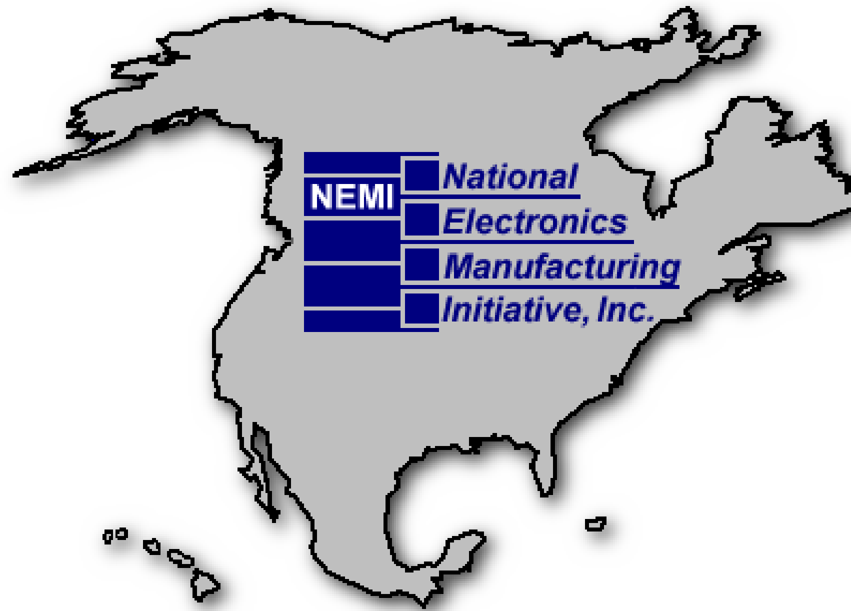

HIGHLIGHTS OF THE 2002 NATIONAL ELECTRONIC MANUFACTURING TECHNOLOGY ROADMAPS AND THEIR APPLICABILITY TO CHINA

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ICEPT 2003, Shanghai China

Topics to be Discussed

- NEMI Background
- Roadmap Process
- 2002 NEMI Roadmap
  - Situation Analysis
  - Key Parameters
  - Identified Needs
  - Paradigm Shifts
- 2004 NEMI Roadmap
- Summary

NEMI Mission

Assure Leadership of the Global Electronics Manufacturing Supply Chain

NEMI Scope

Components
Materials Transformation
Build to Order
Collaborative Design
Materials
Equipment
Software Solutions
Life Cycle Solutions

Supply Chain Management
Information Technology
Logistics
Communications
Business Practices

Marketing → Design → Manufacturing → Order Fulfillment → Customer

Connect with and Strengthen your Supply Chain

What Does NEMI Do?

Leverage the combined Power of Member Companies and their Partners to Provide Industry Leadership

- NEMI Roadmaps the Global Needs of the Electronics Industry
  - Evolution of existing technologies
  - Predictions on emerging/innovative technologies
- NEMI Identifies Gaps (both business & technical) in the electronics Infrastructure
- NEMI Stimulates R&D Projects to fill these Gaps
- NEMI Establishes Regional Implementation Projects to Eliminate these Gaps
- NEMI Stimulates Global Standards to speed the Introduction of New Technology & Business Practices
- NEMI works with other organizations to insure that North American government policy recommendations are aligned with NEMI mission.

NEMI Strengths

- **Strong support of member companies at fairly senior levels.**
- **Technology roadmaps known and used on world wide basis.**
  - **Evolution of existing technologies**
  - **Predictions of disruptive/break-through technologies**
- **Proven track record/methodology to conduct collaboration across the supply chain.**

