anyone can handle. As we move toward supply chain network digitization, autonomous agents running on a continues basis within defined boundaries will be a must for optimal performance.

NETWORK STRATEGIES, TACTICS, AND CAPACITY CONSIDERATIONS

The automotive sector will most likely consider moving toward longer-term, capacity-based contracts in the semiconductor sector, in order to secure their upstream network, and thus improving resiliency, continuity, and operational readiness. The fragility of the current operating model with its reliance on Asia as a hub, has put the industry into crisis mode. It is expected that we will continue to see sporadic shutdowns of capacity across Asia, creating significant supply disruption. Just recently we witnessed significant issues related to a Renesas plant fire affecting many OEM's on a global basis.

Securing future capacity is necessary, and can be done in a way that benefits all parties through all cycles by deploying a real-time supply chain network architecture. The effects of this shortage have extended beyond the automotive sector with many industries struggling to purchase chips. The sectors that provide the best trading partner network ecosystem, which removes artificially inflated and fluctuating requirements driven by the enterprise hub--spoke system design, will gain priority in production. Plus, if they represent smaller percentages of total capacity like automotive then a small allocation or expedite can make a big difference.

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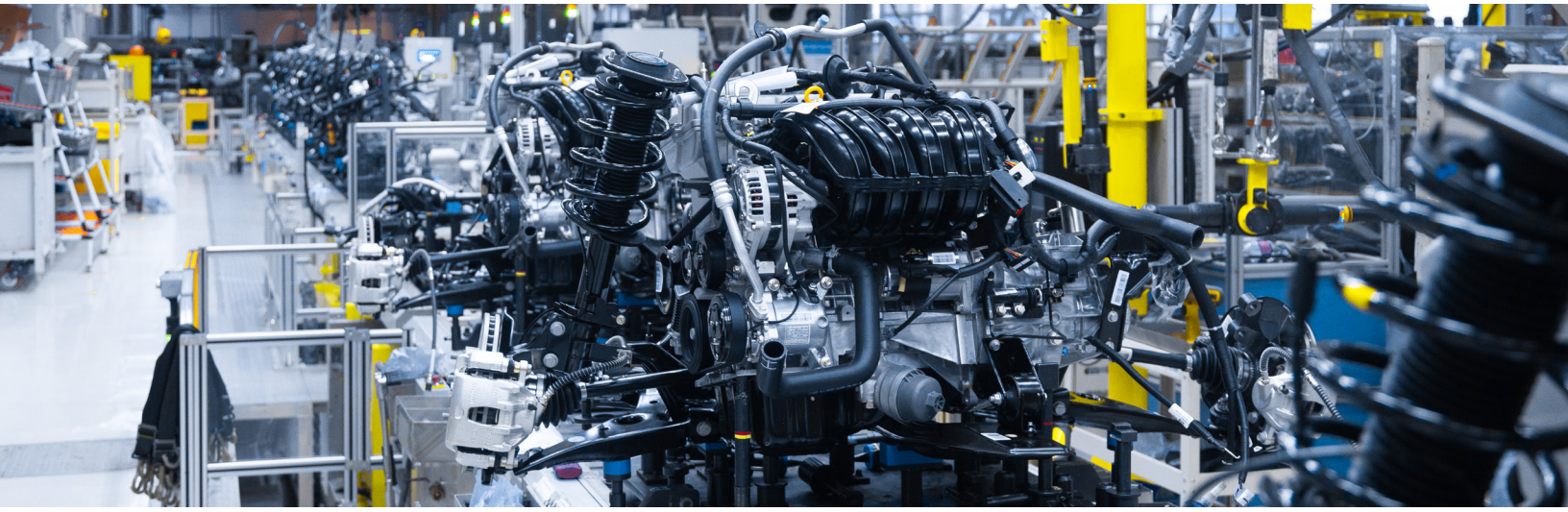

Looking back to 2020, as demand fell off in the automotive sector, it increased for home technology, given the pandemic-driven spike in remote work. The electronics channel consumes greater capacity than the automotive channel, thus a 10% increase in electronics more than offset a 20% decrease in automotive demand. And in fact,the overall demand for semiconductors actually increased.

