Wharton
University of Pennsylvania

Ecosystems for Vehicle Innovation and Sustainable Mobility

Strategic Management Society – Extension Workshop
EUREF Campus, Berlin – September 21, 2016

Organized by:
Daniel Engler, John Paul MacDuffie, Anja Schulze, Florian Taeube

Big News for the U.S. This Week re: Today's Topic

A NEW ERA FOR THE AUTOMOBILE (THE ATLANTIC)

US DOT unveils 'world's first autonomous vehicle policy,' ushering in age of driverless cars (Tech Republic)

U.S. Government Says Self-Driving Vehicles Will Save Money, Time, Lives (National Public Radio)

The Feds Just Got Real About Self-Driving Cars -- It's About Time (Wired)

Self-Driving Cars Must Meet 15 Benchmarks in U.S. Guidance (Bloomberg Business Week)

International Headlines Are Just As Numerous

Poland aims to have 1M EVs on its roads by 2025 (Automotive News Europe)

London will have largest electric bus fleet in Europe by end of the year (Treehugger)

Volkswagen has signed a deal for a joint venture with the newly founded Israeli startup CyMotive Technologies to develop security solutions for connected and autonomous vehicles. (European Tech News)

Jianghuai Surges on Volkswagen China Electric-Car Joint Venture (Bloomberg Business Week)

Faraday Future to Bring on Top VW Executive to Market Its Upcoming Electric Vehicles (Electrek)

AGENDA

8:30 AM	**Welcome-Coffee**
9:00 AM	Welcome and brief opening – John Paul MacDuffie (Wharton, U. Pennsylvania) Reinhard Müller, EUREF, Welcome presentation
9:30 AM	Presentation block 1: Electro-Mobility Carole Donada (ESSEC), Yurong Chen (ESSEC), David Keith (MIT)
11:00 AM	Coffee break
11:30 AM	Presentation block 2: Competition, Collaboration and Coordination Michael Jacobides (London Business School), John Paul MacDuffie (Wharton School, U. Pennsylvania), Francesco Zirpoli (U. Venice)
12:30 PM	Lunch (in the restaurant Werkstatt on the EUREF Campus)
1:30 PM	Guided tour of EUREF-Campus
2:30 PM	Research by doctoral students - presentations of ongoing research by Bo Chen (Ecole Polytechnique), Guilia Marcocchia (Ecole Polytechnique), Ulla Saari (Tampere University of Technology) - coffee will be available
3:30 PM	Hubject visit (E-mobility startup housed at EUREF)
4:00 PM	Presentation block 3: Ecosystems for EVs / Digitized trucking Martin Petschnig (Hubject), Gerhard Novak (PwC)
5:00 PM	Wrap-up and networking
5:30 PM	End

Competition and Collaboration Amid Disruptive Technologies

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John Paul MacDuffie

Professor, Management Department, Wharton School, U. Pennsylvania
Director, Program on Vehicle and Mobility Innovations (PVMI)
Mack Institute for Innovation Management

Two Weeks of Headlines (August 2016)

Ford will build an autonomous car without a steering wheel or pedals by 2021(August 16)

Uber To Roll Out Self-Driving Cars In Pittsburgh (August 18)

Delphi, Mobileye Join Forces to Develop Self-Drive System (August 23)

