GLOBAL INNOVATION IN THE AUTOMOTIVE INDUSTRY

“REFLECTIONS ON MY EXPERIENCE AT GM”

ALAN TAUB

Professor, University of Michigan
Vice President, GM Global R & D, retired

April 13, 2016 Ann Arbor
THE NEW GENERAL MOTORS

“DESIGN, BUILD AND SELL THE WORLD’S BEST VEHICLES”

QUALITY

TECHNOLOGY

BRANDS
GM AFTER RESTRUCTURING (2009)

GLOBAL PRODUCT OPERATIONS – Vice Chairman

- Design
- Vehicle Engineering
- Powertrain Engineering
- Quality
- Purchasing & Supply Chain
- Research & Development
- Strategic Product Alliances
- Intellectual Property Rights

Program Management
ONE ORGANIZATION DRIVING FROM INVENTION TO IMPLEMENTATION

EXPLORATORY
- Exploratory Pre-Gate 0

ADV TECH INNOVATION PROGRAMS
- (Advanced Development)
- 6 - 36 Months Pre-DC/DSI

ADV ENG
- Define Concepts
- Concept(s) Approval
- Refine
- Concept Refinement Complete
- Validate Concept(s)
- Concept Validation Complete

PROD ENG
- Production Implementation
- Validation DC/DSI/VPI
Central R&D organization for General Motors
Organized in 1920 under Charles ("Boss") Kettering
World's first automotive research organization
Activities centralized in Michigan for >85 years
Premise:
- Innovation is enabled by diversity (background, education, local environment…)

Analysis (2001):
- U.S.-centric mindset with Detroit-centric workforce
- >50% researchers born outside U.S. but 98% recruited from U.S. graduate schools

Change Model:
- Globalize GM footprint
- Rebalance resources from <5% external collaboration to >25%
- Globalize collaboration network
GLOBAL R&D FOOTPRINT

Complementary Centers of Expertise (COEs) vs. Satellite Laboratories Dependent on HQ Laboratory
Equal ownership: Boeing and GM

Project portfolio:
- Shared research ~20%
- Directed research ~40%
- Government contracts ~40%

Integrated HRL with GM R&D without losing the beneficial synergies of a co-owned West Coast entity
Premise:
- Innovation is enabled by diversity (background, education, local environment…)

Analysis (2001):
- U.S.-centric mindset with Detroit-centric workforce
- >50% researchers born outside U.S. but 98% recruited from U.S. graduate schools

Change Model:
- Globalize GM footprint
- Rebalance resources from <5% external collaboration to >25%
- Globalize collaboration network
ROLE OF SCIENCE OFFICES

- Facilitate interactions among GM researchers and technical resources in a particular country
  - Universities
  - National labs
  - Technical centers
  - Suppliers

- Drive aggressive global university and national laboratory portfolio with government leveraging

- Master agreements with universities around the world using common IP terms and conditions to make it easy for researchers to manage the relationship
COLLABORATIVE RESEARCH LABORATORIES

- **Strategic partnership** in a key technology area for GM
- Incorporates a **group of professors** in a large program vs. individual projects
- GM fully funds → **automotive exclusive engagement**
  - 5-year commitment with renewal expected
- Collaborative Research Lab is **co-directed**
  - Tasks and goals are defined together
- Encourages people exchange, sabbaticals, student interns, visits
<table>
<thead>
<tr>
<th>University</th>
<th>Technology Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Michigan</td>
<td>Engine Systems Research</td>
</tr>
<tr>
<td></td>
<td>Advanced Vehicle Manufacturing</td>
</tr>
<tr>
<td></td>
<td>Smart Materials &amp; Structures</td>
</tr>
<tr>
<td>Carnegie Mellon</td>
<td>Information Technology</td>
</tr>
<tr>
<td></td>
<td>Autonomous Driving</td>
</tr>
<tr>
<td>Indian Institute of Science</td>
<td>Lightweight Materials</td>
</tr>
<tr>
<td>Brown University</td>
<td>Materials Modeling</td>
</tr>
<tr>
<td>RWTH-Aachen</td>
<td>Advanced Engines</td>
</tr>
<tr>
<td>University of Wisconsin-Madison</td>
<td>Engine Combustion</td>
</tr>
<tr>
<td>M.I.T.</td>
<td>Materials &amp; Manufacturing</td>
</tr>
<tr>
<td></td>
<td>Systems Analysis</td>
</tr>
<tr>
<td>Indian Institute of Technology-Kharagpur</td>
<td>Electronics, Controls and Software</td>
</tr>
<tr>
<td>Shanghai Jiaotong University</td>
<td>Advanced Manufacturing</td>
</tr>
</tbody>
</table>
SILICON VALLEY – AUTOMOTIVE RELATED (2006)

- BMW labs
- Bosch labs
- Honda labs
- Daimler labs
- Toyota labs
- VW labs
- Intel labs
- Pirelli labs
- Siemens labs
- ST Micro labs
- Toyota labs
- Yahoo! labs
- Early observation of new trends, features and concepts
- Select promising new technologies that enable these features
- Conduct a 3-6 month collaborative assessment of the technology/feature/concept with local technology suppliers/high-tech companies
  - Address technical, business, automotive, and integration feasibility
Automotive Cleantech – Technologies related to the greening and electrification of the vehicle, e.g., electric vehicle and fuel cell technology, charging infrastructure, emission controls, motors, smart grid, vehicle energy efficiency technology, biofuels

Infotainment – e.g. vehicle HMI, voice recognition technologies, in-vehicle advertising, cloud services, integration of personal devices

Smart Materials – Technologies that can provide efficiency, performance, cost, mass, and/or environmental benefits to the vehicle, e.g., lightweight materials, eco-friendly materials, materials with phase changing characteristics

Other Game-Changing Technologies – Innovations that address unmet consumer needs or solve technological challenges for GM, e.g., advanced sensors to enable autonomous driving, safety features

Value Chain/Business Model – Alternatives to the traditional automotive business model and opportunities to leverage our technology and assets to capture upstream or downstream revenue opportunities, e.g., car-sharing, secondary battery use
“CONNECTED VEHICLES”

SAFETY AND SECURITY

OnStar®
Electric-Networked Vehicle (EN-V)

ROBONAUT-2
Robotic Manufacturing
WHAT DOES THIS MEAN GOING FORWARD?

• Rate of technology development and implementation is accelerating

• Increasing value-add from Electronics, Controls & Software
  • Greater role of non-traditional automotive companies
  • Personal mobility innovation is growing globally

• Companies need to be integrated into the “innovation ecosystem”
  • “Passive Observation” is not sufficient
  • “Active Collaboration” is required
    • Startups and VC’s
    • Universities and national laboratories
    • Global presence to enable “locally-relevant” solutions