NEMI 2000 Roadmap:
Industry Speaks

Jim McElroy
January 17, 2001
Topics to be Covered

- NEMI Background
- The Roadmap Process
- Roadmap Findings
  - Situation Analysis
  - Roadmap Highlights
  - Productivity Trends
  - Volume Leadership
  - Environmental Focus
  - Paradigm Shifts
  - Strategic Concerns
  - Key Recommendations
  - Summary
- Optoelectronics – John Stafford, Motorola, Inc.

Connect with and Strengthen Your Supply Chain
NEMI Mission

Assure the Global Leadership of the North American Electronics Manufacturing Supply Chain

Connect with and Strengthen Your Supply Chain
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

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Uniqueness of the NEMI Roadmap

- The NEMI Roadmap is **customer driven**, not technology driven.
- **Product Sector Champions** (the voice of the customer)
  - Project future needs
  - Focus on being competitive in World Market.
- **Technology Working Groups (TWGs)**
  - Predict evolution of technology/business practices
  - Identify gaps and showstoppers in technology/infrastructure
  - Focus on needs rather than provide solutions.
- Roadmaps deal with manufacturing rather than end products.
- Roadmap findings are used by Industry, Academia, and Government to focus development & deployment programs.
## The Drivers: Product Sector Profiles

<table>
<thead>
<tr>
<th>Product Sector</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>Low-Cost</td>
<td>High volume consumer products for which cost is the primary driver</td>
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<tr>
<td>Hand Held</td>
<td>Handheld, battery-powered products driven by size and weight reduction</td>
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<tr>
<td>Cost/Performance</td>
<td>Products which seek maximum performance within a few thousand dollar cost limit</td>
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<tr>
<td>High Performance</td>
<td>High-end products for which performance is the primary driver</td>
</tr>
<tr>
<td>Harsh Environment</td>
<td>Products which must operate in extreme environments</td>
</tr>
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</table>
Roadmap Structure - 19 TWGs

Digital Silicon Technology

Business Processes/Technologies
   Enterprise Information Technology
   Supply Chain Management
   Factory Information Systems

Design Technologies
   Modeling, Simulation, and Design Tools
   Thermal Management
   Environmentally Conscious Electronics

Manufacturing Technologies
   Board Assembly
   Test, Inspection, and Measurement
   Final Assembly

Component/Subsystem Technologies
   Packaging
   Interconnection Substrates - Organic
   Interconnection Substrates - Ceramic
   Passive Components
   RF Components
   Optoelectronics
   Displays
   Mass Data Storage
   Energy Storage Systems

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Connect with and Strengthen Your Supply Chain
<table>
<thead>
<tr>
<th>Product Sector</th>
<th>Chair</th>
<th>Co-Chair</th>
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<tr>
<td>Low Cost Product Sector</td>
<td>Ronald Evans</td>
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<td>Terry Dishongh</td>
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<td>IBM</td>
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<td>D.H.R. Sarma</td>
<td>Bill Murphy</td>
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<td>Dephi Delco</td>
<td>Lockheed Martin</td>
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<td>Technology Working Group</td>
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<tr>
<td>Executive Summary</td>
<td>Irwin Asher</td>
<td>Leo Feinstein</td>
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<td>Digital Silicon Technology</td>
<td>Paolo Gargini</td>
<td>Alan Allan</td>
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<td>Enterprise Information Technology</td>
<td>Leo Feinstein (Editor)</td>
<td>NEMI</td>
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<td>Supply Chain Management</td>
<td>Elliott Josi</td>
<td>Suzana Auping</td>
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<td>Factory Information Systems</td>
<td>Tom Zagrodney</td>
<td>Bob Voitus</td>
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<td>Modeling, Simulation, and Design Tools</td>
<td>Sanjeev Sathe</td>
<td>Koneru Ramakrishna</td>
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<td>Thermal Management</td>
<td>Richard Chu</td>
<td>Alex Vukovic</td>
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<td>Environmentally Conscious Electronics</td>
<td>Bob Pfahl</td>
<td>Holly Evans</td>
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<td>Board Assembly</td>
<td>Linda Klober</td>
<td>Bill Barthel</td>
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<td>Test, Inspection &amp; Measurement</td>
<td>Mike Smith</td>
<td>Barry Bell</td>
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<td>Dieter Bergman</td>
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<td>Passive Components</td>
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<td>Mass Data Storage</td>
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<td>Cascade Microtec</td>
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<td>Energy Storage Systems</td>
<td>Lynn Davis</td>
<td>Ed Decker</td>
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2000 Roadmap – Special Recognition

