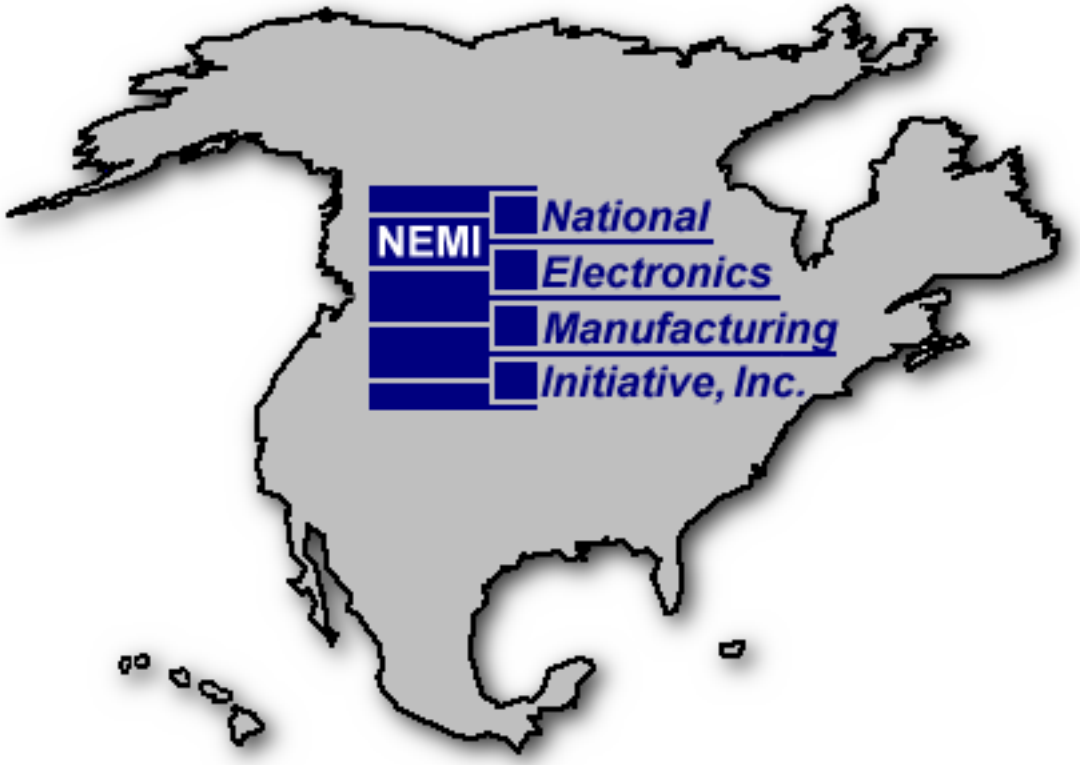


2004 NEMI Roadmap – Work In Progress

Identifying Technology / Business Drivers for the Automotive Industry

Chuck Richardson

SMTA/CAVE 2004

Dearborn, MI

NEMI Mission Statement

NEMI is a North American based consortium whose mission is dedicated to providing leadership for the global electronics manufacturing supply chain for the benefit of its member companies and the industry.

What Does NEMI Do?

Leverage the combined Power of Member Companies to Provide Industry Leadership

- NEMI Conducts Industry Forums on Emerging Topics
- NEMI Roadmaps the Needs of the North American Electronics Industry
- NEMI Identifies Gaps (both business & technical) in the North American Infrastructure
- NEMI Stimulates R&D Projects to fill these Gaps
- NEMI Establishes Implementation Projects to Eliminate these Gaps
- NEMI Stimulates Standards to speed the Introduction of New Technology & Business Practices

Industry Leaders belong to NEMI – OEM/EMS

ALCATEL

CISCO SYSTEMS

DELPHI

DELL™

intel.

CELESTICA

hp invent

IBM

FOXCONN®

Jabil CIRCUIT

Lucent Technologies
Bell Labs Innovations

MOTOROLA

Microsoft®

PLEXUS

NORTEL NETWORKS
BUSINESS WITHOUT BOUNDARIES

STORAGETEK

SANMINA-SCI

SOLECTRON

Sun microsystems

Connect with and Strengthen Your Supply Chain

Industry Leaders belong to NEMI – Suppliers

3M

Agilent Technologies

agile

AMD

BTU

Asymtek
A NORDSON COMPANY

Cookson Electronics
A Division of Cookson Group plc

Centor

DOVER

E2OPEN

AURORA

Endicott Interconnect
Technologies, Inc.

