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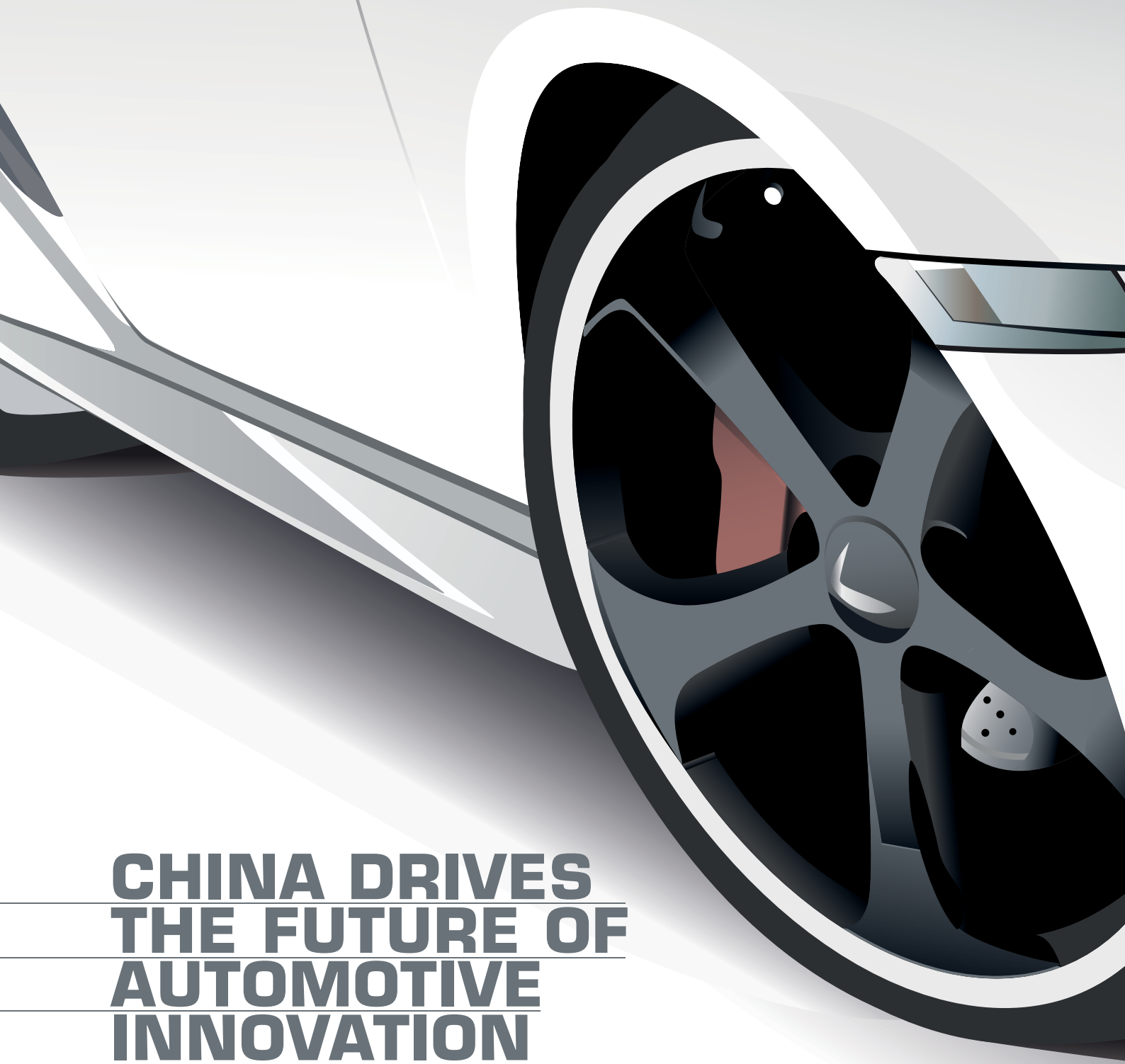

CHINA DRIVES THE FUTURE OF AUTOMOTIVE INNOVATION

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Connected World.
Connected Solutions.