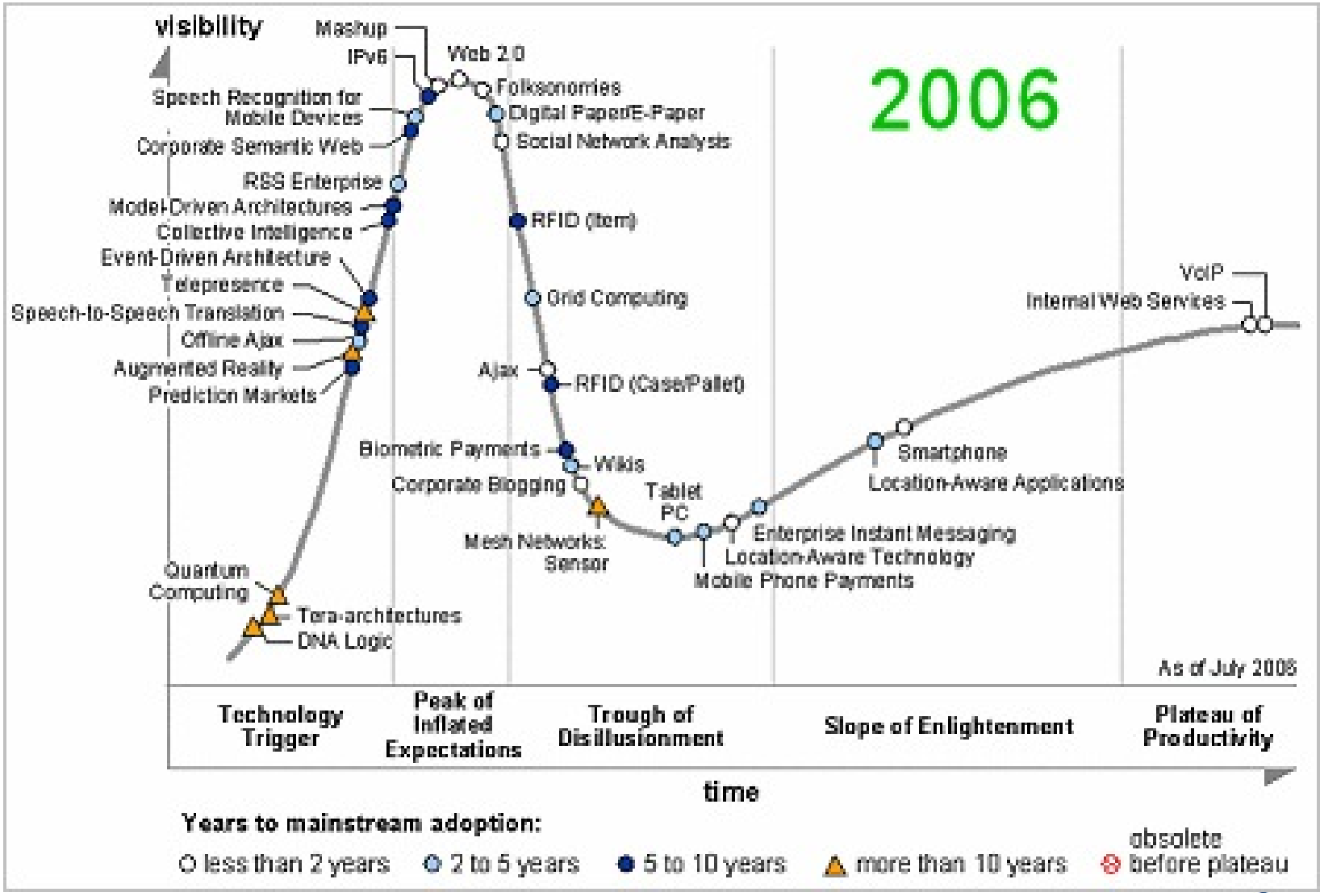
NuTonomy starts trials in Singapore of self-driving taxi service (August 24)

Google Takes on Uber With New Ride-Share Service *Alphabet's