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RESEARCH

A man with a beard and glasses, wearing a blue work shirt and blue gloves, is working on the metal frame of a car in a factory. He is looking intently at his work.

Data driven digital platforms
for automotive transformation

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Executive summary

It is almost cliché that the automotive industry is undergoing transformational change. Perhaps not since the Model T first revolutionized the industry has so much change come so quickly. Driving this evolution is the unstoppable momentum of a Connected, Automated, Shared, and Electrified (CASE) driven digital transformation, which is upending established norms and re-imagining the industry from the inside out. Linear, product-focused business models built on structured data are being replaced by collaborative, data-driven business ecosystems incorporating a broad group of traditional and non-traditional stakeholders and data types. The new value creation frontier is a differentiated, highly-curated, personalized customer experience.

Two key initiatives in this transformation are smart manufacturing/Industry 4.0 and the emphasis on increased collaboration between stakeholders. Critical to this transformation is the ability to eliminate organizational data silos and mine this rich and diverse data stream to derive the next-generation insights to support effective decision-making and innovation at scale. Data analytics, artificial intelligence (AI), and machine learning (ML) are key technologies that provide the tools to achieve these objectives.

From an operational perspective, monolithic legacy enterprise resource planning (ERP) systems are being reimagined as smart, contextual, and agile digital innovation and collaboration platforms, consisting of a core industry-specific, cloud-based ERP combined with a strategic integration platform for supplemental applications. This modular architecture provides the vital agility, visibility, and scalability capabilities essential for automotive companies to compete and thrive in an ever-evolving environment.

Key takeaways and recommendations

1. The automotive industry is being disrupted like no other; linear, static business models are giving way to dynamic, data-driven digital business ecosystems with diverse internal and external stakeholders. Companies that provide a differentiated customer experience will pull ahead of the competition.
2. Manufacturing is growing increasingly agile as last-minute changes, continuous upgrades, and shortening product lifecycles become the norm. Smart Manufacturing/Industry 4.0 is the defining characteristic of the factory of the future, and every organization should have a Smart Manufacturing strategy and implementation plan.



3. Near real-time collaboration and visibility across the ecosystem are crucial for rapidly responding to changes in the business environment, mitigating risk, and accelerating time to market. Business and technology architectures should be geared to supporting these requirements.
4. Data is a key strategic asset. Every organization should have a strategy that eliminates data silos and incorporates tools and technologies to derive next-generation insights from structured and unstructured data for more effective decision-making.
5. Traditional, on-premise ERP-centric business and technology architectures are no longer adequate. Companies need an agile, cloud-based (SaaS) digital platform comprising an industry-specific core ERP for standard business processes and an integration engine to connect with external (intra and inter-enterprise) applications and capabilities, to compete and thrive in the new automotive “normal.”

This paper will explore these themes in greater detail. One thing, however, is very clear: Inaction is not a reasonable option. Success in the automotive industry requires next-generation insights delivered through cloud-enabled digital transformation.

Are your organization and technology architecture equipped for success in this new era?

New demands on the automotive enterprise

In the face of this transformative CASE-driven change, leading automotive enterprises are revisiting established business models, business processes, and information technology foundations. Although conventional business objectives (i.e. financial performance, operational efficiencies, etc.) remain as salient as ever, new industry imperatives are taking on increasing importance:

- **New business models:** New “as a service” business models (e.g., transportation as a service, software as a service, software-defined product features, and upgrades) are driving new products, services, and revenue streams. Challenges will exist in identifying, building, and monetizing new offerings while simultaneously developing and producing “traditional” offerings.

“ **The future of the automotive industry is built upon shared synergies and cross-industry partnerships.**

DANIEL LI
CEO, Zhejiang Geely Holding Co

To illustrate, automakers must continue providing highly-demanded internal combustion vehicles such as pickups and SUVs while simultaneously ensuring they position themselves to benefit from the move towards alternative energy sources. Shareholders will not be forgiving, and survival will be put at risk if financials suffer as a result of abandoning profitable segments too early.

