THE AUTOMOTIVE INDUSTRY AS A DIGITAL BUSINESS

SRINI KOUSHIK
DR RAINER MEHL

NTT INNOVATION INSTITUTE, INC.

This is a time of both great opportunity and great challenge for the global auto industry.

Historically, few companies can rival this global industry for the way that it has reflected and been shaped by important social, cultural, and economic trends.

Economic recession and recovery. Conflict and peace. Energy crisis and demographic shifts. The space race and startup culture. All have had a role in the way the industry thinks about and has approached design, production, distribution, partnerships, and customer interaction.

Today, the industry is facing a powerful new shaping force that is moving nearly every aspect of modern business from **analog to digital.** We are experiencing the birth of a new era of **digital business** unlike any we have ever seen before.

As technology drives the transformation to digital business, the **opportunities for disruption increase,** both from within the industry and from new and often unexpected external threats. Technology trends such as the rise of mobile and pervasive connectivity, data and machine learning, 3D printing and the Social Network of Things, the cloud and virtual systems, APIs and open software – have crushed traditional barriers to entry and expansion, and have accelerated the speed of change within markets.

In this always-on, always-connected digital world, it is critical for the industry to reexamine its approach to the entire value chain using the lens of **delivering customer-defined value at every touch point.** Only with that fresh approach can the business be informed and prepared to successfully evolve to face new possibilities, challenges, and competitors.

Auto companies need to **embrace digital technologies as part of their core DNA.** Only then can they take full advantage of the opportunities it gives them to think smarter by sensing and predicting opportunities, act faster through true business agility, and create a flexible approach to business to quickly take advantage of new circumstances. The rise of new competitive threats from companies born outside the rules of the traditional auto industry makes this need for digital change even more imperative.

Srini Koushik
CEO, NTT i^3

NTT INNOVATION INSTITUTE, INC.

TABLE OF CONTENTS

CHAPTER 1

The Evolution of the Auto Industry: Past, Present and Future 6

- From Auto 1.0 to Auto 4.0
- Why the Industry Has Struggled to Change

CHAPTER 2

Trends Driving Structural Change in Business 16

- Digitization
- The Rise of Millennials and Digital Natives
- Apple-ization
- The Sharing Economy and “Asset-Light” World

CHAPTER 3

The Drivers of Digital Business Transformation 27

- Technology and Digital Transformation
- The Social Network of Things
- Robotics, Autonomous Control, and 3D Printing
- The Connected Car, Connected Driver, and Mobility Customer
- Data, Machine Learning, and Cyber-Security
- Open Source Patents and APIs
- The Changing Nature and Sources of Competition

NTT INNOVATION INSTITUTE, INC.

TABLE OF CONTENTS

CHAPTER 4

Auto 2.0: The Current State of the Industry 44

- Industry 4.0
- Manufacturing Technology
- Redefining the Supply Chain
- The Connected Car Version 1.0
- The Birth of Mobility Services

CHAPTER 5

Learning from Today's Cutting-Edge Leaders 56

- Tesla
- Google Self-Driving Car Project
- BMW iSeries and Consumer Mobility Initiatives

CHAPTER 6

Auto 3.0: Building the New Value Chain of Customer-Centered Innovation 69

- Rethink Value
- Re-imagine the Customer Experience
- Reconsider Culture
- Reorient Processes and Operations
- Re-Engineer IT

TABLE OF CONTENTS

APPENDIX 83

- About NTT Innovation Institute Inc.
- About the Authors
- Collaborator and Contributor Bios
- Other Books from NTT Innovation Institute Inc.
- Photo Credits

CHAPTER 1

The evolution of the auto industry: past, present, and future

FROM AUTO 1.0 TO 4.0

WHY THE INDUSTRY HAS STRUGGLED TO CHANGE

FROM AUTO 1.0 TO 4.0

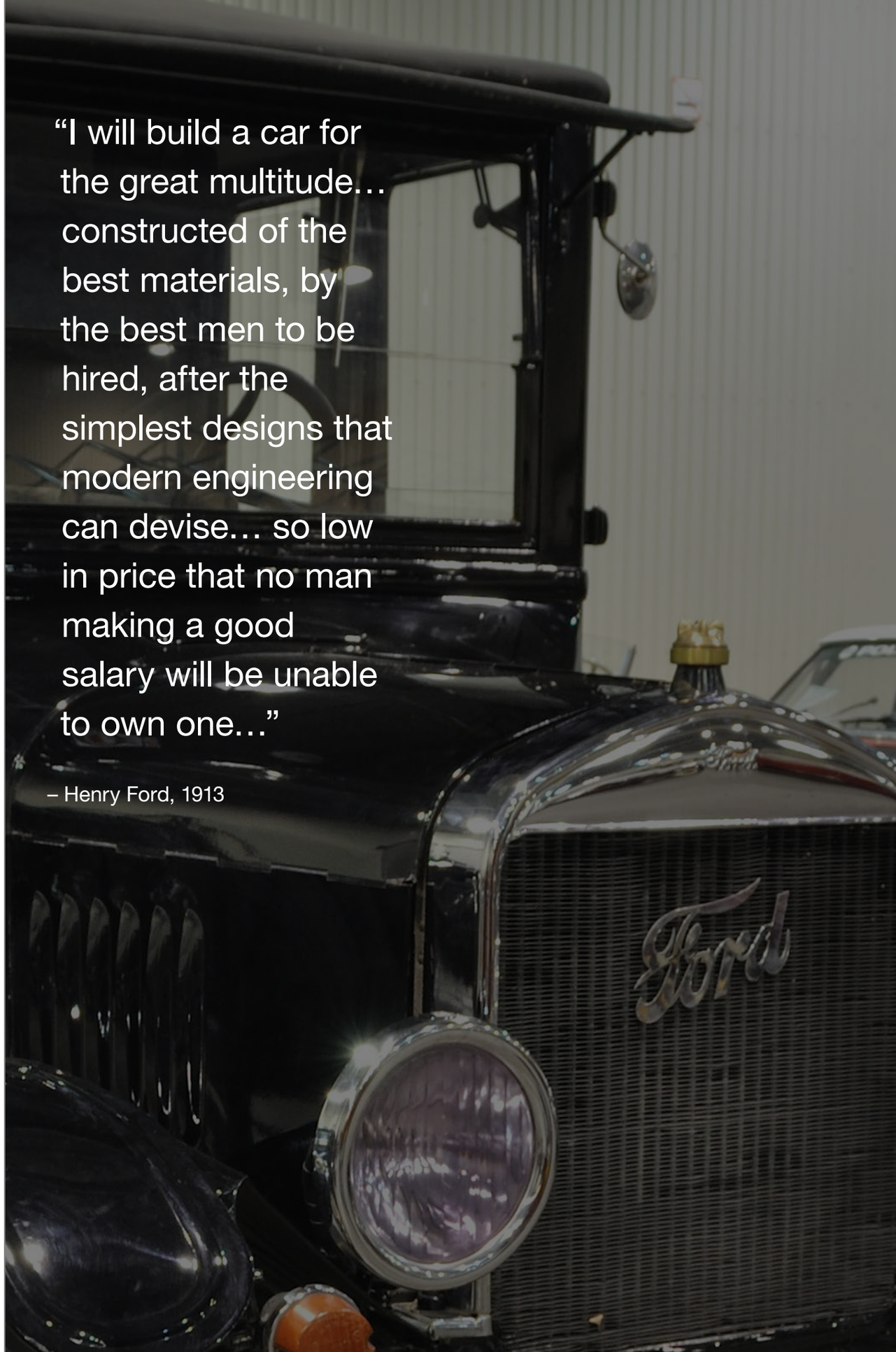
In the past 130 years, there have been very few businesses that can rival the automotive industry for the unmistakable way that it has both reflected and been shaped by significant global social, cultural and economic changes. And now, digital technology is becoming an important way in which those changes are addressed – from understanding customer values and defining the consumer experience, to re-engineering the systems that impact design and manufacturing.

Auto 1.0

Most historians credit the German inventor Karl Benz with creating the first modern production automobile in 1886. For two decades, the automobile was considered to be a novelty item because they were expensive and time-consuming to produce.

Between 1904 and 1908, 241 different firms began producing cars aimed at the American consumer. In 1908, Ford created the Model T, the first car aggressively marketed to appeal to the experiential aspirations of the average family. Ford not only began the articulation of auto marketing, but also addressed the former limitations of the business side of the industry. He introduced and put into practice mass production efficiencies, early lean manufacturing techniques, and vertical supply chain integration (coal and iron mines, timberlands, rubber plantations, a railroad, freighters, sawmills, blast furnaces, a glassworks).

Fast forward to the start of the Great Depression, car companies were largely small and specialized. By the end of the decade, they had been consolidated into the larger corporate brands that would dominate the industry for the next half century.

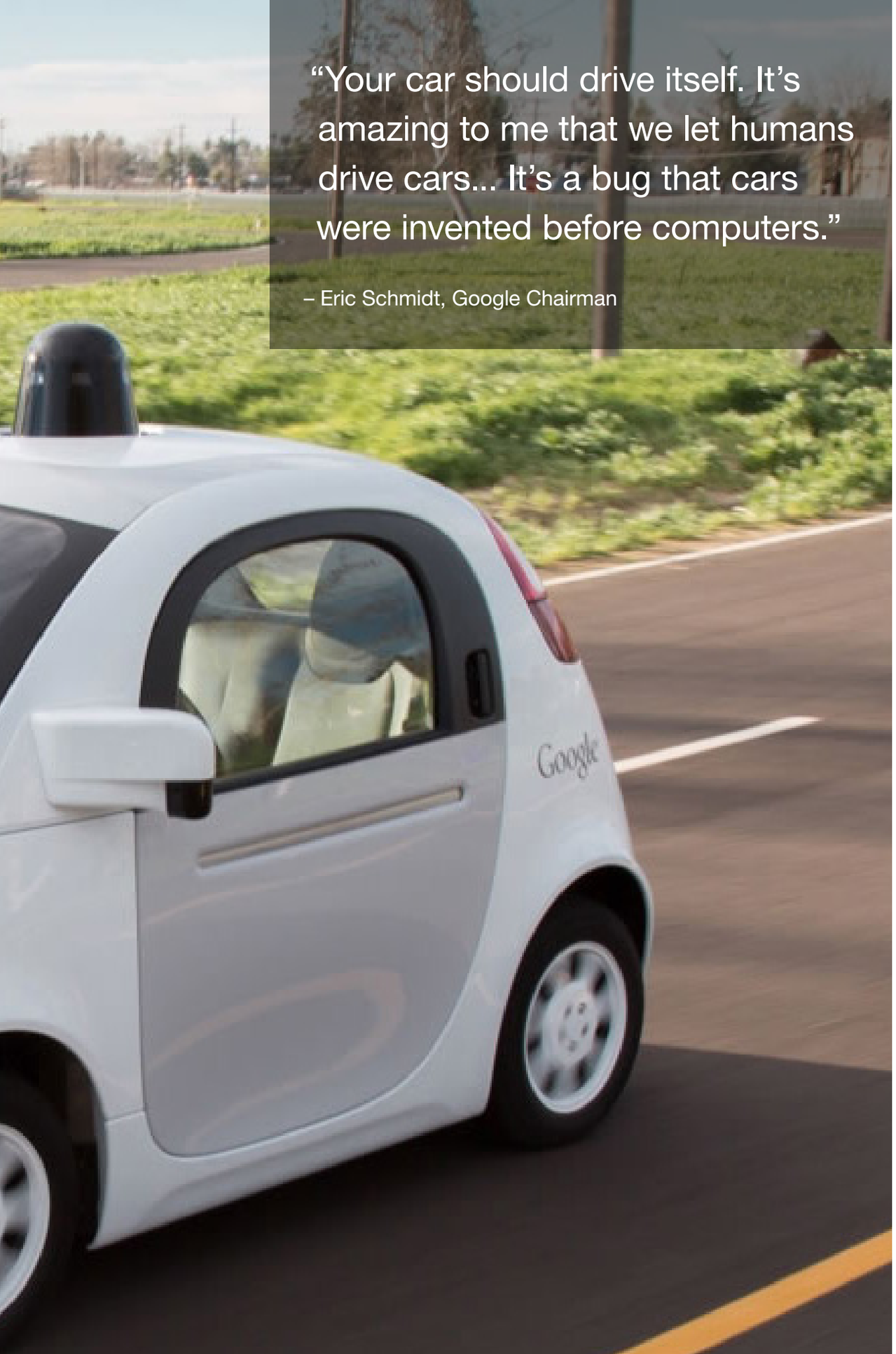


Auto 2.0

Today, the majority of the practices of mainstream automobile companies in Auto 2.0 mirror the cultural and economic forces that shaped the industry over the past half century. The result is that the historic differentiators of quality and reliability have become mere table stakes in the industry.

The post WWII emotional love affair with the car still drives much of car design decisions. Mainstream hybrid explorations are informed by the echoes of the 1970s oil crisis that first forced the industry to consider factors other than design and performance. The globalization of car production and focus on lean manufacturing has its roots in Toyota's approaches in the 1980s. Capital-intensive dealer networks and showrooms manifest decades old perspectives on the relationship between distribution efficiencies and consumer experience.

The integration of technology into vehicles has been largely invisible to the consumer, focused more on performance and dealer diagnostics systems. The advent of the connected car, with the provision of basic infotainment systems, is just beginning to change the role of technology for most manufacturers.



NTT INNOVATION INSTITUTE, INC.

Auto 2.5

Most of the automobile industry examplifies the focus on internal processes with the vehicle design and manufacturing value chain of Auto 2.0. There are, however, new intrapreneurial labs from established major auto OEMs (such as BMW iSeries) and new aggressive entrants (such as Tesla) that seek to redefine the industry by addressing digitally-defined niches that may quickly become mass. This is where the cutting edge of cars is to be found today.

For the digital leaders in the auto industry, the Auto 2.0 concept of “connected car” is evolving into the Auto 2.5 “connected driver.” Software functionality is no longer limited to infotainment delivery, but can now offer consumers the ability to transform their vehicles via OTA software updates that repair problems, bring new levels of optimization, and even new features without ever going to a dealer.

“Connected technology” is having a significant impact both on customer expectations about experience and also on how forward-thinking auto OEMs are re-prioritizing and re-engineering their end-to-end value chain. For the Auto 2.5 company, this is about the design of business that fully reflects the value of the customer over the efficiencies and financial ROI of car production.

Auto 3.0

In this near future, the next phase of evolution of the auto industry will be defined by more consumer-centric approaches to cars and mobility that are reflected throughout the entire value chain. Auto OEMs will need to begin to find ways to derive and drive value from technology-fueled social forces such as the Sharing Economy and Social Network of Things – or risk rapidly becoming irrelevant within a decade.

The long emotional love affair with cars may be supplanted by, or at least matched with, a world in which “mobility customer” decisions are driven by a need for utility and flexibility, as well as for sexy design and power.

The model of the “car as digital app” combined with pervasive electric charging networks, autonomous driving capabilities, and urban on-demand services (e.g Uber and Lyft) will have significant impacts not only on car ownership, but on the industry’s historical infrastructure and economics and related industries such as insurance.

Auto 4.0

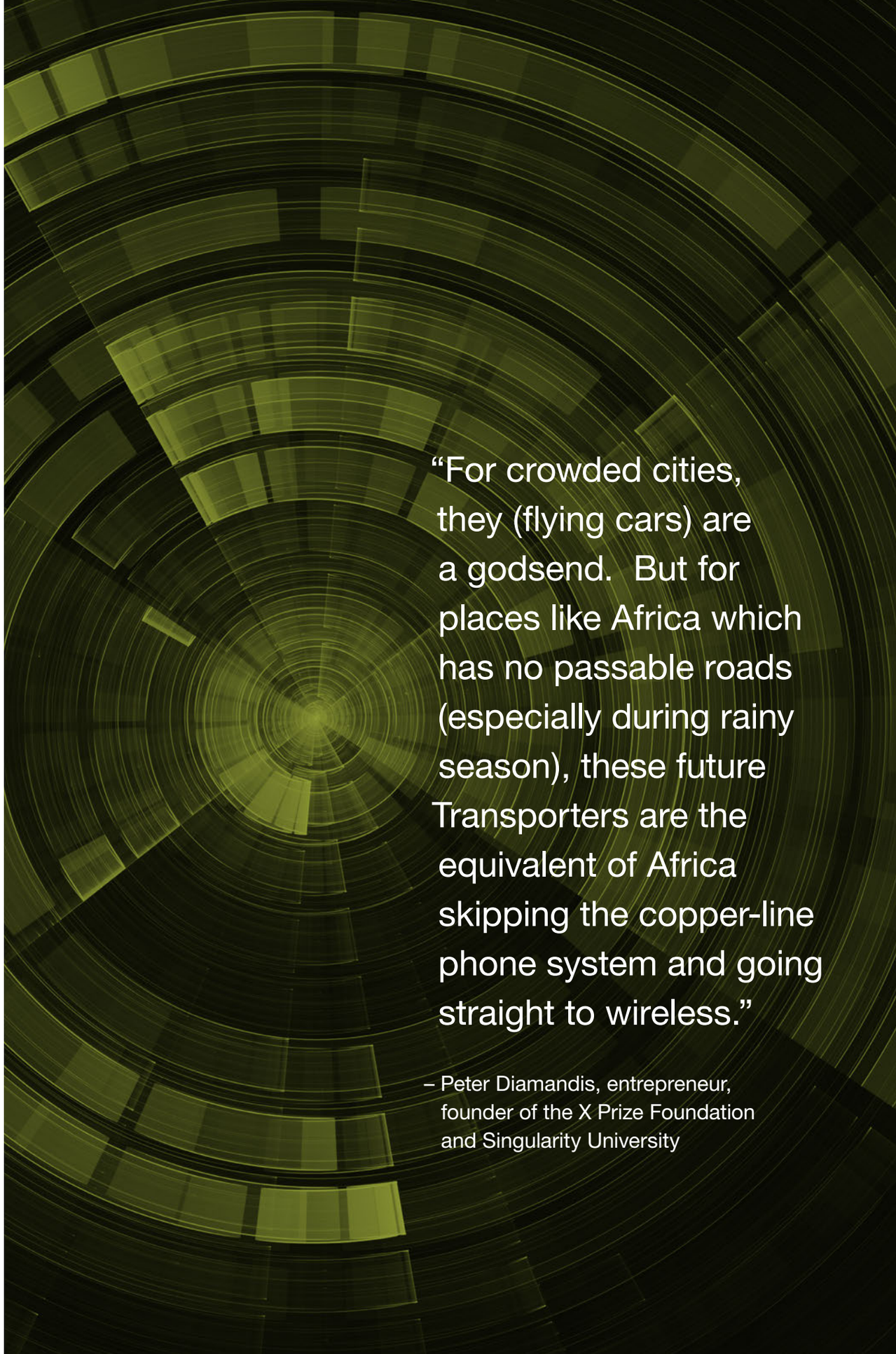
The technological, social, and economic forces of Auto 3.0 will become mainstream in Auto 4.0. With this may well come the final and definitive change in redefining the industry as one of “mobility” as opposed to “automobiles.”

Within 20 years, there will be tens of millions of autonomous vehicles. The ability to call for a vehicle (with or without a driver) on demand may create a new model of shared ownership or access to vehicles and services that take the current utilization of cars from 5-10% to 75% of the hours in a day.

We might even see the flying car long promised in science fiction. Perhaps it will look more like a grown-up version of the quadcopter drones that we see today. Developments in battery, navigation and lightweight, high-strength materials are making this more possible today than ever before.

