Globalization of the Auto Industry
The Race for Competitive Advantage via Global Scale

UMTRI Automotive Futures: Globalization of the Auto Industry
Ann Arbor, MI | 13 April 2016

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World light vehicle sales forecast
Market will reach 100 million by end of the decade; growth peak is approaching

Source: IHS Automotive sales forecasts

Average growth 3.2%
Growth rate peak

Source: IHS Automotive sales forecasts
World: Crude Oil Price Forecast

Gradual increase expected as weak global economy improves

Brent Blend Crude Oil Price ($/barrel)

Price near bottom now, but expected to rise as global economy improves, with some disruption as suppliers return to market.

Source: IHS Economics
Mature Markets’ Segment Sales
Buyers love utilities; SUVs/CUVs are strong—outperforming country average

Source: IHS Automotive, LV global segmentation, indexed to 2012 level
Global Production Growth

Output Growth By Region 2023

- G China: 6.4% Car (6.4M), 2.4% Truck (2.4M), 8.8%
- S Asia: 2.9% Car (2.9M), 2.5% Truck (2.5M), 5.4%
- Europe: 2.0% Car (2.0M), 0.6% Truck (0.6M), 2.6%
- N America: 4% Car (4M), 0.9% Truck (0.9M), 1.3%
- S America: 8% Car (8M), 0.4% Truck (0.4M), 1.2%
- MEA: 5% Car (5M), 0.6% Truck (0.6M), 1.1%
- Japan/Kor: -0.2% Car (-0.2M), -0.7% Truck (-0.7M), -0.9%

Asia w/o J/K: +14.2M, 73% CTG
ROW: +5.3M, 27% CTG

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Global Production Growth

Output Growth By Global Segment 2023

<table>
<thead>
<tr>
<th>Segment</th>
<th>Car</th>
<th>Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>B</td>
<td>2.9</td>
<td>3.3</td>
</tr>
<tr>
<td>C</td>
<td>2.3</td>
<td>4.0</td>
</tr>
<tr>
<td>D</td>
<td>2.0</td>
<td>2.4</td>
</tr>
<tr>
<td>E</td>
<td>1.0</td>
<td>0.3</td>
</tr>
<tr>
<td>C-FF</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>F-FF</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

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Tightening Regulations: Emissions, Fuel Economy Standards
What are Automakers to do?

- Global vehicle CO$_2$ targets are now starting to converge, allowing for more global synergy and analysis
- What’s at stake?

<table>
<thead>
<tr>
<th>Penalties for non-compliance</th>
<th>$400* billion</th>
<th>Brand image as a leader in technological advancements and environmental sustainability</th>
<th>Vehicle profitability Market share</th>
</tr>
</thead>
</table>


Penalties for non-compliance:

- Estimated incremental spend globally to 2020.
- $5–8 billion estimated average annual per original equipment manufacturer (OEM).
Global Super Sets

- One to Many Relationship
- Economies of Scale and Scope
- Flexibility: Vehicle, Sourcing
- Development Efficiency
- Bigger, But Fewer Opportunities
- Double Edged Sword:
  - Reduced Costs, Increased Scale
  - Easier to Shift Sourcing
  - Increased Exposure to Defects
  - Continuous Development
  - Requires time to deploy
## Top 10 - Global Sourcing Shares – 2022