- **Customer centricity:** Industry-wide efforts are underway to provide ever greater levels of personalized, contextualized experiences across the customer lifecycle. Critical to these efforts is providing connectivity and visibility across all customer channels (including web, mobile, social, etc.).
- **Product centricity:** Next-generation technologies (i.e., connected, smart, predictive, autonomous, electrified) are transforming how innovation is brought to vehicles. The emphasis on new features is shifting from hardware to software-defined capabilities and a subscription-based deployment. For example, vehicles can now be upgraded continuously over the air rather than maintaining a fixed set of capabilities during their lifetimes.



- Cross-industry collaboration:** As traditional business models are being disrupted, connected and collaborative data-driven digital ecosystems (incorporating a diverse and constantly evolving group of stakeholders) are emerging. Not long ago, it would have been inconceivable to include finance and insurance companies, cell phone and telecom providers, streaming content providers, concierge and wellness services, and even dining and retail establishments as part of the automotive ecosystem. However, this is where we find ourselves today. Echoing this sentiment, Daniel Li (CEO of Zhejiang Geely Holding Co) remarked: "The future of the automotive industry is built upon shared synergies and cross-industry partnerships."¹ Figure 1 illustrates this ecosystem.
- Need for visibility, agility, resilience, and risk mitigation:** Automakers face continued challenges in anticipating and managing changes within the rapidly evolving business, geopolitical, technology, and security environments. Few things illustrate this better than the supply chain mayhem caused by the COVID-19 Pandemic.

- Critical to success in these endeavors is end-to-end, real-time visibility to support improved sense-and-respond capabilities.
- Sustainability:** As global competition and consumer choice intensify, automakers seek ways to bolster long-term customer relationships and minimize negative impacts on society and the environment.

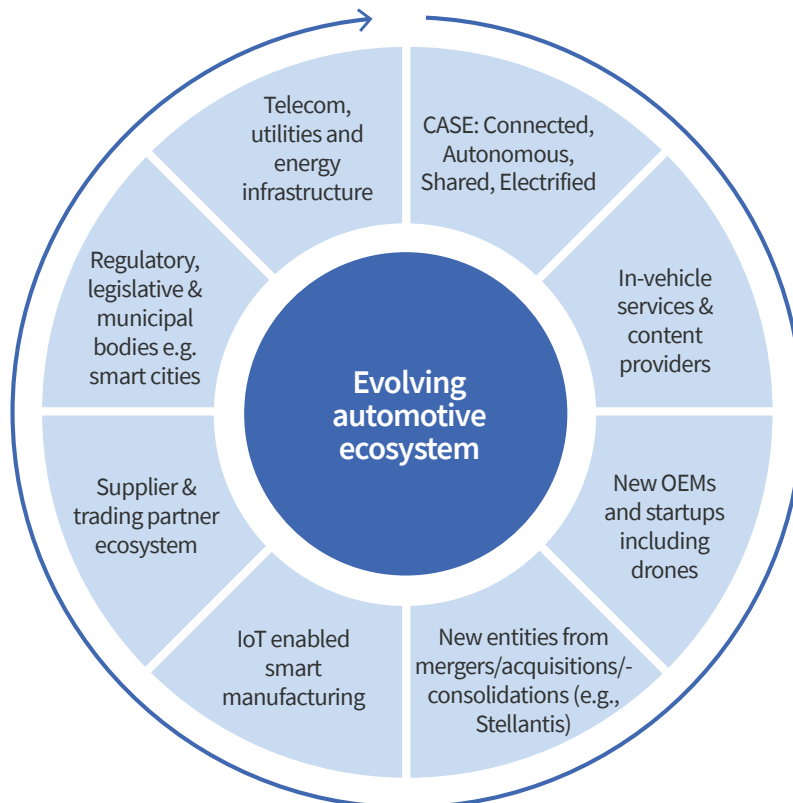
Two key industry initiatives to address the changes

As discussed below, two specific initiatives play a key role in helping the automotive industry address these imperatives.

1. Connected manufacturing / Industry 4.0

The automotive industry has a long history of continuously improving product quality and production efficiencies. In terms of the latter, manufacturers have begun the journey of implementing Industry 4.0 technologies, sometimes also referred to as "smart" or "connected" manufacturing.

