P3 OVERVIEW

SAA – Accelerating Mobility Solutions

Dat Truong
P3 North America

4/18/2018
We bridge our expertise in business and engineering to provide end-to-end solutions.

We work side by side with our clients on business and technical challenges ensuring a sustainable result.
30+ SUBSIDIARIES in the whole P3 group

>75% OF OUR PEOPLE are engineers

ALMOST 4000 EMPLOYEES from more than 40 nations

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>CITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>Dallas / Detroit / Detroit</td>
</tr>
<tr>
<td></td>
<td>/ Morristown / Portland /</td>
</tr>
<tr>
<td></td>
<td>Irvine / Wichita</td>
</tr>
<tr>
<td>CANADA</td>
<td>Montreal / Toronto /</td>
</tr>
<tr>
<td></td>
<td>Ville St Laurent</td>
</tr>
<tr>
<td>MEXICO</td>
<td>Mexico-City</td>
</tr>
<tr>
<td>BRAZIL</td>
<td>São José dos Campos</td>
</tr>
<tr>
<td>GERMANY</td>
<td>Aachen / Berlin / Bruns</td>
</tr>
<tr>
<td></td>
<td>schwag / Bremen / Düsseldorf</td>
</tr>
<tr>
<td></td>
<td>/ Hamburg / Ingolstadt /</td>
</tr>
<tr>
<td></td>
<td>München / Stuttgart /</td>
</tr>
<tr>
<td></td>
<td>Wolfsburg / Köln</td>
</tr>
<tr>
<td>GREAT BRITAIN</td>
<td>Bristol / London /</td>
</tr>
<tr>
<td></td>
<td>Hounslow</td>
</tr>
<tr>
<td>ITALY</td>
<td>Rome</td>
</tr>
<tr>
<td>SPAIN</td>
<td>Madrid / Sevilla</td>
</tr>
<tr>
<td>ROMANIA</td>
<td>Cluj-Napoca</td>
</tr>
<tr>
<td>INDIA</td>
<td>Bangalore</td>
</tr>
<tr>
<td>CHINA</td>
<td>Peking / Shanghai / Shenzhen</td>
</tr>
<tr>
<td>JAPAN</td>
<td>Tokyo</td>
</tr>
<tr>
<td>SOUTH AFRICA</td>
<td>Cape Town</td>
</tr>
<tr>
<td>AUSTRALIA</td>
<td>Sydney</td>
</tr>
</tbody>
</table>
P3 GROUP – OUR CUSTOMERS

We exceed expectations and continue to deliver for our diverse client portfolio
P3 GROUP – FOCUS AREAS

P3 is a global network of innovative and creative experts, serving customers in five industries.

- **AEROSPACE**
  Consulting, engineering and implementation services for all major OEMs and their tier 1 suppliers

- **TELECOMMUNICATIONS**
  Consulting, engineering and testing services for the whole telecommunications industry

- **AUTOMOTIVE**
  Consulting, management support and testing services for the automotive industry

- **ENERGY**
  Consulting and innovative, technical solutions for the energy sector

- **PUBLIC SECTOR**
  Consulting and management support for modernization and optimizing of processes in the public sector.
P3 NORTH AMERICA – TECHNOLOGY FOCUS

We intersect our business units through four key technology areas.

AUTONOMOUS MOBILITY

MANAGEMENT CONSULTING + INNOVATIVE ENGINEERING SOLUTIONS

CONNECTED MOBILITY

ELECTRIC MOBILITY

NEW MOBILITY SERVICES
Our diverse teams is up for the challenge of bridging the gap between technology and business.

**TECHNOLOGY & BUSINESS STRATEGY**
- Technology Product Portfolio & Roadmaps
- Technical and Service Due Diligence
- Product Costing & Optimization
- Benchmarking

**SYSTEMS ENGINEERING**
- Requirements & Specification Development
- Design Verification (DFMEA/HARA)
- Design & Modeling
- System Integration

**PROTOTYPE & TEST EQUIPMENT**
- Bench Design & Building
- Vehicle Retrofits
- Prototyping

**OPERATIONS & SUPPLIER MANAGEMENT**
- Shop floor & Quality improvement
- Smart Factory/ Industry 4.0
- Logistics & Warehouse
- Supplier performance improvement

**DATA ANALYTICS & SOFTWARE DEVELOPMENT**
- App Development & Digitization
- Advanced Analytics & Visualization
- Digital Strategy & Transformation

**TECHNOLOGY DELIVERY MANAGEMENT SERVICES**
- Business Modeling & Business Requirements
- Operational System, Process Design & Development
- Program Management / Agile & SCRUM
- Planning & Timeline Management
- Supplier & Launch Management
- Organizational Transformation & Benchmark

© 2018 P3
Dat Truong
Technology and Marketing Strategy
P3 North America

+1 248 385 6452
dat.truong@p3-group.com

www.p3-group.com
CURRENT TECHNOLOGY CHALLENGES AND TRENDS

SAA – Accelerating Mobility Solutions

Colin Goldsmith

4/18/2018

P3 North America Inc.
The automotive industry is facing tremendous pressure from inside and outside to improve current products but also introduce game changing technologies.