And “roads” – how might they evolve as well? It’s too soon to know what might happen with the Hyperloop project – “a cross between a Concorde, a railgun, and an air hockey table.” Among others, there is already a team of engineers working on this at Hyperloop Technologies, a company founded by venture investor Shervin Pishevar and former SpaceX Engineer Brogan Bambrogan.

What would the world look like if you could take an on-demand autonomous vehicle to a Hyperloop station?



WHY THE INDUSTRY HAS STRUGGLED TO CHANGE

Misaligned Design Cycles

The mainstream auto industry still struggles with long and misaligned design cycles. While many of the industry majors have been able to shorten their cycles from 5-7 years down to 2-3 years, this still does not keep pace with the meteoric speed of change in the software and electronics components that evolve every 6-12 months. As software becomes an increasingly important part of the mobility equation, this means that manufacturers may well choose to continue to build more premium cars with software-electronics integration that is outdated as soon as they roll off the assembly line.

The strategies that the industry has chosen to pursue in order to address this issue have had little significant impact. Using agile and system engineering methodologies may yield some improvement within individual teams, but the needle will not move as long as mechanical and software teams remain relatively isolated from each other. The lack of standards also continues to be an additional burden to change.

As innovation-driven technology companies move more aggressively into the auto industry, the hard-ware-software design integration cycle becomes even more complex. This is particularly true given auto OEMs' limited relationships with companies such as Google, Microsoft, and Apple.

If the auto industry fails to readdress the design cycle issue, it is open to significant disruption from initiatives outside the industry. Effectively aligning and compressing design cycles would enable OEMs to provide more timely and improved integration of electronics and software technology into their vehicles, create a stronger relationship with the customer, and open new revenue opportunities from ongoing services and software-driven customization.

NTT INNOVATION INSTITUTE, INC.

Configuration Complexity

Premium OEMs in particular have pursued a strategy of allowing for consumer customization of their products by providing an increasing number of options and variants. The result has been very complex product structures, often with hundreds of thousands of possible combinations. At those numbers, there are real limits to the economic sense of this approach in providing “consumer choice.” Additionally, too many choices can result in confusion, and effectively no consumer choice at all.

Rather than asking the question of what the most important elements of choice are to the customer and concentrating only on those, the industry has focused on various business and engineering processes to more effectively manage the large numbers of possibilities it is creating. Product structure management with Boolean expressions, variant management, modularization, and platforms are largely engineering and manufacturing-driven decisions that do not strongly tie back to economic and consumer considerations.

Tesla’s approach to customer choice is built around identifying the customization options of greatest importance and value to their customer - as opposed to offering a large volume of options. The company offers limited choices relating to issues that impact manufacturing (number of models, colors, and options packages), and focuses more on customization and value driven by software after purchase.

If the auto industry cannot reframe the current approach to configuration complexity – which is growing with more options coming from world of software – many of their key processes of product development, manufacturing engineering, production, and logistics will be negatively impacted.

Capital Intensive Manufacturing Legacy

Change is expensive. The auto industry faces the dual difficulties of writing off past manufacturing investment, while simultaneously incurring significant new investment, if it is to move toward operations with more flexible production processes.

Billions of dollars have been invested over decades into the factories and manufacturing processes of established auto companies. Business practices require these sizeable costs to be amortized over long periods of time, making it very expensive to quickly write off any of these in order to move on to other more flexible processes. Then building those new manufacturing capabilities will require their own significant capital investment.

New entrants into the market, such as Tesla, have been able to start with a relatively clean slate. They have no legacy systems to evolve or outdated physical plant investment to write off. In order to compete, the major auto OEMs will have to carefully weigh the economic risk of when and how to move to manufacturing systems that will enable them to evolve production faster and for far fewer dollars.

Dealer Network Commitments

Today's dealer networks are the result of the optimization of an old value chain. Dealerships are quickly becoming an inflexible link in the new customer value chain – unable to respond to evolving needs and behaviors.

Dealerships have traditionally been positioned as the front line of communication and engagement with customers, and yet few customers look forward to going to an auto dealership. Dealerships must evolve or be completely rethought so that they provide unique, valuable, self-moderated experiences for customers. This must go far beyond investments in data management, customer care technologies, and website development. The fundamental question must be about the kind of relationship the customer values and how to deliver that, as opposed to how to optimize the existing distribution infrastructure.

CHAPTER 2

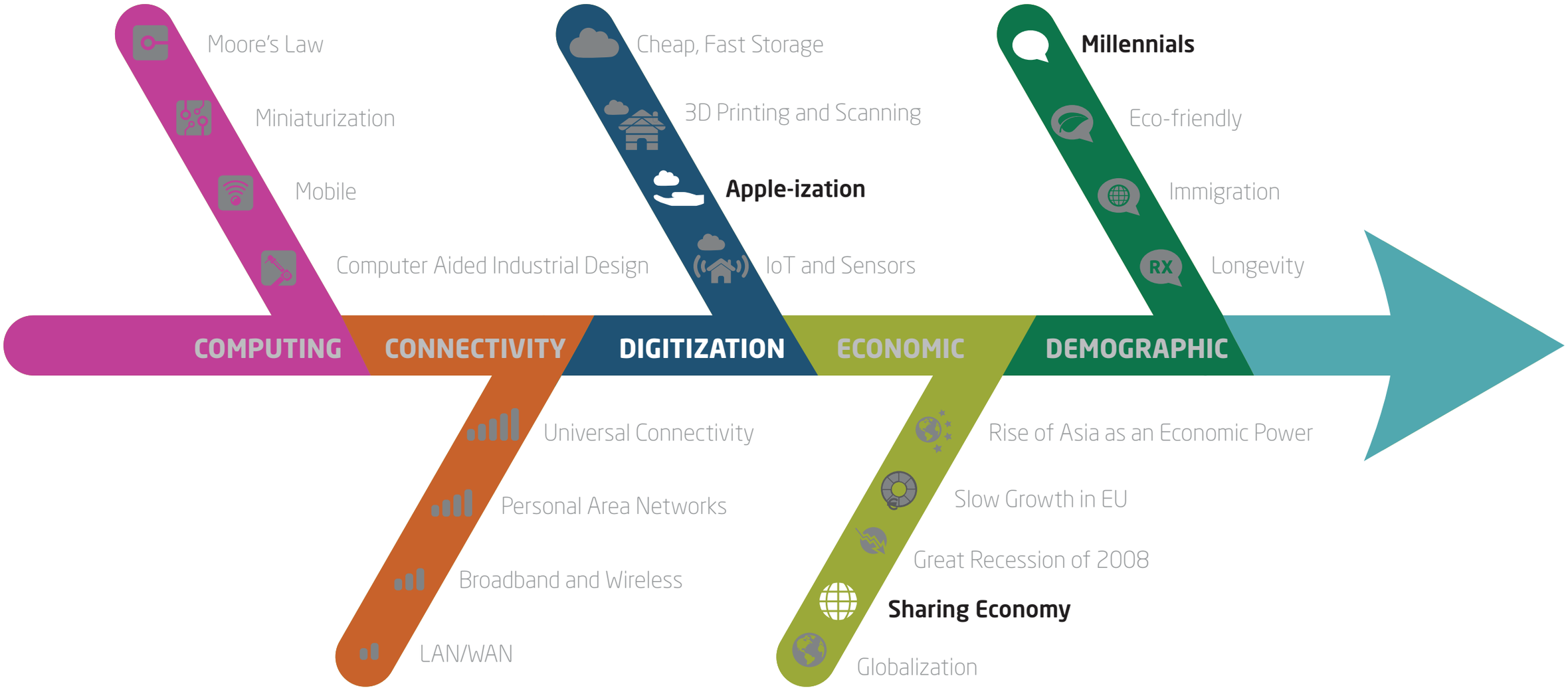
Trends driving structural change in business

DIGITIZATION

MILLENNIALS

APPLE-IZATION

THE SHARING ECONOMY AND "ASSET-LIGHT" WORLD

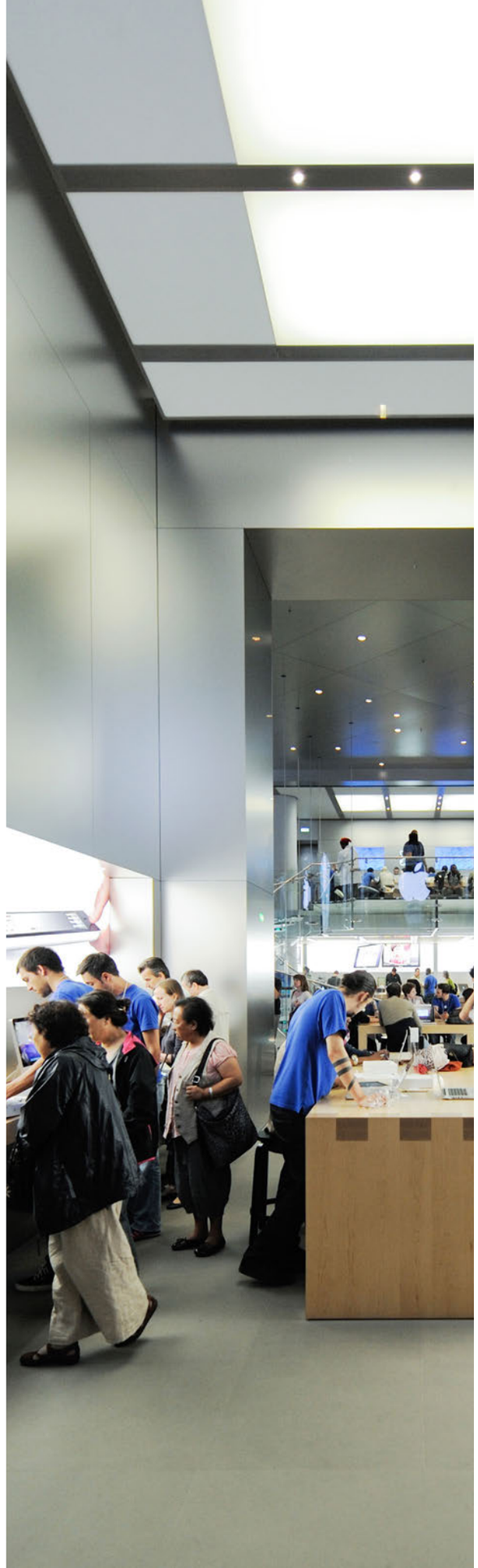

Moore's Law
Miniaturization
Mobile
Computer Aided Industrial Design
COMPUTING
Universal Connectivity
Personal Area Networks
Broadband and Wireless
LAN/WAN
CONNECTIVITY
Cheap, Fast Storage
3D Printing and Scanning
Apple-ization
IoT and Sensors
DIGITIZATION
Rise of Asia as an Economic Power
Slow Growth in EU
Great Recession of 2008
Sharing Economy
Globalization
ECONOMIC
Millennials
Eco-friendly
Immigration
Longevity
DEMOGRAPHIC

DIGITIZATION

As nearly every aspect of modern business that was once analog moves to digital, the opportunities for disruption increase. Market boundaries become permeable. The technical and talent resources required to mount a legitimate challenge to an established leader become easily accessible.

Digitization of the world means that no one approach to a market or innovation is competitive for long. Established and once stable industry leaders now face challengers from outside the traditional industry boundaries - companies such as Google, Apple, and an army of well-funded and nimble technology startups.

Digitization of the formerly analog world of the automobile is forcing companies to face unprecedented change in customer expectations and values around mobility and transportation. The need to respond to the new mobility customer compels the consideration of changes in internal business processes, manufacturing, distribution and supplier partnerships to effectively respond and compete.



NTT INNOVATION INSTITUTE, INC.

The reason why it is so difficult for existing firms to capitalize on disruptive innovations is that their processes and their business model that make them good at the existing business actually make them bad at competing for the disruption.”

- Clayton Christensen, Harvard Business School professor and author “The Innovator’s Dilemma”

MILLENNIALS

Millennial

Generally defined as the generation born 1981-1996. There are more than 70M in the US, a group that is now larger than either Gen X or boomers. They currently represent more than $170B in purchasing power in the US, expected to grow to $1.4T by 2020. Globally there are 2.5B Millennials or 1/3 of the world's entire population.

Digital Native

A phrase coined in 2001 by author Marc Prensky, this term does not refer to any specific generation. It is a "catch-all" for individuals who are indigenous to the use of technology, such as the Internet, computers, and mobile devices – both at home and in school. It is assumed that their early and constant exposure to technology has provided them with a personal understanding and social relationship with it that is unlike any other group.

NTT INNOVATION INSTITUTE, INC.

The Rise of Millennials and Digital Natives

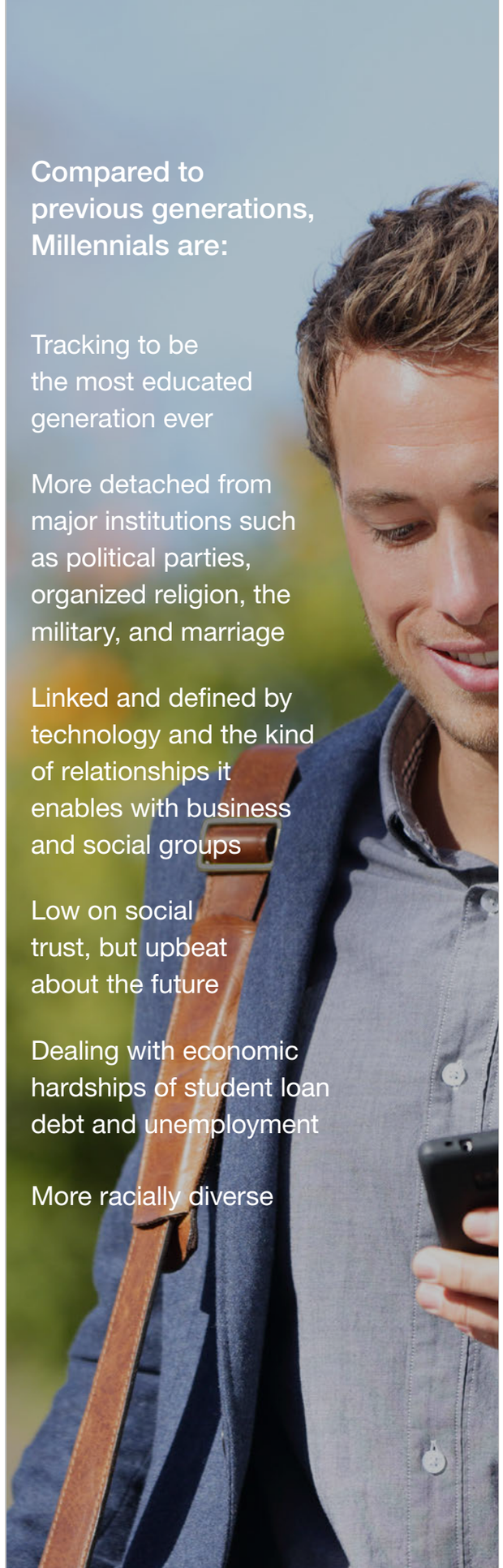
Both the sheer size and digital technology savvy of the Millennial and Digital Native make them important forces for the automotive business to understand and engage. Detached from traditional institutions while intimately attached to their mobile devices, they are creating their own social and economic networks of friends, partners, and brand relationships.

Millennials have been shaped from their earliest days by significant social and economic factors that have had an undeniable impact on how they see, operate, and engage with the world. These include:

- Fifteen years of conflict in the Middle East and a new age of terrorism born out of 9/11
- The 2007-2009 Great Recession and the anemic recovery that followed, resulting in 1/3 of 18-29 year olds being out of workforce, with many "boomeranging" back into the homes of their "helicopter parents"
- Significant changes in attitudes toward privacy and trust in government and business, with Edward Snowden and Julian Assange as icons
- Increasing globalization of the work force with jobs leaving traditional powerhouses like the US

While these events would be expected to have decades long negative consequences on their views of human nature and economic futures, this group still exhibits a generational personality that demonstrates confidence, multi-modal self-expression, flexibility, and connectedness to technology and social groups.

Millennials have a unique relationship with how they choose, use, and advocate brands, products, and services. Products must provide utility with quality, and design married with function. And they no longer see ownership of a product as required for access to the service it provides.

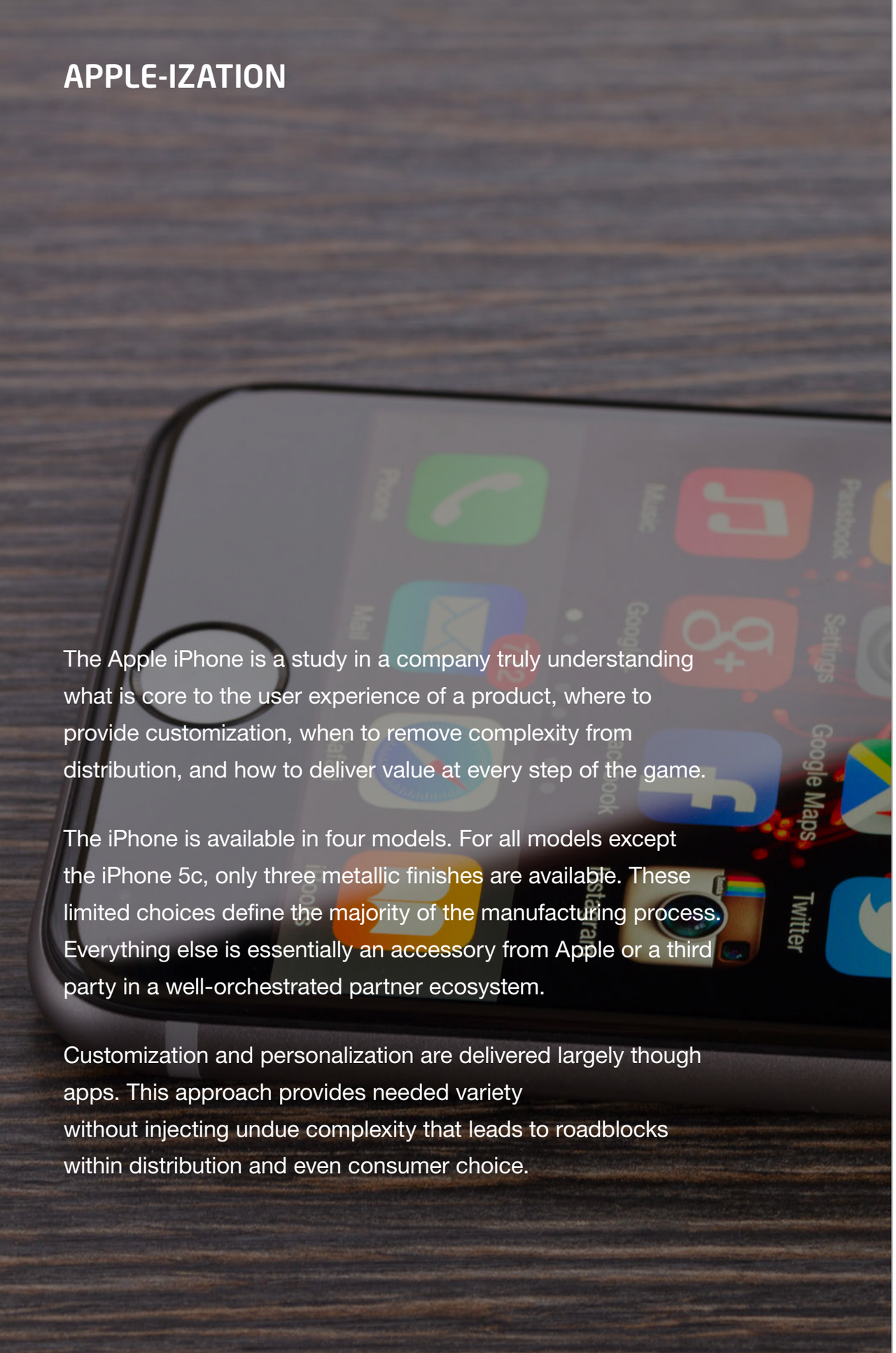


Not unexpectedly, the behaviors of Millennials are leading changes in many areas of mobility. In the US, Millennials are driving less than previous generations in America with a 23% decline in 2009 from 2001. Additionally, the percentage that hold driver's licenses is at its lowest level in 50 years (67% in 2011). This may be the result of several interrelated trends: growth in preference for walkable urban neighborhoods, economic recession making car ownership difficult, and access to on-demand car sharing services fueled by the pervasiveness of smart phones.