carpooling program in SF offers rides at cheaper rates (August 31)*

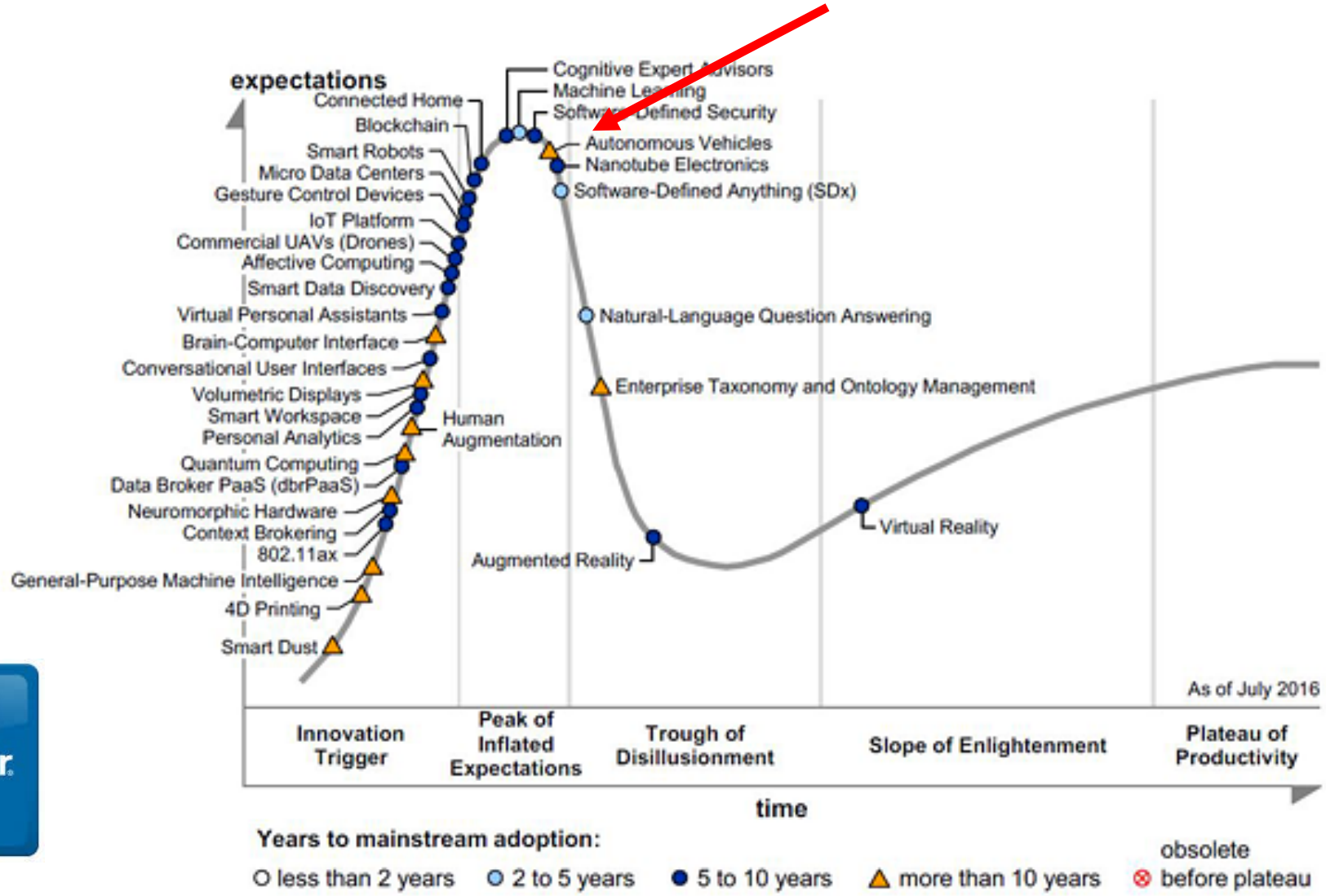
Baidu gets approval to test self-driving cars in California (August 31)