### Emission Compliance
- Increasing emission compliance pressure in EU and China
- Unsolved real world emission compliance
- Conflicting consumer behavior regarding fleet targets

### Electrification
- Initially driven by emission, turning into competitor driven strategy
- Broad offering of system topologies, increasing vehicle platform complexity

### Active Safety/ Autonomous Driving
- Legislative pressure for active safety technology as standard features
- Steadily increasing competition from traditional and disruptive OEMs and startups
The race for autonomous driving has begun, with high expectations from consumers and industry regarding timing, pricing and value add of technology for drivers and society.

**World Wide Vehicle Sales in Million Units**

- **2020**
  - ~100 M#
  - 98.4
  - General market growth stalling, traditional vehicle market driven by emerging countries.
  - SAE Level 3 and 4 techn. need too prove value add in real life situations.
  - Trickle down and economies of scale main focus for broader feedback generation.

- **2025**
  - ~109 M#
  - 11.6
  - Semi/fully autonomous driving techn. become standard offering for premium OEMs.
  - Level 5 vehicles emerging out of special purpose areas into city environments.

- **2030**
  - ~115 M#
  - 4.4
  - 6.6
  - 28.2
  - 75.7

**SAE Level 5**
- Main advantages and value add most likely realizable in urban/mega city environments.

**SAE Level 4**
- Extensive product hardening and innovative testing & validation concepts (machine learning) needed.

**SAE Level 3**
- Main challenge relies on driver-vehicle interaction for control transition.

**SAE Level 0-2**
- Price sensitive active safety technologies driven by regulation and competition.
Although most benefits of autonomous driving are undisputed several road blocks have to be addressed fast enough to prevent the failure of a disruptive idea.

**Disruption Drivers**

1. **More Road Safety**
   - Avoidance of 95% of all typical accident causes, e.g. speeding, distraction, running red lights/stop signs, wrong way
   - Increase of traffic flows in congestion areas

2. **More Flexibility**
   - Decreasing of vehicle ownership enables consumers to use vehicle concepts adapting to daily changing needs without paying more than today

3. **More Time**
   - Average daily commuting time in the US approx. 45-65 minutes that could be used for value added activities, e.g. relaxation, working, entertainment

**Automotive Mobility 2025**

- Image of a car interior with a person relaxing on the seat.

**Disruption Setbacks**

1. **Missing Consumer Trust**
   - Only 25% of Generation X show trust in AD technology.
   - Generation Y/Z much less critical (55% in favor)

2. **Real-World Complexity for Technology and Development**
   - Special environments (rural, city, bad weather) with high complexity and ambiguity still main concern regarding reliability and safety of autonomous vehicles

3. **Costs**
   - Additional costs for semi/fully autonomous features of $5000-8000 can only be covered within premium vehicles initially, fast commoditization necessary for broader applications
Most OEMs Have Announced Aggressive Timelines for Automated Driving Development

- SAE Level 5
- SAE Level 4
- SAE Level 3
- SAE Level 2


Source: P3 research

Unclear (pro-pilot is level 2+, “fully autonomous” by 2022)
US & German OEMs are driving today’s advancement of Autonomous Driving, but China is pushing full speed ahead. Technology AND Legislative Frameworks are Important for Broad Adaptation

**Technology Development**

<table>
<thead>
<tr>
<th>Today</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration</td>
<td>Definition</td>
</tr>
<tr>
<td>Germany</td>
<td>China</td>
</tr>
</tbody>
</table>

**Feature Coverage/Complexity**

<table>
<thead>
<tr>
<th>Today</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration</td>
<td>Definition</td>
</tr>
<tr>
<td>Germany</td>
<td>USA</td>
</tr>
</tbody>
</table>

**Regulations/Legislative Framework**

<table>
<thead>
<tr>
<th>Today</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration</td>
<td>Definition</td>
</tr>
<tr>
<td>Germany</td>
<td>USA</td>
</tr>
</tbody>
</table>

- Germany and the US are currently leading by investments and planned AD milestones
- Key technology getting ready for 2020+
- Especially China has to face highly complex road behaviors and scenarios
- Germany and the US are going for simpler features (e.g. highway pilot)
- City environments still challenging
- The US has been the first to allow AD testing on public roads
- China has sent clear positive signals and is expected to take the lead by 2021

Current Technology Challenges and Trends

**P3 research**
AUTONOMOUS DRIVING REQUIRES A MYRIAD OF COMPETENCIES

Complexity Map

- **Infrastructure**
  - 4G
  - 5G
  - Car2X

- **Technology**
  - Machine Learning
  - HD Maps

- **User Experience**
  - New Business Models
  - Preemptive HMI
  - 3rd Party Services
  - Ubiquitous Avail.