What will happen in the decade starting in 2030 when this group reaches what has historically been considered the peak driving ages of 35-54? Will their behaviors be the same as they are today, or will they revert to traditional patterns of ownership and use?

Regardless of which scenario proves to be true, the amount of driving is likely to be lower than recent years. This will have significant implications for auto manufacturers, adjacent industries, the demand for different types of mobility, and even public policy and transportation infrastructure.

APPLE-IZATION



The Apple iPhone is a study in a company truly understanding what is core to the user experience of a product, where to provide customization, when to remove complexity from distribution, and how to deliver value at every step of the game.

The iPhone is available in four models. For all models except the iPhone 5c, only three metallic finishes are available. These limited choices define the majority of the manufacturing process. Everything else is essentially an accessory from Apple or a third party in a well-orchestrated partner ecosystem.

Customization and personalization are delivered largely though apps. This approach provides needed variety without injecting undue complexity that leads to roadblocks within distribution and even consumer choice.

NTT INNOVATION INSTITUTE, INC.

Apple has been at the forefront of the companies that have consistently and inventively launched products and services that are deeply personal, meaningful, and intuitive. They have conditioned their customers to expect useful and powerful technology delivered with a deep understanding of the desired user experience and a distinctive minimalist design. The company has designed its value chain to reflect those philosophies - from the choice of materials to the in-store and online “fan” experiences.

Other companies inside and far outside the world of consumer technology are studying the Apple phenomena, what we call “Apple-ization,” as one of the ultimate learning opportunities for the digitally-driven business.

There are several key lessons about both consumer value and enterprise operations (and their relationship to each other) that can be taken from Apple’s success and applied to the auto industry:

- Balance of Design and Utility
- Rise of Mass Customization
- Importance of the Supporting Ecosystem
- Abundance of Consumer Choice
- Consumer Expectation of Product Obsolescence
- Product and Business Amortization Cycles

Balance of Design and Utility

With an Apple product, form and function naturally go hand-in-hand. There is a well-established customer expectation that the brand delivers human-centered design with elegance and value.

Rise of Mass Customization

Apple limits the configuration choices available to consumers to reflect those aspects of the experience that benefit the most from personal choice. Strategic limitations on configurations also lead to manufacturing and supply chain efficiencies. Within the world of hardware, Apple is clearly on the side that more choice is not always best, and may actually lead to inaction from an overwhelmed customer.

Importance of the Ecosystem

Dating back to the days of the Apple II, the company has excelled at building and supporting a robust ecosystem of third party developers. This success results from the company's emphasis on delivering a reliable, well-designed foundation on top of which others can create value. Apple's customers benefit from greater personalization of products without Apple having to shoulder the business burden.

lesson:

Utility wrapped in human-centered design is today's baseline expectation from the digitally-savvy customer.

lesson:

Balance product personalization with standardization of manufacturing and predictability of delivery.

lesson:

Keep the core product straightforward and simple, and then add physical customization through an ecosystem of well-informed and collaborative partners.

NTT INNOVATION INSTITUTE, INC.

Abundant Consumer Choice

The world of the iTunes and Apps Stores has given the Apple customer a nearly endless world of choice to add functionality to their product. Barriers to switching to a different app and vendor in those environments are virtually non-existent.

lesson:

Understand what is important for user customization to deliver the most value. Don't touch anything else. Too much choice can become no choice.

Consumer Expectation of Product Obsolescence

The rhythm of new hardware announcements and software upgrades has accustomed customers to expect various levels of obsolescence in products. Some of the "Apple fans" must have every new product at the moment of launch, and end up replacing products every 18 months or less. Others wait for a new product to become more established and to prove its value.

lesson:

Products will have varying levels of "obsolescence" depending on the ability to add value and function through after-market software.

Amortization Cycles

Even with the ability to upgrade and change functionality through software, product and business amortization cycles have changed in response to the speed of technology change. Different levels of performance and function are now expected every 18 months as opposed to 3-5 years.

lesson:

Business must respond to ever shrinking cycles of consumer value. A 5-year development cycle doesn't work if the product is essentially technologically obsolete at release.

Apple has demonstrated that the elements of choice, flexibility, transparency and consumer-defined experience are now critical dimensions that businesses cannot ignore.

The “Apple-ization” of the auto industry could help drive the business and their IT organizations to look beyond technology as an end in itself - and to focus on the experience and value provided to customers by their technology-enabled products and services.

THE SHARING ECONOMY AND "ASSET-LIGHT" WORLD

Mary Meeker, a partner at the venture capital firm Kleiner, Perkins, Caufield, & Byers, has identified a growing generation of consumers as the "Asset-Light Generation." These individuals have embraced preferences for utility and simplicity along with a new model of consumption that is motivated by their desire to save resources, money, and time. Their preferred social engagement and on-demand consumption models are dramatically changing the business landscape, and have already lead to the emergence and growth of the Sharing Economy.

That Sharing Economy is a vibrant, culturally-driven economic system built around the sharing of human and physical assets. It redefines economic flexibility to make it easier for people to get what they want, when and how they want it. And it has created new, and still controversial, ways of making additional money, if not a full living.

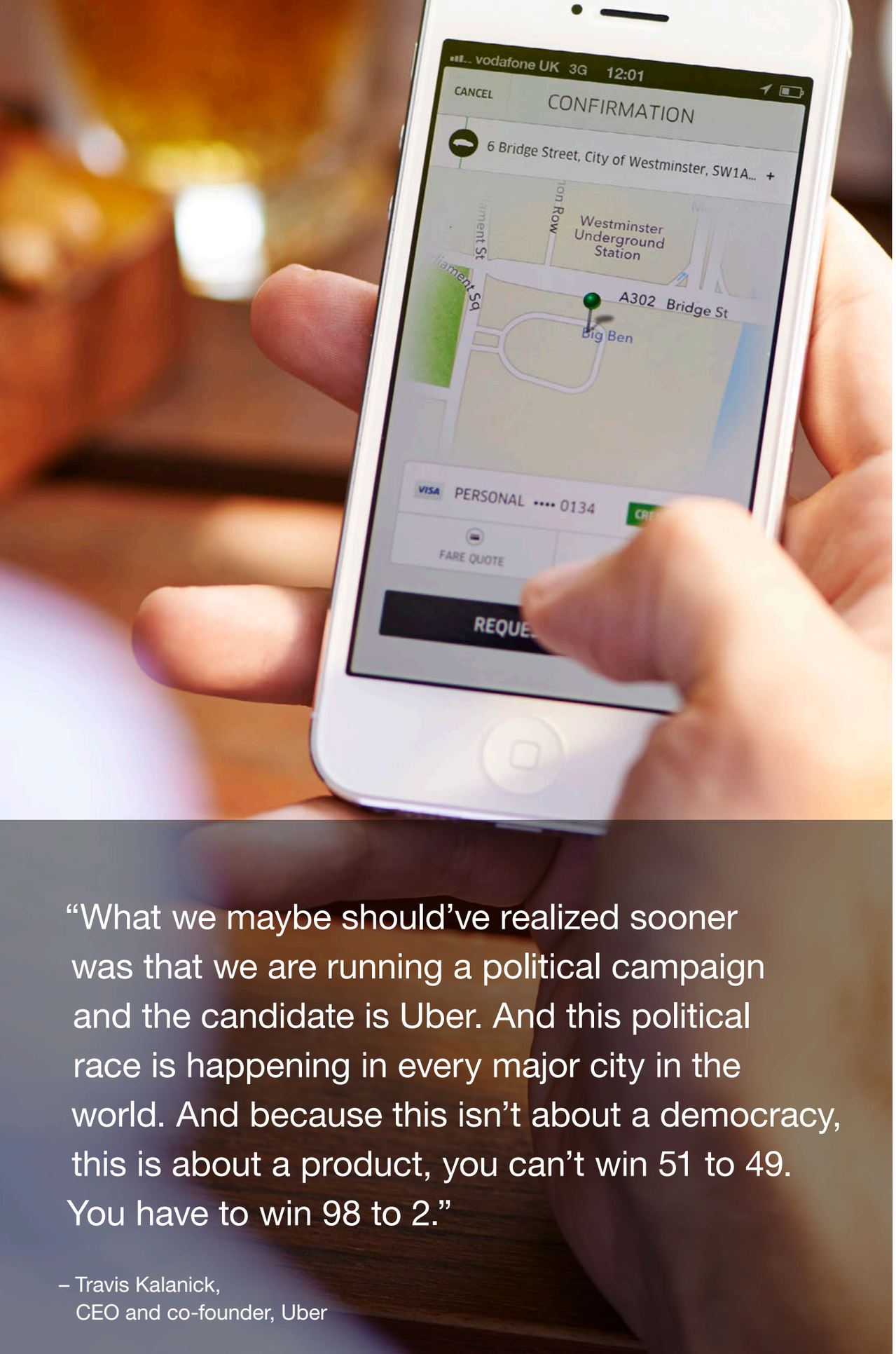
The meteoric growth and valuations of some of the Sharing Economy's most famous "unicorns" has resulted from their ability to take full advantage of:

- Digital representation and transfer of physical assets owned by others
- Ability to quickly and intelligently identify excess capacity and then aggregate mass audience around intent
- Cultural zeitgeist, economic concerns, and values of Millennials

The Sharing Economy's models of operations and growth may permanently change the rules of some of the most asset-intensive industries in the world, including the auto industry.

"I want to be able to go to any city and be able to get around that city for less than the cost of owning a car and with the ease of a car without actually having to own a car. I want to be able to consume transportation as a service."

– Logan Green,
CEO and co-founder of Lyft



"What we maybe should've realized sooner was that we are running a political campaign and the candidate is Uber. And this political race is happening in every major city in the world. And because this isn't about a democracy, this is about a product, you can't win 51 to 49. You have to win 98 to 2."

– Travis Kalanick,
CEO and co-founder, Uber

NTT INNOVATION INSTITUTE, INC.

What do the behaviors and rules of the Sharing Economy mean for the auto industry and related markets?

- As Millennials age into their prime driving years, the average driver's need for a car or multiple cars (at least in the US) may decline rapidly given their experience with on-demand mobility.
- New levels of trust and rapport are developing for members of the "asset-light" economy and the on-demand mobility service providers they interact with up to several times per day.
- Value is noted and rated immediately and directly. Positive experiences relayed via social channels trumps traditional advertising for users who want to hear about new products and services from their friends and trusted influencers.
- Customers are evolving into relationships with companies that are more similar to collaborative partnerships versus extractive consumerism.
- Public policy and discussion around appropriate regulation that enable the delivery of consumer-desired mobility types in urban environments may gate, but not stop, expansion.
- Insurance liability is shifting from the individual user or driver to the service provider (Uber, Lyft, ZipCar), or even to the manufacturer for future self-driving cars. This provides both a challenge in terms of new business risk, but also provides an opportunity for expansion into the adjacent insurance market.

CHAPTER 3

The drivers of digital business transformation

TECHNOLOGY AND DIGITAL TRANSFORMATION

THE SOCIAL NETWORK OF THINGS

ROBOTICS, AUTONOMOUS CONTROL, AND 3D PRINTING

THE CONNECTED CAR, CONNECTED DRIVER, AND MOBILITY CUSTOMER

DATA, MACHINE LEARNING, AND CYBER-SECURITY

OPEN SOURCE PATENTS AND APIS

THE CHANGING NATURE AND SOURCES OF COMPETITION

If we believe that all businesses now need to become technology first digital businesses, then how do we define that?

Digital Business:

- Provides customer-centric, seamless, and context-aware experiences that result in a sustainable competitive advantage.
- Requires technology, but demands a vision and plan beyond the latest technology in order to deliver on a new value proposition.
- Moves beyond the “value extraction” model of a “consumer” to an approach built around “reciprocal exchange” of value with customers.
- Operates in ecosystems where the focus of competition has shifted from product features to individualized experiences.
- Delivers experiences designed to play to a firm’s strengths by leveraging people, processes, data and the Social Network of Things across the entire value chain.

Key Attributes of a Digital Business Technology

Flexibility
Scalability
Interoperability

Human Relationships

Empathy and Relevance
Respect

TECHNOLOGY AND DIGITAL TRANSFORMATION

Technology is a necessary, but not sufficient, component of digital transformation. When it does come to technology, businesses need to focus on, understand, and implement systems that follow three critical characteristics of flexibility, scalability, and interoperability.

Flexibility

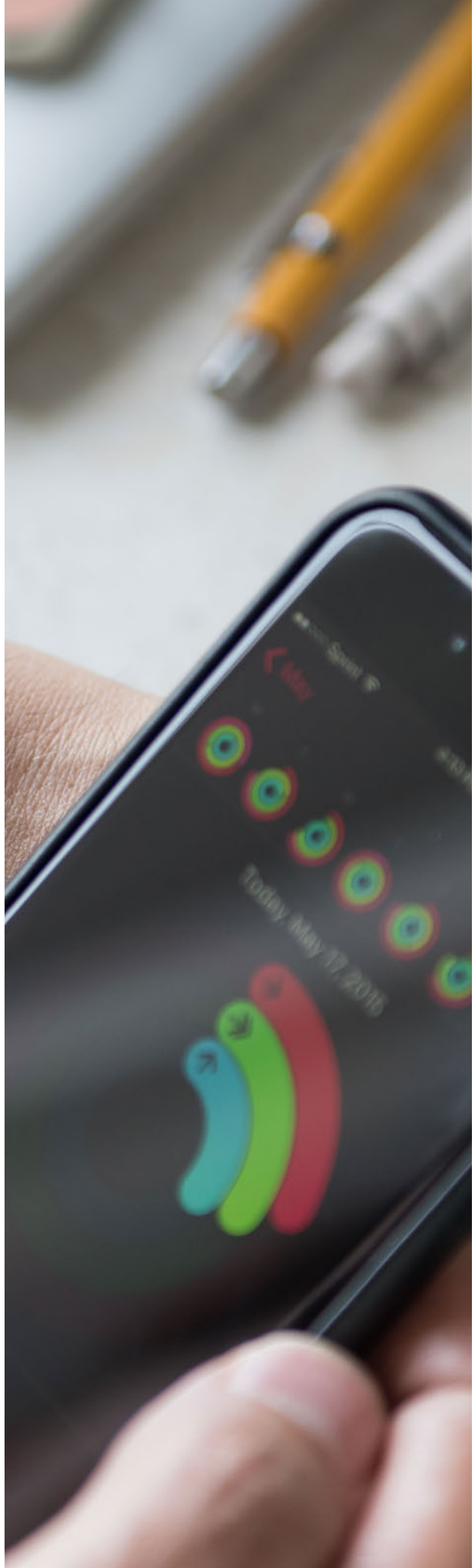
Digital businesses are built to achieve sustainable competitive advantage by being agile, resilient, and responsive. They understand the importance of flexible enterprise architectures and build efficient, reliable back-end systems. Digital businesses use technology flexibility to enable them to:

- Think smarter through the intelligent and effective use of predictive and real-time analytics at all critical touch points of the data value stream
- Act faster by lowering barriers to entry and enabling their employees to experiment quickly and cheaply with prototypes and pilot programs
- Adapt business and operational models to changing customer desires and market dynamics

Scalability

In order to build a truly flexible and adaptive system, companies must know how to start small and quickly experiment with solutions. This allows them to test effectiveness before choosing to scale to meet high demand - or - ramp down to reduce costs. Digital businesses can use scalability to help them design:

- Flexible enterprise architectures that can be expanded across the company
- Partnerships with cloud, SaaS, and security providers, so that internal teams can focus on code and users



NTT INNOVATION INSTITUTE, INC.

Interoperability

Today's customers expect seamless experiences that blend individual transactions and engagements into a larger context across all of their touch points with a company or product. Digital businesses focus on interoperability and its standards in order to create and deliver:

- Customer experiences that easily travel across all platforms and networks, from a desktop in an office, to a smartphone on the go, to an embedded system
- Highly integrated and intelligent manufacturing facilities and supply chains

THE SOCIAL NETWORK OF THINGS

Evolving from the Internet of Things to the Social Network of Things

Since the phrase was first coined in 1999 by the British entrepreneur Kevin Ashton, much has been written and debated about the potentially game-changing impact of the Internet of Things as it relates to the evolution of consumer experiences and enterprise processes.

Phase 1: Internet of Things

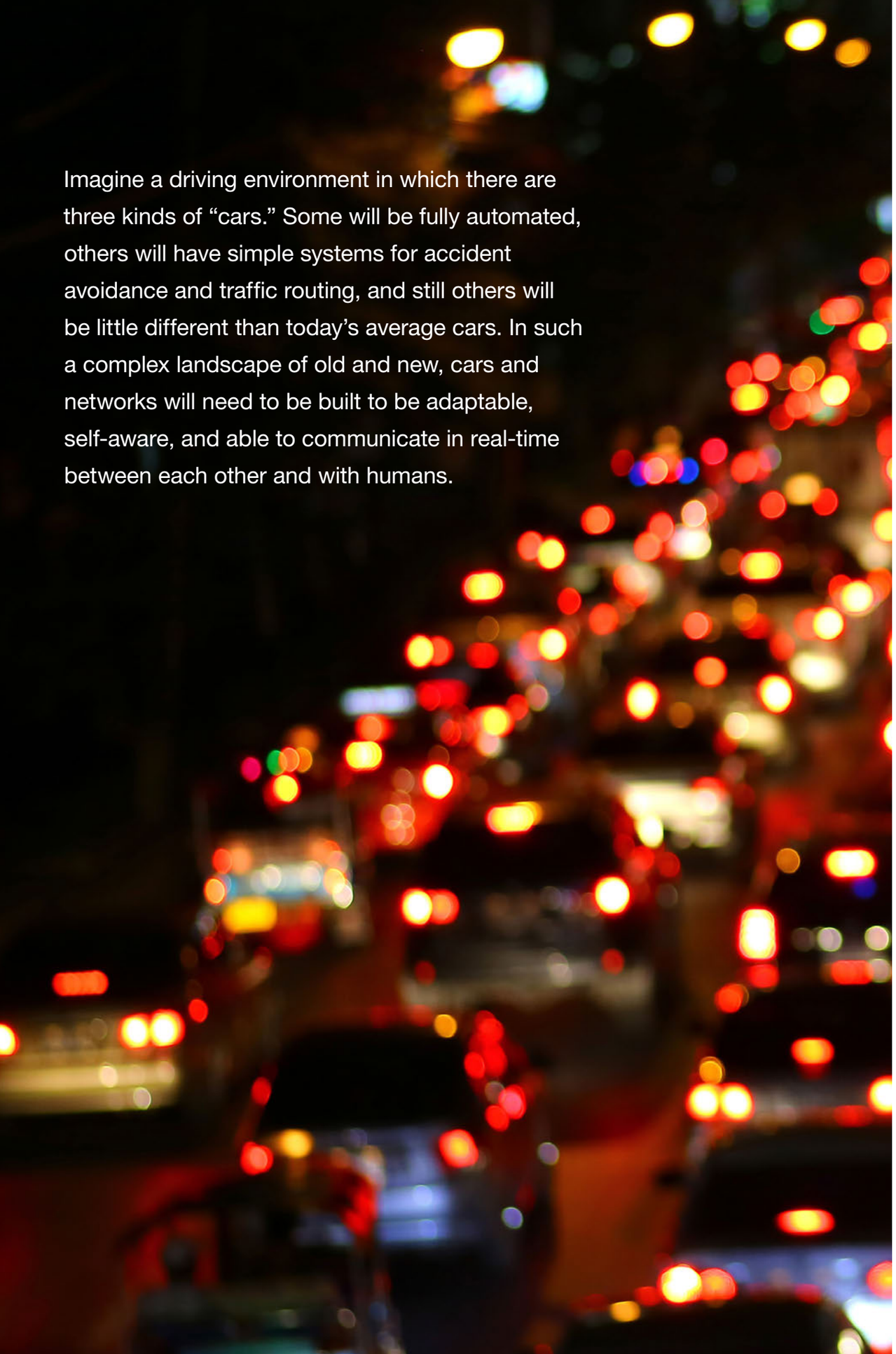
The first phase of IoT largely focused on adding sensors to devices designed for relatively isolated purposes, with the data generated primarily used for reporting purposes. This is still the case for the majority of companies and applications. Look at Fitbit in the consumer space, most smart meters in the utility industry, and on-board data recording or navigation systems in cars.