When the automotive sector began its march to recovery in the second half of 2020, there was no capacity left to allocate, because the sector was already running at full capacity, and typically has only expanded capacity about 5% per year on average. And to make matters worse, chip consumption per vehicle will continue to grow rapidly with expansions in electric vehicles (EV), connected car capabilities, advanced optics, autonomous control, shared mobility, and data services.

Companies with risk management planning capabilities similar to what is available on the One Network platform, compounded the problem for the “have-nots” by reacting to elevated chip supply risk levels. Based on a number of variables related to geopolitical tensions, industry growth, logistical constraints, and supply disruptions they are proactively increasing their chip inventories.

Part sourcing processes in automotive have been finely tuned over the years but continue to lack resiliency. Material authorizations typically only cover a few weeks to a few months, preceded by 6 to 12 month purchase orders. The electronics sector is much more favorable in both areas with higher levels of commitment in terms of both contract length and material authorizations, therefore it gains from this commitment in terms of capacity.

Automotive supply chain network planning for 2020 and 2021 misread the upcoming market scenario. The models which were deployed for planning purposes didn’t appear to have had a bottom-up execution representation of the physical and logical supply chain network upstream, through their tier 2 and semiconductor suppliers. And top down the representation didn’t include an expanded set of geodemographic or geopolitical vectors, along with the right machine learning constructs to drive an improved set of predictions.

The severity of the current crisis will also cause automotive companies and their subsystem suppliers to rethink some of their Just-in-Time (JIT) manufacturing practices. JIT has delivered many benefits, but needs to be balanced within an agile network.

One Network deploys a hub-to-hub supply chain network platform that enables agility across all trading partners. As market conditions shift, whether it be in demand or supply, the network reacts in real time collaboratively, across all trading partners based on permissions granted by the demand hub generating the purchase orders. Thus, there’s no need to worry about inventory disruption using the lower and more streamlined profiles driven by JIT policies, as long as they are housed in a network construct that takes into account mitigating vectors and adjusts those policies as conditions change, both in the long term and the short term. Policies available in the network include supplier or

vendor managed inventory along with statistical, probabilistic, demand-based and pull-based algorithms.

Strategically the problem will continue to worsen for automotive OEM's and their subsystem suppliers. Demand for capacity which produces the types of chips required by automobiles and trucks, is also being generated by much of the IoT expansion across the industry, including 5G radio frequency chips. Capacity is being consumed as fast as it is added, thus the need to rethink contract structures along with gaining visibility and control of the entire network, including taking raw material and rare earth positions upstream of the tier 1 and tier 2 suppliers.

Adding to this problem is the continued shift to more sophisticated electronic componentry in every new vehicle model year. There is potential to redesign certain chips to more of the mainstream technologies being driven by the high tech companies for use in their products, so that additional industry capacity can be applied. However, this would be more at the strategic end of the timeline.
Lead times to add capacity or move to alternate supply in semiconductor range from 6 to 12 months and longer, depending on supplier qualification procedures. Thus, it's unlikely that chip capacity will catch up to demand in the short term.

This makes it critical to take a full network view to plan the best volume/mix possible for the business, with the capability to react to execution issues in real time, so that the planned volume/mix is updated daily and delivered to the customer on quality, on time and in full.

NETWORK DECISION-MAKING AND PROBLEM RESOLUTION

Trust between trading partners will be key moving forward. The practice of over-ordering given anticipated allocations is a leading cause of the bullwhip effect upstream through the supply base. Subsystem providers along with their semiconductor suppliers continue to complain about the lack of visibility to real demand information.

Moving to a real-time, single version of the truth, multi-party supply chain network is the best option to make the best out of a difficult situation in the short term. Continuing to suffer with the systems that contributed to the problem will likely lead to even bigger problems in the future.