- **Cost Optimization**
  - Central Process.
  - New EE Platforms
  - HW/ SW Frameworks

- **Test and Validation**
  - HiL
  - SiL
  - Virtual Testing

- **Data Management**
  - Big Data
  - Data as a Service

- **Autonomous Driving Success Factors**
  - Sensors
  - Path Planning
  - Machine Learning
  - HD Maps

- **Data as a Service**
FOCUSING IN ON PERSPECTIVES

Complexity Map

Infrastructure

Test and Validation

Technology

Autonomous Driving Success Factors

User Experience

Cost Optimization

Data Management

New EE Platforms

Virtual Testing

Central Process.

HiL

SiL

New Business Models

Preemptive HMI

3rd Party Services

Ubiquitous Avail.

4G

5G

Car2X

Machine Learning

HD Maps

Sensors

Path Planning

Data as a Service

Big Data

Data Management

Big Data

Data as a Service

4G

5G

Car2X

Machine Learning

HD Maps

Sensors

Path Planning

New Business Models

Preemptive HMI

3rd Party Services

Ubiquitous Avail.

5G

4G

Car2X

Machine Learning

HD Maps

Sensors

Path Planning

New Business Models

Preemptive HMI

3rd Party Services

Ubiquitous Avail.

5G

4G

Car2X

Machine Learning

HD Maps

Sensors

Path Planning

New Business Models

Preemptive HMI

3rd Party Services

Ubiquitous Avail.
The increase of complexity is not happening within the vehicle alone with numerous ecosystems outside of automotive are now suddenly connected to a vehicle.

The market has not yet determined the distribution of data and its processing value chain.
Vision sensors will dominate the equipment rate of future vehicles due to their high information density and diversity but RADAR will experience a strong push forward as well.

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Std. Configuration</th>
<th>High Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart Camera</td>
<td>2x</td>
<td>1x</td>
</tr>
<tr>
<td>Surround View Camera</td>
<td>4x</td>
<td>6-8x</td>
</tr>
<tr>
<td>Long-Range Radar</td>
<td>1x</td>
<td>1x</td>
</tr>
<tr>
<td>Short-Range Radar</td>
<td>2x</td>
<td>4x</td>
</tr>
<tr>
<td>LIDAR</td>
<td>0x</td>
<td>2x</td>
</tr>
<tr>
<td>Infrared</td>
<td>0x</td>
<td>0x</td>
</tr>
<tr>
<td>Ultrasonic</td>
<td>12x</td>
<td>2x</td>
</tr>
<tr>
<td>GPS/IMU</td>
<td>1x</td>
<td>1x</td>
</tr>
</tbody>
</table>

- **OEM specific vision concept**
- **Additional Rear Radar Feasible**
- **Replacement of US sensors**
- **OEM specific LIDAR concept**
- **Limited value add in comparison to LIDAR**
- **Challenged by commod. RADARs**
- **Increase of precision required for DR**
In order to achieve critical cost reduction following domains within the product development cycles have to addressed and executed different from today's solutions:

1. **Limitation of HW/ sensor platforms to a minimum**
   Reduction of direct and indirect costs through economies of scale and focus on value added developments within SW.

2. **Development and maintenance of SW building blocks library**
   Aiming at 85% SW reusability over all vehicles, achieving flexibility through virtualization functions.

3. **Agile T&V developed once, applied everywhere**
   Shifting traditional T&V activities into implementation phases, shortening of feedback loops with automation.

4. **Fast trickle down of advanced features and technology**
   Enforcing economies of scale of advanced feature developments to achieve cost and sourcing synergies.

5. **Leverage of 3rd party modules and open innovation**
   Focus on core competence, avoiding distraction generating “pet” projects that can’t deliver differentiation. Leverage of strategic 3rd parties.
FOCUSING IN ON PERSPECTIVES

Complexity Map

- Infrastructure
  - 4G
  - 5G
  - Car2X

- Technology
  - HD Maps
  - Sensors
  - Machine Learning
  - Path Planning

- Autonomy Driving Success Factors

- Test and Validation
  - HiL
  - SiL
  - Virtual Testing

- User Experience
  - New Business Models
  - Preemptive HMI
  - Ubiquitous Avail.

- Cost Optimization
  - Central Process.
  - New EE Platforms
  - HW/SW Frameworks

- Data Management
  - Big Data
  - Data as a Service

- Data as a Service

- FOCUSING IN ON PERSPECTIVES
OEMs and Tier 1s are struggling already today to visualize and notify users of ADAS features and behaviors. These features need to be intuitive for the driver to improve safety during driving rather than creating distraction.

1. Display of information and warnings to driver highly OEM dependent

2. Source and meaning of audible warnings not always distinguishable in critical situations

3. Level of details displayed towards driver not adaptable to personal preferences

4. Level of details of situational awareness of vehicle towards driver not always sufficient or trust increasing
User experience solutions for automotive need to change fundamentally in the way they are conceptualized and implemented, breaking with today's understanding of it.