Phase 2: The Transition to Greater Integration and Intelligence

Today, industry evolution has taken us to somewhere between the Internet of Things and the near future possibilities of the Social Network of Things. Last year's isolated products with attached sensors are being replaced with greater levels of network power, social connectivity, systems interoperability, and robotic hardware. In the car, this is experienced in the evolution of navigation from old GPS systems to the socially-driven Waze app and community. In the smart factory, this is about machines that can predict maintenance needs and order their own replacement parts.

"In the twentieth century, computers were brains without senses—they only knew what we told them. That was a huge limitation… In the twenty-first century, because of the Internet of Things, computers can sense things for themselves… In the imminent future, it will enable things like self-driving cars, which will give us back the 20 days a year we spend doing nothing but driving, will save 40,000 lives a year in the U.S. alone, will reduce traffic and pollution, and will allow cities to grow without devoting as much land to roads."

– Kevin Ashton in The Smithsonian, January 2015



Imagine a driving environment in which there are three kinds of “cars.” Some will be fully automated, others will have simple systems for accident avoidance and traffic routing, and still others will be little different than today’s average cars. In such a complex landscape of old and new, cars and networks will need to be built to be adaptable, self-aware, and able to communicate in real-time between each other and with humans.

NTT INNOVATION INSTITUTE, INC.

Phase 3:
The Social Network of Things

The Social Network of Things is predicted to mark a time when devices, machines, and people are deeply connected through pervasive computing, rich networks with highly integrated sensing capabilities, advances in machine learning and cognitive computing, robust APIs and equally important – significant cultural changes. This evolution of connectivity, integrated standards, and intelligence will enable most of our personal devices and industrial machines to increasingly interact, collaborate and coordinate with each other – if that is the human design choice. This is what distinguishes the Social Network of Things and its evolution from today’s Internet of Things.

An auto industry that is integrating the Social Network of Things will be faced with some fascinating and fundamental questions.

How will we look at a world in which it is becoming less possible to decouple human from machine social networks?

How will we build interfaces and networks that enable us to interact with machines that make key decisions for and about other human beings—such as two driverless cars coordinating with each other to avoid an accident?

How will we need to evolve IT platforms and systems to be able to respond to the needs and demands of billions of connected devices that can easily impact the safety and health of humanity?

How will we define and ensure the level of cyber-security needed to protect someone’s life in a vehicle, which far exceeds that needed for today’s e-commerce and mobile wallet transactions?

Evolving from the Internet of Things to the Social Network of Things

	INTERNET OF THINGS →	TRANSITIONAL PHASE →	SOCIAL NETWORK OF THINGS
OVERVIEW	Purposes for devices are still relatively isolated Information focused on reporting	Introduction of basic networks and social aspects Basic augmentation of human capacity	Devices are highly networked Devices and systems that can predict, negotiate, and impact outcomes
THE SEARCH FOR	Efficiency	Efficiency	Transformative experiences
DATA	Access to recent info from individual devices	Near real-time on-demand data access	Real-time data from multiple sources
INTELLIGENCE	Device data to human feedback loop	Limited machine learning driven by humans	Autonomous decision making
CHALLENGES	Privacy Security Interoperability Limited Networks	Privacy v. Functionality Network security v. Innovation Interoperability Dumb Networks	Safety conflicts Cyber-security Social and technology complexity Legacy systems
TECHNOLOGY	Cloud platforms Data Proximity Tools Sensors Robotic toys	Products dominate systems and networks Analytics and Big Data Machine learning Smart products Robotic manufacturing	Adaptive and resilient platforms Little Data Cognitive computing Rich APIs Proliferation of robotics and intelligent devices
EXAMPLE	Web-enables GPS and maps	Waze app and crowd sourcing community	Self-driving cars

COGNITIVE ROBOTIC SYSTEMS, AUTONOMOUS CONTROL, AND 3D PRINTING

Auto manufacturing processes have largely been limited to assembly within one single factory. Technology and consumer value demands are already in play that will soon result in the elimination of the boundaries of individual factories. Production will be based around virtually interconnected facilities and labs in multiple geographical regions. The world of production will become increasingly networked until "everything is intelligently connected with everything else." This means that the complexity of production and supplier networks will grow enormously, before they eventually become simpler.

Evolution of the Integrated Value Chain of Manufacturing

To date, the strategic focus on change in manufacturing has been on increasing the speed and flexibility of production and how that determines how effectively and efficiently a car can be produced.

To achieve this, the industry has focused on developing smarter internal devices and processes. The ripples through the enterprise have been largely about the impact on a financial ROI metric.

In the unfolding world of Auto 3.0, manufacturing is more about software and hardware systems standards that facilitate deep integration that turns real-time data into intelligence and autonomous action. The focus on intelligence will be on both autonomous cognitive machines and more advanced human-machine collaboration. This cycle of evolution will enable mass customization and greater responsiveness to customer values. The new metric of success will no longer just be ROI, but the customer value attributed to transparency, accessible relationships, and a "bespoke-like" product.

FUTURE SCENARIO

In the near future, Industry 4.0 and the Social Network of Things may lead us to fully autonomous manufacturing facilities and production plants. A production plant could exist in any location in the world, and be run from another location. When needed, engineers could be dispatched to make repairs or perform maintenance, knowing exactly what to expect and which parts or tools to bring.

Cultural Changes Required for Next Generation Manufacturing

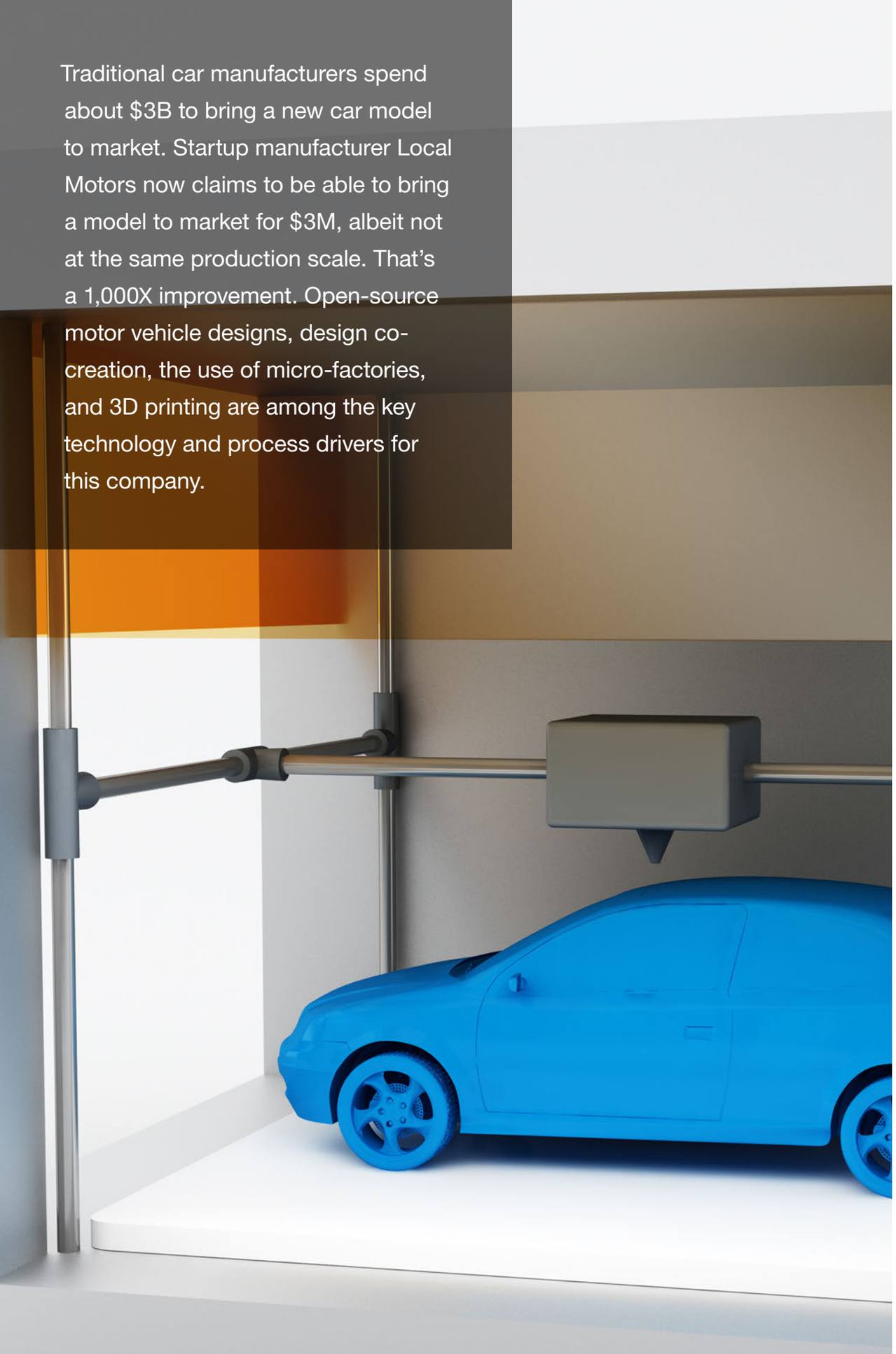
Cultural change will be required for the next evolution of auto manufacturing. This will be especially true in relationship to the need for increasing acceptance of information technology and collaborative systems outside the company's own controlled factory environments.

In an industry where there is increasing dependence on suppliers to provide just in time delivery, wouldn't it help the production line to know exactly where the truck is with those materials, or if it is in a traffic jam? That kind of timely information would enable the production line to be automatically and autonomously adjusted for any schedule change.

Consumer technology companies such as Amazon, Airbnb, and Uber have shown that this kind of transparency can be a key competitive advantage.

The coming evolution of the auto factory will be defined by "advanced cyber-physical systems" that include:

- Human-machine interfaces and "collaborative robotics"
- Self-aware machines with autonomous control
- Networked systems that can directly influence their environment
- Flexible and small batch manufacturing systems
- Condition monitoring and predictive maintenance
- Intelligent self-organizing logistics



Traditional car manufacturers spend about $3B to bring a new car model to market. Startup manufacturer Local Motors now claims to be able to bring a model to market for $3M, albeit not at the same production scale. That's a 1,000X improvement. Open-source motor vehicle designs, design co-creation, the use of micro-factories, and 3D printing are among the key technology and process drivers for this company.

NTT INNOVATION INSTITUTE, INC.

3D Printing Goes Mainstream

3D printing technology can have significant impact on several touch points in the auto value chain including the design cycle, replacement parts for customer service, and even customer co-design of their vehicles.

As cars and processes have become increasingly digital in the auto industry, one of the challenges has been in the misalignment of hardware-software design and development cycles. What if the cycle for hardware could look more like its accompanying software, and be compressed to under a year? This could be possible with the use of 3D printers to create prototypes in the design cycle.

For the car owner, one of the greatest annoyances is in needing a replacement part and not having one easily accessible. Using locally deployed 3D printers and creating a "print parts on demand" service business could change not only the customer experience, but also the whole supply chain and warehousing infrastructure.

For the car enthusiast, what might be more intriguing than being able to be the co-designer of part of their own vehicle? There are companies today that can print the outside of a car. That creates a new kind of mass customization for the industry.

THE CONNECTED CAR, CONNECTED DRIVER AND MOBILITY CUSTOMER

NTT INNOVATION INSTITUTE, INC.

When “cars become apps” and on-demand mobility doesn’t require owning a vehicle

The evolution of the connected car presents new requirements and challenges for the auto industry. While the connected car has been a part of the language of the industry for over a decade, the rise of the connected driver and the mobility customer is relatively new – and will be game-changing for those who are prepared.

Connected Car

The connected car has largely been focused on delivering content from infotainment networks and enabling dealers to access black boxes for diagnostics.

Connected Driver

With the connected driver, there is a deeper integration of the customer-car-service relationship. The “car functions as an app” enabling the vehicle to obtain new functionality and service repairs via OTA software uploads. The driver experience discussion evolves beyond the tradeoffs of the distracted driver and their infotainment systems. New business models around “renting” downloadable capabilities in the car versus permanently purchasing them become possibilities.

Mobility Customer

Mobility customers look across a variety of platforms and options for their transportation needs, which are often on-demand. Their choices may be the result of a practical and emotional rethinking of how they relate to their once beloved cars. They may see all options as equally likely: car ownership, two-way car sharing, one-way ride sharing, app-facilitated car pools, long distance buses, and even bike sharing.

CONNECTED CAR ····· CONNECTED DRIVER ····· MOBILITY CUSTOMER ····›

What will facilitate the ability to address the evolving needs of the connected driver and mobility customer?

In today's most cutting edge versions of the connected car, we are already seeing a reflection of the consumer expectations of services in an on-demand, everywhere accessible world. Decreasing costs of connectivity; understanding the tradeoffs between tethered, embedded, and hybrid systems; and the ubiquitous presence of smart phones have framed the discussion and development.

That which has slowed or even prevented the development of certain kinds of services in the past - will be diminished or removed in the world of Auto 3.0 where the connected driver and mobility customer will rule.

Technology Capabilities

New technical capabilities will need to reside inside auto OEMs or by means of close strategic partnership. Many of these skills are in areas that have not traditionally been strengths for the industry - including software development, telecommunications engineering, user experience design, and IT automation.

Driver Experience and Embedded versus Tethered or Hybrid Systems

Will customers continue to be reluctant to pay the cost of embedded systems vs. those on their smart phones? What kind of relationship with the customer can and should auto OEMs have in a world where Apple CarPlay and Google are moving into the driver's cockpit?

Product Development Cycles

Processes, systems, and technologies will need to be implemented to more closely sync the development cycles of software and hardware, and to meet the "I want it now" demands of customers.

Data Integration

Front-end systems will need to be able to seamlessly address greater data volumes and integration, always-available connectivity, and countless apps. With the reliance on data to drive customer experience and car functionality, backend systems and technologies around analytics, data privacy, and cyber-security will be as important as the design of the physical driver experience.

BIG AND LITTLE DATA, MACHINE LEARNING, AND CYBER-SECURITY

Data is core to understanding and delivering on both the new customer experiences and manufacturing processes demanded by Auto 3.0. The automotive industry is projected to be the 2nd largest generator of data in the world in 2015. To take advantage of the new data-driven business opportunities, auto OEMs will need to understand and address IT infrastructure, technology expertise, and business and policy systems in relationship to the issues of:

- Big Data
- Little Data
- Machine Learning and Cognitive Computing
- Cyber-Security
- Consumer Privacy

Big Data

The unprecedented growth in volume, variety and velocity of Big Data that is generated moment-to-moment by both driver/car and manufacturing activities provides new opportunities to auto companies. That will be true if the right systems and expertise can be put in place that are in alignment with the customer value chain. Big Data is being generated from: the car itself, manufacturing processes, supply chain, content and technology partners, and customer interactions.

Using Big Data requires intelligent data warehouses, advances in real-time analytics, and well-designed business intelligence dashboards. Big Data analytics have value across the entire value chain including: product design and performance, preventive and predictive maintenance, and supply chain forecasting.

Little Data

Little Data includes information about the activities and actions of an individual person including: in-car infotainment preferences, patterns of travel, and social media engagement. Small data can yield deep understanding about both micro and macro trends. The key to unlocking these insights is not just about technology, but also social and legal contracts. Companies must not only get permission from someone to collect their data (opt-in vs. opt-out), but also clearly set expectations for its use and how it will deliver value to the consumer, and not just to the business.

“Data science is the next hurdle. Information is trivial unless you can make sense of it, and we’re working on machines that can do this for us.”

– Kevin Ashton, journalist who coined the phrase “Internet of Things”

Machine Learning and Cognitive Computing

Machine learning based on data inputs and outputs within specific contexts is a key force in the evolution of both autonomous robotic manufacturing and self-driving vehicles.

In the case of vehicles, cameras, sensors, and specially designed computers create 3D representations of the world that are used to navigate safely through unpredictable traffic. The rule set and ability to make complex split-second decisions is the result of both man-made and machine learning in the systems.

In the factory, robots can have the capability for both autonomous and human-collaborative modes as a result of the intelligence imparted by machine learning that evolves them into “cognitive computers.” In time, cognitive computing may expand from individual robots and processes to entire factories or factory networks.

Cyber-Security

As the volume of computers, networks and code grow both in the connected car and in “smart factories” there is a growing need to understand and address the technology and policy issues around cyber-security.

In Manufacturing

What happens when someone hijacks a factory, or even one element of a highly integrated production line?

What kind of significant business damage, both in terms of economics and brand reputation, could result form undetected “digital product tampering”?