Bring your trading partner ecosystem onto the Digital Supply Chain Network™ for a real-time, multi-party planning and execution experience. Align goals from the OEM upstream through the subsystem, tier 1, semiconductor and overall tier 2 suppliers along with upstream visibility to raw materials. With a fully engaged network, you wasting money covering for the inefficiencies in the old ERP-based hub-and-spoke model - which as everyone has now experienced - is a disconnected web of misinformation.

These savings can be intelligently redeployed where scenarios have proven that paying a little more on the supply side of the equation will have big improvements on fulfilling profitable demand. This would include smart expedites in wafer production or by using more expensive chips or chipsets in order to complete vehicles and generate revenue.
Once on the same network, the differences between the two supply chain structures can be harmonized, bringing the more adaptable automotive sector together with the more stable but somewhat inflexible semiconductor sector. The supply chain network will provide both the stable planning and longer planning horizons required by the semiconductor sector, along with the more agile and adaptable automotive supply chain network operations. Furthermore, the advanced analytics will help plan where fluctuations require inventory protection and where they don't.

In fast growing and global markets, we will always be faced with cycles of overproduction and underproduction, especially given the contrast in manufacturing strategies and the related capacity planning. With all trading partners in the same network issues can be significantly mitigated, and market growth opportunities exploited.

Bringing the automotive subsystem supplier processes onto the network generates value in all time horizons from planning through execution. The process today provides orders and delivery schedules to the semiconductor suppliers across a 6-month planning horizon using a weekly update.

The semiconductor suppliers aggregate and review the orders across all customers and release them as order backlog to

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Through demand translation across the network the semiconductor suppliers will understand the relationship between car models and chips. This will enable the semiconductor planners to analyze market trends and reliably apply them to their future production requirements.

their capacity planning system. The semiconductor sales department builds forecasts based on these received orders, customer contracts, and market trends. These forecasts along with the order backlog are then used to drive the capacity planning process in order to plan and allocate capacities across product groups and semiconductor technologies. Capacity issues are addressed as part of the S&OP planning meetings which lay part of the foundation for future investment decisions. Bringing this process onto the network will drive significant benefit. Visibility for the semiconductor planners on their product's end user market will move from being very limited to being real time or near real time.

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The process moves from having a limited ability to collaborate with more than one supply chain trading partner/network node at a time, to one that is multi-party enabled. This then drives alignment and communication capability enabling investment decision-making between the automotive supplier and the semiconductor supplier. Given there remains material variance in automotive demand in the 3-to-4-month window, released production orders are still subject to change; thus a seamless transition from planning through execution addressing all exceptions with strong analytics is essential as part of the process.

And finally, demand from the automotive OEM and their subsystem suppliers undergoes a number of planning cycles prior to reaching the semiconductor suppliers. Every tier as demand moves upstream takes several days to adjust requirements, even if it is vertically integrated in the same enterprise, simply due to the vast number of ERP instances. This forces all suppliers to operate from inflated and fluctuating requirements along with the parameters driving those issues being hidden inside sophisticated systems and not well understood. And most processes at a tier within the network focus on managing within their plants rather than between plants.

As a result, the semiconductor suppliers would be affected by large demand fluctuations even if the original demand of the automotive OEM was stable. However, demand stability issues do make the situation worse. We have seen final assembly downtime due to reconciliation issues announced just weeks ahead of line shutdown, 830 volatility with 100's of changes per week, vehicle mix adjustments as high as 30%, and material release shifts of over 25% on a week to week basis.

FUTURE FORWARD

Looking to the future, capacity alignment between the automotive OEM's and their semiconductor suppliers across major product groups and semiconductor technologies is essential. The network is designed to flow demand upstream across all time horizons, strategic, operational, and tactical.

NEO analytics will identify all planning errors and potential capacity bottlenecks, as well as being able to calculate investment needs for required semiconductor technologies.

The multi-party capabilities of the Digital Supply Chain Network™ provide a significant leverage point for collaborative capacity planning in the ability to improve the inflated and fluctuating demand data within the supply chain. Essentially the volumetric and mix swings caused by the upstream material planning tiers in the network, are eliminated with the semiconductor suppliers having real-time access to demand data from the OEM or the subsystem supplier, based on permissions.