<table>
<thead>
<tr>
<th>OEM</th>
<th>Units (Millions)</th>
<th>South Asia</th>
<th>South America</th>
<th>North America</th>
<th>M. East Africa</th>
<th>Japan/Korea</th>
<th>Greater China</th>
<th>Europe</th>
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</thead>
<tbody>
<tr>
<td>VW</td>
<td>11.8</td>
<td>4%</td>
<td>6%</td>
<td>8%</td>
<td>1%</td>
<td>0%</td>
<td>35%</td>
<td>46%</td>
</tr>
<tr>
<td>GM (w/Wuling)</td>
<td>11.1</td>
<td>4%</td>
<td>6%</td>
<td>32%</td>
<td>1%</td>
<td>3%</td>
<td>42%</td>
<td>13%</td>
</tr>
<tr>
<td>Toyota</td>
<td>11.0</td>
<td>22%</td>
<td>3%</td>
<td>20%</td>
<td>2%</td>
<td>33%</td>
<td>14%</td>
<td>7%</td>
</tr>
<tr>
<td>Ren/Nissan</td>
<td>10.8</td>
<td>10%</td>
<td>5%</td>
<td>17%</td>
<td>6%</td>
<td>11%</td>
<td>16%</td>
<td>36%</td>
</tr>
<tr>
<td>Hyundai/Kia</td>
<td>9.1</td>
<td>10%</td>
<td>3%</td>
<td>13%</td>
<td>0%</td>
<td>38%</td>
<td>22%</td>
<td>14%</td>
</tr>
<tr>
<td>GM</td>
<td>8.5</td>
<td>5%</td>
<td>7%</td>
<td>40%</td>
<td>1%</td>
<td>4%</td>
<td>27%</td>
<td>16%</td>
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<tr>
<td>Ford</td>
<td>7.1</td>
<td>9%</td>
<td>7%</td>
<td>44%</td>
<td>1%</td>
<td>0%</td>
<td>17%</td>
<td>22%</td>
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<tr>
<td>Honda</td>
<td>5.6</td>
<td>20%</td>
<td>4%</td>
<td>36%</td>
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<td>15%</td>
<td>23%</td>
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<tr>
<td>FCA</td>
<td>5.4</td>
<td>2%</td>
<td>14%</td>
<td>45%</td>
<td>0%</td>
<td>0%</td>
<td>8%</td>
<td>31%</td>
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<tr>
<td>PSA</td>
<td>3.9</td>
<td>0%</td>
<td>4%</td>
<td>0%</td>
<td>6%</td>
<td>0%</td>
<td>29%</td>
<td>60%</td>
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<tr>
<td>Suzuki</td>
<td>3.6</td>
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<td>0%</td>
<td>22%</td>
<td>8%</td>
<td>4%</td>
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<tr>
<td>Unit Vol</td>
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<td>18.9</td>
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<td>31.9</td>
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<td>Global Avg</td>
<td>12%</td>
<td>4%</td>
<td>18%</td>
<td>3%</td>
<td>12%</td>
<td>30%</td>
<td>22%</td>
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</tbody>
</table>
Top 10 OEMs – Bodytype Shares – 2023

<table>
<thead>
<tr>
<th>OEM</th>
<th>Units (Millions)</th>
<th>Car</th>
<th>SUV</th>
<th>Pickup</th>
<th>Van</th>
<th>MPV</th>
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</thead>
<tbody>
<tr>
<td>VW</td>
<td>11.8</td>
<td>68%</td>
<td>23%</td>
<td>1%</td>
<td>4%</td>
<td>4%</td>
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<tr>
<td>GM (w/Wuling)</td>
<td>11.1</td>
<td>42%</td>
<td>23%</td>
<td>11%</td>
<td>17%</td>
<td>6%</td>
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<tr>
<td>Toyota</td>
<td>11.0</td>
<td>48%</td>
<td>23%</td>
<td>12%</td>
<td>3%</td>
<td>14%</td>
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<tr>
<td>Ren/Nissan</td>
<td>10.8</td>
<td>52%</td>
<td>30%</td>
<td>4%</td>
<td>6%</td>
<td>7%</td>
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<tr>
<td>Hyundai/Kia</td>
<td>9.1</td>
<td>64%</td>
<td>28%</td>
<td>4%</td>
<td>0%</td>
<td>4%</td>
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<tr>
<td>GM</td>
<td>8.5</td>
<td>55%</td>
<td>28%</td>
<td>12%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Ford</td>
<td>7.1</td>
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<td>29%</td>
<td>18%</td>
<td>10%</td>
<td>1%</td>
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<tr>
<td>Honda</td>
<td>5.6</td>
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<td>0%</td>
<td>13%</td>
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<tr>
<td>FCA</td>
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<td>33%</td>
<td>39%</td>
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<td>9%</td>
<td>5%</td>
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<td>PSA</td>
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<td>57%</td>
<td>26%</td>
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<td>14%</td>
<td>3%</td>
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<tr>
<td>Suzuki</td>
<td>3.6</td>
<td>47%</td>
<td>18%</td>
<td>9%</td>
<td>6%</td>
<td>20%</td>
</tr>
<tr>
<td>Unit Vol</td>
<td>51.3</td>
<td>31.6</td>
<td>10.3</td>
<td>7.7</td>
<td>7.1</td>
<td></td>
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<tr>
<td>Unit Chg</td>
<td>7.3</td>
<td>8.6</td>
<td>1.9</td>
<td>1.1</td>
<td>.6</td>
<td></td>
</tr>
<tr>
<td>Global Avg</td>
<td></td>
<td>44%</td>
<td>29%</td>
<td>10%</td>
<td>7%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Unit Vol = 51.3