Preface

For global automakers, Asia Pacific, and above all China, represents the greatest opportunity for growth in the 21st century. In 2009, China surpassed the US as the world's largest market by volume, and has remained the leading global auto market ever since. Despite a recent slowdown, China will likely surpass 25 million units in annual car sales in 2015. Over the coming decades, China will remain the key battleground to dominate of the global auto industry.

However, this battle will not be waged using the conventional automotive technologies which have been refined over the past century. We believe several driving forces, which are particularly evident in China, have the potential to disrupt the status quo of the automotive industry:

- The **unique context of China's urban transportation challenge, the high penetration rate of mobile internet, combined with the rapid and aggressive introduction of alternative mobility and ownership concepts,** are compressing the time needed to commercialize smart, connected car technology and related services.

- **The automotive value chain is being disrupted** by non-traditional players as they enter and compete to deliver mobility solutions. **Disruptive new entrants are utilizing big data to draw insights about customers' mobility patterns in order to address their "pain points" and offer new solutions for their mobility needs.** Such mobility needs are increasingly being met through on-demand and shared services versus individual ownership.

We believe that the confluence of these forces, along with rapid innovation to address "pain points" associated with mobility in the China context, are positioning China as the catalyst to drive the transformation of the business model and technological underpinnings of the global auto industry.

The Personal Mobility Revolution

Henry Ford's introduction of the moving assembly line in 1908 changed the world: making automotive transportation affordable for the masses, accelerating the industrial revolution, and shaping the distribution of economic wealth. While we have witnessed great technological advances over the past century, the business models and products of the automobile industry still resemble those pioneered over a century ago. Recent advances in the world of mobile connectivity, big data and social networks are now infiltrating the traditional realm of the automotive industry, making the auto industry and its business model ripe for digital "disruption".

The first wave of the personal mobility revolution is illustrated in Exhibit 1. This first wave of innovation was sparked by two key inventions: the use of an internal combustion engine to power the coach in the late 19th century, followed by Henry Ford's introduction of the moving assembly line in the early 20th century, making individual car ownership affordable for the average wage earner.

In over 100 years since it was pioneered, the "mass production" business model has only changed incrementally. While there have been significant technological advances as well as paradigm shifts in organizing automotive supply chains and assembly operations, one cannot deny the fact that the car today is still propelled by an internal combustion engine, and is assembled in a mass production environment that certainly is more sophisticated, but is still rooted in 20th century industrial practices.

It is a lesson of history that all great dynasties must eventually be replaced. This lesson also applies to business models; they are only relevant for a finite period of time and must then be transformed or replaced. There was a shift from Ford's "Mass Production" paradigm to Toyota's "Lean Production System", and now industry is moving towards "Mass Customization" for a more personalized experience.

Many forces are driving the transformation of the global automotive business model, business process, as well as the product itself. Automakers, suppliers, and new entrants are in a race to invent the future car along with a profitable business model to serve the mobility needs of the 21st century. How this may evolve going forward is illustrated in Exhibit 2.

Beyond the hardware itself, we are witnessing a paradigm shift from an "Owning Economy" to a "Sharing Economy", driven by consumer preferences. For example, AirBnB allows homeowners monetize the unused capacity of their living space. Workplaces are also increasingly being shared through fractional usage. As a third space after the home and the workplace, we are beginning to see the emergence of platforms to enable fractional ownership and sharing of automobiles. Indeed, the popularity of sharing concepts such as peer-to-peer car-pooling and on-demand bus services indicates a bright future for shared mobility solutions.