FCI

Heraeus

Kulicke & Soffa

LACE Technologies

MatrixOne

KESTER

merix

Senju Comtek

ROHM
HAAS
ELECTRONIC MATERIALS

SUMITOMO ELECTRIC
LIGHTWAVE

UniversaL

TERADYNE

Speedline
technologies

Texas Instruments

tyco
Electronics

Vitronics Soltec
A DOVER COMPANY

VYTRAN
CORPORATION

Connect with and Strengthen Your Supply Chain

Industry Leaders – Consultants, Government, Organizations, and Universities

AeA

AMR Research

EIA Electronic Industries Alliance

IPC Association Connecting Electronics Industries

CMAP Centre for Microelectronics Assembly and Packaging

IEEC

METAGROUP

Georgia Institute of Technology

MIT

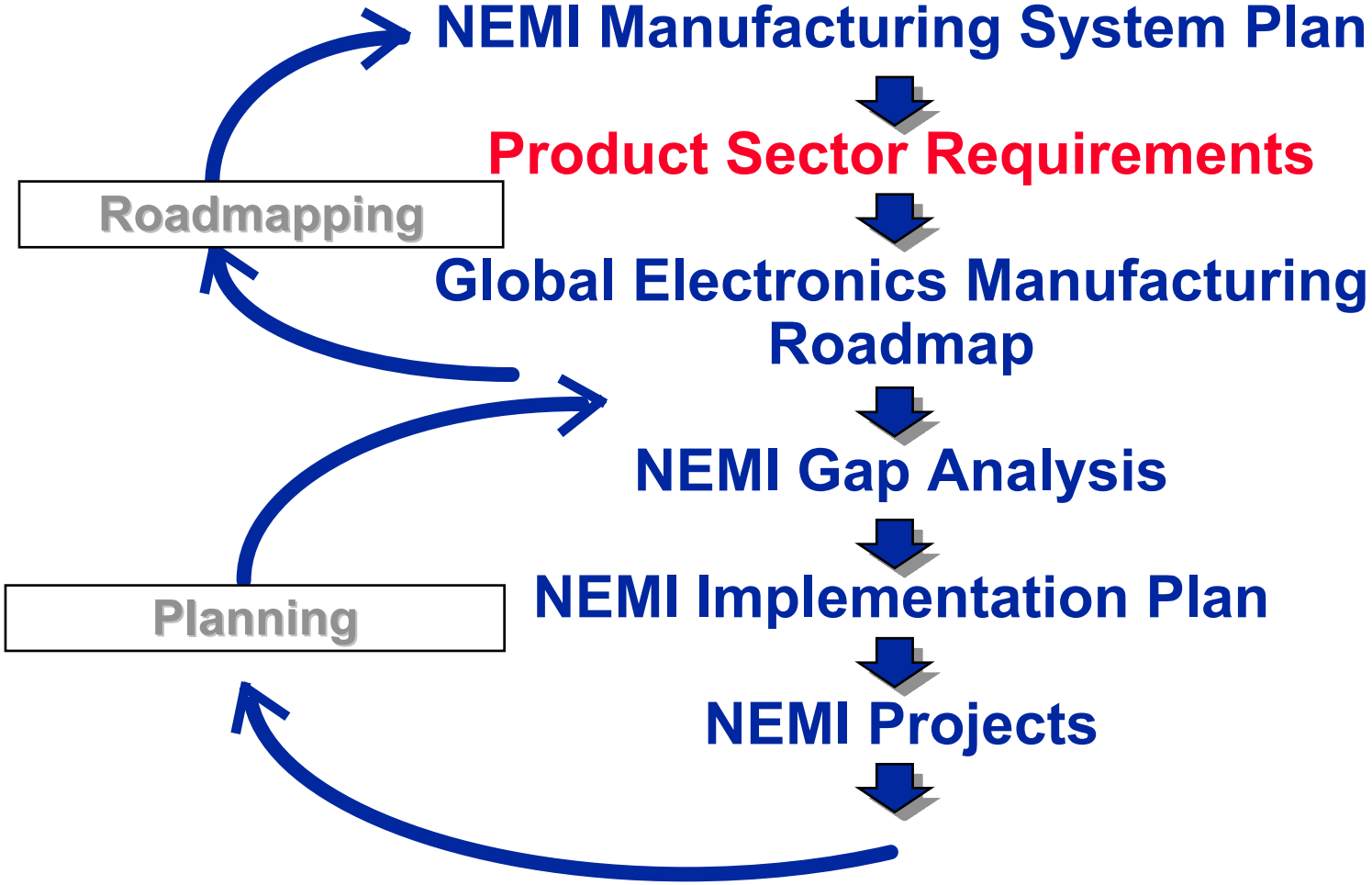
NCMS

Virginia's Center for Innovative Technology

NIST

Développement économique et régional Québec

NEMI Planning Methodology



Connect with and Strengthen Your Supply Chain

NEMI Roadmap Emulator Chapters

- **2004 Roadmap cycle will include 7 Product Emulator Chapters**
- **A product emulator is defined as an abstract representation of a product to allow companies to share needs without sharing proprietary product information**
- **Each chapter sets OEM requirements over the next 10 years**
- **Requirements are presented as key product attributes in spreadsheet format and supporting text discussing business and state of the art issues**