Figure 1: The evolving automotive ecosystem





The concept emerged at the turn of the millennium, introducing IoT-enabled cyber-physical systems to share, analyze, and guide intelligent actions for various manufacturing processes. Connected manufacturing aims to improve overall equipment effectiveness (OEE) and leverage data analytics to optimize the supply chain, logistics, demand forecasts, production planning, and scheduling, quality control, and capacity utilization.

However, as a whole, manufacturers are only just beginning to realize the true potential of Industry 4.0. It is important to emphasize that this digital transformation offers the potential to redesign and optimize the entire global manufacturing footprint, positioning factories closer to markets, reducing logistics nightmares, and increasing the visibility between ecosystem partners, including manufacturers, suppliers, and customers. Furthermore, in a capital-intensive industry such as automotive, Industry 4.0 technologies can significantly positively impact return on invested capital (ROIC) and profitability.

The smart, connected factory is defined by several important characteristics:

1. **Improved customer experience:** Consumers increasingly demand highly personalized products as part of an enhanced customer experience. Industry 4.0 can provide the manufacturing agility, flexibility, and efficiency to offer customers such highly personalized products and services, thereby enhancing their brand experience, increasing loyalty, satisfaction, and ultimately, profitability.
2. **Production close to market:** To reduce delays and transport costs, leading manufacturers are building smaller smart factories closer to the customer. Redesigning the manufacturing footprint is especially imperative for the automotive industry, with its notoriously complex, fragile, and logistically challenging global operations and supply chain
3. **Integrated operations:** Manufacturers must tightly integrate and streamline processes across demand management, shop floor operations, and supply chain to realize efficiencies and maximize profitability

4. **Global operational visibility and control:** Reacting quickly to (and anticipating) supply chain and other operational challenges.

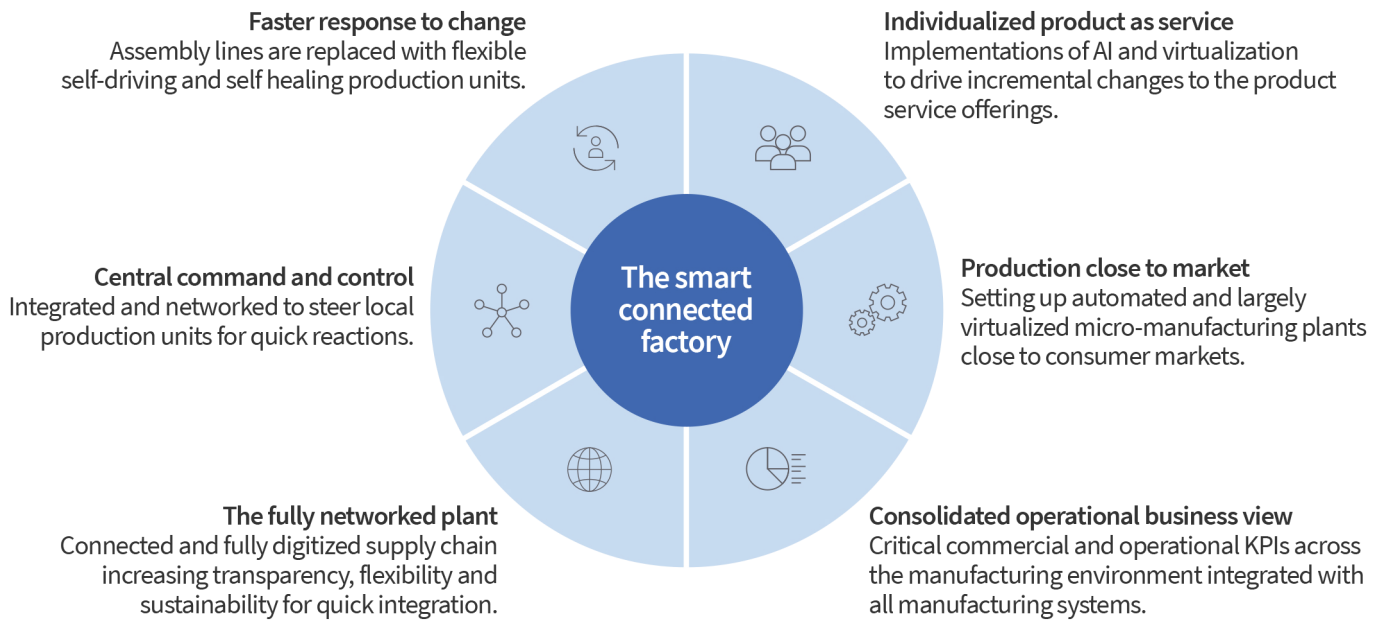
Achieving the goals of Industry 4.0 is not a simple endeavor, particularly from a technological perspective. At a high level, automakers will need an integrated information system encompassing the entire value chain (including a single view of orders, shipments, and inventory). This system must also provide timely visibility to supply chain disruptions and a rapid response capability to address them and improve supply chain performance over time. Additionally, an advanced digital foundation will enable greater levels of intelligent automation by leveraging artificial intelligence and machine learning-driven insights and actions, further improving the end-to-end manufacturing process. Figure 2 (below) visually represents the capabilities required for the Smart, Connected Factory.