The data distortions of the past will be eliminated, thus enabling a harmonized capacity planning capability across all trading partners in the network.

Within the automotive subsystem supplier market, One Network has already activated and deployed capabilities which provide automated monitoring and alarm functions through predictive analytics. NEO autonomous agents run on the network, and are designed to respond in real time to potential issues, within user-specified parameters. When those parameters are exceeded, they elevate the issue to a workbench to enable user interaction and resolution.

Networks are also very useful when applying postponement strategies for inventory so that optimal demand fulfillment scenarios can be successfully executed. As automotive companies and their semiconductor partners collaborate on the design side of the semiconductor, providing for later configuration downstream through either soft/programmatic approaches or hard/modular approaches, enables later stage decision-making to have a big effect on mix flexibility and inventory positions.

Standard component approaches also make it easier to structure alternate sources in the network, providing flexibility, cost advantages and improved resiliency in the face of escalating risks. With a standard components approach, several suppliers can be qualified for a single component. Customized products like ASIC's typically contract with a single supplier, due to the quality and testing requirements. To gain flexibility, a good practice is to qualify several production lines in this situation.

Something to think about is whether to guarantee capacity by contract to avoid capacity bottlenecks. This essentially becomes a risk-sharing agreement between the automotive OEM or subsystem supplier and the semiconductor manufacturer. The power of Digital Supply Chain Network™ is a big factor in this case, given there is no better way for trading partners to manage risk than with a real-time, single version of the truth.

ACHIEVING RESILIENCE, CONTINUITY AND OPERATIONAL READINESS WITH A SUPPLY CHAIN NETWORK

The advantage of enabling a real-time supply chain network to solve for the Automotive semiconductor problem is clear. First, it enables the ability to optimize business performance by executing the best mix possible to meet available demand based on constrained supply, while solving for any exceptions that occur in meeting demand and executing on performance expectations. Second, will be the prevention of major deviations between supply and demand of semiconductor components on a long-term basis, along with the ability to ensure production capacities and stock levels are in line with changing market conditions – delivering Resilience, Continuity, and Operational Readiness.

JOE BELLINI

Joe is certified in AI/ML from MIT Sloan, is an alumnus of Harvard Business School, and holds degrees in Applied Mathematics and Statistics and Mechanical Engineering. He is a past award winner in the Mathematics Olympiad competition, authored the patent for Extended Enterprise Planning across a Supply Chain, and has been listed by Supply and Demand Chain Executive Magazine as a Pro to Know for the past two years.