2004 Product Emulator Descriptions

Emulators	Characteristics
Portable / Consumer	High volume Consumer Products for which cost is the primary driver including Hand held, battery-powered products driven by size and weight reduction
System in a Package	Complete function provided in a package to system manufacturer
Office Systems / Large Business Systems	Products which seek maximum performance from a few thousand dollar cost limit to literally no cost limit
Network / Datacom / Telecom Products	Products that serve the networking, datacom and telecom markets and cover a wide range of cost and performance targets
Specialty Emulators	**Defined by Operating Environment**
Medical Products	Products which must operate within a high reliability environment
Automotive	**Products which must operate in an automotive environment**
Defense and Aerospace	Products which must operate in extreme environments

2004 Product Emulator Groups

Product Emulator	Chair
Automotive Products	Jim Spall, Delphi
Aerospace/Defense Products	William E. Murphy, Lockheed Martin
Medical Products	Terry Dishongh, Intel
Consumer / Portable Products	Gerry Bird, 3M
System-In-Package	Joe Adam, Skyworks
Office/Large Business System Products	Tom Pearson, Intel George Katopis, IBM Erich Klink, IBM
Network, Data, Telecom	Mike Schabel, Lucent

NEMI 2004 Roadmaps
19 Individual Roadmap Chapters

- Semiconductor Technology
- Packaging
- Mass data storage
- Board Assembly
- Final Assembly
- Environmentally Conscious Electronics
- Interconnect Substrates Organic
- Interconnect Substrates Ceramic
- Connectors
- Sensors (new for 2004)
- RF Components & Subsystems
- Optoelectronics
- Passive Components
- Energy Storage Systems
- Display
- Modeling, Simulation & Design Tools
- Thermal Management
- Test, Inspection & Measurement
- Product Lifecycle Information Management