Current NEMI Membership

- 3M
- 3 SAE Technologies
- Adept Technology, Inc.
- Advanced Micro Devices, Inc. (AMD)
- Aerotech World Trade
- Agile Software Corporation
- Agilent Technologies, Inc.
- Alcatel Canada, Inc.
- American Electronics Association (AEA)
- AMR Research
- Asymtek
- Aurora Instruments
- BTU International
- Centre for Microelectronics Assembly & Packaging (CMAP)
- Celestica, Inc.
- ChipPac, Inc.
- Cimetrix, Inc.
- Cisco Systems
- Cookson Electronics
- Delphi Delco Electronics Systems
- Dell Computer
- Dover Technologies International
- E2open
- Electronic Industries Association (EIA)
- Endicott Interconnect Technology (EIT)
- FCI
- Georgia Institute of Technology
- GSI Lumonics
- Heraeus
- Hewlett Packard Company
- IBM Corporation
- Indium Corporation of America
- IPC
- IEEC SUNY, Binghamton
- Intel Corporation
- Jabil Circuit, Inc.
- Kester Northrop Grumman
- KIC Thermal Profiling
- kSARIA
- Kulicke and Soffa Industries, Inc.
- LACE Technologies
- Loctite Corporation
- Lucent Technologies, Inc.
- Massachusetts Institute of Technology (MIT)
- Merix Corporation
- META Group
- Ministere de L'industrie et du Commerce Government du Quebec
- Motorola
- National Center for Manufacturing Sciences (NCMS)
- National Institute of Standards and Technology (NIST)
- Nextrom Photonics
- Nortel Networks
- Orbotech
- Plexus Corp.
- Sanmina-SCI Corporation
- Shipley Company
- Solectron Corporation
- Storage Technology Corporation
- Sumitomo Electric Lightwave
- Sun Microsystems
- Texas Instruments, Inc.
- Tyco Electronics
- Virginia's Center for Innovative Technology (CIT)
- Vytran

NEMI Roadmap Cycle

NEMI Implementation Cycle

Connect with and Strengthen your Supply Chain

NEMI Supply Chain Model
Roadmapping (TWGs) vs. Projects (TIGs)

Product Life Cycle Information Management

Connectors

RF Components

Test, Inspection & Measurement

Passive Components

Thermal Management

Optoelectronics

Semiconductor Devices

Packaging

Mass Storage (Magnetic & Optical)

Red = TWG & TIG

Blue = TWG

Shadow/ White = Cross Cut TWG

Ceramic Substrates

Displays

Energy Storage Systems

Organic Substrates

Board Assembly

Final Assembly

Customer

Modeling, Simulation, and Design Tools

Environmentally Conscious Electronics

Connect with and Strengthen your Supply Chain

Transition to Pb-free Assembly

- 1998 Roadmap Identified the Gap
- Phase I Project developed the alloy, process, components and reliability data from 1998-2002
- Phase II Project is expanding the technology base to include rework, wave-soldering, and reliability of lead finishes
- 2002 Roadmap Identified a number of Business Issues to Convert to a Pb-free Supply Chain.
- Phase III Project teams are currently being established to address these global supply chain transition issues.

Results:

- The NEMI efforts have accelerated the establishment of SAC alloys as the new standard and reduced the effort in each member company.

Roadmap Structure - 18 TWGs

Semiconductor Technology
- Digital Silicon Technology

Business Processes / Technologies
- Product Lifecycle Information Management

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
- Connectors
- Packaging
- Interconnection Substrates - Organic
- Interconnection Substrates - Ceramic
- Passive Components
- RF Components
- Optoelectronics
- Displays
- Mass Data Storage
- Energy Storage Systems

NEMI Affiliations

OIDA

Optoelectronics and Optical Storage

NEMI Optoelectronics TWG

NEMI Mass Data Storage TWG

Magnetic and Optical Storage

Displays

NEMI
National
Electronics
Manufacturing
Initiative, Inc.

NEMI Supply Chain Management TWG

Supply Chain Management

NEMI / SIA System Drivers

NEMI Roadmap

Semiconductors

NEMI / SIA Packaging TWG

NEMI / IPC Interconnect TWG

Interconnect Substrates—Organic

Interconnect Substrates—Ceramic

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The Drivers: Product Sector Profiles

Product Sector	Characteristics
Consumer	High volume consumer products for which cost is the primary driver
Portable	Handheld, battery-powered products driven by size and weight reduction
Office	Products which seek maximum performance within a few thousand dollar cost limit
Large Business	High-end products for which performance is the primary driver
Automotive/ Defense	Products which must operate in extreme environments