Unit Chg = 7.3

Contribution to Growth 2023

- Car 37%
- SUV 44%
- MPV 3%
- Van 6%
- Pickup 10%
Global Capacity
Utilization Rate Contrast – By Region and OEM

% straight-time utilization

- North America
- Europe
- Japan/Korea
- Global
- Greater China
- South Asia
- South America
- Middle East/Africa

2013 2015 2017 2019 2021 2023

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Global Program Launches by Region
Increased Launch Activity Raises Risk

Increased industry pace places pressure on talent, resources and infrastructure.
Supplier Dynamics
Mega Platforms Enable Distributed Production Growth

Cross Segment Application
Speeds Consolidation

Production (Millions of Units)

% Share of Global Output


18% 18% 27% 39% 40% 41% 47% 51% 55%

1M+ Platform < 1M Platform Share
## Global Architectures
### The Quest for Platform Efficiency

**NGA**

**New Global Architecture**

- NGA to support new front-wheel-drive platforms for B, C and D-segment programs. Major powertrain, braking and steering components will be shared across platforms. Flexibility will be enhanced in areas of exterior and interior styling to deliver broader range of vehicles.
- Scale and purpose differentiate; informed by success of IMV.

**CMF**

**Common Module Family**

- A platform is a horizontal segmentation; a CMF is a cross-sector concept – Renault-Nissan describing the introduction of new architecture approach.
- A Common Module Family is an engineering architecture that covers vehicles form one or more segments, based on the assembly of compatible Big Modules: engine bay, cockpit, front underbody, rear underbody and electrical/electronic architecture.
- CMF will generate an average 30-40% reduction in entry cost per model and 20-30% reduction in parts cost for the Alliance.

**EMP**

**Efficient Modular Platform**

- Advanced modularity allows for completely new combinations: Four different track widths; Five wheelbases; Two cockpit and cowl solutions; Two rear suspension architectures.
- Increased manufacturing flexibility, allowing for up to six rear unit versions on a single line.
- PSA describing EMP2; Efficient Modular Platform.

**MQB**

**Modularer Querbaukasten**

- Standardized fixed technical measures: such as the distance from throttle to the middle of the front wheel, and the fixed transverse engine position.
- Variable parameters, such as the wheelbase, track width, vehicle length and wheel sizes.
- 88% reduction of engine and transmission variations with MQB, this includes all alternative engines, such as CNG, Hybrid or Electric engines.
- Lower weight.
Supplier Dynamics
Top 10 Global Platforms – 2022

- Nine of the Top-10 global platforms in N. America
- Developing markets push drives growth
- Consolidation in B-through D-segments drives gains
- Race for scale favors larger, diversified OEMs

Segment (Top Nameplate)

- C (Elantra)
- C/D (Civic/Accord)
- C/D (Focus/Fusion)
- B (Polo)
- C (Sentra)
- B/C (Sonic/Cruze)
- C/D (Sonata)
- C (Corolla)
- B (Versa)
- C (Golf)

North America Exposure

- Nine of the Top-10 global platforms in N. America
- Developing markets push drives growth
- Consolidation in B-through D-segments drives gains
- Race for scale favors larger, diversified OEMs
Toyota Global Profile