In the Connected Car

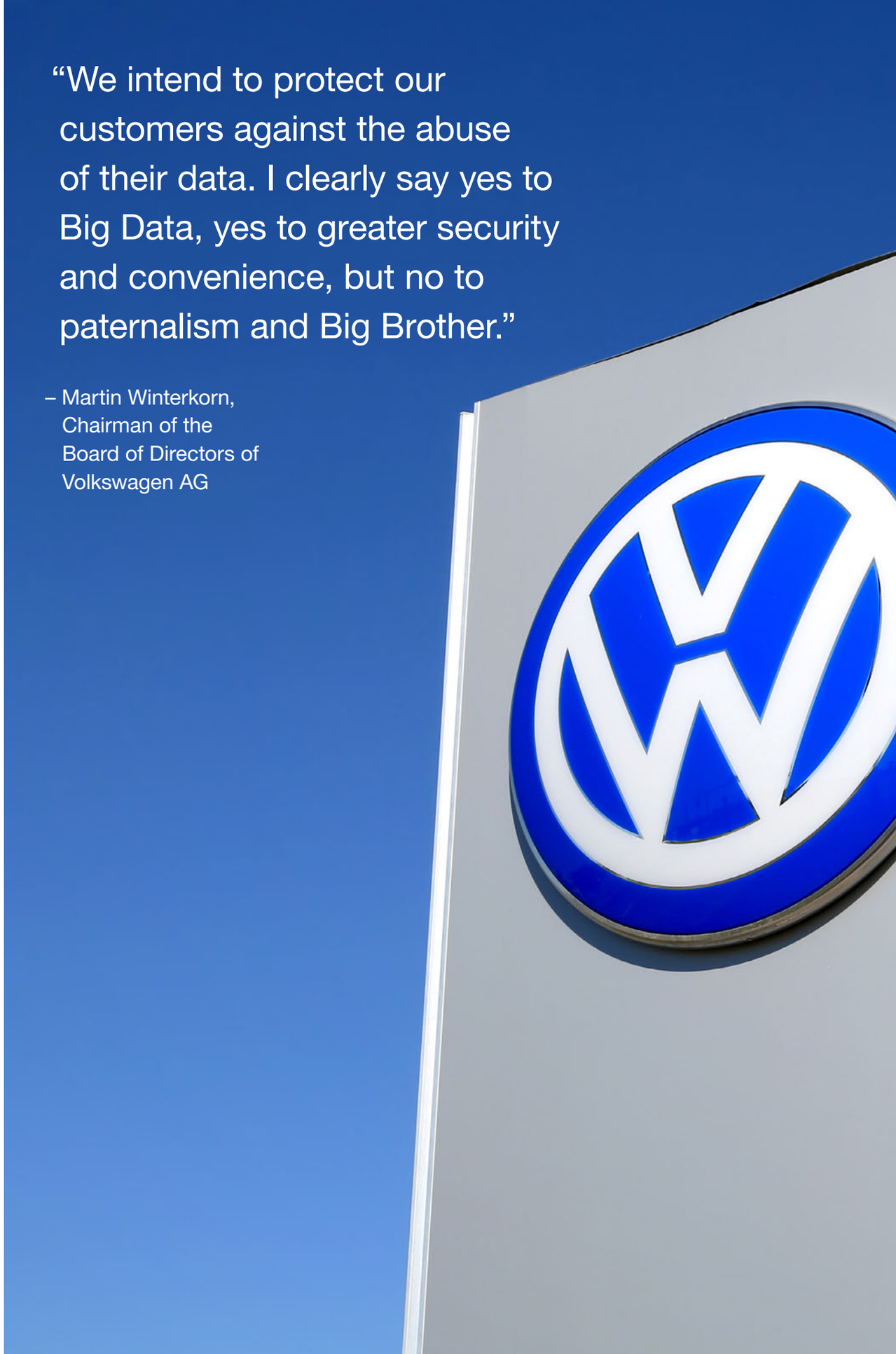
What protections need to be in place to prevent the hijacking of a car, or even to provide a warning that there is tampering underway within a single system?

While we focus on the drama of a hijacked vehicle, what about the economic impact of adversely hacking a vehicle’s performance?

As the environment around a car become more infused with sensors that supply real-time data to the vehicle, what happen if those systems are attacked?

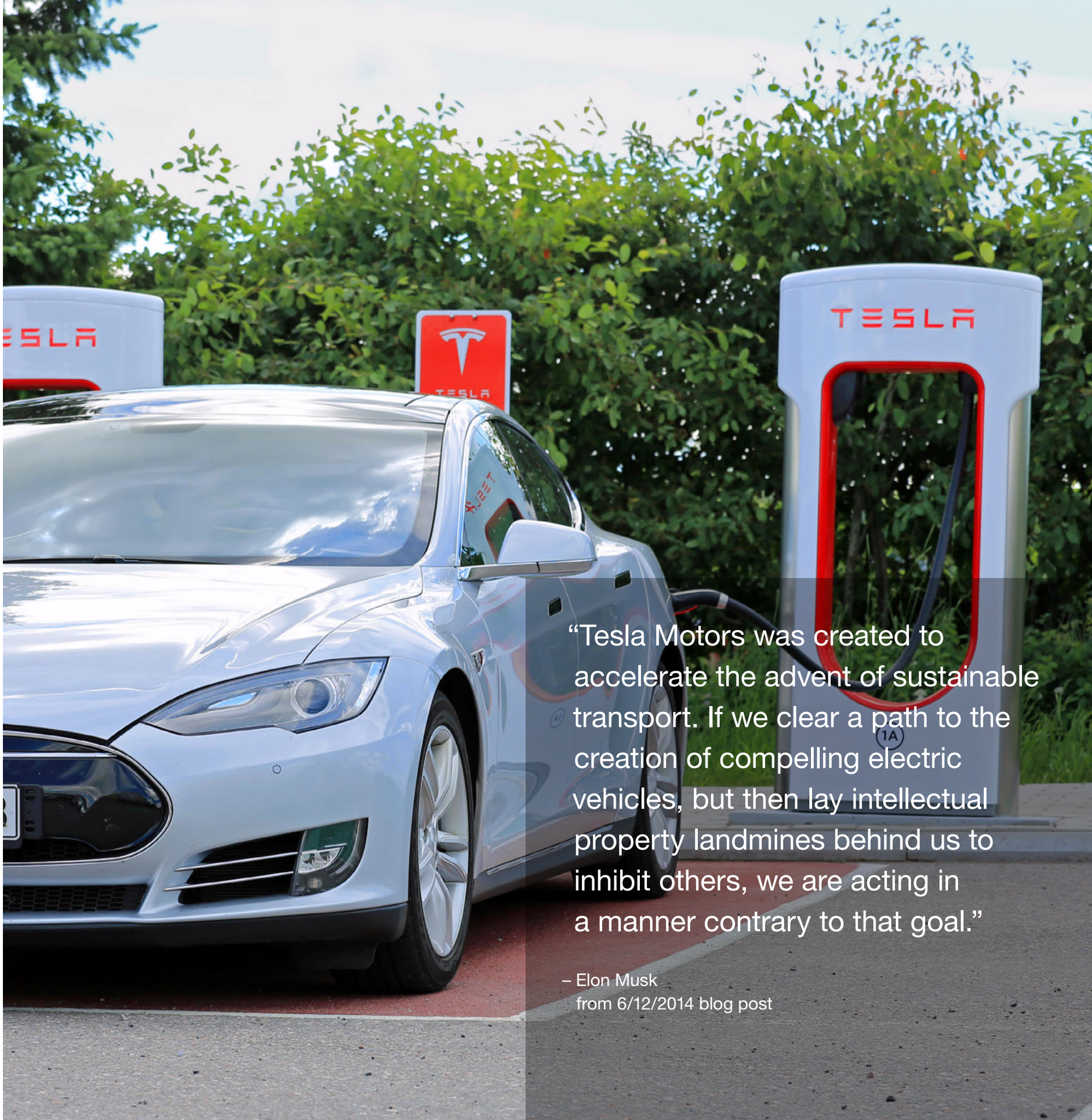
“We intend to protect our customers against the abuse of their data. I clearly say yes to Big Data, yes to greater security and convenience, but no to paternalism and Big Brother.”

– Martin Winterkorn,
Chairman of the
Board of Directors of
Volkswagen AG



Open Source Patents and APIs

The ability to create ecosystems of complimentary products and services built upon the IP and APIs of others has been a key driver in the exponential growth of the technology industry over the past 5 years. The auto industry has been one that has closely guarded its secrets in the past, so this kind of “free market” experimental product system has never existed. As cars and the auto industry become more technology-driven, might this change in the not too distant future?



“Tesla Motors was created to accelerate the advent of sustainable transport. If we clear a path to the creation of compelling electric vehicles, but then lay intellectual property landmines behind us to inhibit others, we are acting in a manner contrary to that goal.”

– Elon Musk
from 6/12/2014 blog post

THE CHANGING NATURE AND SOURCES OF COMPETITION

As digital businesses are evolving, the nature and source of competition is changing with them – often in dramatic and unexpected ways.

Technology enables competition from outside the industry

With technologies that lower the costs of entry into the market and that also enable rapid scaling on demand, new entrants unburdened by legacy infrastructure and practices will challenge established industry leaders. This same dynamic may also enable challengers to move into adjacent markets that expand their economic opportunity.

digital future:

Will new entrants such as Tesla that initially focus on “niche” markets become the mainstream leaders of tomorrow? Will the on-demand utility-driven models of app-based ride sharing services replace a significant portion of urban auto ownership, and force a multi-platform redefinition of mainstream mobility? Will Tesla’s move into energy for homes fuel future success in cars?

Intermediaries and rules of arbitrage are no longer relevant

Companies and industries that have built significant portions of their competitive advantage around serving as gatekeeper or intermediary are seeing their core value propositions eroding and their competitive advantage crumbling. Data-driven technologies, the cloud, and social platforms are enabling challengers to quickly aggregate and understand disperse sources of information, and convey that to an audience with which it can directly communicate.

digital future:

Will Google with its long held mission to “organize the world’s information,” not only help consumers make better insurance comparison decisions, but get into the business of providing or brokering product itself? Will the Tesla “no dealer” model succeed, dislodging the traditional auto dealership structure as industry intermediary to customers?

Competition is Changing

- Technology enables new sources of competition from outside the industry
- Intermediaries and rules of arbitrage are no longer relevant
- Access to alternative capital sources (venture, angels, the crowd) inspires “little bets”
- Customer advocacy and behavior is an even bigger factor in competitive success
- The tenure for leading companies becomes shorter

Access to capital from the venture community, angels and the crowd inspires “little bets”

If the barrier of access to needed levels of capital can be lowered or provided through non-traditional sources, challenger strategies for targeting initially niche markets within an industry may scale quickly to a mass-market opportunity. Companies that pursue markets where they no longer need to own all of the assets of “production” naturally have lower fixed financial requirements. Challengers can also target markets that incumbents do not see as returning the financial ROI required to support their massive infrastructure.

digital future:

Will Tesla evolve from its initial status of “fan boy toy” to “mainstream darling” in 2017 with a $30k electric vehicle tied into a network of Supercharger stations?

Customer advocacy and behavior will be an even bigger factor in a business’ competitive success

Customers are increasingly in the driver seat as a result of their nearly unlimited access and choice about information, products, and services. Millennials in particular have an innate understanding of marketing and of their value as consumers. They’re significantly more likely than older generations to believe they have the capacity to help a brand succeed or fail.

digital future:

Will customers be making decisions that boards and executives are making today?

The tenure for leading companies becomes shorter and is no longer guaranteed

Looking at the changes in the composition of the S&P 500 over the past 60 years shows this to already be true. In 1958, the average tenure of a company in this index was 61 years. By 1980 this had dropped to 25 years, and in 2011 it was but 18. At the current churn rate, 75% of the current firms will be replaced by companies first entering the index in 2027. Technology is accelerating this fact of the impermanence of business life.

digital future:

Will size matter in the future or will agility determine the leaders to follow and their tenure at the top of a new kind of index?

“Innovation distinguishes between a leader and a follower.”

- Steve Jobs

CHAPTER 4

Auto 2.0: the current state of the industry

INDUSTRY 4.0

MANUFACTURING TECHNOLOGY

REDEFINING THE SUPPLY CHAIN

THE CONNECTED CAR VERSION 1.0

THE BIRTH OF MOBILITY SERVICES

INDUSTRY 4.0

NTT INNOVATION INSTITUTE, INC.

Industrial Revolution Meets Internet Evolution

Industry 4.0 is designed to evolve the world of manufacturing by bringing together the machines, facilities, factories, and networks of the Industrial Revolution with the digital information and communications technologies of Internet Revolution.

Over the past 250 years, manufacturing has moved from a series of “revolutions” to the current “meaningful evolution.” No longer is manufacturing just about isolated automation via IT and isolated intelligence. It is about a new level of organization and control with fully digital and networked models of product development, supply chain, production, delivery, and service.

Interoperability and Connectivity

Humans, machines, and factories can connect and communicate via the Industrial Internet of Things.

Autonomy

Systems can make decisions autonomously based on data, analytics, and past successful behaviors.

Real-Time Decision-Making

Technology and systems collect and analyze data to provide insights that drive decisions from humans and/or machines.

Process Modularity

Manufacturing is not bound by a single physical construct, but can adapt by changing individual modules.

Service Orientation

Software enables post purchase services to deliver additional customization, capabilities, and extension of the product lifecycle.

By using deeply integrated hardware and software to connect machines, processes, systems, and humans –

Intelligent networks can be created along the entire product design and manufacturing value chain -

These networks can constantly inform and control each other autonomously -

Via real-time decision-making systems informed by data, analytics and machine learning.

With Industry 4.0 we have the birth of smart factories, products, services, and businesses.

Smart Factory

Data-driven networked manufacturing systems with both autonomous control and human-machine interaction.

Smart Product

Customizable, technologically advanced, and intelligent products enabled by sensors, networks, communications interfaces, embedded software, and apps.

Smart Service

Physical products linked with software-delivered services to provide customers with evolving added value versus obsolescence.

Smart Business

New models for collaboration, partnership and measuring success across the value chain of manufacturing.

The Challenges of Standards and Security

Technology always brings with it both big promises and potential dangers. This is no exception for Industry 4.0 in which both the lack of IoT standards and cyber-security impact the extent to which the manufacturing elements of the auto industry value chain can evolve digitally. Without standards, communication between software solutions, machines, and IT systems are difficult.

If and when standards enable the meaningful connection of machines, processes and humans - security and the potential for sabotage will need to be addressed. In the near future auto industry, security concerns are not limited to the idea of hackers hijacking a connected car. What happens when someone hijacks a factory, or even one element of a highly integrated production line? What kind of significant business damage - both in terms of economics and brand reputation - could that do to a company if undetected? If security is not effectively addressed, there may well be the potential for the creation of “digital product tampering.”

NTT INNOVATION INSTITUTE, INC.

Industry 4.0:
Elements, Technology, and Participants

INDUSTRY 4.0 ELEMENTS	TECHNOLOGY INFRASTRUCTURE	PARTICIPANTS	TECHNOLOGY ENABLERS
SMART FACTORY	DATA & ANALYTICS	COMPANY	BIG & LITTLE DATA
SMART PRODUCTS	CLOUD SERVICES	CUSTOMERS	ANALYTICS
SMART SERVICES	CYBER-SECURITY	SUPPLIERS	CLOUD
SMART BUSINESS	ARCHITECTURE & APPLICATION INTEGRATION	PARTNERS & EXPERTS	MOBILE DEVICES
		THE CROWD	ROBOTICS

MANUFACTURING TECHNOLOGY

Building on Lean Processes with Robotics

Much of auto production process efficiencies and cost management continue to be based around principles of lean manufacturing with their origins in the “continuous flow” assembly lines of Henry Ford and the “Just In Time” manufacturing methods of Toyota. With its concentration on reducing and avoiding inefficiencies and minimizing waste, lean has defined and driven the industry’s current level of flexibility for responding to changing output needs.

New ways of building on lean manufacturing processes are needed as software, and not physical resources, become more important in the customer-centric process.

Issues of mass customization are different than those of mass production’s assembly line speed.

Industrial robots are also becoming an integrated part of the evolving lean process. Their value is increasing as they become more intelligent, collaborative and autonomous as a result of the Industrial Internet of Things with technologies of embedded sensors, big data, real time analytics, and machine learning.

Tesla vs. Ford Manufacturing Volumes

Tesla produces 110 vehicles/day

Ford produces 8,110 vehicles/day

The Data Chain - Where the auto industry excels in manufacturing today

As an industry, today's auto manufacturers excel in three main areas:

- Vertical systems integration
- Automation of machines and production
- Delivery of individual production information from orders to the assembly line

In the area of vertical systems integration, the auto industry has been a role model for other manufacturers. Integrating data from ERP to planning optimization to shop floor scheduling and execution has been an area of technical and business process focus. The ability to digitally have configuration information travel with every vehicle down the assembly line means that the right information gets to the right machine, down to the level of calling out which screwdriver and what level of torque needs to be applied against a particular component and step. More recently, with some machines having the ability to both send and receive data, this new stream is being integrated into the manufacturing process, assisting in areas such as predictive maintenance.

The most cutting edge factories of today are beginning to be positioned for the world of Auto 3.0 where they will need to be able to respond more effectively to consumer demands. Data-driven and highly networked manufacturing systems with both autonomous control and human-machine interaction will be the standard, not the exception.

This will be the new production baseline in order to create the highly flexible factory ecosystems needed for both mass production and mass customization.

Only a few years ago, when there was a problem with a machine, an engineer would be dispatched to see what was wrong. Upon diagnosis, they may not have the right tools or parts and would then have to go back to the central office to acquire them. In a worse case scenario, the needed parts would not even be in stock.

In the world of the Smart Factory, when there is an issue with a machine, engineers receive digital alerts about problems along with a list of the tools and parts needed. Tablets and GPS trackers guide them to the exact location of the problem and also provide visual information to aassist in the repair.

In some factories, machines are beginning to be able to self-diagnose and predict problems, then autonomously order the needed parts.

REDEFINING THE SUPPLY CHAIN

Horizontal and Vertical Integration

Horizontal integration has been the supply chain strategy of the past in the auto industry when a company's survival was defined by its ability to quickly gain economies of scale and scope. In preparation for the future, vertical integration across all points of the value chain is becoming a tactical and strategic priority with increasing competitive needs to integrate multiple stages of production, as well as to create individual components for the final product.

Vertical integration has historically been fueled by the vulnerability of complex global supply chains to economic downturns. Now it is increasing in importance as companies jockey for access to and control of new technologies and cutting-edge materials. Today the focus may be on batteries and carbon fiber. In the next few years when those become commodities, it will be something else. There is no permanent advantage here. There is only a persistent need for evolution and integration of the supply chain through investment and partnerships.

Case in point: Tesla produces 95 percent of its parts in-house. That is truly massive vertical integration.

The Tesla Gigafactory

The Tesla Gigafactory will produce lithium-ion batteries at a rate to support the manufacture of 500,000 electric cars per year. By 2020, the plant will be capable of producing as many lithium-ion batteries as the entire world produced in 2013. The company expects that volume manufacturing of its mass-market vehicle will drive down the cost-per-kWh of its batteries by 30 percent within the first year.

THE CONNECTED CAR VERSION 1.0

Connected cars are not anything new. They have been around for over a decade.

It's what they can now do and in the near future that is truly revolutionary. They are dramatically changing consumer expectations and behaviors, as well as the need for IT reinvention in the enterprise. The connected car may be the exception today. By the end of the decade it will be the rule.

Connected cars started out to provide auto-generated emergency roadside calls for help. (Remember OnStar?)

Then came Internet radio and streaming music via connected smart phones and connectivity adaptor kits.

Now connected cars are:

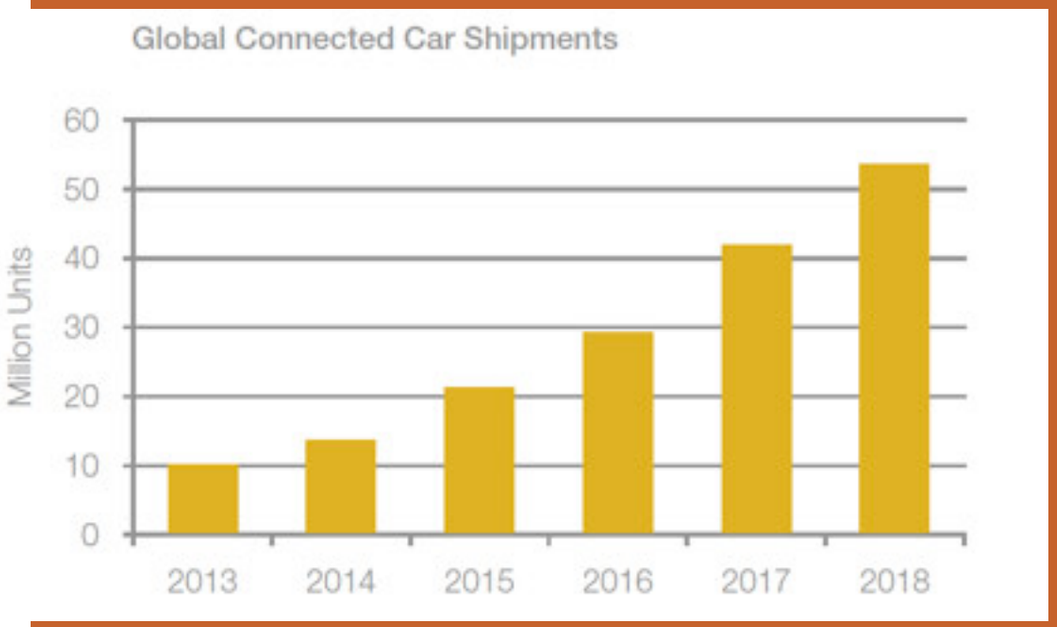
- Becoming a mobile node in a huge computer-controlled transport network.
- Morphing into mobile data centers

Connected cars are no longer a premium car offering limited to Tesla, Mercedes Benz, BMW, and Audi. They are now a part of mainstream brands such as Ford, VW, Toyota, and Nissan.