2. **The evolution of collaboration—from adversaries to partners to real-time decision networks**

As automotive processes evolve, so too does the way that ecosystem partners work together. To illustrate this fact, let's briefly consider the history of OEM relationships.

Early iterations of OEM and supplier relationships could be characterized as hierarchical. In other words, the OEM defines a work package, and the supplier delivers to the specifications required by the OEM. Relationships during this phase were often dominated by conflict and pressure to reduce prices rather than real collaboration. Also, during this phase, suppliers were often seen as replaceable. Occasionally, in this model, suppliers were able to find some leverage. A case attracting major attention during the 1990s occurred when a supplier of door locks challenged the price decreases demanded by a major OEM in Germany. The supplier refused the new prices, stopping the supply of parts to a high-volume assembly line for four weeks.

Figure 2: Capabilities Required for the Smart, Connected Factory



Such showdowns became rare during the next phase of OEM/supplier relationships. The prevalence of strategic relationships increased as OEMs relied on more complex subassemblies and highly specialized components provided by suppliers. This phase was characterized by joint research and development activities and more information sharing with a select group of strategic suppliers, sometimes leading to sole-sourcing.

More recently, these strategic relationships became stressed during the COVID pandemic of 2020. A series of disruptions led OEMs to conclude that they may have become overly reliant on individual suppliers. In addition, the long-established JIT (just-in-time) model of inventory control suddenly became a potential source of shortages and assembly disruptions. Automakers, expecting sales to decline, reduced semiconductor orders, only to find that they faced serious future stock shortages—hampering new vehicle production today. Many OEMs are actively adjusting their supplier strategy. Toyota—ironically, the pioneer of JIT—has, for example, raised inventory levels for semiconductor chips. Others such as Ford have invested in deeper vertical integration to control the supply of microchips, while VW and Tesla have managed to secure EV raw materials.

These recent developments spawned a new, more evolved OEM and supplier collaboration paradigm involving global collaborative networks characterized by greater transparency and more connected planning. Under this scenario, OEMs are concentrating on their ability to identify new threats early and react quickly. At the same time, efforts are being made to integrate suppliers more tightly into OEM production schedules.

Optimizing this market-driven supply chain will require leveraging data from ever-more-connected consumers, factories, automobiles, and trading partners. Gathering and analyzing this data will enable manufacturers to reduce business risk and become more agile by identifying potential supply issues, increasing efficiencies, and giving customers more accurate timelines. Better yet, predictive analytics can anticipate supply constraints, with manufacturers able to adjust their supply networks proactively.

To support this new connected supply chain paradigm, OEMs and suppliers are being continually challenged on two fronts: first, business processes must be reengineered to rationalize, harmonize, and coordinate activities across OEMs and suppliers. Second, and perhaps more of a challenge, efforts must be made to eliminate siloed and heterogeneous information systems that hinder collaboration within the ecosystem.



Data—a key strategic asset

As businesses become more connected (i.e., connected consumers, vehicles, factories) and enterprise processes become more digitally transformed, it is also critical that information technology and data strategies evolve. This becomes clear when considering the sheer volume and variety of data enterprises must manage today. According to some experts, the amount of data society generates, uses, and retains doubles approximately every four years. Simultaneously, data variety will also explode, consisting of data from traditional structured enterprise transactional systems (PLM, ERP, CRM) and new unstructured or semi-structured data sources (IoT connected devices, web clickstreams, social, sensors, GPS, logs).