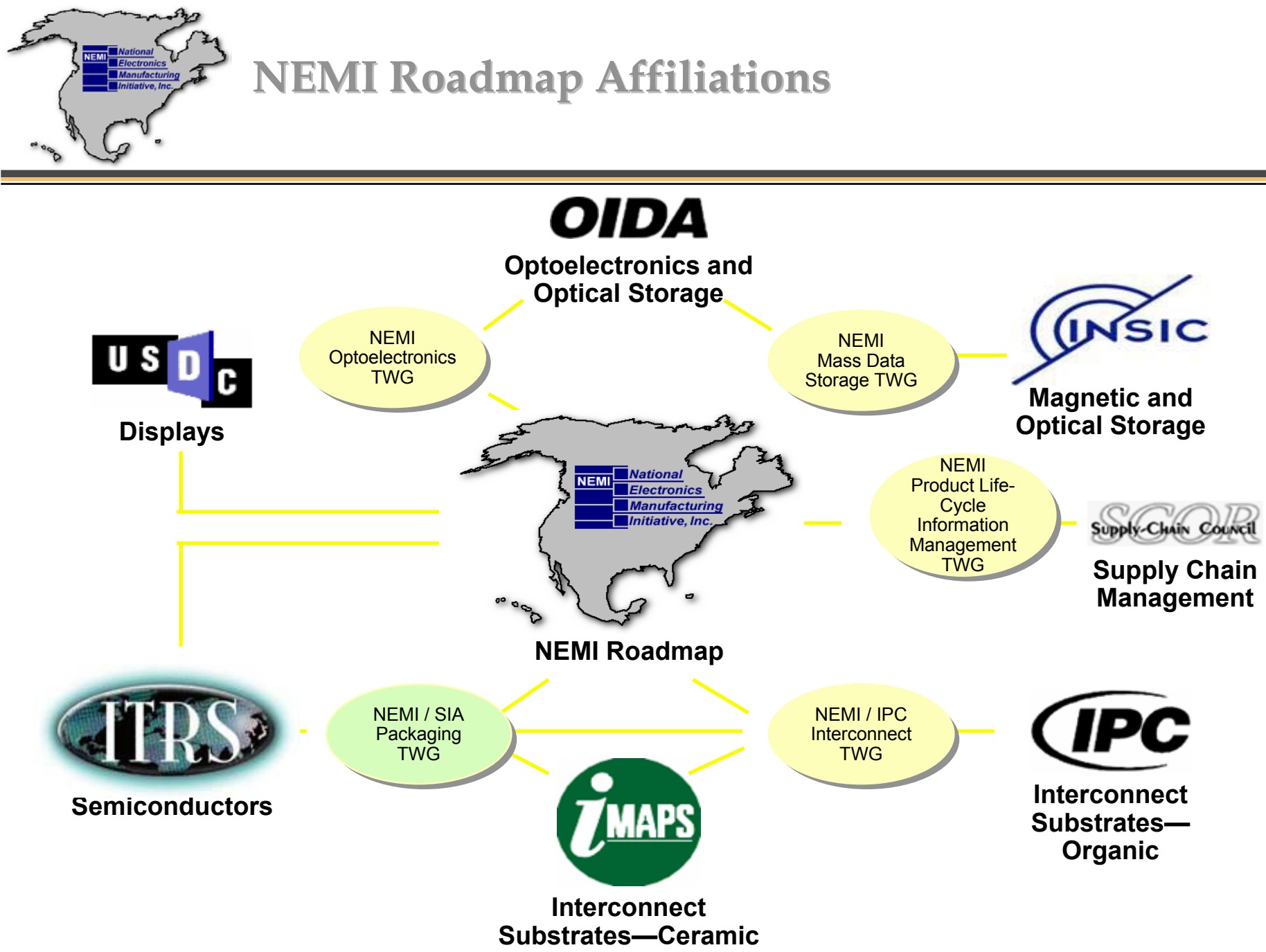
2004 TWG Leadership

Business Processes / Technologies	Chair(s)	Co-Chair(s)
Product Lifecycle Information Management	Eric Simmon, NIST	Peter Peloquin, Intel
Design Technologies		
Modeling, Simulation & Design Tools	Sanjeev Sathe, EIT	S.B. Park, Binghamton U.
Environmentally Conscious Electronics	Mark Newton, Dell	Joe Johnson, Microsoft
Thermal Management	Tom Roth, Cam Murray, 3M	Alex Vukovic, U. of Ottowa
Manufacturing Technologies		
Final Assembly	Mike Reagin, Delphi	Reijo Tuokko, Tampere U.
Board Assembly	Kirk VanDreel, Plexus	Dennis Krizman, Celestica
Test, Inspection & Measurement	Michael J. Smith, Teradyne	Stig Oresjo, Agilent

2004 TWG Leadership (cont.)

Component / Subsystem Technologies	Chair(s)	Co-Chair(s)
Semiconductor Technology	Paolo Gargini, Intel	Alan K. Allan, Intel
Optoelectronics	John Stafford, Consultant	Laura Turbini, CMAP
Packaging	Joseph Adam, Skyworks Solutions	Bill Bottoms, 3 MT Solutions
Passive Components	Philip Lessner, Kemet	Joseph Dougherty, PSU
Connectors	John MacWilliams, Consultant	
RF Components	Vijay Nair, Intel	J. Stevenson Kenney, GIT Eric W. Strid, Cascade Microtech
Sensors	Mike Pecht, U. Maryland	Gans Ganesan, U. Maryland
Displays	M. Robert Pinnel, USDC	J. Norman Bardsley, USDC
Energy Storage Systems	Dan Doughty, Sandia Labs	Ralph Brodd, Broddarp
Interconnect Substrates (Ceramic)	Howard Imhoff, Metalor	Ton Schless, Midas Vision
Interconnect Substrates (Organic)	John T. Fisher, Consultant	Dieter Bergman, IPC
Mass Data Storage	Tom Coughlin, Coughlin Associates	Roger F. Hoyt, Hitachi