<table>
<thead>
<tr>
<th>Today’s Automotive UX Solution</th>
<th>Tomorrow’s Automotive UX Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distinct UX Domains</strong></td>
<td><strong>Multi-Modal UX</strong></td>
</tr>
<tr>
<td>• Technology components and solutions <strong>executing functions independently</strong></td>
<td>• Superior fusion and processing system <strong>takes all information about driver</strong> and passengers <strong>into account</strong> (status, wellbeing, cognitive load level)</td>
</tr>
<tr>
<td>• No sophisticated interaction between UX domains</td>
<td></td>
</tr>
<tr>
<td><strong>Driver Adapts To Vehicle</strong></td>
<td><strong>Vehicle Adapts to Driver</strong></td>
</tr>
<tr>
<td>• Drivers have to learn <strong>vehicle specific usage</strong> scenarios</td>
<td>• Vehicle is able to personalize driver <strong>specific settings</strong> and interaction details</td>
</tr>
<tr>
<td>• Driver warnings or information are not <strong>standardized</strong> and different from OEM to OEM</td>
<td>• Driver is warned and informed in the most effective way, suiting individual capabilities</td>
</tr>
<tr>
<td><strong>UX Interaction Is Initiated by Driver</strong></td>
<td><strong>Driver Reacts to Anticipated Vehicle Fcts.</strong></td>
</tr>
<tr>
<td>• For majority of interaction features <strong>drivers or passengers need to initiate execution of functionality</strong> or feature</td>
<td>• UX system anticipates interaction wishes by <strong>driver</strong> or passengers</td>
</tr>
<tr>
<td></td>
<td>• Automated execution of tasks or features are only modified by user interruption</td>
</tr>
<tr>
<td><strong>UX Is A Limited Environment</strong></td>
<td><strong>UX Is A Well Connected Part of Daily Living</strong></td>
</tr>
<tr>
<td>• Automotive interaction features are limited to the vehicle or Web/Smartphone interfaces</td>
<td>• Vehicle features are highly integrated into other connected environments of the daily living</td>
</tr>
</tbody>
</table>
The whole industry is shifting and only those companies who get their internal & external factors aligned will succeed.

Autonomy will likely grow in hand with connectivity, shared economy and electrification.

Internal

1. Ability to **optimize positioning in a constantly changing value chain**

2. Achieving success not only pre-dominantly **based on technology**, but more on the overall solution

3. **Leapfrog of developments** rather than being bound to legacy platforms

External

4. Develop partnerships without creating new competition

5. Openness to radical changes of how **business models** are conceived & lived

6. Meet and exceed different & changing **requirements** of local markets/ regulations

**Current Technology Challenges and Trends**

- **Autonomous Mobility**
- **Electric Mobility**
- **Connected Mobility**
- **New Mobility Services**

© 2018 P3
Colin Goldsmith
Managing Partner
P3 North America, Inc.
+1 585 943 2273
colin.goldsmith@p3-group.com

www.p3-group.com
PRODUCT COST ENGINEERING X.0

Fundamentals are Back in Fashion

Ted Mabley
April 18, 2018
“Much of the future of the automotive industry is going to be determined and developed, right here,” Mark Ruess, Global Vice President Product Development General Motors “But only if we can develop, attract and acquire the engineering talent to do so.”

Challenges for Product Cost Management

- New Products and Technologies
- Higher Importance placed on Software Development
- Low Volumes
OEM Cost Estimation Challenges include:

- Little to No experience with costing of new technologies (good with what we know)
  - Fabrication of component parts may be unknown
  - Assembly processes that are unknown or in the process of being defined
- Supply and Demand impact on pricing
- The basic premises on cost engineering remain the same
  - Bottom up estimates require a baseline Bill of Process and cost parameters (machine rates, labor, material rates, cycle times, etc)
The impact of increasing electronics on vehicles is increasing software required to make it work

- Biggest challenge is to separate software development from product cost
- Definition: Software, like ED&D, can be defined as non-reoccurring charges required to adapt a product technology to a specific vehicle.
  - This is not the same thing as a joint development project between two parties
  - There is an element of some costs being re-used, some is minor modification, and some will require all new
    - Not too dissimilar as a basic new development program in a specific system such as an Instrument Panel
Most conventional cost modeling is based on high volumes. Cost Estimators will be challenged to add labor content and setup time, as well as reduce capital. But, this is only part of the story:

- Supplier ROI expectations change with low volume programs.
- Traditional tooling assumptions will crush a low volume business case.
- Many other usual customer specific issues can be magnified.
  - Production Schedule Fluctuations
  - Engineering Changes
  - Fixed Cost Coverage