Roadmap Development

Product Sector Needs Vs. Technology Evolution

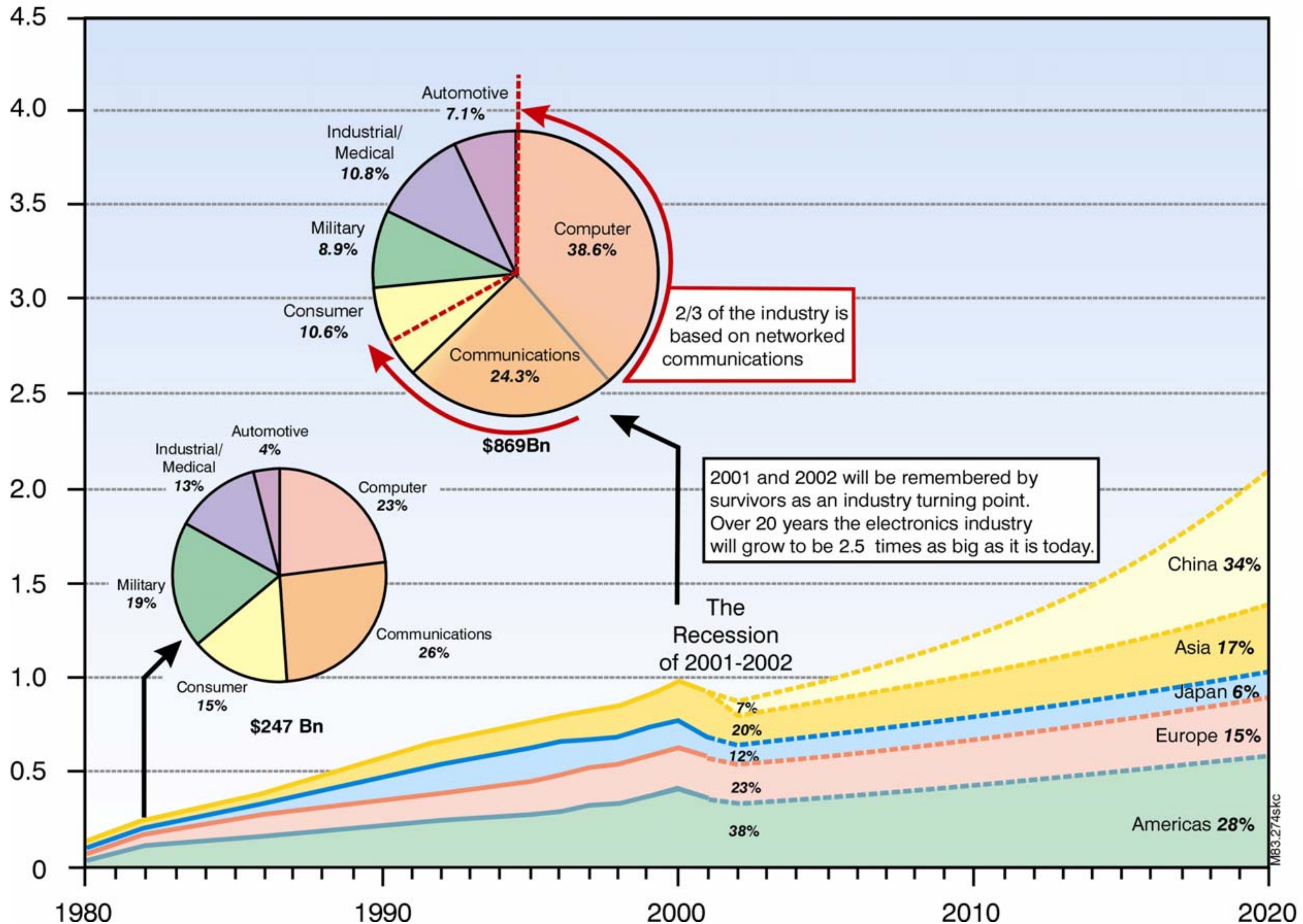
TWGs	Product Sectors
Digital Silicon Technology	
Business Processes **Prod Lifecycle Information Mgmt.**	
Design Technologies Modeling, Thermal, etc.	
Manufacturing Technologies Board Assy, Test, etc.	
Comp./Subsyst. Technologies Packaging, Substrates, Displays, etc.	