• Roadmap Management Team
  – Irwin Asher, Lucent Technologies
  – Leo Feinstein, NEMI
  – Ron Gedney, NEMI

• NEMI Technical Committee
  – Shape roadmap scope
  – Editorial Board

• NEMI Board of Directors
  – Help insure relevancy
  – Influence strategy
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What’s New for 2000 Roadmap?

• New TWGs/chapters created
  – Enterprise Information Technology
  – Thermal Management

• MEMS Technology addressed in relevant chapters

• In addition to predictions, each TWG addressed:
  – Business issues/climate impacting their area
  – Specific R&D challenges needing attention
  – More structured validation of ’98 predictions

• Growing support/participation of industry
  – Over 400 content experts involved
  – Representing 190 companies/organizations

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Situation Analysis

• Incredible growth of the electronics industry
  – Driven by explosion of new products & services
  – Made possible by technology advances and favorable business climate.

• Relentless restructuring of industry
  – Driven by competitive forces
  – Focus on Core Competency; Outsource the rest
  – Rapid growth of EMS Providers.

• More demanding customer base
  – “We want it now for free!”
  – Becoming more conscious of impact on society.
• Increasingly distributed manufacturing causes business issues to dominate quest for efficiency.

• Cost pressures are relentless (e.g. cell phone market bifurcation: low cost & high function).

• Explosive growth of top tier of EMS segment.

• Displays are Key Element of machine interface
  – LCD encroachment of CRT market
  – Potential emergence of Organic LED displays
  – Significant investment in mfg. capacity ($40B over 2-3 yrs.)
• Moore’s law rules but the landscape is changing:
  – Packaging role expanding (e.g. SOP)
  – Application of “reusable cores” (i.e. SoC) as one strategy to deal with designer productivity gap.

• Optoelectronics has finally hit “mainstream”
  – Technology capabilities
  – Rapid market growth ($90B by 2003)
  – Will drive significant investment in mfg. technology.

• New applications of MEMS on a number of fronts
  – Displays
  – Servo control for mass data storage
  – Optical switches
  – Laser tuning
  – Microbatteries.
Productivity Trends

• Electronics products and related Solutions/Services are a key factor in the structural growth of Productivity Improvement for the Global Economy.
  – While hype is still ahead of substance, the Internet is a Key Change Agent
  – Focus shifting from personal productivity to group productivity opportunities.

• Functional integration of semiconductors continues at a rate of 58% per year, the productivity improvements of chip designers lags behind growing at only 21% per year.
Chip Complexity vs. Designer Productivity

Design Productivity Crisis

Potential Design Complexity and Designer Productivity

Year | Technology | Chip Complexity | Frequency | 3 Yr. Design Staff | Staff Cost |
-----|------------|----------------|-----------|-------------------|-----------|
1997  | 0.25 Micron | 13 M Tr. | 400 | 210 | 90 M |
1998  | 0.25 Micron | 20 M Tr. | 500 | 270 | 120 M |
1999  | 0.18 Micron | 32 M Tr. | 600 | 360 | 160 M |
2002  | 0.13 Micron | 130 M Tr. | 900 | 800 | 360 M |

* @ $150K / Staff Yr. (In 1996 Dollars)
The New Volume Drivers

• Communications products to replace computers as key driver of volume manufacturing.
• New products, enabled by new technologies, are creating a pronounced shift in the industry:
  – Blurring of the lines: computers & communications
  – Cell phone market growth (1B units per yr. By 2002/2004)
  – Bluetooth emergence
  – Optoelectronics
  – Automotive electronics (adding functionality of home & office to your car).
Bluetooth Module

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Environmental Focus

• Complex issue that is shaped by many forces
  – Regulation
  – Product differentiation
  – Market access.