CHALLENGE #3 FOR PRODUCT COST MANAGEMENT
LOW VOLUMES
P3 GROUP SOLUTIONS TO MEET THESE CHALLENGES

People
- Developed a “Academy” approach to address the people development issue especially in the area of product cost management
- Deep domain experts that provide desired skill sets for clients
- Rotation to keep skill sets fresh, demand for new technologies vs plastic injection mold

Processes
- Global network to leverage results and resources
- Global Knowledge repository managed by SME’s
- Knowledge of processes required for how new products are designed, developed and produced

Technologies
- New low volume manufacturing methods (battery packs)
- Leverage of software development knowledge into cost assessment tools
- Benchmarking of components and processes from other industries to leverage into client engagements
THANK YOU FOR THE TIME AND ATTENTION TODAY

“A pessimist sees the difficulty in every opportunity; An optimist sees the opportunity in every difficulty.”

Winston S. Churchill

Ted Mabley
Mobile 248.613.9200
edward.mabley@p3-group.com
TRANSFORMATION IN THE AUTO INDUSTRY
HYPE & REALITY

PARTHA GOSWAMI
Technology Trends & Insights

April 18, 2018
Society of Automotive Analysts
Southfield, MI
We’re in the throes of technology-driven change & disruption

Quadrants of Disruption

**Durability**: Disruption is evident, but not life-threatening

**Vulnerability**: Incumbents susceptible to more future disruption

**Viability**: Competitive advantage short-lived, as new disruptors emerge

**Volatility**: Prominence of violent, sudden disruption

Source: Accenture study on Trends in disruption in Industry segments Feb 2018
But we tend to....

- **Overestimate** the pace of technology in the short run
- **Underestimate** the pace in the long run.

Roy Amara  
Scientist & Futurist  
Quoted in 2006
Gartner’s Hype Curve partly validates Amara’s Law

- Peak of Inflated Expectation
- Trough of Disillusionment
- Slope of Enlightenment
- Plateau of Productivity

Emerging Technology Expectation

Technology Trigger

TIME
Gartner Hype Curve 2017: A Closer Look

2017 Emerging Technologies

- Deep Learning: 2-5 (Years to maturity)
- Autonomous Vehicles: 5-10
- Block Chain: 10+
- Commercial Drones: 5-10
- Quantum Computing: 10+
- Conversational UI: 2-5
- Virtual Assistant: 10+
- AGI: 10+

AGI = Artificial General Intelligence

Auto Industry: Past Decades

- Stable OEM-Tier1/2/3 Hierarchy
- Long life cycle & largely unchanged architecture
- Growth of “BRIC” markets - one of very few business expansions

• Slower pace of technology innovation
  
  Oldsmobile Guidestar Navigation system (1992)
  OnStar on-board telematics (1996)
Change in the Auto Industry | 2007-2017

The iPhone Decade

- Impact of Mobile
- Growth of IoT, Cloud, Big Data
- “Viral” Social Media
- Big Tech – FAANG & BAT*
- Resurgence of AI
- Notion of faster life-cycle & Over the Air (OTA) product update

FAANG (Facebook, Apple, Amazon, Netflix, Google) & BAT (Baidu, Alibaba, TenCent) embody the market dominance of new technology

* AI: Artificial Intelligence

- “Cloud for hire” AWS 2006
- iPhone Launch 2007
- “Things” outnumber “Humans” in Internet 2008
- GPUs repurposed for neural net modeling 2009
- Facebook IPO 2012
- App based ride hailing 2012
- Watson as a business unit 2014
- AlphaGo AI defeats world GO champion 2017
Three Dimensions of this Change

- **Vehicle Transition** from a HW-defined to a SW-defined platform

- **ACES (or CASE)**
  - **ACE**: Fast growth of **Autonomous** technology, **Connectivity** and **Electrification**
  - **S**: Car as a platform for **Mobility Services**

- **Overhaul of Value Chain**: The industry is served by a new eco-system of startups & technology providers

According to McKinsey, between 2010 and 2030, SW will grow 7% to 30% of vehicle content, whereas mechanical content will reduce from 68% to 41%.

Source: McKinsey & Company
What’s the anticipated trajectory of these changes?

- The most common scenario is based on **hype & optimism**
- “Race” to Level 4 or 5 autonomy
- High expectation of the penetration of **MaaS** or **TaaS**

TaaS=Transportation as a Service
MaaS=Mobility as a Service
Some unique challenges along this trajectory

- All the new software and hardware have to be “Automotive Grade”
- The newly minted AVs have to
  - Co-exist with Level 0 or 1 cars*
  - Handle the “edge” cases of driving →
  - Potentially do better than 1.13** fatalities/100 M miles
- The supply chain has to scale significantly for high volume for both AVs & EVs

---

* US Roads: 250M+ vehicles
**IIHS Data (2015)


**IIHS Data (2015)

Source: IHS Markit
Other areas to navigate:

**Affordability & Adoption**

**Example: BCG Study:** 10 year adoption curve

Cruise Control & ACC* (Adaptive Cruise Control)

First ACC in the US launched in 2000.