2002 Roadmap Input & Coverage

- Developed by >350 individuals from 170 organizations (including non-member companies)
- Covers 18 technology, business practice and infrastructure topics in the areas of:
  - Semiconductor technology
  - Business processes/technology
  - Design technologies
  - Manufacturing technologies
  - Component subsystem technologies
- Over 1000 pages of information

Situation Analysis-Business

- Market downturn since mid-2000 has greatly impacted forecasted growth projections.
- Business models across the electronics industry continue to change, leading to significant shifts in roles and responsibilities across the supply chain.
- Supply chain management offers the greatest potential for increasing productivity.
- There has been a movement of manufacturing to China from both North America and Southeast Asia:
  - Low-cost, highly skilled workforce
  - Massive market opportunity.



PRISMARK PARTNERS LLC

Connect with and Strengthen your Supply Chain

Situation Analysis-China

- Growth of Electronics Mfg. in China is explosive
  - Today 7% of Electronics assembly in PRC
  - Projected to be 34% by 2020 (Prismark Partners)
  - America's share expected to shrink from 38% to 28%

Situation Analysis-Regulatory

- Environmental legislation in various product segments will require the electronics industry to share detailed material content data of their products and components.
- To meet regional legislative requirements, manufacturers must remove environmental “Materials of Concern,” such as lead, mercury, bromine and cadmium.
- Globally, the electronics industry is facing end-of-life or producer responsibility legislation.

Situation Analysis-Market

- **The use of Cell Phones for web access is forecasted to exceed the use of personal computers for web access by 2005-6.**
- **PC growth is forecasted to be low/stalled through 2003.**
- **The LCD industry will invest $40B in manufacturing capacity for displays over the next several years to keep up with demand.**
- **Wireless networking and automotive entertainment are emerging as volume drivers.**
  - **Wireless networking will grow to 2B units by 2006-2007.**

Situation Analysis-Technology

- Growth in silicon device size is slowing, and the rate of reduction in feature size will resume its historic three-year cycle.
- LCD and plasma displays are starting to encroach on the CRT market.
- MEMS technology is making new capabilities feasible such as: displays; servo control for mass data storage, optical switches, laser tuning; RF components, passives; and micro-batteries.
- System in Package (SiP) has emerged as the fastest growing packaging technology - although still representing a relatively small percentage of the unit volume.

Identified Needs- Manufacturing Technologies

- **Board assembly will be challenged with providing material control and identification standards during the transition between lead-free and eutectic materials and throughout the product life cycle.**

- **For board assembly of optoelectronics to be competitive in North America, it is important to develop low-temperature soldering and automated fiber handling and assembly.**

- **Cost improvements are needed to make flexible automation viable for all manufacturing.**

2002 Key Parameters for Portable Product Sector

First Year of Significant Production	Metric	2003	2005	2007	2013
Cost					
Board Assembly (Conversion) Cost	¢ per I/O	0.5	0.45	0.4	0.3
Substrate Cost (6-layer, blind/buried)	$\$/cm^2$	0.055	0.04	0.03	0.03
Microvia Board Cost (4-layer)	$\$/cm^2$	0.04	0.03	0.025	0.015
IC Package Cost	¢ per I/O	0.7	0.65	0.5	0.4
Design-Packaging Density					
Average Component I/O Density	I/O per cm^2	70	80	100	140
Max Component I/O Density**	I/O per cm^2	280	320	350	450
I/O per Component, avg.	#	6	7	7.5	9
Package I/O Pitch (Perimeter)	mm	0.5	0.5	0.5	0.5
Max I/O per package	I/O/pkg	324	400	424	480
Package I/O Pitch (Area Array)	mm	0.5	0.5	0.5	0.5
Substrate Lines and Spaces	microns	75	65	65	35
Substrate Pad Diameter*	microns	225	200	175	125
Components per cm^2	$\#/cm^2$	15	15	17	25

Portable Product Sector (2000 vs. 2002)

First Year of Significant Production			*2001*	*2003*	*2005*	*2007*	*2011*	*2013*
Year	***Parameter***	***Metric***	***Cost***					
2000	Substrate Cost (6 layer, blind/buried)	$/cm²	0.10	0.10	0.09		0.07	
2002			0.07	0.05	0.04	0.03	0.03	0.03
2000	Microvia Board Cost (4 layer)	$/cm²	0.095	0.09	0.08		0.05	
2002			0.05	0.04	0.03	0.02	0.02	0.01
	Density, Dimension, Number		***Value***					
2000	Max I/O per package	I/O/pkg	256	288	312		360	
2002			256	324	400	424	450	480
2000	Av. I/O per package	I/0÷pkg	3.6	4.0	4.4		5.0	
2002			3.6	6	7	7.5	8	9
2000	Substrate Lines/Spaces	µm	60	35	30		20	
2002			100	75	65	65	50	35
2000	Components/sq. cm	#/sq.cm	15.5	20	23		30	
2002			15	15	15	17	22	25
2000	Substrate Pad Diameter	µm	120	80	70		50	
2002			250	225	200	175	150	125
2000	Frequency on Board	MHz	250	300	350		500	
2002			100	150	250	300	350	400