Connected cars can deliver highly desired consumer benefits of convenience, safety, energy efficiency, entertainment, and information.

For the auto OEM, they are driving the exploration of new services and revenue models, the formation of innovation units and strategic partnerships, and greater technology complexity needing to be addressed by the IT practice.

Many of today's "connected cars" have more lines of code than a Boeing 787. The Tesla S is thought to have more than 30 million lines of code, with the Chevy Volt having 10 million.



Currently (2015) connected cars are 10% of new cars, rising to 90% by the end of the decade (2020).

It's All About the Data (and Networks)

Data is the basis for all connected car services, whether it is broadcast to the vehicle or collected from the various built-in sensors or devices in the car and even its surrounding environment.

With the connected car, data is both received and transmitted, as well as collected and stored locally.

- Receive information:
  Streaming media services, directions and road conditions, remote service, predictive diagnostics, and software updates.
- Transmit information:
  Location based information, requests via the Internet, and booking appointments.
- Collect and store information:
  Record trips, driving behavior, car status.

This kind of built-in and networked data power is beginning to drive not only truly revolutionary consumer services, but also the need for the enterprise to re-engineer its IT systems, teams, and partnerships around responsiveness.

Concerns about data use and privacy are also beginning to be raised and will be a critical part of the evolution of the connected car. Manufacturers will be under increasing pressure to make money from data and will hence be motivated to own it. Consumers will be rightly concerned about what auto companies are learning and sharing about them as they drive, whether it is with insurance companies or government agencies.

The Strategic Importance of the Connected Car

The evolution of the connected car from its current base state is strategically important for established auto OEMs. Already several brands are working to evolve their century old brands from “car manufacturer” to “mobility provider.” No one wants to loose access to an important part of the customer value chain, and be relegated to the role of a commodity “data pipeline” with Apple and Google moving in as expert service and user experience providers.

If the connected car continues to evolve its capabilities and become omnipresent in the next 10 years, the auto industry needs to prepare now to address some significant parts of the customer value chain.

- Service design, distribution, revenue channels, partnerships
- Support and interconnection between multiple forms of connectivity
- New ways of looking at car usage and ownership

	MARKET CAP	# COUNTRIES	# CITIES	# VEHICLES / DRIVERS
UBER	$42 B	58	300	162,000 *“active drivers”*
ZIP CAR	$500 M *(when sold to Avis in 2013)*	7	100 +	10,000+ vehicles
BMW DRIVENOW	$81 B	4 *(US, Germany, Austria, UK)*	8	2400 vehicles
FORD GETAROUND	NA	1 *(US only)*	6	700 with 200,000 “users”

THE BIRTH OF MOBILITY SERVICES

NTT INNOVATION INSTITUTE, INC.

Silicon Valley Upstarts and Auto Leader Initiatives

In the US, the number of “zerocar families” has been growing since 2007, and now accounts for nearly 10% of households.

This has resulted in the emergence of a new class of transportation services that is being called “Mobility Services”. These services offer on–demand, utility-driven choices in transportation that are tailored to meet specific customer needs.

A number of economic and social factors have contributed to the rapid growth of mobility services, including the 2007-2009 recession, increasing urbanization, and the influence of Millennials and their digitally-driven social preferences. Technology plays a major role, by providing minimum efficient scale to those companies with flexible value chains and agile technology. Silicon Valley and large auto manufacturers have responded by establishing startups, divisions, partnerships and investments to address the needs of this rapidly growing customer segment. Highly successful startups such as Uber and Lyft have used technology to create a new market and have been rewarded with multi-billion dollar valuations.

Leaders in the automotive industry such as BMW, Daimler, and Ford have also ventured into the mobility services marketplace with services such as BMW Drivenow and Ford Getaround.

With its open platform, Moovel, Daimler is establishing a leadership position by combining different mobility options from public transportation over car, and bike-sharing to taxi or even private transportation options from which the customer can choose.

CHAPTER 5

Learning from today's cutting-edge leaders

TESLA

GOOGLE SELF-DRIVING CAR PROJECT

BMW iSERIES AND CONSUMER MOBILITY INITIATIVES

TESLA

This Is Not Your Father's Automobile Company

Tesla has challenged the market dynamics and practices of the established auto industry, leading the shift from analog to digital by creating a car defined by software and the user-experience. Starting with the goal of developing a great product—a sexy high-performance electric car—the company has relentlessly focused on reinventing every aspect of the value chain (sales, manufacturing, mechanics, service, and business model) with the customer always in mind. This is a company that does not see any element of the industry as sacred; all are subject to harnessing the disruptive forces of digital business to its advantage. Tesla has also been successful not only in relying on its own intellect and creativity, but has successfully engaged both generous government incentives and the exceptional enthusiasm of its customers.

The Challenger Brand Finds That Niche versus Mass is an Advantage

Tesla has found that niche can trump mass when moving into an established product category with large dominant players. By focusing on a digitally-savvy customer set with desires for a high design, high tech, all electric vehicle, the company crafted a product offering and end-to-end value chain unencumbered by past practices. Larger players were not immediately incentivized to move into the space of this challenger brand as it represented such a small percentage of their current sales, and appeared to many almost as a Silicon Valley novelty. The billions of dollars of assets in infrastructure, manufacturing and supply chain that historically make the leaders successful now function as an anchor to the past, while serving as an advantage to the new entrant who is building from a clean slate.

Tesla Teaches Us That

- There is power in niche vs. mass
- The connected car evolves to an "app on wheels"
- Customers should be part of movements, not transactions
- Bespoke products can be created by mass manufacturing
- Open IP platforms can stir innovation
- The network effect can meet a commitment to social good

The Next Evolution of the Connected Car Is Really an “App on Wheels”

For Tesla, the “connected car” and how it relates to their customer has been at the center of their design, business, and manufacturing decisions. Consumer-focused (versus dealer-focused) software is at the core of the “car as app model.” Long-established OEMs will have the challenges of addressing the issues of “software as add-on” to vehicles evolving from a mechanical past.

Data connectivity and software architecture are as central to Tesla as is the physical design of their vehicles. Its concept of connectivity services was never limited to entertainment, driving directions, and calls for emergency services. Because the company owns the car operating system and driver interface, and sees the car as a generator and receiver of data, there are real-time insights into both car functionality and the customers’ driving experience. Services have been crafted to address both of these.

While the competition might have over the air map upgrades, there is still the need to go to the dealer to plug-in onboard computers to access diagnostic data. With Tesla, the use of the network to predict issues and software downloads to address problems or even provide new features – has provided unprecedented consumer convenience while minimizing vehicle obsolescence. This kind of remote software download capability might be the way that an autonomous-driving feature is eventually provided for purchase, as well as opportunities for drivers to “rent or test drive” new high performing driving modes for special trips.

> “If something is important enough, even if the odds are against you, you should still do it.”
>
> – Elon Musk, CEO of Tesla

NTT INNOVATION INSTITUTE, INC.

Make the Customer Part of a Movement, Not a Transaction

Tesla understands that its core customers are hungry for more than a unique driving experience. Tesla drivers want to be co-creators of their vehicle, and have purchase and service experiences that eliminate complexity. The company's direct to consumer model means that "dealerships" are actually playful and informative showrooms where the focus is on engagement and learning rather than backroom sales negotiation. Touch screens and kiosks in the physical world serve as compliments to online user forums and community groups that make the customer part of a movement, not part of a transaction. Co-creation of a Tesla car extends beyond selecting the model and color to the owner being able to customize their dashboard interface after purchase.

Bespoke Product Can Be Created By Automated Mass Manufacturing

Tesla vehicles are built-to-order bespoke products, and yet they are produced in a highly automated robotic manufacturing environment. The company has built its own IT solutions to drive both automated production volumes and close linkages with its ERP and e-commerce platforms, both of which its IT team built within 4 months.

With more limited production runs than what established car manufacturers would need to reach to meet their ROIs, Tesla focuses on optimizing each stage of its vertically integrated value chain as opposed to optimizing production volume. Currently, the most important elements in the value chain relate to consumer confidence about "driving distance," so battery production and accessible charging networks are a priority over production volume.

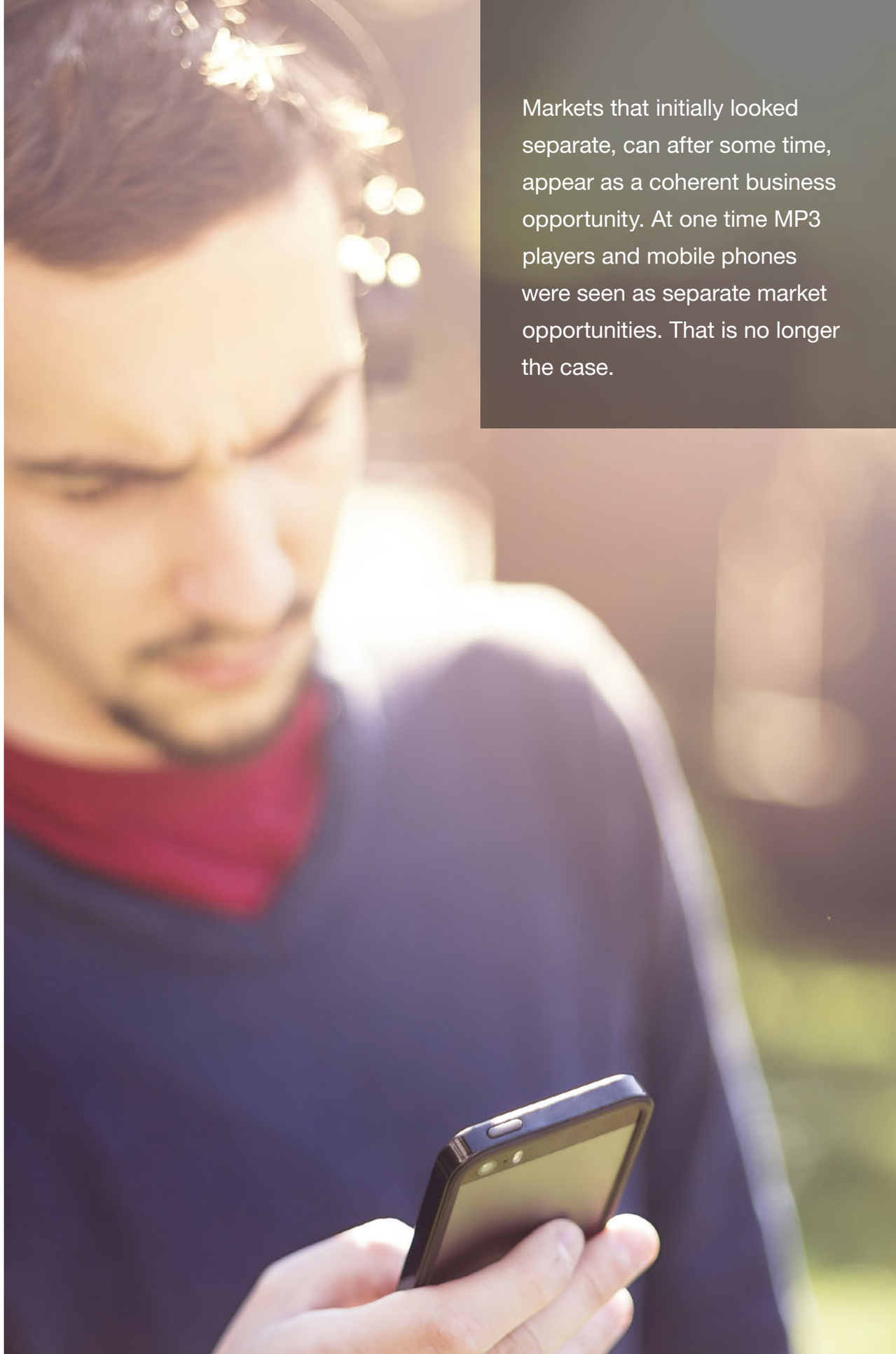
Open IP Platforms Can Stir New Innovation

Partnerships play a key role in Tesla's game plan, and initially focused on serving the needs of the connected car with telco operators and content providers. With the company's announcement to open up its patents, the opportunity to create an even more robust set of business partnerships, markets, and co-created products is now on the table. While this may be new in the auto industry, this kind of co-innovation model already exists in other industries. GE and its relationship with startup Quirky in the connected product space is an important example of co-creation from non-traditional sources with the involvement of a Fortune 500 company.

By securing the opportunity to have others in the industry building off its specs, Tesla gains a new revenue source to sell batteries, super charging stations, and other services not only in the auto industry but to homeowners, businesses, and utility companies. Its existing position of excellent in batteries, and its sister company Solar City's focus on home solar energy, may provide a jump-start to success in new spaces with new revenue sources.

The Network Effect Meets a Commitment to Social Good

In the electric vehicle market, whoever creates the best charging network experience married with the right car and business model, will shape the future of mobility. Tesla's Supercharger network may well be its version of iTunes or Google Play, serving as the ecosystem that extends the use and value of the product for the consumer. And it is not a bad thing either that the network serves as a flagship symbol for the company's commitment to social good, which has become an important buying criteria not only for Millennials, but for boomers and Gen X alike.



Markets that initially looked separate, can after some time, appear as a coherent business opportunity. At one time MP3 players and mobile phones were seen as separate market opportunities. That is no longer the case.

GOOGLE SELF-DRIVING CAR PROJECT

Exploring What It Means to Have an Autonomous Vehicle

Google's self-driving vehicles have been on the road for years, starting with modified Lexus and Prius cars. Now the technology that powered those models is in Google's first purpose-built custom cars that hit the road in July 2015.

Why would one of the biggest technology companies in the world - known for search, Internet advertising, and a smart phone OS - get into the car business? If you think about the company's extensive experience with making sense of vast amounts of real-time data, along with its penchant for putting some stakes in the ground with socially relevant moonshot initiatives – then it makes a lot of sense.

What would be possible if a vehicle could be built that could shoulder the entire burden of driving? Could a vehicle that takes anyone from point A to point B at the push of a button, transform mobility for everyone?

These are very different questions than those about sexier design, better mileage, or more premium options. And with different questions, will come different results.

There are some important premises about mobility (as opposed to just cars) that are the foundation for Google's exploration.

- Safety:
  What if you could reduce the 94 percent of accidents that are caused by human error?
- Human productivity and creativity:
  What if you could reclaim the billions of hours of human potential wasted in traffic?
- Accessibility:
  What if everyone could be mobile, with everyday destinations and new opportunities within reach of those who might otherwise be excluded by economics or disabilities?

Google's Self-Driving Car Teaches Us That

- The ability to capture and translate data may be the most important driver of mobility in the future
- For an important group of customers, mobility is about utility over design
- Car ownership may no longer be required to get on-demand mobility for anyone
- Rapid experimentation and prototyping within a niche of unaddressed customer need may change the trajectory of an industry more quickly than ever before

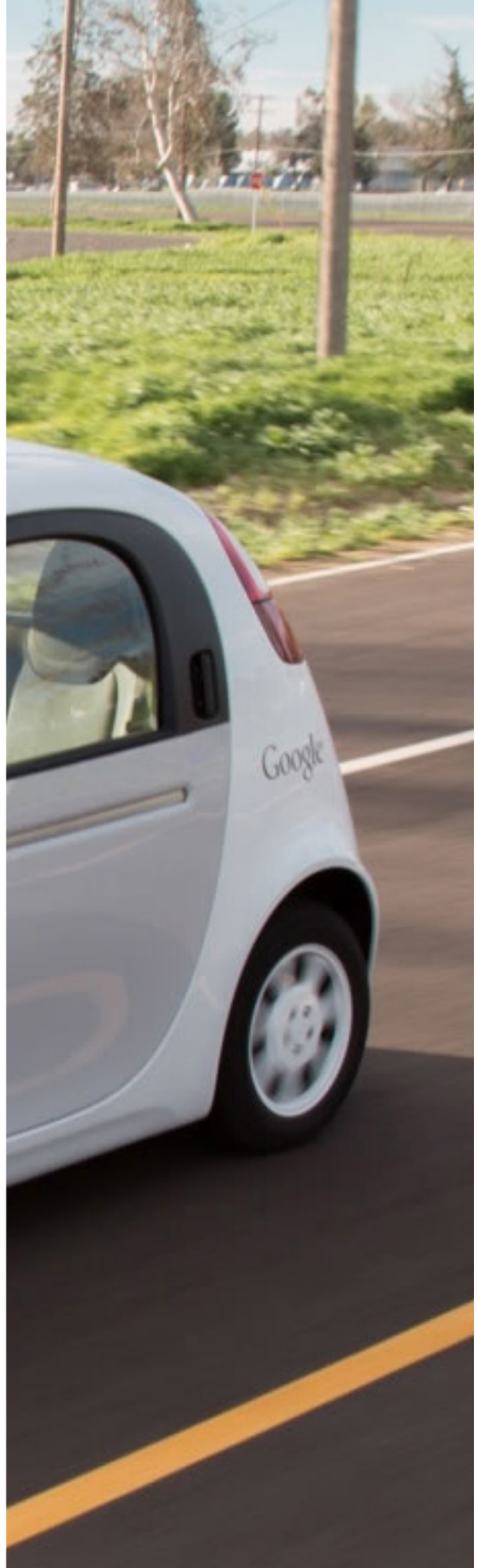
In the World of Technology, Form Follows Function

Why design a self-driving vehicle from the ground up? If the concept of safety is the starting point of the investigation, then re-imaging what a vehicle should look like in relationship to how it needs to perform when it's built for self-driving – is essential. The result is a rounded-shape prototype vehicle with an unobstructed 360 field of view for sensors that can capture visual data from two football fields away. That's essentially the distance required to safely stop an average car going 60 mph.

When Experimenting, Learning is More Important than Luxury

Google's design aesthetic has always been on the side of minimalism. So it is not unexpected that its approach to prototyping and experimenting with autonomous mobility is about designing for learning and not luxury. While the creature comforts and luxury finishes are absent, the functional needs of passengers (two seats), safety (seatbelts), urban cargo (space for passengers' belongings), and user interface (start-stop button and a screen that shows the route)—are what's included beyond the extensive built-in network of technology.

While this is a very Google approach to consumer-product experimentation, it may not be that far off from what the new mobility customers, particularly those in urban environments, are demanding. Basic utility is gaining priority over the value of envy-inducing design. Given that trend, Google may know more about the new mobility customer than the auto industry may have given them credit.



NTT INNOVATION INSTITUTE, INC.

"We've been bolting things onto cars for a long time and started to realize that that's very limiting when you are working within the constraint of an existing vehicle. We wanted to rethink a vehicle from a fresh sheet of paper, and what that vehicle needs to look like when it is custom built for self driving."

– Jaime Waydo,
Systems Engineer,
Google Self-Driving Cars

NTT INNOVATION INSTITUTE, INC.