Although just ten years ago, Autonomous Vehicles (AV) not noticed much…

Not yet on the Gartner hype cycle



…by 2016, AV are beyond the hype cycle peak!



Source: Gartner (July 2016)

It may well be a time of disruptive change…

- Electric vehicles mark first fundamental change in automotive dominant design in nearly 100 years
- “Connected car” (aka “computer on wheels”) creates “third place” potential for “rolling office”, “mobile living room”, gateway to infotainment (but also a target for hackers…)
- Autonomous vehicles promise to reduce deaths, remake transportation services, change urban design, eliminate jobs, provide mobility to disabled and elderly
- Ride-hailing firms (eg Uber) replace ownership with “usage” in scalable “asset-light” strategy that dooms incumbent taxis -- but could be transformative if coupled with self-driving cars
- All provide opening for new entrants from tech sector, race for dominance but also opportunities to collaborate

… yet in this industry, the existing structure will shape and slow the direction & pace of change

- 88.6 million vehicles sold worldwide in 2015; 0.54 million were electric vehicles (0.6%), none were fully connected cars or fully autonomous vehicles
- Automakers (aka Original Equipment Manufacturers, or OEMs) still dominate due to system integration role and being required to meet societal goals and expectations
- Complex, multi-technology product (5,000-10,000 parts) supported by complex multi-tiered global supply chain
- Stable dominant design (since 1920s) and primarily integral product architecture (vs. modular)
- New entrants, if they are actually designing/building vehicles, must master (most) current OEM capabilities

Setting the Context

1. Structural Features of Auto Industry *(slow to change)*
2. Evolutionary Changes in Auto Industry *(moderate speed)*
3. Disruptive Technological Changes *(fast pace)*
4. Dilemmas of Competition and Collaboration Amid Disruptive Technological Change

Structural Features of Auto Industry (slow to change)

- Primarily integral (vs. modular) architecture
- Strong and persistent system integrator (SI) role for OEMs; OEMs need to “know more than they make”
- SI role bolstered by OEM desire for control of supply chain but also OEM’s regulatory responsibility and legal liability
- OEMs as SI pursue knowledge of all relevant technologies via massive R&D budgets, dwarfing supplier investments
- Strong preference for industry-specific standards (vs. open standards) and within-industry (vs. cross-industry) alliances
- System integrator capability is the fundamental basis of OEM competitiveness (and it can be gained in different ways)