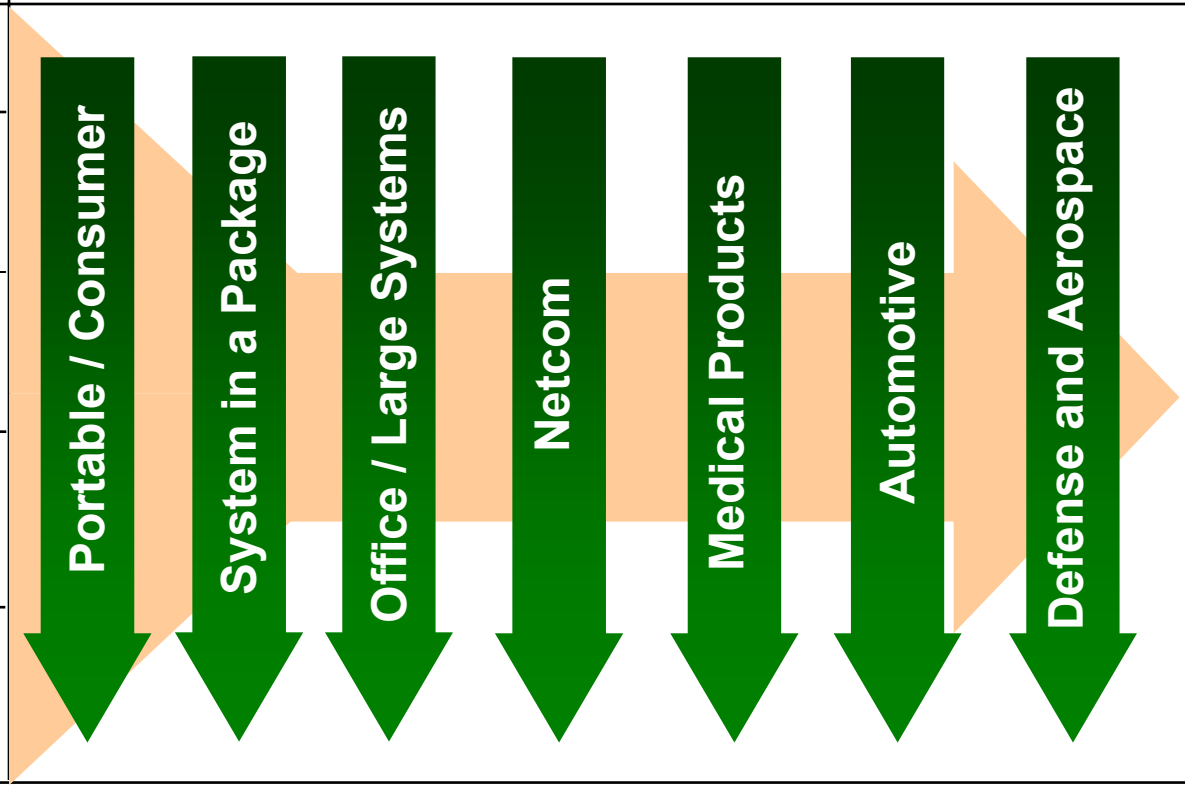
NEMI Roadmap Affiliations



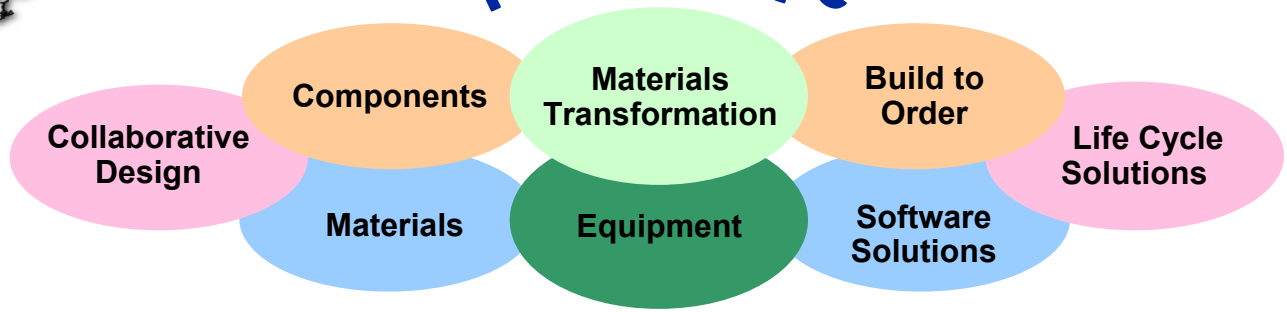
Connect with and Strengthen Your Supply Chain

Product Sector Needs Vs. Technology Evolution

TWGs	Product Emulator Groups
Semiconductor Technology	
Business Processes Prod Lifecycle Information Mgmt.	
Design Technologies Modeling, Thermal, etc.	
Manufacturing Technologies Board Assy, Test, etc.	
Comp./Subsyst. Technologies Packaging, Substrates, Displays, etc.	



NEMI Scope



Substrates TIG Projects:

- High Frequency Materials Effects for HDI
- Integral Passives Testing
- Optical PWB Cost Modeling

Board Assembly TIG Projects:

- DPMO
- Materials & Processes for High-Performance Products
- Substrate Surface Finishes for Lead-Free

Product Life Cycle Information Management TIG Projects:

- PDX Extensions & Updates
- Data Exchange Convergence Project
  - Industry Adoption

Optoelectronics TIG Projects:

- Fiber Optic Splice Improvement
- Fiber Optic Signal Performance
- Fiber Optic Splice Loss Measurement Specification
- Fiber Connector End-Face Inspection Specifications

Environmentally Conscious Electronics TIG Projects:

- Lead-Free Assembly & Rework
- Tin Whisker Accelerated Test
- Tin Whisker Modeling
- Tin Whisker User Group
- RoHS Transition Group

China Efforts:

- Sharing Best Practices
- Lead-Free Transition

Member Collaboration Efforts

2004 Automotive Product Sector Chapter –
Preliminary Table of Contents

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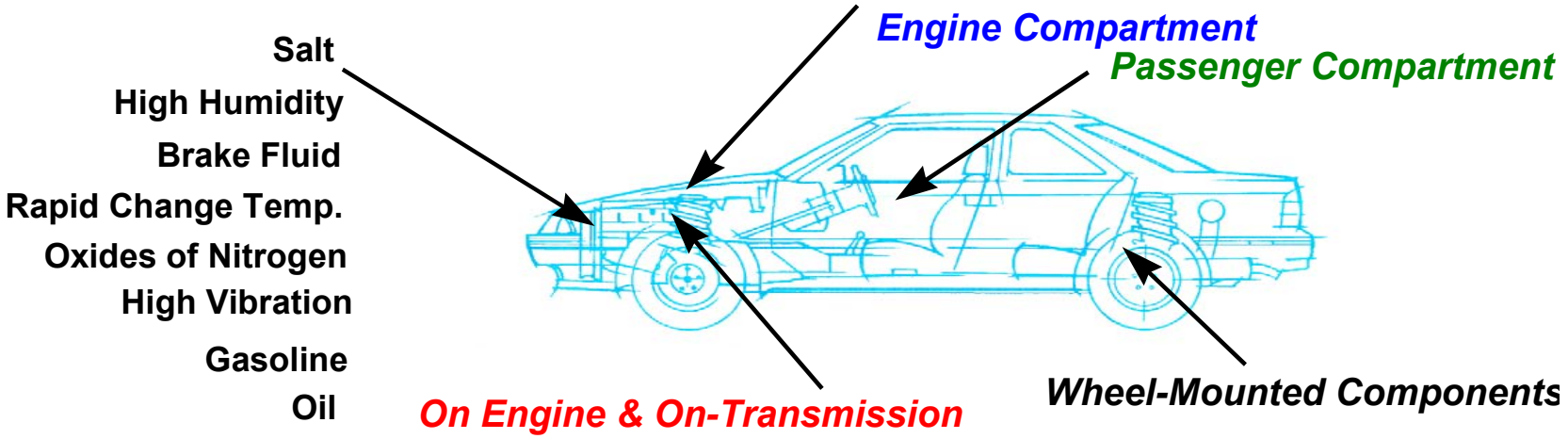
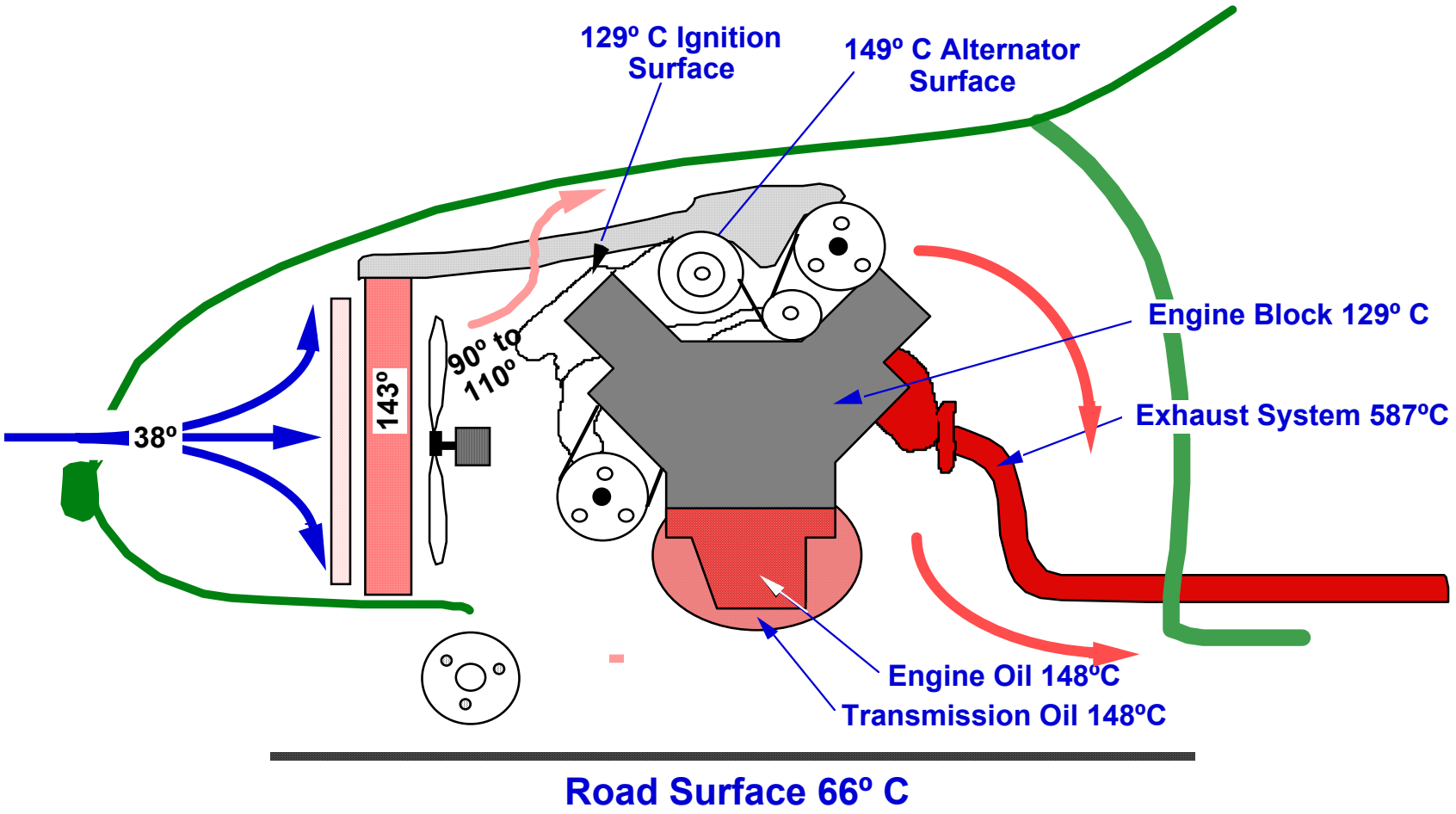
Automotive Harsh Environment Zones