Technology Must be Married with Purpose

Like Tesla with its software approach to the car, everything in the Google project is custom-made. Nothing is borrowed from other uses or purposes, which can result in limitations. Since it’s the software that makes the car self-driving, and it must therefore function flawlessly with handshakes between sensor and software, Google created their own computer. Designed to withstand the specific vibrations and temperatures of the driving environment, it’s fundamentally very different from someone’s office desktop.

With this kind of technology in place – other form-function issues are resolved such as no need for a steering wheel or the kind of brake pads that a conventional vehicle requires. And then extend that to what kind of insurance models this needs – such as lower rates and pay as you go insurance for non-owners, or even insurance premiums paid by car manufacturers and not riders.

Security and Privacy - the Two-Headed Monster

With data and safety at the core of the functionality of Google’s self-driving car project, cyber-security is a more critical issue than in your “normal” connected car with functionality focused on navigation and entertainment. Having your streaming media interrupted is a very different concern than hackers taking control of your vehicle. And with greater concerns around data and security often comes increased discussion around privacy. If you don’t own the car you are driving in, who has access to the information about your various destinations? Who will own the data from the many thousands of riders associated with a single on-demand autonomous vehicle?

What if the Future is Only 3-5 Years Away?

If self-driving cars quickly become mainstream, what might this mean not only for auto manufacturers, but also supply chain partners and service providers?

- What happens to the suppliers of safety equipment such as airbags if accidents become mitigated by sensors and software?
- What happens to the revenues from parking garages and meters when you never need to park?
- What happens to the number of cars that need to be manufactured each year if car utilization rises from its current 5-10% up to 75%? And if fewer people decide to own cars versus calling for an always available self-driving vehicle?
- How and who gets charged for insurance and do “premiums” fall?
- What happens to the energy industry if most self-driving cars are electric?

BMW iSERIES AND CONSUMER MOBILITY INITIATIVES

Exploring Next Generation Mobility within an Established Industry Leader

As an automobile brand with a 100 year history, BMW carries with it all of the advantages and disadvantages of an industry leader during a time of growing digital disruption. Billions of dollars of manufacturing assets, deep supply chain relationships, and industry-specific talent may have given it the ultimate edge at one time. Can they be rethought and restructured to the company's advantage today and in the future? Or will the burden of past excellence place an irreparable drag on the company's need for digital transformation?

Start-up Prototyping Meets Established Manufacturing and Distribution Models

BMW has placed its digital bets on two major initiatives: the i-Series of cars and mobility initiatives focused on the delivery of services outside the realm of car ownership. The company established a separate business unit and hired talent from outside the industry. Acting like a startup through the exploration stage, the company then brings products and services in-house for go-to-market with its established manufacturing and distribution channels. Will this hybrid value chain work and provide a product with appeal at all touch points to the emerging mobility customer?

BMW's Initiatives Are Exploring Questions:

- Is the traditional performance car customer of the past the same as the mobility customer of the future?
- Can a hybrid value chain work with startup prototyping and traditionally-oriented manufacturing and distribution?
- Are there separate roles for software to play in providing infotainment to consumers and maintenance data to dealers - or - should there be a unified software model designed to provide transparency and extensibility of the car functionality directly to the consumer?
- Can a design and manufacturing company transform into a business that balances product ownership with on-demand mobility service "rental?"
- What is the best way to respond to government mandated directives around CO_2 emissions in concert with the sustainability demands of consumers?

Project i: BMWi8 and BMWi3

In 2011, BMW unveiled the first concept cars from its BMWi sub-brand - the small i3 urban electric car and the i8, a high-performance plug-in hybrid luxury sports vehicle. With both models, the company chose a business strategy to build around the traditional BMW values of “sheer driving pleasure” matched with its new agenda of “efficient dynamics” focused on fuel-engine efficiency. These two strategies have driven the company’s decisions around traditional factors of design and performance, materials and supply chain, the extent and functionality of software, and pre/post customer experience.

BMW i8 – Materials and Vertical Integration

In order to meet its goal of fuel efficiency without giving up horsepower, the BMWi8 uses a carbon fiber composite. This choice has led to other changes in the value chain including vertical integration via an investment in batteries and in FGL Carbon (for carbon fiber pre-press to create parts that can be taken directly to the factory for assembly). Manufacturing techniques have also been modified as a result of the new material. The production site for the i8 in Leipzig Germany is part test laboratory, part robotic assembly. The challenge and learning is around the difficulty in integrating carbon fiber into the production process at speed and volume, since it must be baked or glued versus bolted or welded. This requires human labor.

BMW's View of the Connected Car

Both the i3 and i8 reflect the company's current viewpoint on the role of software, driver and the connected car. Consumer accessible services focus on infotainment and simple functions such as remote unlocking or controlling the climate of the car. Software that accesses vehicle diagnostics is dealer-focused. There are no remote software or feature updates as in the case of Tesla.

BMW Mobility

Separate from vehicle projects, BMW digital services group has been experimenting with alternative mobility service offerings for several years. This has been with a still historic brand-aligned approach of "premium car sharing." With a team from industries outside the world of autos – Internet, mobile, communication and IT - they are looking to inject a shorter innovation cycle and a more integrated digital mobility experience into the company – be it experiences in the car, on the Web, or with mobile apps.

BMW mobility experiences range from the owned car and beyond to ride sharing, parking services, bikes, and buses. Car specific services include:

- DriveNow – locate, reserve and access a vehicle.
- ParkNow – locate and paying for parking spaces
- ChargeNow – locate and using public charging stations in cities for the i3.

CHAPTER 6

Auto 3.0: building the new value chain of customer-centered innovation

RETHINK VALUE

REIMAGINE THE CUSTOMER EXPERIENCE

RECONSIDER CULTURE

REORIENT PROCESSES AND OPERATIONS

RE-ENGINEER IT

As we move into the next stage of evolution of the auto industry – a time that is expected to be unlike any that has preceded it – there are important questions that the established industry leaders need to be considering.

For individuals and companies to begin to explore their own strategies and answers to these questions, we suggest a model for looking at the digitally driven forces reshaping the auto industry.

- How do we build a more customer-centric approach to cars and mobility that is reflected throughout the entire value chain?
- How do we begin to derive value from the growing Sharing Economy, rather than be disrupted and made irrelevant by it within the next decade?
- How do we look ahead and see what non-traditional companies may become disrupters in the world of autos, as well as how we might be disrupters in other adjacent industries?

RETHINK VALUE

REIMAGINE CUSTOMER EXPERIENCE

RECONSIDER CULTURE

REORIENT PROCESSES AND OPERATIONS

RE-ENGINEER IT

The Innovation Spectrum

With the exception of a few recent newcomers and skunk works teams in established companies, the traditional concept of innovation in the auto industry has historically been relatively narrow in its view of the world. If the industry is to evolve into a truly digital business, there must be a pairing of a new view of innovation and the delivery of value. This pairing must generate discussion and progress that goes beyond the boundaries of the industry's current base product, the car – and into examining the values that can jumpstart the bigger and more dynamic concept of mobility.

Digital Business Drives Innovation

As technology and cultural changes continue to shift the way business is done on a global scale, companies can no longer thrive simply by being the best at delivering one form of value. No one approach to innovation is competitive for very long anymore. The new economic and social leaders will be organizations that are effective at tapping the entire spectrum of innovation. They will be those that are able to leverage their own 'native genius' while simultaneously collaborating with other firms, leveraging major cultural trends and entering into more value-driven relationships with their customers.

Understanding Value and Innovation

If we are to rethink value as a means to drive innovation, then this new viewpoint must be one focused on a fully reciprocal exchange of value with customers and partners. Value-driven relationships must break out of the boundaries of more traditional models of extraction with the 'consumer.'

A digital auto industry will flourish only when the nature of competition has shifted from a focus on product features to delivering individualized consumer experiences.

Full-Spectrum Innovation and the Auto Industry

Full-Spectrum Innovation is an important concept in framing new value propositions for the auto industry. At its core is the idea of creating value in every possible place, at any defining moment, and during all critical touch points—from culture and society to government to partners to end users. By rethinking what value should mean today and in the future, auto manufacturers can let go of long held assumptions, practices, and metrics - and create the next generation digital systems and experiences that will not only lead to new products, but jump start a new mobility industry.

What will it mean for the auto industry to rethink, create, and measure value with customers, partners, suppliers, channels, influencers, and government agencies?

The Innovation Spectrum

- Framing new value propositions and digital experiences

NTT INNOVATION INSTITUTE, INC.

When social and economic forces shift and begin to change the way we see and relate to individuals and the world around us – the time is ripe for innovation.

Digital business strategy moves the focus from individual products to the creation of platforms and networks.

Technology changes both large and small companies' ability to quickly concept, prototype, pilot, manufacture, and launch products.

Understanding customer value and engaging in customer-centric activities defines innovation.

CULTURE	GOVERNMENT & LEGAL	BUSINESS MODELS, PLATFORMS & LEADERSHIP	MARKETS	DISTRIBUTION & PROCESSES	PRODUCTS & OFFERINGS	RELATIONSHIPS & COMMUNITY	BRAND & EXPERIENCE

Without the right legal frameworks, balancing the needs of the commons and the capacity for innovation can come to a standstill.

Markets ignored by traditional companies often become fertile ground for disruptive players.

Products can morph and add additional functionality overtime - through software, partnerships or complimentary services.

Brand and experience innovation reflects customers' values, desires, and world views.

The Innovation Spectrum in the Auto Industry

NTT INNOVATION INSTITUTE, INC.

CULTURE

- Social media
- Globalization
- Millennials and Digital Natives
- Eco-consciousness
- Sharing Economy

GOVERNMENT & LEGAL

- Public Policy
- Privacy and Security
- Open Source Patents and IP
- Dealership Regulations
- Insurance Regulations

BUSINESS MODELS, PLATFORMS & LEADERSHIP

- Dealerships redefined or obsoleted
- Software-defined car as app
- OTA updates for service and functions
- Rise of new and decline of old revenue sources
- Size and speed as success metrics

MARKETS

- Affluent eco-customers and tech enthusiasts
- Utility driven mobility customers vs. status drivers
- Niche trumps mass to enter new markets
- New forms of marketing and PR

DISTRIBUTION & PROCESSES

- Customer kiosks vs. dealership sales floor
- Charger networks
- Mobile apps
- Social networks
- Vertical integration
- Smart Factories

PRODUCTS & OFFERINGS

- Modular software intensive products
- Ease of configuration
- Bespoke and built to order
- Continuous updates
- Fuel-charger network

RELATIONSHIPS & COMMUNITY

- Owners' clubs
- Crowdsourcing information and design
- Socially-sourced maps and traffic
- New technology and carrier partnerships

BRAND & EXPERIENCE

- Accessible UI/UX
- Individualized experiences
- Experiential marketing
- High tech high touch

REIMAGINE THE CUSTOMER EXPERIENCE

The Need to Embrace Design Thinking and Human-Centered Processes

Innovation is about quickly transforming ideas into action. Successful companies of all sizes embrace small experiments and make "little bets" to create speed and reveal insights around the innovation they need to stay ahead of disruptive trends and have a chance to lead change in their industry.

Design thinking is a human-centered process that frames an approach to innovation seen through the eyes of the people who need and will use it. This is a multi-disciplinary team sport that brings together elements of art, engineering, business, anthropology, and technology in the service of solving problems that matter.

Teams need to embrace traits of creativity, collaboration, experimentation, left and right brain thinking, and user-centeredness. This enables:

- Fostering empathy with the people for whom you are designing
- Generating volumes of ideas
- Building multiple iterative prototypes
- Sharing work in process with the people you're designing for
- Shepherding new innovative solutions out to test in the world

"The mission of design thinking is to translate observation into insights and insights into products and services that will improve lives."

– Tim Brown, CEO, IDEO
in "Change By Design"

Moving from Questions About the Function of a Car to What Mobility Enables

Leaders in design thinking are reframing questions and discarding the current architecture, structure and design of cars. They are taking a more systems-wide view to how mobility might fit into human lives in the future. Questions are then naturally reframed from:

"What can the car do?"
- to –
"What does the car enable me to do?"
- to –
"What does mobility enable people to do?"

New technology investigations can also drive new ways of framing explorations about the nature of the customer-driver experience and cars. What if you believe that new autonomous car technology (such as that from Google) may create a world in which at least some vehicles no longer require a steering wheel and the various dials and controls of today's cars. The question about driver ergonomics might then be reframed into one around the values of multi-functional personal space in a mobile environment. Discussion about streaming media services may no longer be about a balance of media access with driver distraction, but be reframed into one about making the mobile experience more like the in-home experience.

"The beauty of design is being able to look at the bigger picture."

– Geoff Wardle,
director of advanced mobility
research at Art Center College
of Design in Los Angeles CA

Human Relationships and Digital Transformation

Digital business requires a fundamentally different and transparent relationship with customers and partners. Old ways of defining relationships as “360 degree views” or “share of wallet” need to be replaced with an emphasis on a model that helps customers get the value they desire from their relationship with the company. This relationship needs to be built upon characteristics of empathy, relevance, and respect.

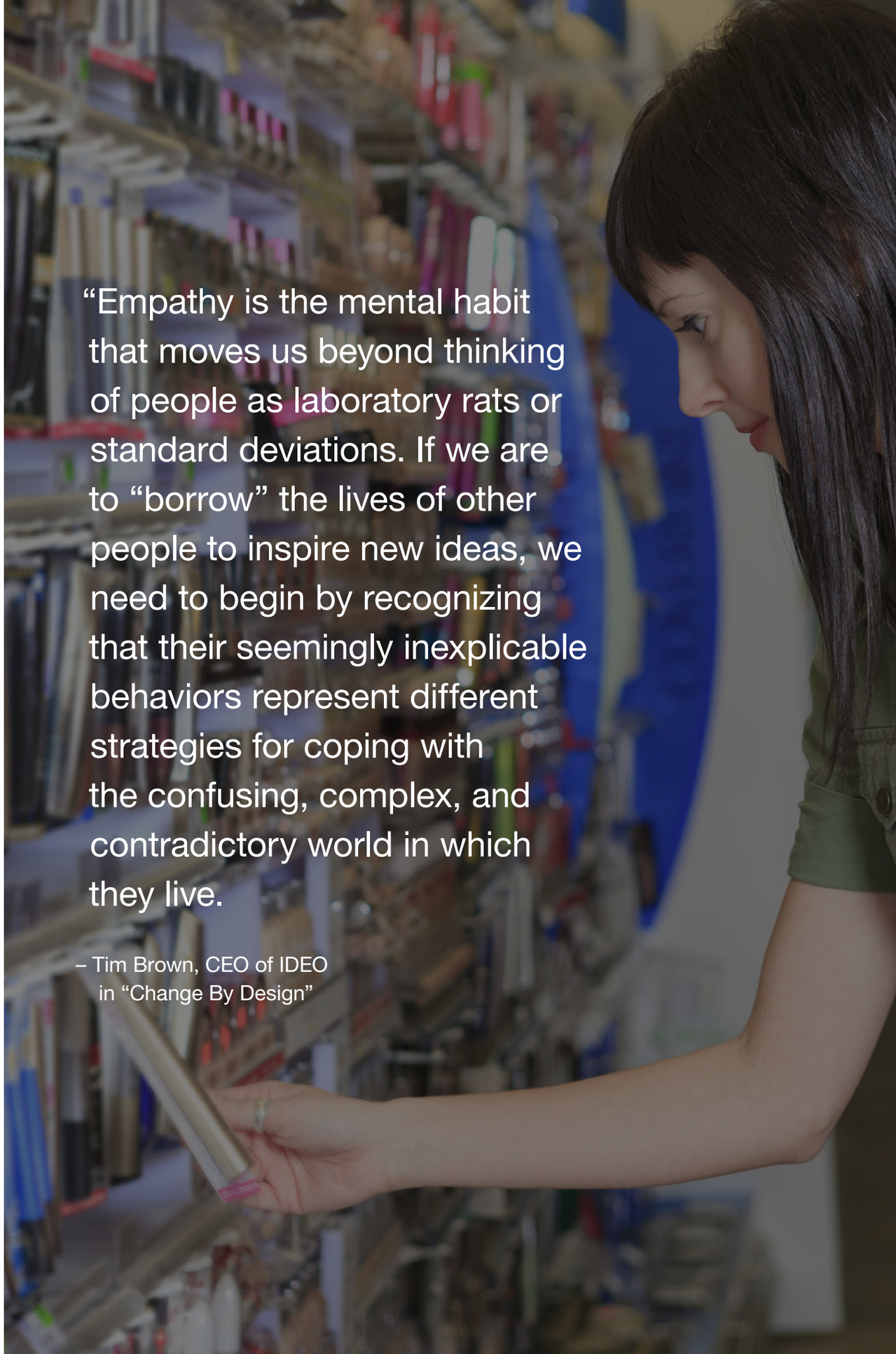
Empathy and Relevance

Digital business’ relationship to the customer experience represents a shift from focusing on what’s best from an enterprise’s viewpoint to the end user’s perspective. Today’s customers value personalization, customization, and even co-creation of their experiences. Companies must start by deeply understanding the context in which their product or service is used— why, where, how, and by whom—in order to create a design that meets the demands of today’s customer.

At the core of understanding the human-centric user experience is the concept of design thinking. Design thinking focuses on concepts of empathy and relevance—asking questions to reveal how the product or service provides value to the customer.

Respect for the Customer

Digital businesses must know their customers, understand their preferences, and act on their behalf. The digital-savvy individual has very little time or patience for the exploitative tendencies of traditional companies – intent on extracting value from them. Digital companies need to acknowledge the importance of earning customers’ trust and the difficulty of regaining it.



Nurturing Cultures of Innovation and Sustainability

Culture change is one of the most difficult things to effectively define and generate in an organization - particularly in large, established ones. Culture needs to be seen as a complement to the more formal, well-articulated rules of doing business. Yet many of the rules and guidelines of historic corporate success—including hierarchy, processes, and the elimination of risk—often stifle culture change and the innovation that can accompany it.

Embracing the tenants of the cultures of innovation and sustainability are necessary if the auto industry is to successfully transform and succeed in a competitive digital marketplace. A company must look at its values, how it sees customers, and its internal culture to determine what it can change.

Embracing a culture of innovation and sustainability might entail broadening efforts from focusing on government mandated CO2 emissions levels to rethinking the manufacturing process, supply chain, and even recycling of vehicles themselves.

Innovation Culture

- Embraces design thinking and human-centered design
- Measures what's meaningful
- Looks outward, not just inward
- Fosters learning more than knowing
- Understands the value and parameters of risk and failure
- Values the unstructured

Sustainability Culture

- Moves the discussions from moral obligation to opportunity
- Emphasizes execution as much as ideals
- Integrates the discussion into the strategy and operations of the company
- Eliminates competing priorities inside the company
- Sees sustainable materials and processes as part of brand differentiation
- Empowers teams that morph as new processes and ideas unfold.

"We love big bets. Our company culture encourages experimentation and the free flow of ideas."