Global Output By Region

<table>
<thead>
<tr>
<th>Region</th>
<th>2015</th>
<th>2023</th>
<th>2015-2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>S Asia</td>
<td>1.8</td>
<td>2.5</td>
<td>+0.7</td>
</tr>
<tr>
<td>S America</td>
<td>0.3</td>
<td>0.3</td>
<td>+0.0</td>
</tr>
<tr>
<td>N America</td>
<td>2.0</td>
<td>2.2</td>
<td>+0.2</td>
</tr>
<tr>
<td>Middle East / Africa</td>
<td>0.1</td>
<td>0.2</td>
<td>+0.1</td>
</tr>
<tr>
<td>Japan/Korea</td>
<td>3.9</td>
<td>3.5</td>
<td>-0.4</td>
</tr>
<tr>
<td>China</td>
<td>1.2</td>
<td>1.6</td>
<td>+0.4</td>
</tr>
<tr>
<td>Europe</td>
<td>0.7</td>
<td>0.8</td>
<td>+0.1</td>
</tr>
</tbody>
</table>

Global Output By Segment & Region

- MEA
- EUR
- S AMER
- N AMER
- S ASIA
- CHINA
- J/K

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Global Architectures
Focus to Reduce Platform Counts and Increase Scale

Average volume by platform and platform efficiency

- Hyundai: 0.8 (2014), 0.6 (2022), 4 platforms
- Volkswagen: 0.8 (2014), 0.5 (2022), 3 platforms
- Honda: 0.7 (2014), 0.4 (2022), 2 platforms
- BMW: 0.7 (2014), 0.7 (2022), 2 platforms
- Ford: 0.6 (2014), 0.4 (2022), 4 platforms
- Suzuki: 0.4 (2014), 0.3 (2022), 3 platforms
- Toyota: 0.5 (2014), 0.5 (2022), 3 platforms
- R/N: 0.6 (2014), 0.6 (2022), 8 platforms
- PSA: 0.5 (2014), 0.5 (2022), 5 platforms
- GM: 0.5 (2014), 0.5 (2022), 6 platforms
- FCA: 0.3 (2014), 0.3 (2022), 3 platforms
- Mitsubishi: 0.2 (2014), 0.1 (2022), 2 platforms
- Daimler: 0.2 (2014), 0.1 (2022), 2 platforms
- Mazda: 0.3 (2014), 0.3 (2022), 2 platforms

- Average volume per platform in 2014
- Average volume per platform in 2022
- Number of platforms to support 80% of volume in 2022
Global Platform Dichotomy

Increasing centralization of architecture development

Regional opportunities:

- Development
- Sourcing
- Purchasing
Risk Hedge

- Varied Risk Hedges
  - Exports
  - Localization
  - Throughput
- Life Stage
- Growth vs Saturation
- Content Requirements
Innovation Creates Technical Hurdles
Advances In Lightweighting

- Varied Strategies
- Aluminum
- Mixed Materials
- CFRP
- Compound effect of mass reduction
- Parts reduction
- Complexity
- Costs
- Tooling
Autonomous Driving: When, Not If

- Effect of consumer electronics
- Autonomous car considerations
- Impact on cycle, cadence and planning considerations:
Autonomy: cities expected to aggressively curb congestion

U.S. = 83% urban now → 87% by 2025: Europe 77% → 82%

• City leaders and their teams (urban and transportation planners) are all focused on congestion control

• The economic vitality of a city depends first and foremost on assuredly fluid mobility
Autonomous Driving: When, Not If

Self-Driving Car Evolution

L5: Self-driving Only

L4: Full Self-driving

L3: Limited Self-driving

L2: Partial Autonomy

L1

2010 2015 2020 2025 2030

Self-Driving & Human-Driven Car

Self-Driving Car Only

Adaptive Cruise Control

ACC & LKA

Auto Pilot: Traffic Jam

Auto Pilot: Highway

Auto Pilot: Parking

Auto Pilot: Road Train

Autonomous Braking: Many Systems

Park Assist

2010 2015 2020 2025 2030

Autonomy Functionality
Summary

• Global Integration
• Varied Growth Trajectories
• Regulatory Compliance Gap
• Innovation Complexity: Light-Weighting & Luxury
• Road to Autonomous
• Increasing Opportunity & Demands
Thank You!

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