Organizational Spectrum of Innovation Platforms

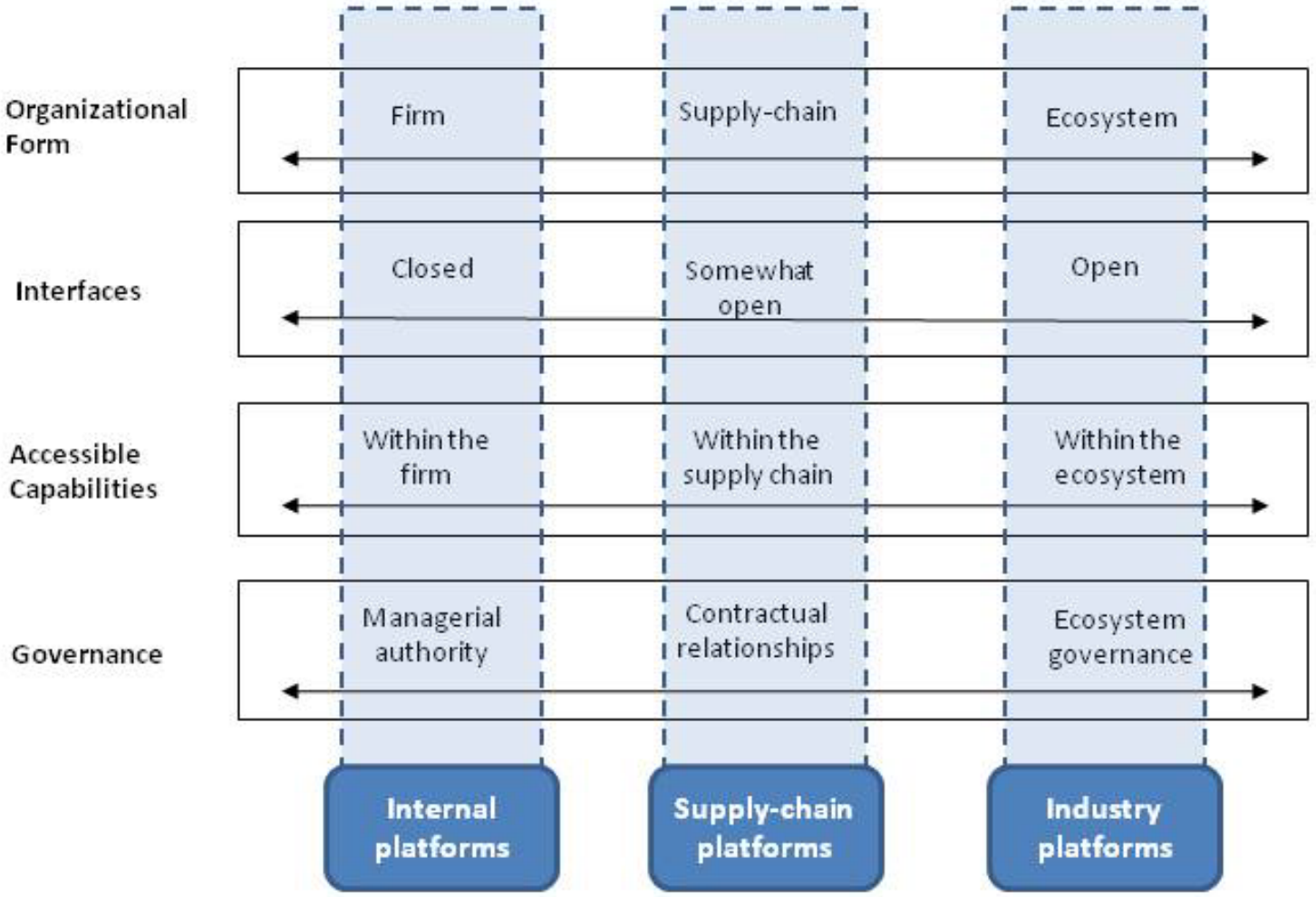


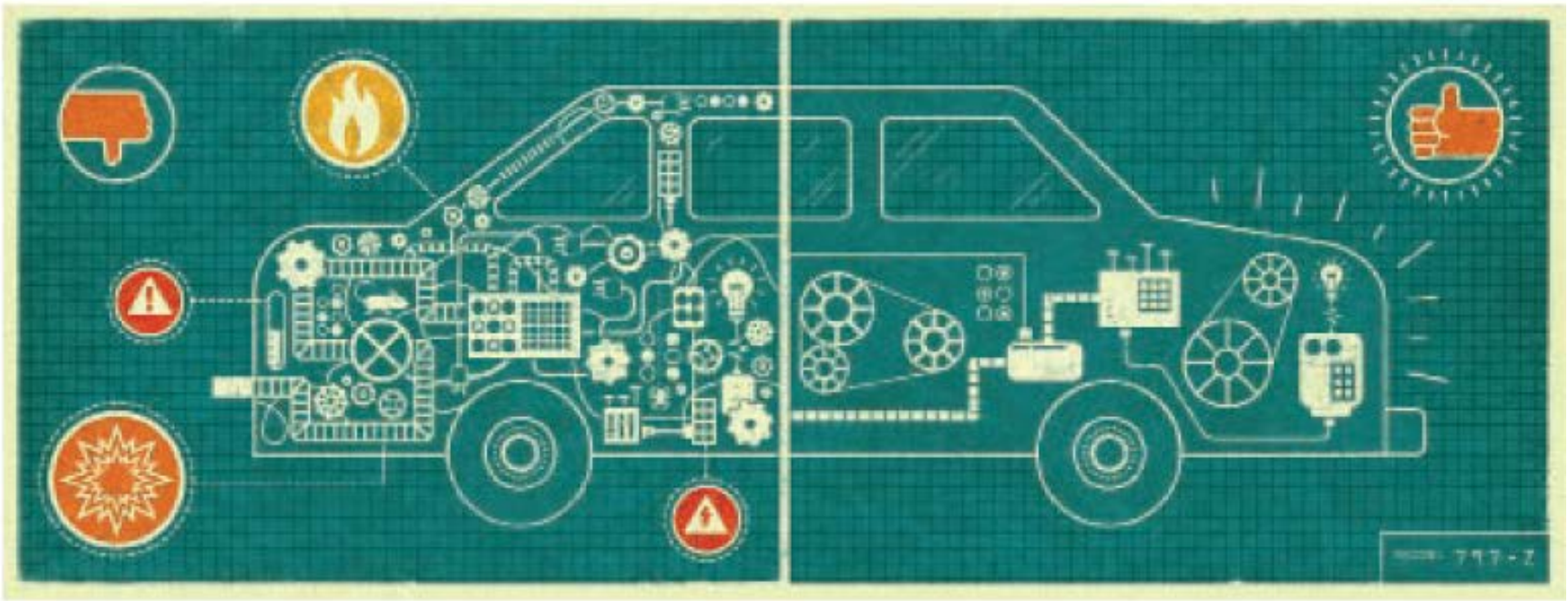
Fig. 1. The organizational continuum of technological platforms.

A. Gawer / Research Policy 43 (2014) 1239–1249

Evolutionary Changes in Auto Industry (moderate speed)

- From vertically-integrated to reliance on suppliers (first manufacturing, then product design, then innovation) or alliance partners
- From internal combustion engine (ICE) only to portfolio of drive trains
- From electro-mechanical to digital & electro-chemical technologies
- From highly integral product architectures to (somewhat) more modularity
- From “know more than you make” vis-à-vis system integrator (SI) role to needing collaboration to gain access to technological expertise
- From hierarchically-controlled supply chains and within-industry alliances to cross-industry collaborations and acquisitions of tech startups
- From competition among OEMs (and OEM + its supply chain) to competition among ecosystems (and ecosystem strategies)
- From stable business model to challenges from new mobility and usage (rather than ownership) business models