Exhibit 1. The First Personal Mobility Revolution

Horse-drawn carriage

- First form of vehicular travel
- Uses "horse power"
- Abundant use of wood, leather with some metals
- Furniture makers were a major part of the supplier chain

Internal combustion engine

- 1886 - The birth of the modern "automobile"
- Self-powered vehicles fitted with internal combustion engines
- Early automobiles had to be lightweight for the low-powered engines and coaches were primarily made from wood

Industrial automobiles

- 1908 - The first mass produced automobiles
- More powerful and reliable engines with transmissions
- Assembly line, interchangeable parts, and increasing use of metals, especially brass, throughout the car
- Tire manufacturers were born

Exhibit 2. The Next Personal Mobility Revolution

Golden era

- 1920-1970 Vehicles grew in size and became more powerful
- Fully enclosed cabins, standardized controls, creature comforts
- Abundant use of metals, especially steel, and innovation in features and functions, initially focused on mechanical and powertrain systems

Modern Automobile

- Engineered to optimize highway driving speeds and occupant safety-therefore over-engineered for urban mobility
- Initial deployment of alternate power sources or "new energy vehicles"
- Occasional use of composite materials and lightweight alloys
- Early adoption of modern smart devices and mobile connectivity with IOV

Future Personal Mobility Device

- Designed specifically for city-use
- Lower driving speeds and V2V crash avoidance technology reduce crash protection requirements and enable smaller and lighter vehicles made primarily of lightweight composites

? What will power these vehicles?
Space-age materials and features?
How will vehicles be used?

The development of autonomous driving technology will reduce the role of and eventually eliminate the need for a driver and thus further challenge the concept of "ownership". Autonomous vehicles, in combination with on-demand mobility services, will fundamentally disrupt the traditional automotive industry business model by delivering significantly safer and more affordable access to mobility than those offered via the traditional ownership model.

Six Themes Shaping the Future of Mobility

We believe that the next great wave of mobility innovation will emanate from China, and several themes have emerged which signal that China's automotive industry will be at the forefront of digital disruption. We have arrived at an inflection point where new entrants - in particular Chinese internet technology companies who understand the market context - are serving mobility needs in a unique and innovative way. As a result, they are revolutionizing mobility habits of consumers and thus disrupting the core business of traditional automotive manufacturers.

We will illustrate this by describing six themes that are shaping the future of mobility:

1. **The Internet of Things (IoT) has become the next great battleground for automotive innovation, driven by consumer expectations for ubiquitous connectivity**

The challenge faced by most automakers is the balance between the cost of advanced technology and the willingness of consumers to pay for these features. Often, regulatory pressure is the main driver for adding advanced safety and powertrain technology to the car.

A distinguishing characteristic of the new mobility revolution is that IoT technology is becoming pervasive. In contrast with innovation driven by regulatory push, the connected car technology is being pulled from the marketplace. In fact, there are over half a billion users of smart device technology in China today, and they are increasingly using this technology to access services and content which make their daily lives more convenient. Chinese consumers, especially the tech-savvy younger generation, demand greater connectivity, more accessible services and a more personalized user experience.

As a third space after their home and workplace, users now expect a car to fit into their lifestyle as a technologically and socially connected platform which delivers in-vehicle connectivity, occupant safety, and infotainment. It is increasingly evident that big data is leading to customized services which can be delivered to the mobility services user.

Leveraging their big data and analytics insights on serving the daily needs of their user base, China's homegrown Internet and Communications Technology (ICT) companies are rapidly developing and deploying a portfolio of mobility solutions to serve these customers. Mobility service companies like Didi-Kuaidi and Yidao Yongche use advanced algorithm and heat map data analytics to analyze multiple mobility data points such as the density of users, availability of drivers, real-time traffic and time of journey in order to understand the dynamic mobility patterns and user preference for more efficient allocation of resources.

2. **Non-traditional players are disrupting the linear automotive value chain, providing an asset-light, services-oriented ecosystem to serve mobility needs**

Internet companies are leveraging connected mobility services as a means to disintermediate the value chain of the automotive industry and capture a profitable services ecosystem. Technology companies, especially the likes of disruptors including Baidu, Alibaba, and Tencent (BAT), have great opportunities as they leverage existing customer relationships with technology platforms, extending their reach into mobility solutions and eventually vehicle technology development.

Such companies have an inherent advantage of having continuous interactions with users around services which are delivered through connected devices, and these companies are open to collaborations with suitable partners who help to complete their mobility solutions ecosystem.