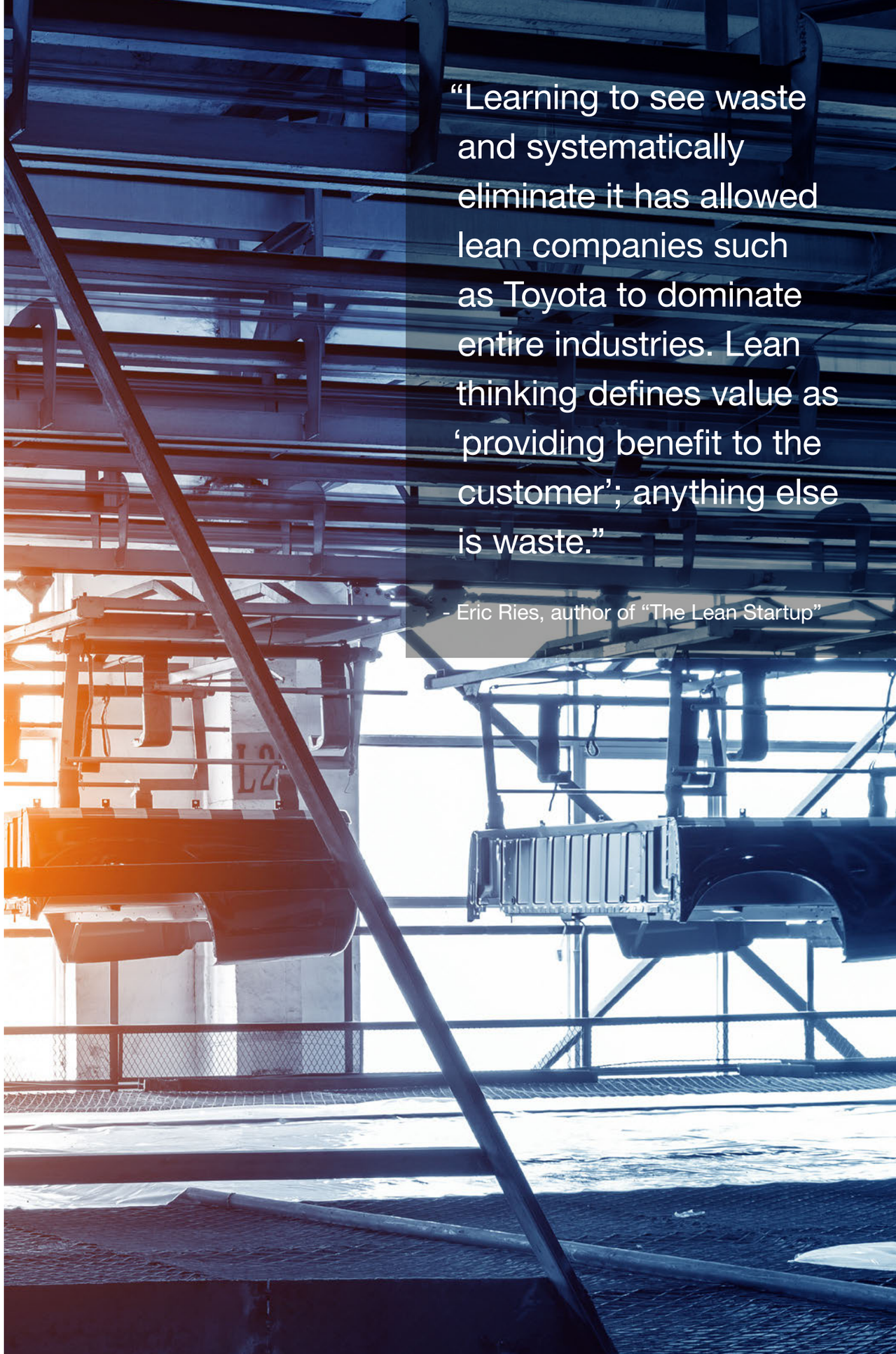
– Larry Page, CEO , Google

REORIENT PROCESSES AND OPERATIONS

Creating Organizations that Facilitate Customer Value and Engagement

The need to reorient processes and operations is a natural outcome of the exercise of rethinking value to map to customers' needs, and then building an appropriate culture of innovation around that. Historically, the organizational structure of the auto industry has been driven by a need for internal efficiencies, resulting in vertically oriented functional structures. Customers, however, usually need to interact and have visibility with a company across vertical functions, given their desire to be able to access various groups simultaneously across the company. Customers want and need to engage horizontally.

In the digitally-driven company, where that which adds value to the customer experience reigns supreme, it would seem that auto companies need to begin to rethink they way that they are organized, at least to the level that they present themselves to customers. In thinking about processes and the structures that follow them, auto companies would be wise to begin with the question: "What is relevant to the customer and how do they want to access it?"



NTT INNOVATION INSTITUTE, INC.

RE-ENGINEER IT

The companies of Auto 3.0 will thrive or stumble in a new dynamic global marketplace with rules of operation that are constantly being rewritten by changes in the surrounding social, cultural, economic, political, and technical landscapes. Digital technology and the information infrastructure that supports it are driving the sea change in values, customer experiences, operations, and technology. Historic competitive advantage, market valuations and reputations that took decades to create are susceptible to being displaced at any moment of time – from forces inside or outside the industry.

The key to success for businesses in this exciting and sometimes chaotic marketplace is Business Agility. Business Agility is the ability to sense changes and respond quickly and efficiently by adapting products, services, and operations to address emerging opportunities and challenges. Companies with business agility have technology in their DNA and the organizational capability to use it as a source of competitive advantage - to experimenting with options, proto-typing potential solutions, gaining insights from internal and external data, and quickly executing to drive meaningful business outcomes.

The successors in this new digital era of the automotive industry will be the companies with both the technology and cultural DNA that can imagine and implement the flexible IT systems and teams the world of business agility now demands.

Some of their most innovative and formidable future competitors of the leading auto OEMs “were born digital” – Tesla and Google for example. Unsaddled by legacy systems and practices, they have a significant structural advantage that allows them to rapidly enter markets and scale by leveraging new information technology infra-structure and processes. These structural advantages give them incredible business agility that they can effectively use to out-maneuver significantly larger and more established competitors.

As established auto companies begin to evolve into the successful digital organizations of the future, they need to begin with the realization that the road to becoming a digital business goes through their IT functions. The challenge that many of them face is that they are saddled with IT that has organizational structures, management models, operational processes, workforces, and systems that were built to solve the “turn of the century” problems of the past.

The new auto company IT environment must be a hybrid IT environment where Agile IT coexists with the well-established information systems of record. IT can no longer be limited to a ‘come and fix it’ utility within a business. Auto companies must shift their focus from IT as an isolated department-centric utility to IT as a strategic capability deployed across the company. Creating this kind of environment will, by definition, require a flexible, extensible and reliable bridge between systems of Agile and traditional IT.

Historic Barriers to IT Evolution in the Auto Industry

- Perceived requirement that all information services be on premise
- Lack of acceptance and trust in cloud environments
- Focus on technology for internal purposes and not in collaboration with suppliers, strategic partners, and customers

The new equation for IT success in the evolving digital auto company:

AGILE IT + PLATFORM THINKING

The old industrial IT model focused ruthlessly on standardization, implementing command and control based management structures, and centralized teams designed to drive economies of scale and optimize unit costs. While providing success in addressing long-term projects or repeatable, recurring problems, this approach to IT has been accompanied by increased time to market, reduced flexibility and stifled innovation.

Agile IT is about building a new sustainable model for managing the “Business of IT.” It is purpose-built to be adaptive and extensible to meet the evolving IT needs of digital businesses. Using systems thinking, it addresses the skills, process, technology, systems, and organizational dynamics that are the underpinning of today’s digital businesses.

Agile IT focuses on how to implement new technology and processes in a faster and less capital-intensive manner. It provides the ability to achieve minimum efficient scale in any process without requiring the volume, size, and scale that used to be required to drive efficiency in the old industrialized IT model.

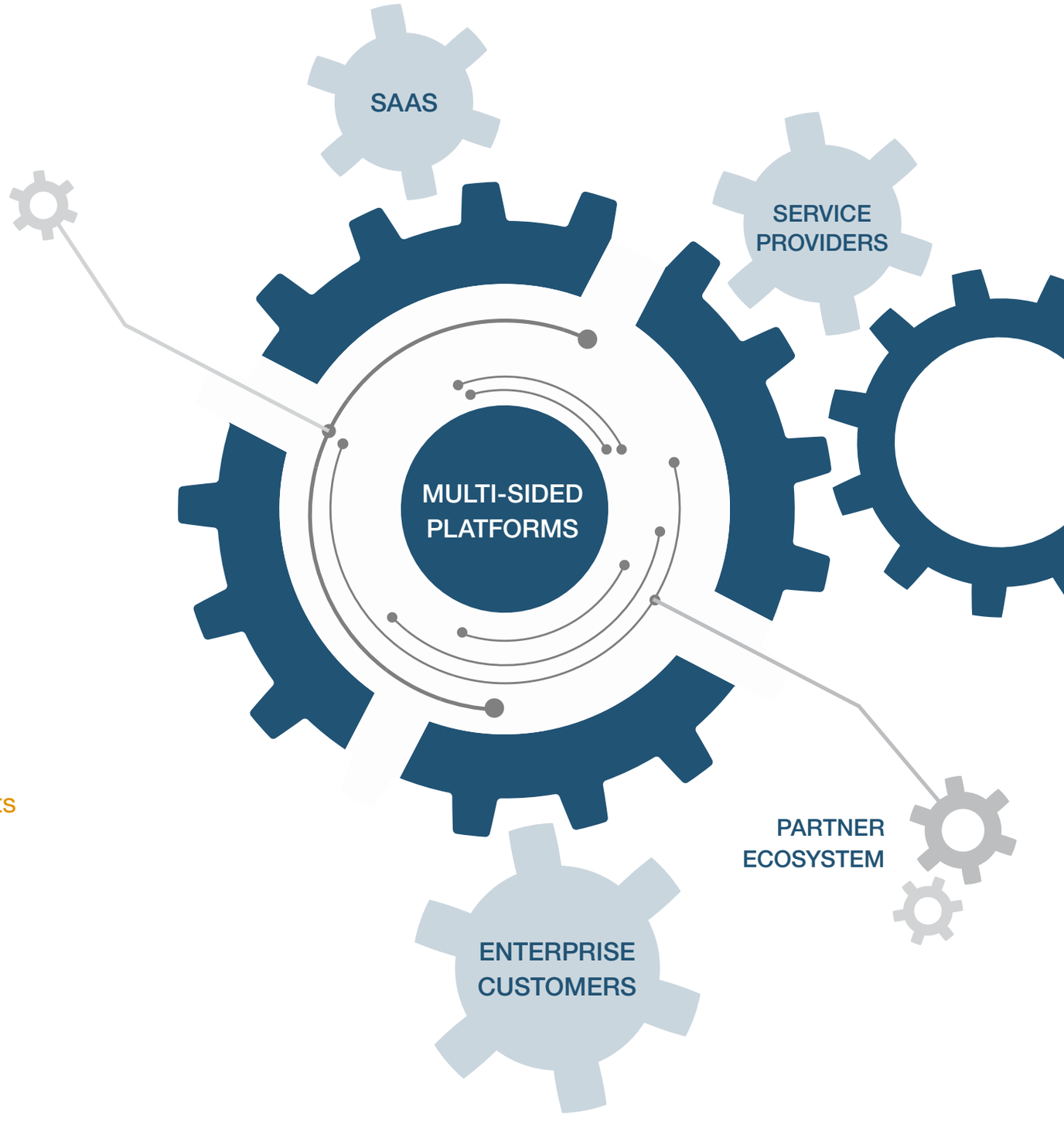
The digital auto company that demands business agility requires an approach to IT that fosters experimentation and innovation at a rapid pace. Today’s IT organizations can adopt the new Agile IT model in an incremental and iterative way.

Platform Thinking

In order to build the Agile IT systems required by the emerging digital generation automobile company, robust and well-designed technological and strategic platforms must be put into place, often in parts of the company outside of the traditional IT domain. Platform Thinking focuses on creating more throughput and output for IT without resorting to traditional approaches to achieving scale.

Around the approach to Platform Thinking, the most important concerns for IT leaders will be to:

- Create scalable, secure, and extensible systems
- Construct a highly cohesive set of services
- Build with an ecosystem of partners
- Loosely couple internal IT systems with partner systems
- Consume IT as a service
- Take advantage of open APIs
- Provide value to all participants a cross the company



APPENDIX

ABOUT NTT INNOVATION INSTITUTE, INC.

ABOUT THE AUTHORS

COLLABORATOR AND CONTRIBUTOR BIOS

OTHER BOOKS FROM NTT INNOVATION INSTITUTE, INC.

ABOUT NTT INNOVATION INSTITUTE, INC.

NTT Innovation Institute, Inc. is the Silicon Valley-based, open innovation/applied research and development center of NTT Group. NTT i³ builds platforms that are transforming today's enterprises into the digital businesses of the future. Our platforms help clients engage with customers and markets in exciting new ways by pushing the boundaries of cloud computing, information security, machine learning, and the Social Network of Things. NTT i³ builds on the vast intellectual capital base of NTT Group, which invests more than $2.2 billion a year in R&D, with an extensive network of technology partners, engineers, and scientists.

NTT i³'s Core Platforms for Agile IT

In order to build the agile and hybrid IT systems required by the emerging digital generation of automobile companies, robust and well-designed technological and strategic platforms must be put into place, often inareas outside of the traditional IT domain. Legacy systems must be modified and integrated in a way that acknowledges complex privacy, speed, and reliability needs that were inconceivable at the time of their original design. And all of these IT systems need to be integrated and orchestrated in a way that makes the management of a dynamic hybrid information environment possible.

NTT i³ offers three platforms to help IT departments tackle these challenges:

Cloud Services Orchestration Platform

that allows IT departments to understand their application portfolios, migrate the most suited applications to the cloud and provide a seamless way to manage this new hybrid environment.

Global Threat Intelligence Platform

that brings real-time data-driven insights into the identification and understanding of cyber-security threats and needs.

An Elastic Services Edge Platform

that leverages network function virtualization (NFV) to push virtual network functions (VNF) to the edge of the enterprise's network, bringing agility, security, and flexibility into the infrastructure.

NTT INNOVATION INSTITUTE, INC.

Srini Koushik

Srini Koushik is the President and CEO of NTT Innovation Institute Inc., the Silicon Valley-based R&D arm of the NTT Group, a global leader in information and communications technology.

With thirty years of experience as a programmer, architect, CTO, CDO, and CIO for Fortune 100 Companies including IBM, HP, and Nationwide, Srini has a track record of unpacking complex problems, and hacking the technology and culture of global enterprises to deliver extraordinary results.

He is an Open Group Distinguished Certified Architect and has published several articles, including co-authoring a best-selling book, Patterns for eBusiness in 2001.

Srini was elected to the IBM Academy of Technology, and was named an IBM Distinguished Engineer in 1996. He was named an Elite8 CIO by Insurance and Technology, a Top 25 CTO by Infoworld, a Top 10 All-Star in the financial services industry by TechDecisions, and a 2014 Computerworld Premier 100 Technology Leader.

Srini has a passion for lifelong learning and holds a bachelor's degree in physics from the University of Madras, a master's degree in computer science from the University of Bombay, a master's degree in business administration from Ohio State University, and executive education on Systems Thinking, Design Thinking, Clean Energy and Innovation from the MIT Sloan School of Management and Duke University.

NTT INNOVATION INSTITUTE, INC.

Dr. Rainer Mehl

Rainer is Head of Global Automotive Business and EMEA Head of Manufacturing Consulting for NTT DATA. He is responsible for market positioning, strategic direction setting, sales, and on/offshore delivery.

Rainer has over twenty years of experience in the consulting and IT services industry. He started his career 1995 with Price Waterhouse and then PwC, where he became a partner in 2000. After IBM acquired PwC in 2002, he continued as Partner Vice President. Rainer leads consulting projects as well as large IT programs for automotive clients, focusing on customer experience processes and system integration. Since 2010, Rainer leads the Manufacturing and Automotive Industry group at NTT DATA.

Rainer studied Economics and Political Science at the University of Hamburg. He has a Ph.D. from the Universities of Hamburg and Torino. His thesis focused on organizational development in the automotive industry.

COLLABORATOR AND CONTRIBUTOR BIOS

NTT INNOVATION INSTITUTE, INC.

Jens Krueger

Competence Unit Manager, Innovation and Product Lifecycle Management, NTT DATA

Jens is an executive consultant at NTT DATA Germany. After studying computer science and business administration, he worked for 8 years in the engineering IT department of an international Tier 1 automotive supplier, playing a major role as the project manager for the global PLM project. Since 1998, he has worked for NTT DATA in Munich in the competence center of Innovation & Product Lifecycle Management. He manages the PLM Platforms, Strategy & Architecture" Team and works with clients from the automotive and aerospace industries.

Monika Sadowska

Management Consultant at NTT DATA

Monika is a Management Consultant at NTT DATA Germany. She specializes in consulting services such as strategy development, change management, business process improvement, training, and coaching as well as international rollout management for automotive and manufacturing industry. She is part of the global automotive initiative at NTT DATA, supporting operationalization of global strategy, sales and marketing activities as well as process adaptations. Her focus is on developing collaborative processes, and fostering knowledge sharing, dialogue, and innovation. Monika has a master's degree in Business Administration with major in European Business Consulting from Munich University of Applied Sciences.

NTT INNOVATION INSTITUTE, INC.

Adam Stephenson

Senior Director, Customer Experience Center

Adam leads customer experience and business development programs for NTT Group at the Customer Experience Center in Silicon Valley. He works to strengthen executive relationships with key business and corporate decision makers by connecting client business objectives with current and emerging technologies and services. He has over 20 years of experience in technology and business development, and is an expert in software and services. He is a frequent speaker, evangelist, and ambassador for the NTT Group and NTT Innovation Institute brands within the United States, with corporate groups as well as technology innovation and social responsibility forums. Adam has bachelor degrees in Technical Writing and Computer Science from Oregon State University.

ADDITIONAL CONTRIBUTORS - NTT DATA GERMANY

Siegfried Adam
Senior Managing Consultant Connected Business Solutions

Christoph Aretz
Senior Managing Consultant Marketing and Sales

Lutz Kauertz
Vice President Discrete Manufacturing, Head of Metals, Mining and Engineering

Markus Klamet
Senior Managing Consultant, After Sales Services

Christof Kleinhenz
Managing Consultant Connected Car

Sebastian Tschödrich
Managing Consultant Digitization

Claudia Wegerer
Managing Consultant After Sales Services

Michael Wegenaer-Schuchardt
Managing Consultant Analytics and Big Data

OTHER BOOKS FROM NTT INNOVATION INSTITUTE INC.

NTT INNOVATION INSTITUTE, INC.

The following books can be found at:
www.NTTI3.com/publications

Digital Business Transformation

The Social Network of Things

Agile IT: Today's IT for Tomorrow's Solutions

PHOTO CREDITS

NTT INNOVATION INSTITUTE, INC.

Page 6	IgorGolovniov / Shutterstock.com
Page 7	Stanislaw Tokarski / Shutterstock.com
Page 8	http://www.bmw.com
Page 9	http://www.google.com/selfdrivingcar
Page 10	http://www.bmw.com (press kit)
Page 14	StockStudio / Shutterstock.com
Page 16	barbsimages / Shutterstock.com
Page 18	Hadrian / Shutterstock.com
Page 21	Neirfy / Shutterstock.com
Page 22	Chromatic Studio / Shutterstock.com
Page 24	pio3 / Shutterstock.com
Page 25	Lyft_PressKit_01.JPG
Page 29	Anna Hoychuk / Shutterstock.com
Page 34	Bibiphoto /Shutterstock.com
Page 40	Taina Sohlman / Shutterstock.com
Page 41	Taina Sohlman / Shutterstock.com
Page 44	www.wired.com
Page 50	Filip Krstic / Shutterstock.com
Page 56	Hattanas Kumchai / Shutterstock.com
Page 57	Taina Sohlman / Shutterstock.com
Page 59	lumen-digital / Shutterstock.com
Page 61	http://www.google.com/selfdrivingcar
Page 63	http://www.google.com/selfdrivingcar
Page 64	http://www.google.com/selfdrivingcar
Page 66	http://www.bmw.com
Page 67	http://www.bmw.com
Page 75	http://www.toyota.com