A Complex Product Becoming More Complex

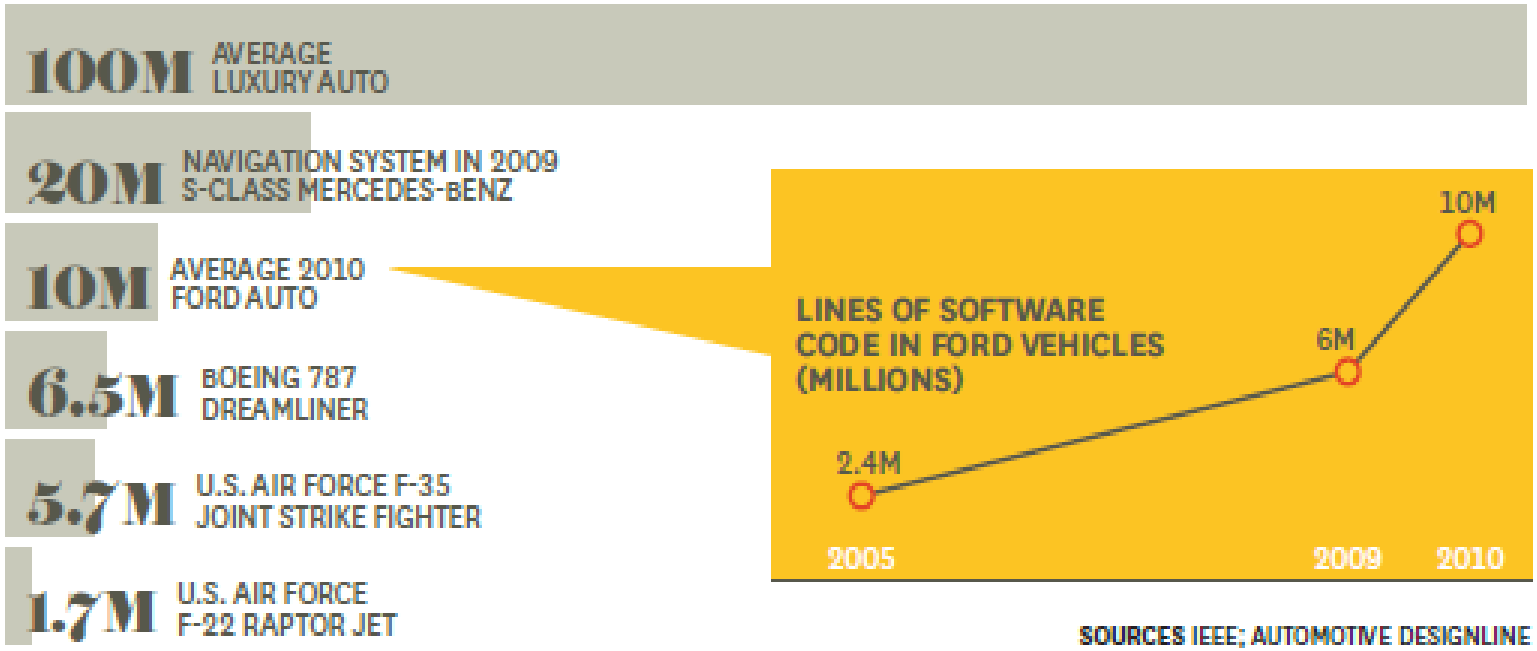


- Automotive “dominant design” hasn’t fundamentally changed in 100 years, but its complexity continues to rise
- Automobiles, as heavy, fast-moving objects operating in public space, face ever higher regulatory & consumer demands
- New technologies are only increasing this complexity

Software proliferation is one source of complexity

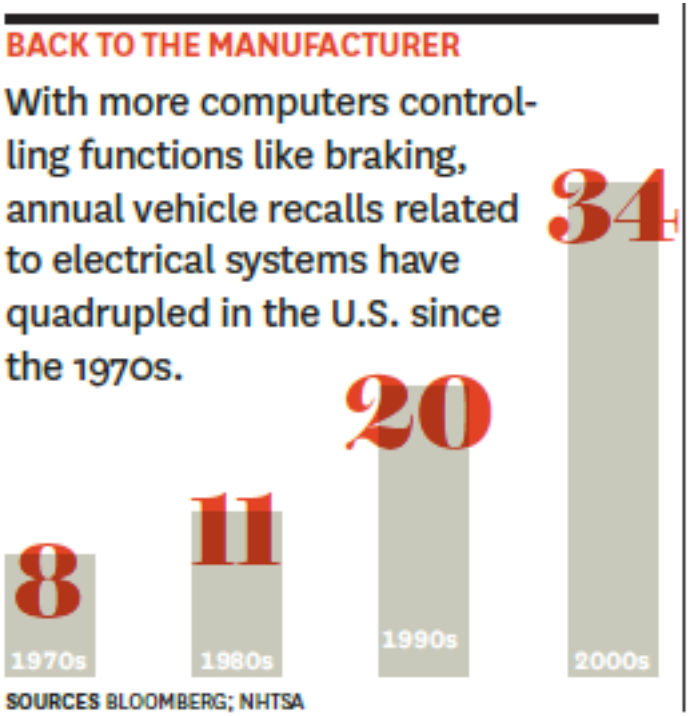
MORE COMPLEX THAN A FIGHTER JET

Safety regulations and consumer demand for performance and convenience have led to an exponential spike in cars' software complexity.



SOURCES IEEE; AUTOMOTIVE DESIGNLINE

Increases in Vehicle Recalls:
Many Causes, Including Dramatic Increases in Complexity



- Recalls arise from intersection of technological and market drivers of complexity plus heightened regulatory standards and monitoring

- Increases in vehicle reliability and safety at the same time as number of recalls surges higher

Disruptive Technologies/Concepts (fast pace)

- New drive trains (advanced ICE, HEV, PHEV, BEV, fuel cell) and new fuel sources (electricity, hydrogen, ethanol, biodiesel)
- "Connected car" – intra-vehicle networks (from industry-proprietary to open standards, e.g. Ethernet); vehicle-to-vehicle (V2V); vehicle-to-infrastructure (V2I); new infotainment services
- Autonomous vehicle (AV) – "driver assist" (Levels 1 & 2) to "primary vehicle control" (Level 3) to "full vehicle control" (Level 4)
- New mobility business models based on asset sharing (car-sharing/ride-sharing) that threaten to reduce vehicle ownership