• Regional differences are dramatic
  – Europe driving regulatory agenda
  – Japan, a world leader in consumer electronics, appeals to “GO GREEN” desires of customers
  – North America prepares to compete on all fronts.

• Areas of focus
  – Materials of concern
  – Design for recycling
  – Design for resource sustainability (longer term focus).
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Panasonic Mini-Disk Player

Sn-Ag-Bi solder
Paradigm Shifts

- Volume being driven by communications/wireless products.
- Chip level integration driving need for more layers of on-chip interconnect (up to 10 layers over 10 yrs.).
- Factory information systems are becoming ubiquitous across the mfg. environment.
- Silicon technology rate of improvement will move back to 3-year cycle.
- With use of technologies such as integral passives, PWB fabricator will be increasingly responsible for delivering electrical specifications.
Depiction of the Embedded Passives (Singulated) Construction

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EMS providers are expanding their capabilities to include design, sourcing, repair, order fulfillment, etc.

The Internet and distributed manufacturing enables small/highly leveraged companies to compete globally with traditional, larger companies.

Mfg. productivity improvement focus will shift from materials conversion to efficient supply chain responsiveness.

Supply Chain Management will be a key differentiator
- Integrated response vs. functional expertise
- Manage inventory in more elegant ways (Build to Order, Design for Postponement, improved visibility/planning)
## Logistics Cost Improvement

<table>
<thead>
<tr>
<th>Year</th>
<th>Logistics Costs as a Percentage of GDP</th>
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<tbody>
<tr>
<td>1980</td>
<td>15.7%</td>
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<tr>
<td>1985</td>
<td>12.3%</td>
</tr>
<tr>
<td>1990</td>
<td>11.4%</td>
</tr>
<tr>
<td>1995</td>
<td>10.4%</td>
</tr>
<tr>
<td>1996</td>
<td>10.3%</td>
</tr>
<tr>
<td>1997</td>
<td>10.1%</td>
</tr>
<tr>
<td>1998</td>
<td>10.1%</td>
</tr>
<tr>
<td>1999</td>
<td>9.9%</td>
</tr>
</tbody>
</table>

From 11th Annual State of Logistics Report - Robert Delaney

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## Magnitude of Logistics Costs

### Snapshot of U.S. Logistics Market

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrying Costs</td>
<td>$332B</td>
</tr>
<tr>
<td>Transportation (motor carriers)</td>
<td>$450B</td>
</tr>
<tr>
<td>Transportation (other)</td>
<td>$136B</td>
</tr>
<tr>
<td>Total Cost (1999 Estimate)</td>
<td>$918B</td>
</tr>
</tbody>
</table>

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Strategic Concerns

- Full potential of Supply Chain Management and Enterprise Information Technology requires “mind set change” from “cost center” to “value center”.
- Restructuring causing significant shifts in R&D leadership (OEM => EMS => Suppliers) without sacrificing low overhead function.
- While product & technology complexity increases, design productivity is not keeping pace.
- North American firms continue to lag in volume HDI capability – impact to PWB market share.
- Cost effective methodologies for elimination of materials of concern and product take back.
Key Recommendations

- Explore/promote efficient approaches for R&D in the Distributed Mfg. Model
  - Changing role of OEMs
  - EMS/Supplier partnerships
  - Industry/Academia/Government partnerships.

- Leverage industry consortia/trade associations to deploy technology/business practices in a competitive manner.

- NEMI should continue to focus environmental efforts as one strategy to create Industry Standard Solutions.

- NEMI should continue to broaden agenda to include collaboration on supply chain and business practices.

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Summary

- **Innovation continues to be a driving factor for the expansion of Electronics business**
  - Lots of new products & services emerging
  - Made possible by new applications of technology
  - Increased functionality at lower cost
  - Growth can be impacted by investment climate and consumer confidence.

- **Emergence of Global markets raises the bar for manufacturing leadership**
  - Ability to manage & leverage time/cost pressures
  - Orchestration of Responsive Supply Webs
  - Adaptable strategy (response to new products/markets)
  - Flawless execution.

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