Component Location	Operating Temperature (Baseplate)
Passenger Compartment	-40 °C to 85 °C
Engine Compartment	-40 °C to 125 °C
On-Engine and On-Transmission	-40 °C to 140 °C
Wheel-Mounted Components	-40 °C to 250 °C

Under-Hood Air Flow

Current Air Flow Dynamics



Emulator Spreadsheet Sections

- PWB Costs
- Assembly Costs
- Package Costs
- Business Costs
- Cycle Time
- Reliability
- Devices
- Passive Components
- RF Components
- Display
- Memory
- Components / Package
- PWB / Substrates
- Interconnects
- Electrical
- Power
- Environmental
- Thermal
- Supply Chain Locations
- Sensors
- Modeling, Simulation & Design Tools

Roadmap of Automotive Emulator Quantified Key Attribute Needs (2005 – 2015)
- *Sample of Parameters*

Parameter	Metric	*2005*	*2007*	*2009*	*2015*
PWB Costs (FR4)					
6 layer conventional	$ per cm2	0.016	0.012	0.011	0.009
Package Costs					
IC Package Cost	¢ per I/O	0.5	0.4	0.3	0.3
Connector Cost	¢ per I/O	2	1.5	1	0.7
Cycle Time					
Time to add EMS	Weeks	24	22	20	18
NPI Cycle Time	Weeks	78	72	66	60
Reliability					
Temperature Range	Deg C - Deg C	-40 to 115	-40 to 125	-40 to 125	-40 to 125
Number of Cycles	Cycles to Pass	1000	1000	1200	1300
Use Shock Environment	Gs & ms to Pass	25G, 15ms	25G, 15ms	25G, 15ms	25G, 15ms

Roadmap of Automotive Emulator Quantified Key Attribute Needs (2005 – 2015) - *Sample of Parameters (con't)*

Parameter	Metric	2005	2007	2009	2015
Memory					
Main Memory Type	Type	Flash	Flash	Flash	Flash
Main Memory Size	MB	2	2	4	8
Storage Memory Type	Type	None	None	None	None
Storage Memory Size	MB	N/A	N/A	N/A	N/A
Components/ Package					
Max Component I/O density	I/O/sq.cm	90	120	140	200
Average Component I/O density	I/O/sq.cm	30	40	50	60
Average Component Density	#/sq.cm	80	90	100	120
Maximum I/O per package	I/O per part	400	400	500	600
Average I/O per package	I/O per part	60	60	70	70
Max Components/sq. cm.	#/sq.cm	3	3	3.5	4
Package I/O Pitch, (area array)	mm	1	0.8	0.65	0.4
Package I/O Pitch (perimeter)	mm	0.5	0.5	0.5	0.4
Number of Terminals - Max Digital	#	400	400	500	600
Minimum Terminal Pitch BGA	mm	1	0.8	0.65	0.4