After 16+ years, availability of ACC in MY17 hovered around 45-54%.

**Trust**

<table>
<thead>
<tr>
<th>AGE</th>
<th>16-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65-74</th>
<th>75+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>26.2%</td>
<td>40.0%</td>
<td>34.4%</td>
<td>23.4%</td>
<td>18.9%</td>
<td>14.2%</td>
<td>12.7%</td>
</tr>
</tbody>
</table>

**Comfort / Likely Adoption: Full Autonomy**

Source: MIT Agelab
2016 White Paper on Consumer Preferences


**SOURCE:** https://www.bcgperspectives.com/content/articles/automotive-consumer-insight-revolution-drivers-seat-road-autonomous-vehicles/?chapter=5
Lesson from History: Trajectory of AI

- **Decades of Development**
- **Acceleration**
  - Big data
  - Compute power

- **Success of AlphaGo**
- **AI Chips**
- **Deep Learning**
- **Facebook, Baidu, Google’s AI Research**

- **Availability of Data**
- **Growth of GPU**

* Similar to Gartner’s “Trough of Disillusionment”
We can invoke Amara’s law & history of AI to hypothesize that:

Success & Mainstreaming of many new technologies (AV & EV included) could follow a similar initial slow phase followed by fast acceleration

- Initial phase solving many hard problems such as:
  - High Performance/Watt Computation
  - Capability to resolve ambiguous edge cases
  - Automotive Grade Reliability

- Accelerated phase

Scenario 1

Scenario 2

Scenario 3

A: Autonomous
E: Electrification
C: Connected
In Summary:

• 2007-17 was a watershed decade for automotive, that initiated & catalyzed many key changes

• Explosion of Mobile, Cloud technology & success of Big Tech have sparked imagination & expectation of consumers

• Industry, however, still has to solve several unique challenges – technical or otherwise

• Change & reinvention of automobile is certain, but its pace may be different from today’s hype
HOW IS GM EMBRACING THIS CHANGE?

I believe the auto industry will change more in the next five to 10 years than it has in the last 50.

Mary Barra
CEO and Chairman of General Motors
Connectivity

>2 MILLION
4G-EQUIPPED VEHICLES

LARGEST DEPLOYMENT OF
4G LTE SERVICES
IN AUTOMOTIVE INDUSTRY

>1 BILLION
CUSTOMER REQUESTS SINCE 1996

Infotainment system capable of OTA updates before 2020

Cadillac CTS
V2V Deployment
Electrification

• Bolt EV – First Electric car to combine long range & affordability
• 238 miles range on a single charge

20+ NEW
ALL ELECTRIC VEHICLES

GLOBALLY BY 2023
Super Cruise

- Super Cruise™ Industry’s first true hands-free driving technology for the highway
- Supported by driver monitoring system
Autonomous

• Second generation test vehicles - Testing in progress at multiple locations

• Industry first – vehicles built off a regular production line
FUTURE MOBILITY
where IT ALL COMES TOGETHER

Learn & innovate Mobility Service
• New Mobility Access
• Sharing
• Alternate asset ownership models

TaaS/MaaS/CaaS: Transportation/Mobility/Car as a Service
New Mobility Models

Home: Closed community shared-use

City: Open community shared-use.

Alternative or Supplement to traditional ownership

Weekly rental Delivery Service, Rides etc.

Remote APIs

KeylessOn demand access
Finally, Learning, Scaling & Optimizing from data

Fast, iterative develop/deploy cycles

Agile development method driving continuous improvement

Unique data and data use

EV cycles
Data-driven dev priorities and roadmap

In 18mos

- 200 Features added
- 50 bug fixes
- 3-5 Major Enhancements
THANK YOU!

Partha.Goswami@GM.com
DISCUSSION TOPICS

1. motivating factors
2. benchmarking for the future
3. future scenarios explored
4. conclusions
In a driverless vehicle, what 3 activities would you do that you can’t currently do while driving?

- Email: 22
- Beauty: 4
- Social Media: 6
- Phone: 22
- Net: 7
- Work: 58
- Media: 48
- Eat/Drink: 18
- Sleep: 51
- Family: 16
- Read: 58
- Other: 16
- Play Air Guitar during Eddie Van Halen Solos: 1

© 2018 P3
What are 3 hesitations of yours in the automotive industry going to full autonomous vehicles?

- Cost/Access: 31
- Info/Education/Adopt Speed: 56
- Safety, Trust, Reliability: 98
- Infrastructure: 48
- Control: 32
- Mix of Autonomous and Regular Vehicles: 30
What 3 things frustrate you the most using the technology in current vehicles?