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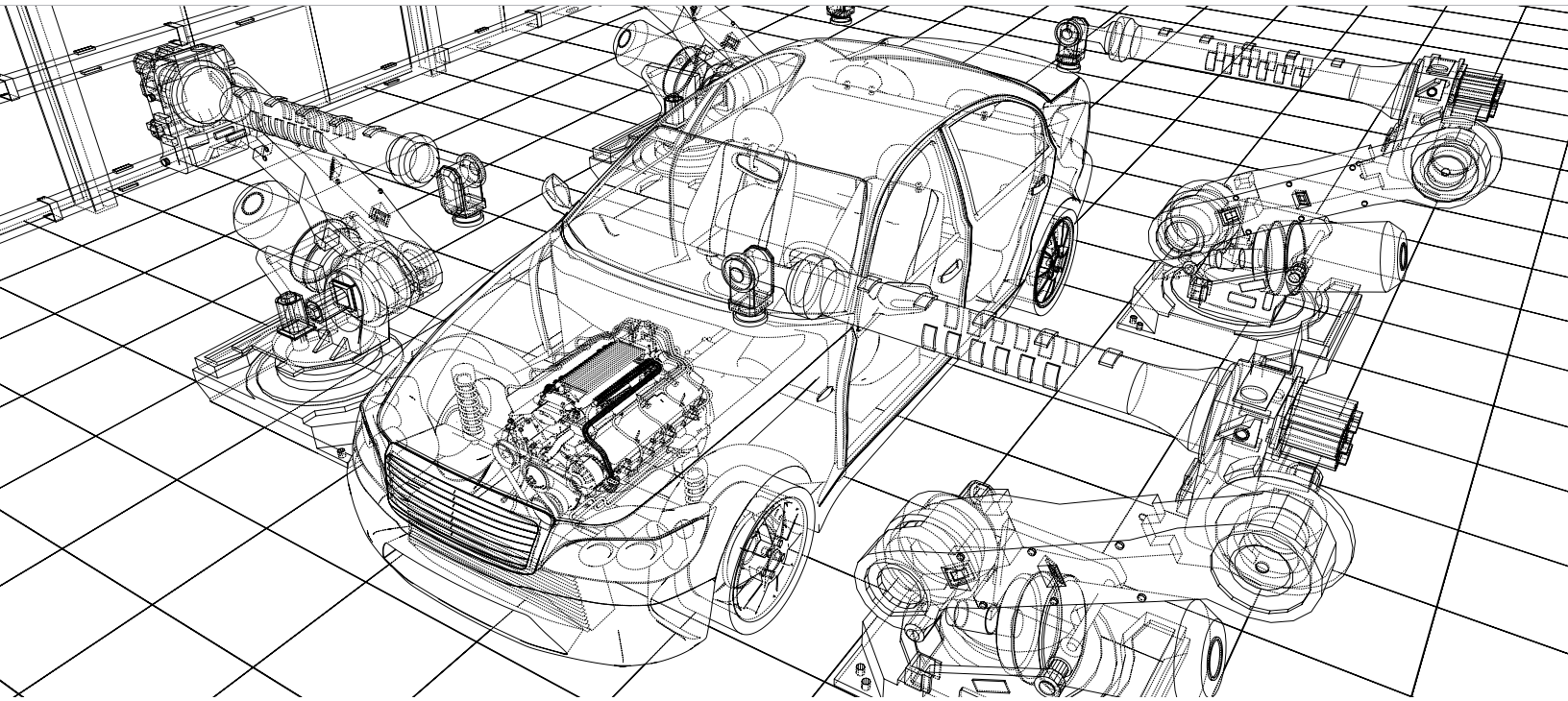

ABOUT ONE NETWORK

One Network is the leader in intelligent control towers for autonomous supply chain management. From inbound supply to outbound order fulfilment and logistics, this multi-tier, multiparty digital platform helps optimize and automate planning and execution across the entire Digital Supply Chain™ network and every trading partner. Powered by NEO, One Network's machine learning and intelligent agent technology, real time predictive and prescriptive analytics enable industry-leading performance for the highest services levels and product quality at the lowest possible cost. It's the industry's only solution with a fully integrated data model from the consumer to suppliers and all logistics partners, providing a network-wide, real-time single version of the truth. Leading global organizations have joined One Network, transforming industries like Retail, Food Service, Consumer Goods, Automotive, Healthcare, Public Sector, Telecom, Defense, and Logistics. Headquartered in Dallas, One Network has offices across the Americas, Europe, and APAC. For more information visit www.onenetwork.com

One Network Enterprises™

US Corporate Headquarters

4055 Valley View Ln, Suite 1000
Dallas, TX 75244

+1 866 302 1936 (toll free)
+1 972 385 8630
inquiries@onenetwork.com
www.onenetwork.com

One Network Europe

Office 3.03
1 King Street
London, EC2V 8AU

+44 (0) 203 28 66 901
europe@onenetwork.com

One Network Australia/ Asia-Pacific/Japan

+61 401 990 435
cedwards@onenetwork.com

One Network India Pvt Ltd

Westend Centre III, Survey No. 169/1,
Second Floor, South Wing, Sector 2
Aundh, Pune 411007, Maharashtra, India

+91 20 49111800
indiasales@onenetwork.com

One Network Russia

+7 916 303 2351
russia@onenetwork.com