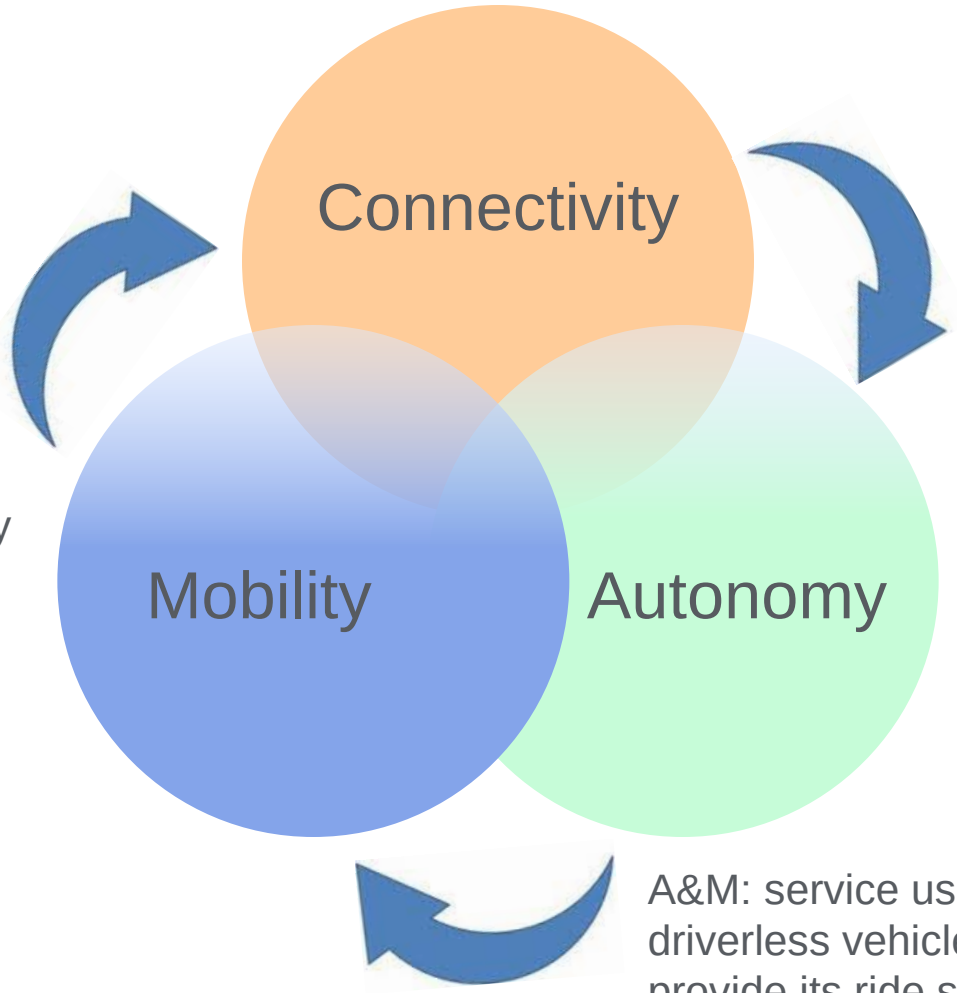
If each disruptive change arrived separately, OEMs could cope (as they have in the past)

- Given past investments in R&D, OEMs hold the majority of patents related to EVs, autonomous vehicles, etc.
- OEMs hire new technical talent to gain expertise in new technologies, e.g. chemical engineers to understand batteries
- OEMs also acquire to gain expertise, e.g. in software development, sensors, mapping, related to new features
- OEMs form alliances with each other to share the massive costs of developing new technologies and draw on supplier expertise
- BUT… new entrants and tech firms may have the advantage in making big leaps to new concepts and business models

Instead these technologies are converging/combining

- Tesla and AutoPilot (aiming for Level 3 AV in top-of-line EV)
- Google partnering with FCA (first step in becoming auto OS?)
- Uber and Volvo in Pittsburgh (first test of driverless taxis)
- Uber acquisition of Otto (autonomous trucks)
- Every reason to expect that:
  - Most EVs will rush to add AV features
  - New entrants will integrate AV with new drive trains (e.g. EV+AV @Apple)
  - Mobility providers, e.g. Uber, have strong incentive to move to AV
  - Cities, when partnering to experiment with AVs or ride-sharing services, may mandate low- or zero-emissions vehicles, e.g. Autolib (EV) in Paris

Connectivity, Autonomy, and Mobility: Changing fast and increasingly inter-related



C&M: vehicle communicates availability to mobility app (Uber now)

C&A: autonomous vehicles “talk” with infrastructure (V2I) or other vehicles (V2V)

A&M: service uses driverless vehicles to provide its ride services (Uber tomorrow)

Dilemmas of Competition and Collaboration (from Incumbents' POV)

- We don't have mastery of all relevant technologies any more
- We have to rely on suppliers for innovations within technologies that we don't understand so well
- We can't count on hiring the necessary technical talent (or doing it fast enough or making the right acquisitions or retaining talent we hire/acquire)
- We can't get where we want simply by partnering with other OEMs, we have to collaborate with firms outside the industry
- With slow progress for our within-industry closed standard-setting efforts, we have to work on open standards – under processes we can't control
- We need to work with tech firms that believe "we can disrupt anything", see us as slow and conservative, and want control of the data
- Our competitors make investments, establish alliances, acquire startups amid high uncertainty about technical change, and we have to respond
- Amid these developments, we face limits to our "collaborative capacity"