- Usability/Intuitiveness/UX Design: 61
- Features and Functions Not Working: 46
- My phone does it better (functions, speed, apps, voice, navigation, etc): 25
- Cost: 20
- Driver Distraction: 10
- Lack of Standardization between Manufacturers: 5

MOTIVATING FACTORS FOR NEW MOBILITY SOLUTIONS.
today’s trends + current research + future technology concepts

where am I now → where do I want to be
FUTURE SCENARIO 1: AUTO OEMS DOMINATE

**positive indicators**

- integration experience of new technologies into vehicles
- established pipeline of technology, manufacturing facilities, and suppliers
- leading materials innovations for lightweight structures and durable interiors
- strongest brand association to on-the-road safety and quality
- ability to offer true vehicle personalization through mobility models that reward brand loyalty

**predicted characteristics**

- vehicles will provide easier access and multiple configurations to meet a broad range of needs
- vehicles will need to last for at least 2x more miles than they are designed for today
- one moderate crash could easily force a vehicle to be recycled
FUTURE SCENARIO 1: AUTO OEMS DOMINATE

mobile living room

1. Permanent, main seating in rear of vehicle. Lightweight and durable
2. Display integrated into glass for visual alerts and shared content
3. Local touch controls for main seating. Also, voice control for authorized users
4. Interactive, holographic displays for each passenger
5. Fold flat seats available under optimal driving conditions
6. Modular arrangements to allow for increased storage space as needed. Able to hide and remove. Options for child seats, pet carriers, appliances, etc.
### FUTURE SCENARIO 2: RIDE SHARING COMPANIES DOMINATE

<table>
<thead>
<tr>
<th>positive indicators</th>
<th>predicted characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ adoption rate of ride sharing as an alternative to many current modes of transportation</td>
<td>▪ vehicles will become a commodity and the dominant ownership model will be fleets</td>
</tr>
<tr>
<td>▪ average age is increasing for first time buyers in the current generation of drivers</td>
<td>▪ vehicles will need to last for at least 6x more miles than they are designed for today</td>
</tr>
<tr>
<td>▪ adoption of on-demand, subscription, and pay-as-you-go services is increasing across all industries</td>
<td>▪ limited innovation with bare minimum implementations as mobility costs are driven down</td>
</tr>
<tr>
<td></td>
<td>▪ costs may increase long term if there are large asset losses due to theft, vandalism, or cybersecurity attacks</td>
</tr>
</tbody>
</table>
FUTURE SCENARIO 2: RIDE SHARING COMPANIES DOMINATE

**personal.**

**groups.**

**commuters.**
## FUTURE SCENARIO 3: TECH GIANTS DOMINATE

<table>
<thead>
<tr>
<th>positive indicators</th>
<th>predicted characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>• significant user base allows for large amounts of user data to be leveraged for additional use cases</td>
<td>• consumers will trust non-automotive brands to deliver mobility solutions</td>
</tr>
<tr>
<td>• established service platforms have become household staples in HW and SW</td>
<td>• companies will provide incentives and discounts to consumers who use associated platform services</td>
</tr>
<tr>
<td>• service platforms have continuous touch points with users and are adaptive to their needs</td>
<td>• consumers will be willing to trade advertisements for mobility discounts</td>
</tr>
<tr>
<td>• ability to innovate and react quickly to the market resonates with young consumers</td>
<td>• certified, mobility platforms will be purchased or rented as part of a fleet from OEMs or similar</td>
</tr>
</tbody>
</table>
FUTURE SCENARIO 3: TECH GIANTS DOMINATE

mobile showroom.

- featured products
- hello, Andy! rewards/coupons, daily deals
- hello, Leslie! calendar
- hello, Ron! sports highlights
  - to do: pay rent, order present
  - daily fitness
  - call mom
- sponsored content
- direct ads in support of free mobility
- interactive walls to support productivity
- rentals of partner mobility services

news / weather by aiVideo

- product demos
- modular seating
- productivity booths
## FUTURE SCENARIO 4: COMPLETE DISRUPTION OCCURS

<table>
<thead>
<tr>
<th>positive indicators</th>
<th>predicted characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ status quo is being challenged by startups in all industries</td>
<td>▪ microeconomies of local services and on-demand delivery emerge</td>
</tr>
<tr>
<td>▪ new business models are being widely adopted even if they are restricted by regulations</td>
<td>▪ ownership is reduced of many traditional items due to conversion to digital or adoption of subscription models</td>
</tr>
<tr>
<td>▪ corporate investment and support of startup community</td>
<td>▪ accelerated adoption of digital technologies</td>
</tr>
<tr>
<td>▪ increased experimentation by large companies into new business verticals, models, and revenue streams</td>
<td></td>
</tr>
<tr>
<td>▪ consumers willing to invest to bring products they desire to market</td>
<td></td>
</tr>
</tbody>
</table>
FUTURE SCENARIO 4: COMPLETE DISRUPTION OCCURS

always mobile.

mobility not required.

https://www.designboom.com/design/cornelius-comans-bufalino/
THERE WILL BE MANY SOLUTIONS TO FUTURE MOBILITY USE CASES