Key Parameter Discussion: PWB Costs (FR4)

- HVAC and Clusters use 2 layer conventional boards
- Engine Control Modules use 4-6 layer conventional boards
- Satellite Digital Audio products use 6 layer boards
- Most products are not using microvias due to cost

Key Parameter Discussion: Package Costs

- **IC Package Costs are based on BGA devices**
- **Connector Costs are based on no sealing and no filtering**

Key Parameter Discussion: Reliability

- Based on under-hood requirements (temperatures and the amount of cycles)
- Passenger requirements would be -40C to 85C
- Shock requirement is based on surviving potholes

Key Parameter Discussion: Devices

- **Stacked die and multiple die in a SIP package are not common yet**

Key Parameter Discussion: Passive Components

- **Embedded passives exist on ceramic and LTCC substrates**
- **Integrated passives must be evaluated on the basis of cost from a system aspect**
  - **Increased PWB density**
  - **Decreased PWB size**

Key Parameter Discussion: Display

- Today's mix is 60% Vacuum Florescent (VF) and 40% LCD
- Future is 70% LCD and 30% VF
- VF displays are $2 to $4 and are used in Radios and HVAC modules
- LCD displays are $100 and are used in navigation and entertainment

Key Parameter Discussion: Power

- **Higher voltage systems will be introduced with hybrid vehicles**
  - **Only the systems that need the higher voltage will be on the high voltage bus**
  - **Examples are Start/Stop systems and Electric Power Steering (EPS)**
- **Nickel Metal Hydride batteries are used on Hybrid vehicles today at a 4X cost premium over Pb Acid**
  - **Energy Density = 70 (Whr/kg)**
  - **Power Density = 150 (W/kg)**
  - **Life Cycles per battery = 1,500**

Key Parameter Discussion: Power

- **Lithium Ion use will depend on price**
  - **Energy Density = 120 (Whr/kg)**
  - **Power Density = 230 (W/kg)**
  - **Life Cycles per battery = 600**
- **Fuel Cells may be capable of replacing battery packs in HEVs when available and cost / performance competitive**

Key Parameter Discussion: Environmental

- **Automotive is exempt from RoHS and WEEE**
- **Customers are asking for Lead Free solutions in 2009 products**
- **Automotive will change as customers require it as part of the quote package**

Key Parameter Discussion: Sensors

- Antilock Brakes - Passive and Active wheel speed sensors
- Stability Enhancement Systems - Steering wheel position, lateral accelerometer, and yaw rate
- Air bags - Accelerometers, roll over
- Adaptive Cruise Control - Radar sensors
- Blind spot systems - Radar systems
- Parking Aids - Radar and Ultrasonic sensors
- Electric Power Steering - Steering wheel position and torque

Key Parameter Discussion: Supply Chain Locations

- Automotive suppliers design, manufacture and build globally
- No dominant geography can be identified
- Trend is to low cost design centers
- Trend is to low cost manufacturing sites

Notable Future Automotive Initiatives

- Vehicle OEMs Demanding System Solutions
- MEMS (Micro-electromechanical Systems) Are Finding Increased Applications As Sensors
- Thermal Management Initiatives In Packaged Component Materials / Processes Accelerating
- HEV Initiatives Are Spurring Activity To Develop Automotive Grade High Voltage / Current Power Electronics Components
- Digital Sensors To Simplify The Polling Requirements of Processors And Systems Architecture Changes For Single Wire Control
- Mechatronics (Embedded Electronics with Mechanical Components) Pushing Novel Packaging Solutions and Thermal Management / Harsh Environment Capabilities
- Expanding Supplier Base With QS9000 Certification
- Technologies / Products That Minimize Driver Distraction

The Automotive Industry Moving Forward - Identified Challenges

- Cost Effectiveness
- Reliability – 100,000 miles or 10 Years
- Harsh Environment Becoming Harsher
- HEV (Hybrid Electric Vehicles) Creating New Opportunities For Automotive Electronics
- Merging of Automotive and Consumer Electronics
- Ability To Respond To Environmental Legislation
- Substrate, Component Assembly, and IC Package Costs Should Drop 30% and 60% In The Next 5 and 10 Years Respectively

The Automotive Industry Moving Forward - Identified Challenges

- **Current Qualification System Locks Engine Controller Designs In Place, Limiting The Rate of Innovation**
- **Contract Manufacturing Currently Assembles About 6% of Automotive Electronics In 2004 – Growth Will Require Addressing Concerns of Analyzing / Correlating Warranty / Field Failures to Manufacturing Processes**
- **Global Competitiveness Will Place Even Greater Emphasis On Cost, Size and Complexity**
  - **Winners Will Be Those That Master The Reduction in Each of These Areas**

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