Traditional OEMs are at risk of their business model being relegated to a high-risk, asset-intensive, commoditized, business-to-business (B2B) channel for delivering hardware to the profitable ecosystem of the mobility services providers.

3. **Shifting power dynamics among both new and traditional players will redefine roles in the new ecosystem**

The entrance of ICT companies (including infrastructure, information technology, telecommunications, electronic services providers, and the BAT digital giants), represents an existential threat to the business model of traditional automotive value chain players. Beyond their initial forays into providing car-booking services, Chinese BAT players have each announced plans to explore new energy vehicle and autonomous driving technology.

While China's new car sales growth has been decelerating, the car service and maintenance industry in China has substantial room for growth as the car population ages and continues to expand. This will drive a wave of innovation around fleet management, remote diagnostics, and online-to-offline services. Digital giants have the scale, capabilities and capital to develop and commercialize such technology-enabled products as part of their expanding mobility services ecosystems.

4. **Traditional automotive value chain players must re-assess their business model and approach**

Automotive OEMs are responding to the challenge by providing in-car intelligent systems as a feature to their customers (examples include GM's OnStar, BMW's Connected Drive, Ford's SYNC). Advanced human-machine interface(HMI) technologies which include speech recognition, touch screens, and wireless internet connectivity have become mainstream offerings, but are generally reserved for the more premium equipment levels. Some OEMs are developing their own in-car smart systems. Leading examples include Tesla, which has chosen to own the customer's "big data" and run back-end operations to support their electric vehicle (EV) business model.

Major equipment suppliers, especially tier-1 equipment makers such as Continental, Bosch, ZF, Delphi, Visteon, and others are building out their portfolio of connected car technologies in order to remain relevant in the Internet of Vehicles (IoV) value chain. The inherent advantage for such suppliers have is that they can act as a bridge between automotive OEMs and ICT players for the development of in-car systems technology such as vehicle-to-vehicle (V2V) communications, advanced driver assistance systems, and on-board navigation and infotainment systems.

However, traditional tier-1 suppliers are inherently B2B companies that lack a consumer brand identity and they would be challenged to prove themselves relevant in a value chain dominated by B2C services, due to their lack of a consumer brand identity. Managing multiple stakeholder relationships with not just OEMs, but also other suppliers, technology, internet companies and service providers will be particularly challenging for the traditional suppliers.

To avoid being completely disintermediated, automotive Original Equipment Manufacturers (OEMs) and in-car systems suppliers are beginning to form synergistic collaborations with leading ICT companies to leverage complementary strengths. Recently, both global and domestic OEMs have cooperated with major Chinese internet companies (including BMW with Baidu and SAIC with Alibaba).

5. Electrification, lightweight, connected and autonomous technologies will become the core & defining attributes of the future car

The modern automobile depicted in Exhibit 2 is over-engineered to meet almost all conceivable needs for transporting people and cargo over both long and short distances. A car typically weighs more than 20 times as much as its driver weighs, can travel 500 kilometers without refueling, can exceed more than 150 kilometers per hour, requires about 10 square meters of parking space, where it sits unused for approximately 22 hours a day.

Personal mobility devices engineered for use in China's urbanized context will be designed specifically for city-use, to transport a few people and light cargo over short distances. Such devices will operate at lower driving speeds in cities, and utilize V2V crash avoidance technology, reducing crash protection requirements and enabling smaller and lighter vehicles.

In addition, we believe there is a natural evolution from on-demand connected mobility solutions to the electrification of the transportation services fleet. China's efforts to push individual electric vehicle ownership has thus far produced rather limited results. However, the rise in popularity of on-demand mobility services has opened up the potential for large scale EV adoption, led by fleet operators and government organizations who are serving the pay-per-use mobility services market. The rapid expansion of this segment of the market can provide China with the scale needed to "leapfrog" the rest of the world's deployment of electric vehicle technology and related infrastructure.