While partnerships among OEMs are common, new collaborations cross industry boundaries

Among OEMs:

GM-BMW-Mercedes on hybrid drive trains *(dissolved 2009)*

Honda-GM on fuel cells; also BMW-Toyota

Renault-Nissan joint vehicle development (also w/ Daimler, Mitsubishi)

Across Industries:

Nissan with NASA (AV); Sony/Konami (in-car game controller); Microsoft (cloud-based telematics)

Mobileye-Intel-BMW on autonomous vehicle standards

Mobileye-Delphi on autonomous vehicle systems

Ford-Google-Uber-Lyft-Volvo for autonomous vehicle regulation

Fiat Chrysler-Google – puts Google's AV tech into 100 Pacifica's

Uber-Volvo-Pittsburgh – test AV taxi service in a difficult-to-map city

Google-GM-Honda-Ford-Uber-Hyundai in patent protection alliance

Case Study: Ford (1)

- Ford Sync
  - Infotainment interface developed with Microsoft (MyFordTouch)
  - Acquisition of Livio for link to outside apps (SmartDevice Link platform)
  - Many problems with MyFordTouch – lower JD Power scores, bad press
  - Microsoft dropped (continued role in cloud support for software updates)
  - Sync 3.0 switches to QNX (from Blackberry) OS w/ Panasonic as integrator
  - Toyota agrees to adopt Ford's App Link (next gen SDL, fully open-source)
  - Sync 3.0 will ship with integration of Android Auto, Apple Car Play plus apps for Spotify, Pandora in all 2017 Ford models
- This example combines so many trends!
  - Partners outside auto industry (and changing those partners)
  - Acquisition of tech firm (Livio) for its platform software
  - Open source for new App Link; developing it with a competitor
  - Accepting that consumers want to use apps on their phone

Case Study: Ford (2)

- Ford sets up Ford Smart Mobility LLC as separate subsidiary “to design, build, grow and invest in new mobility services” (April 2016)
  - “We want to disrupt ourselves…. We needed to give them the flexibility and the operating structure to be competitive with other technology and mobility services companies that move really fast.” (CEO Mark Fields, April 7, 2016)
- Ford, Uber, Google, Lyft, Volvo set up alliance to push for federal guidelines to speed the transition to autonomous vehicles (April 2016)
  - “Self-Driving Coalition for Safer Streets” has former NHTSA head Anthony Strickland as its chief counsel and spokesperson
  - "The best path … is to have one clear set of federal standards.” (Strickland)
- Ford explains why its efforts to partner with Google and Uber failed (CEO Mark Fields, May 31, 2016)
  - “What we want from anybody that we partner with is: One, an equal amount of benefit that each company can bring to the party. The dynamics get very funky very quickly if somebody thinks they're getting screwed.”
  - “And two: Cultural fit, because you’re going to be working with these folks. Beyond what the spreadsheet says, you’ve got to make sure there's cultural fit."

Case Study: Ford (3)

- Ford (August 2016) announcement: Fully autonomous car launched in 2021
  - No steering wheel or other controls for a driver.
  - Will first prioritize commercial fleet applications, e.g. urban ride-sharing services
  - Prior steps: Investment in Pivotal (software to speed Ford's app development); testing 30 Ford Fusions at M-Place (testing ground at U. Michigan)
  - Makes big investment (along with Baidu) in Velodyne for Lidar technology (current cost per unit = $8000; aiming for high volume @ $500/each)
  - Also investing in Pivotal, Civil Maps (high-resolution 3D mapping)
  - Acquisition of SAIPS (Israeli firm doing machine learning software)
  - Exclusive licensing agreement with Nirenberg Neuroscience ("virtual retina")
  - Doubling size and staff at its Silicon Valley office
- "We abandoned the stepping-stone approach of driver-assist technologies and decided we'd take the full leap to deliver a fully autonomous level four-capable vehicle," R&D head Raj Nair said. "It's safer to develop a system that can be in control 100 percent of the time."

Closing Questions

- Will a struggle over access/control of data limit the potential for collaboration between auto & tech sectors?
- Slow move of OEMs towards participating in developing open standards – better to join or to block?
- Regulatory role shifting towards more facilitative of coordinated change? Or new stage of adversarial relationship after flood of recalls (and VW deception)?
- Proliferation of partnerships between auto and tech firms driven by need to share costs and access knowledge & talent; will this exceed collaborative capacity of OEMs?
- Ecosystems go beyond firms to include policymakers and governments; what common goals can advance change?