Effectively managing this complexity is increasingly becoming “top of mind” for automotive decision-makers as the industry increasingly relies on digitization. For example, automakers are turning to virtual testing and digital twins to reduce destructive physical testing.

These petabytes of data need to be brought together to extract maximum value from advanced technologies such as machine learning and artificial intelligence to achieve next-generation business process performance and enterprise decision-making.

Bringing all data together

As is the case with most mature industries, the automotive industry is continually challenged by the existence of data silos. In many ways, however, the requirements imposed by new digital and connected business processes have made these traditional barriers even more noticeable.

As a direct consequence of complex regional and divisional business operations, in addition to ongoing merger and acquisition activities, structured enterprise transaction data is often stored in multiple instances of different business systems (ERP, CRM, SCM, etc.). These enterprise system data silos can cause ongoing challenges in supporting new real-time business process requirements and accurate and timely reporting.

At the same time, new data sources from the connected world, including semi-structured data (IoT and sensor data, internet clickstreams, vehicle clickstreams, GPS, Social, etc.) and unstructured data (images, audio, etc.) have typically been managed in separate systems, isolated from the core enterprise transactions systems described previously, creating yet additional data silos. These data silos are directly contrary to the goals of a digitally transforming organization.

Data as the foundation for next generation insights, machine learning, and AI

Next-generation automotive excellence will be characterized by companies anticipating and reacting to business conditions in real-time across all aspects of their operations. Successful companies will harness meaningful data, including traditional data sources and the “new” data types described earlier. This data forms the foundation of learning and the ability to make advanced real-time decisions. Examples of modern applications that leverage data to make real-time decisions include predictive vehicle maintenance recommendations, personalized marketing offers, and “digital twin” simulations of manufacturing operations.

So exactly why is data important in this regard? As it turns out, humans and machines “learn” similarly. For any given situation, both humans and machines must first absorb experiences (data), followed by applying a set of rules (algorithms) that facilitate problem-solving. Whether positive or negative outcomes, humans and machines learn from the exercise. The ability for enterprises to “learn” from historical experiences and then predict an appropriate current action is the foundation for effective real-time decision making, including next-best actions and personalized recommendations—the foundation for customer experience excellence and business process automation. For this reason, data forms the foundation for machine learning and artificial intelligence and why next-generation data management platforms incorporating all data are essential for digitally transforming organizations.



The transformation of ERP to a digital innovation platform

From static to dynamic

Historically, companies have architected their organizations and IT portfolios to be enterprise-centric, and the traditional on-premise, monolithic ERP model was a cornerstone of this approach. However, this inside-out model, with static, scheduled interfaces to the “outside world,” is inadequate for the demands of a dynamic, constantly changing, real-time business environment. In addition, historical ERP systems focus mainly on structured data resulting from ERP transactions, not the less structured data that characterizes today's “newer” data types (i.e. IoT, clickstream, social media). As discussed above, this siloed, intra-organizational, and structured data focus does not provide the agility to adapt to and get ahead of current and anticipated business conditions.

Modular instead of monolithic

The monolithic legacy model is giving way to a more modular, standardized cloud-based “hub and spoke” networked approach, which can adapt and scale in line with business priorities. According to Gartner®, “Monolithic ERP applications are no longer the center of gravity for enterprises. Rather, the capabilities to integrate, manage data, secure data and applications, and identify and provide optimal user experience have become the focus; often given the overall enterprise strategy rather than simply a core ERP focus.”² The modular ERP approach is built around a core, vertical-specific ERP solution as a strategic integration platform to connect to supplemental applications, potentially from multiple vendors. This core ERP becomes the foundational platform enabling agility and innovation at scale. Automotive-specific enhancements are easily added through the multi-tenant cloud and deployed without individual configuration requirements. This enables the ERP platform to deliver a dynamic mix of integrated, industry-specific capabilities which evolve in sync with the latest industry needs.

Smart, contextual, and agile

At this point, one might ask how and why a modular IT architecture is important for agility and innovation at scale, which we have suggested are non-negotiable capabilities for success. To a large extent, the answer lies in the ability to rapidly sense and respond to changing business conditions and anticipate them.