Deployment of an on-demand fleet of connected vehicles is a stepping-stone and an accelerator toward electrification, which will occur in China on a significant scale by 2020. Beyond this, the economics of converting such a fleet of mobility solutions over to semi-autonomous and eventually fully autonomous vehicles will become an incremental step over 10-year timeframe, given China's commitment to invest in the required infrastructure.

6. The automotive experience for users will become much more service-oriented, offering a multitude of personalized and on-demand options

Cars are set to become technologically and socially connected platforms, with the capability to facilitate interaction between vehicles and users with external objects, infrastructure and even enterprises. Independent of whether the car is individually owned or accessed via a mobility service, the experience of driving will still be highly personalized and flexible with the reliance on cloud computing for storing and processing of individual data (including usage parameters such as seat adjustments and music preferences), making the experience highly tailored to the individual user.

Users of mobility services will be empowered with choices based on seamlessly integrated, processed real-time data including traffic information and V2V communication, all accessible via their personal connectivity devices.

Digital authentication technology will be used to identify individuals on electronic systems, with associated data readily spread across platforms from vehicles.

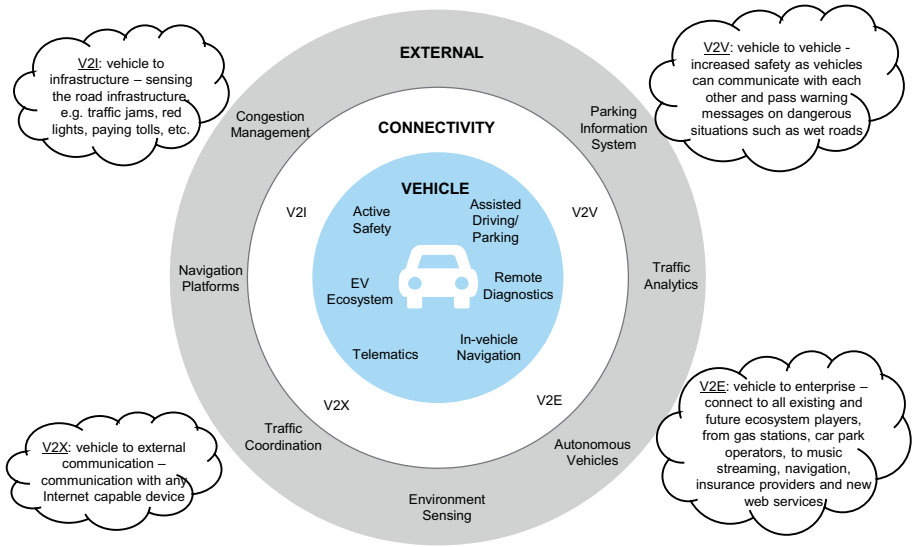
A Vision of the Future Car

Overall, future cars can be described as fully connected vehicles that deliver a personalized mobility service experience. Let us define what is meant by the adjectives in this sentence, and then envision the changes that we can expect in the design of such a product.

CONNECTED VEHICLES

Big data services are at the core of smart mobility. A services-based ecosystem powered by the Internet of Things will emerge. As depicted in Exhibit 3, connectivity will transform the automobile into an intelligent platform for an explosive variety of in-vehicle and external

Exhibit 3. Connected Vehicles



services, adopting mobile technologies to seamlessly integrate with users' personal devices, networks - connecting the driver and users to multiple external points of information that transform the car into a platform for managing everyday life tasks.

PERSONALIZED

Future mobility will become a service-based, yet personalized experience with the use of real-time big data, location-based technologies and analytics, regardless of whether the car is individually owned or used as a service.

MOBILITY SERVICE

Highly integrated analytics will allow for dynamic matching of supply and demand for mobility services tailored to an individual's mobility patterns, all designed to eliminate the stresses associated with their daily mobility needs. Examples include:

- On-demand cars, including ride hailing, ride sharing, car sharing, car rentals
- Real time traffic management
- Real time traveler information
- Smart parking • Autonomous vehicles
- Personal travel assistant apps

Key Features & Functions of the Future Automobile

There are several concepts for how the mobility value chain is evolving, which will shape the design for the automobile over the next decade:

1. **Mobility on Demand:** Innovative services companies, particularly China's ICT giants, have emerged as "digital disruptors" who are competing to serve the exponential growth of "mobility on demand". Car designs must accommodate the needs of this growing services fleet.