Paradigm Shifts

- **The convergence of broadband communications and digital technology has increased product opportunities while creating uncertainty in marketing**

- **System in Package modules (ex. Bluetooth, WiFi (802.11b,a,g) and GSM (Global System for Mobile Communication)) is speeding the design of new portable and office system products and reducing risk to the OEM.**

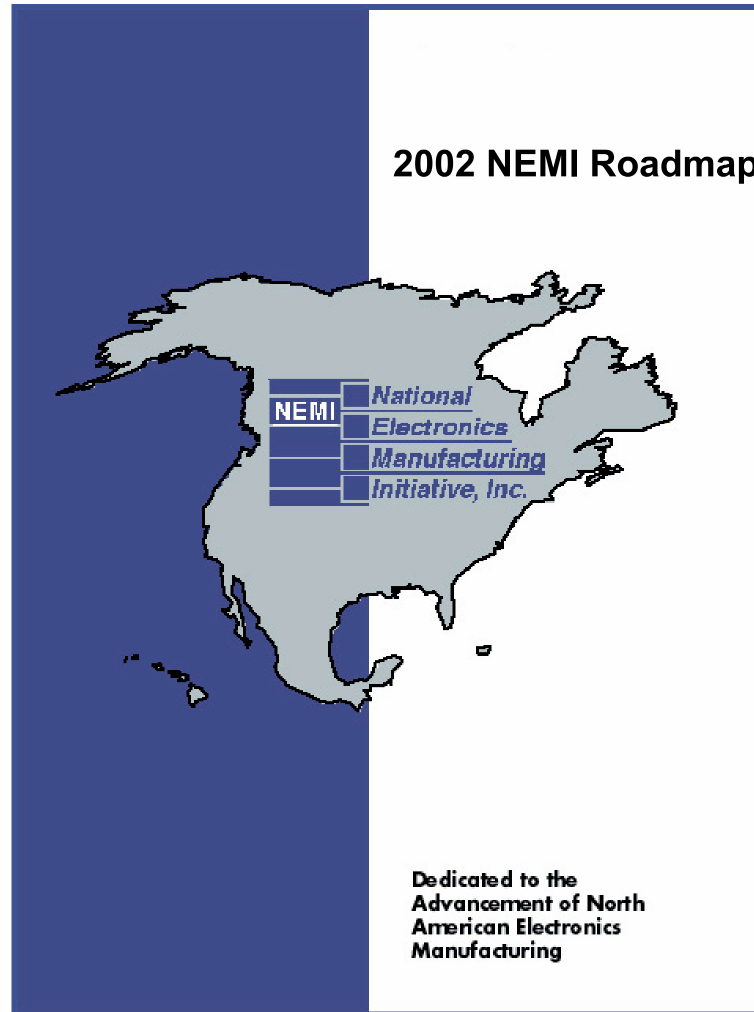
Roadmapping

- **Globalize the NEMI Roadmapping Process Beginning with 2004 Roadmap**
  - **Process and Timing for Internationalizing on a TWG by TWG basis**
    - **Packaging, and Mass Storage already internationalized**
    - **Create Single Global NEMI TWGs, not regional TWGs**
    - **Do not Internationalize Product Emulators in 2004**
  - **Invite International and Regional Organizations to Participate within our current process**

Summary

- Key observations from 2002 NEMI Roadmap
  - Technology: "System in Package" emerging as technology driver
  - Market: Technology needs delayed by the economy
  - Cost: Placing more emphasis on Supply Chain Management
- 2004 NEMI Roadmap
  - Will begin to globalize the roadmap Process
  - Will strengthen the 2004 Product Sector Emulators
  - Will focus the discussion on business issues

2002 NEMI Roadmap
www.nemi.org



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