Every aspect of the enterprise—from product development to after-sales and warranty support—must be in sync and operating at the same clock speed. This requires smart, contextual, and agile systems—attributes not typically associated with legacy technologies.

Doing business digitally demands the ability to rapidly add or subtract functionality in line with changing business needs. Furthermore, technology tools such as a data lake, analytics, artificial intelligence, and machine learning among others, are typically embedded within modern ERPs. These tools are essential for extracting business value from the massive data streams generated by digital ecosystems. By some estimates, up to 80% of the data an organization needs resides outside the four walls, underscoring the need to interact with various applications and technologies. Data is, in fact, a key strategic asset that we have discussed above.

Architected for the speed of digital business

Stakeholders in a digital network need real-time (or near-real-time) role-based visibility into the network to make timely business decisions. Given the speed of digital business and the need mentioned above for visibility, a cloud-based (SaaS) enterprise platform or “digital backbone” is the recommended way to connect stakeholders to the capabilities they need and provide a unified, tailored, and consistent view of information. The table in Figure 3 below summarizes differences and key trends in the move from traditional ERP (on the left) and its reimagined evolution to a digital innovation platform (on the right). These are further grouped into three broad categories: People, Process, and Technology.

Conclusion

It is often said that success belongs to the prepared. In today's digitally transforming and connected automotive industry, being prepared requires a wholesale re-evaluation of traditional business processes, technology capabilities, and corporate culture. Critical across each of these dimensions is effectively harnessing the power of data. Moving forward, success will reward those enterprises who most effectively align critical new data management skills with modern information technology platforms to enable real-time, dynamic business processes and decision-making—the beating heart of the next-generation automotive enterprise.

Figure 3: The Evolution of ERP

FROM (LEGACY)	TO (MODERN)
People	
Access for a few well-trained users	Role-based, extended enterprise access
Dependence on scarce, highly-skilled technical resources, complex implementation	Low/no-code capability allows “citizen” developers to extract value directly; industry-specific, preconfigured for rapid time to value
Complex/opaque user interface/experience; physically constrained access (desktop/laptop)	Transparent, engaging user-centric design and experience. Anytime, anywhere, any device access.
Process	
Intra-enterprise (within the four walls) focus; static interfaces, limited interoperability, visibility, and collaboration	Inter-enterprise (beyond the four walls) focus; Near-real-time, dynamic visibility and collaboration, greater inter-operability
Process driven with limited optimization	Business capability and data-driven; embedded AI/ML capabilities for process optimization
Technology	
On-premise, monolithic ERP, inflexible, sometimes out of sync with business	Cloud-based, Industry-specific, scalable, modular, integrated digital platform; always current and aligned with business
Structured data, multiple data sources, after-the-fact transactional reporting	All types of data, single source of truth; Smart/contextual, data-driven analytics with embedded AI/ML
Focus on stability, standardization, and integration; challenging to integrate advanced technologies, e.g., Industry 4.0	Focus on agility and innovation; modular design facilitates the integration of new technologies and capabilities
Cybersecurity vulnerabilities/constant patching and software updates	Hardened cloud-based infrastructure

About the authors

The Center for Automotive Research is an independent non-profit that produces industry-driven research and fosters dialogue on critical issues facing the automotive industry and its impact on the U.S. economy and society. CAR researchers closely track current and future global automotive industry and technology trends and assess their impacts. CAR researchers also study international collaborations and stay abreast of changes in international trade and regulatory environments, the development of technology standards, and the deployment of new vehicle technologies.

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For citations and references to this publication, please use the following:

Dransfeld, H., Ger, M., Maithel, P., Smith, B., Data driven digital platforms for automotive transformation, The Center for Automotive Research, 2022

¹ Automotive News, June 20, 2022; <https://www.autonews.com>

² Predicts 2022: Postpandemic Recovery Optimism and New Strategic Growth to Fuel Investment in ERP, Gartner, 14 December 2021. GARTNER is a registered trademark and service mark of Gartner, Inc. and/or its affiliates in the U.S. and internationally and is used herein with permission. All rights reserved. <https://www.gartner.com>

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