2. **Connected Electronic Device:** Beyond the home and the office, the car is becoming the "third space" for consumption of internet-based services. These include the traditional automotive services (After Sales Services), as new as connected car services (as depicted in Exhibit 3). In particular, an extensive use of big data and user information will be integrated into all components and functions of the car, and delivered through integrated hardware (on-board diagnostics, heads-up displays, head units), software (operating systems, navigation), and services (telematics). Companies will seek to differentiate themselves on the overall connected car services experience versus

3. **Electric Drivetrain:** The popularity of on-demand mobility services, combined with favorable government policy toward EVs in China, will drive a higher proportion of these cars to be powered by electricity. This will accelerate the build-out of infrastructure and mitigation of the higher cost of electric drivetrains.

4. **Advanced Driver Assistance & Safety:** Cars will increasingly incorporate sensors and feeds linked with infrastructure, greatly lowering the likelihood of accidents. Routine tasks such as parking are increasingly delegated to the car, and fully autonomous driving will evolve in stages, allowing a choice of full or semi-autonomous driving.

Exhibit 4 summarizes the impact of these concepts on the major systems of the car.

Exhibit 4. Features of the Car in 2025

BODY

Significant weight reduction

- Light weight materials become critical driving higher use of steel alloys, aluminum, aluminum alloys, plastics, carbon-fiber

INTERIORS & SEATING

Touch screens throughout the car

- Certain user expectations or regulatory requirements may make switches or push buttons necessary for some applications
- Gestures and voice controls will be incorporated to a greater degree

Higher usage and personalization of skins, tactile materials, button types, colors.

KEY FEATURES

SAFETY

"Accident proof" vehicles, based on safety information fed to the car; V2X, V2I embedded components, eg. sensors, vehicle communications, infrastructure, eg. ECU warnings, actuator alarms, automatic brakes

INTEGRATED TECH & ELECTRONICS

Like a Personal Assistant, the car can anticipate what the driver wants based on usage patterns, anticipates needs, reduces drivers' workload; automatically loads features

- Easily accessible applications targeting specific needs
- Driver recognition, customized usage parameters
- Location-based navigation and services tailored to the user

POWERTRAIN

Electric cars become popular with optimized battery and electric drive technology, especially in China's urban centers.

Competing in the Future Mobility Ecosystem

Accurately anticipating the features and functions of the car of the future does not guarantee a position of strength in the future mobility ecosystem. To succeed, companies will need to define their core purpose in serving the mobility needs of a customer who is increasingly digital-savvy and empowered to select among a range of options to serve their mobility needs. The car of the future must fit into the "connected mobility" lifestyles of customers who are increasingly seeking convenience and variety.

Hardware-centric automotive OEMs and in-car systems suppliers will find themselves competing for the future business with the likes of new entrants with a clear focus on technology (Tesla), software (Apple and Google), or services (including Uber and a number of Chinese ICT players). Companies must be able to adapt to quickly changing external forces in order to innovate at "internet speed" and cope with this new breed of competition. OEMs also need to learn handling these new suppliers bringing electronics and embedded software.

One clear capability needed in this new landscape is that there is a much greater need for a variety of services offered to consumers, and that companies need to provide a unique user experience in order to keep customers loyal to their mobility services ecosystem. All players in this ecosystem must connect and build close relationships with customers, although the levels and types of services offered will depend on the players' position on the value chain and proximity to the customer.

Beyond this, Chinese internet giants are particularly adept at delivering innovative solutions to meet the needs of the Chinese customers whom they already have a deep relationship with. The largest and most successful Chinese digital companies - Baidu, Alibaba and Tencent are forming mobility services ecosystems to leverage complementary capabilities across multidisciplinary business partners and business divisions.