- **commuting**
  - on a defined schedule
  - multiple trips a week
  - traffic is problematic

- **leisure**
  - travel for 2-6 people
  - multiple locations possible
  - parking problematic

- **date night**
  - travel for 2 people
  - privacy preferred
  - may prefer upscale options

- **errands**
  - need room for purchased items
  - family travel often

- **auto OEMs**
  - need room for storage
  - multiday trips possible
  - small and big groups

- **ride sharing**
  - travel for large groups
  - traffic is problematic
  - parking is problematic

- **tech giants**
  - need room for purchased items
  - parking is problematic

- **disruptors**
  - carrying luggage
  - parking is problematic

- **weekend adventure**

- **organized events**

- **shopping**

- **non-commuting work travel**
CONCLUSIONS

It’s important to know where you stand today...

Objective Input

- Feature and function level specific testing
  - Pass/Fail compared to specifications and requirements
  - Performance (timing)
- Detailed Test Cases and Test Plans
  - To ensure full capability testing for feature or functions under test, with overview sheet for quick snapshot of results
- Self-Evaluation and Cross-Comparison
  - Vehicles in similar market/class, and possibly above
  - Comparison to class above provides added-value
- Reports with visual data point comparisons, rankings, and recommendations

Subjective Input

- Technical and Non-Technical perspective testing
  - Accessibility, Usability, Design
- Recommendations from these subjective viewpoints and testing
- Diverse pool of engineers to better gain a broader look at the product under test
- User-Impression Testing
  - Raw approach of subjective viewpoints
  - Little guidance gains maximum exposure
- What trend’s are important to the consumer base
- Develop an action plan based on recommendations and findings
CONCLUSIONS

...to know where to develop for tomorrow!

Objective Input
- Performance
  - All features under review
  - Speed, recognition, stability
- Future Technological Trends
  - Trends towards 2050
  - Off-board vs. On-board
  - Infotainment vs. Mirroring
- Cost and Risk Assessments
  - Future proofing for a little extra?
  - Added-value to consumer as a differentiator
- Easy updates
  - Modular
  - OTA

Subjective Input
- User Experience
  - What do customers WANT vs. NEED!
  - Is this a new feature for the sake of needing a new feature?
  - Is our technology approachable?
- Autonomous Vehicles
  - Scary, Not Safe, Responsibility, Security...all UX factors
  - Other industry trends...mobile, computer, health
  - Driver to Passenger experience
- Open Box Questions
  - Don’t ask “what do you think about this SPECIFIC THING”
  - Ask “what do you think about this AREA”
CONCLUSIONS

Benchmark Early and Often...on both Objective and Subjective

Always Up-to-Date Information

• Knowing where you are in relation to the industry on a consistent basis helps development of future products
• More consistent benchmarking (both objective and subjective) approach leads to immediate findings of gaps, which ultimately ends in timely solutions

Hands-on Approach

• Feel first hand consumer reviews, input and problems
• Tactile feeling to the output of data from the other vehicles

Future Proofing

• Benchmarking your technology, not only against other vehicles, but the tech in the market NOW and COMING creates a strong strategy and development plan

Future Development

• Using all of these key factors makes development, testing and launching of new products swifter and more stable
P3NA TECHNIK DAYS OVERVIEW

Summary of Event

P3’s Stance to Our Clients
• To give P3NA’s stance on latest automotive technologies in the market, and approach to future trends in the industry

Up Close and Personal
• Personalized and hands-on user experience with vehicles under test

In-Depth Report
• Detailed report-out of findings for clients of subjective and objective data for each vehicle, as well as cross comparison of vehicles

P3 Capabilities
• Develop, test, validate and report on ADAS/Autonomy, Infotainment Technologies, and Telematics/Connected Vehicle

Recommendations to Clients
• Recommendations for each vehicle to cover the “how do we close the gap” questions

P3 Technik Awards
• “Awards” for certain categories to highlight differences
Take a Tour!

Tour Includes:

- Fully connected and operational technology services
- Sample semi-guided use cases P3 uses during benchmarking
- Sample report at the completion of benchmarking
- P3 Subject Matter Experts to communicate thoughts and experiences
PLAN FOR ACTION

1. Define your strategy: technology, partnerships, differentiation.

2. Understand your customer’s expectations, needs, and consumer trends.

3. Invest intelligently in innovative product and service concepts.

4. Reduce risks by prototyping and completing multiple rounds of user testing and benchmarking.
Erik Alvarado
Manager, User Experience
Testing and Validation
P3 North America

+1 248 925 9248
erik.alvarado@p3-group.com

www.p3-group.com
**ADAPT** – Autonomous Data & Analytics Platform for Testing

- Sensor and algorithm evaluation test platform used to benchmark sensors
- P3 also provides vehicle retrofit and custom fleet building services

Experience our methodology for structure innovation with our xP3rience Lab workshops.