Alibaba, the leading e-commerce giant in China, has established the Alibaba Automotive Division. It leverages its own digital ecosystem of online-to-offline (O2O) services (e.g. automotive e-commerce, online payment, entertainment and aftermarket services) to tap into the automotive market. It has a comprehensive portfolio of solutions and partners that can provide a holistic suite of services covering the end-to-end vehicle ownership lifecycle and mobility value chain. In March 2015, it announced partnership with SAIC and jointly invested USD 160 million to develop connected cars.

Tencent, the largest online social and gaming company in China with over USD 200 billion market capitalization, has teamed up with Foxconn Technology, a major manufacturing partner of Apple, and China Harmony Auto to build a smart electric car. Tencent has also launched LuBao, an on-board diagnostics (OBD) device, to capture driving data for the purpose of usage-based insurance (UBI).

Similar cross-boundary collaborative partnerships between automotive and Internet companies are prevalent in China. Further examples include BAIC and LeTV (an online media content producer and distributor); BAIC and Didi-Kuaidi; Chery, Pateo and Yidao; BMW and Baidu; Baidu and Uber etc.

By building ecosystems, they are able to jump capability gaps and leapfrog to emerging opportunities that were previously beyond the boundaries of their core competencies. Such ecosystem collaborations attempt to create additional value through synergistic relationships and co-evolution with the partners.

Implications for Players in the New Value Chain

A new form of connected mobility is driving new technologies in the domains of navigation, analytics, driver safety, driver assistance and information virtualization. The challenge of understanding the opportunities and the threats of this new industry will set the scene for a new competitive environment for both traditional OEMs and non-traditional players looking to establish themselves as the global leaders of connected mobility. 1

Automakers and suppliers must heavily invest in R&D, especially in this new mobility ecosystem, in order to create differentiated and defensible intellectual property. Both must recognize the potential threat from new entrants into the automotive value chain. Specifically, technology developments are creating new business models for diagnostics and repair, and other new mobility on demand services. Automakers and suppliers must determine their way to play in this emerging Online-to-Offline (O2O) business or risk losing the customer relationship to aggressive online service portals. Collaborative partnerships may be necessary in order to build out this expanded mobility services ecosystem.

A recent example is the joint effort between Mercedes, BMW and Audi, to acquire the software company Here, a global leader in the mapping and location intelligence, from Nokia. This joint acquisition signals their quest for strategic leadership in cartography and mapping software intelligence, a crucial competence to guide the future of connected mobility.

In addition, collaboration partners must align their go-to-market models with underlying customer needs to effectively capture the (remove 'the') loyalty of consumers to their brands and unique value propositions. Although different players collaborate and work closely with others in the ecosystem, they must at the same time accept that winning is not mutually exclusive; individually, they compete for information and user insights, reacting quickly to stay ahead of the game.

While the focus of this paper is on the future of automotive innovation, it is clear that the disruptive forces reshaping the industry are particularly evident today, especially in China. China has become an incubator for disruptive business model innovations, and this is certainly evident in the manner in which mobility services are being deployed in the market. Digital technology is driving the future of the automotive industry, and we believe the commercialization pathway for future automotive innovation will travel through and may indeed originate from China.

1 B. Russo, C.K. Lim, G. Pross, U. Kushnir, "How Connected Mobility Technology is Driving the Future of the Automotive Industry", Gao Feng Insights Briefing Paper

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Bill Russo is Managing Director and the Automotive Practice leader at Gao Feng Advisory Company. With 15 years as an automotive executive, including over 11 years of experience in China and Asia, Mr. Russo has worked with numerous multi-national and local Chinese firms in the formulation and implementation of their global market and product strategies. Mr. Russo was previously the Vice President of Chrysler North East Asia, where he managed the business operations for the Greater China and South Korea markets. Prior to this, Mr. Russo was the Head of Product & Business Strategy for Chrysler. He also has nearly 12 years of experience in the electronics and IT industry, having worked at IBM Corporation, and formerly served as Vice President of Corporate Development at Harman International.

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