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What makes the IPC Roadmap Unique?

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Introduction

Have you ever been confused after you have read two or three different roadmaps and even though they were supposedly mapping the same attribute in the same time periods, the numbers in the cells were different? Do you often wonder, "Do these people ever talk to each other"?

Interestingly, even though different all of the roadmaps may be correct. The following list some of the reasons for the differences and explains the uniqueness of the individual roadmaps.

Industry wide technology roadmapping, which is a fairly new activity in the U.S., is believed to have been started in Detroit in the late 80's when the automotive industry asked their suppliers to present roadmaps of their future products. The focus of many of these presentations was cost reduction not necessarily technology as the U.S. auto industry was in the middle of severe cost cutting activities to increase their competitiveness.

There are now numerous national roadmaps. The steel industry, the aluminum industry, and the forging and casting industries all have published technology roadmaps. In the electronics industry there is also a large number of roadmaps: The National Electronics Manufacturing Initiative (NEMI) roadmap, The Association Connecting Electronics Industries (IPC) roadmap, The Semiconductor Industry Association (SIA) roadmap, and the Japanese JISSO roadmap.

Gary S. Vasilash, as Editor - In – Chief of Automotive Manufacturing & Production_Magazine once made two broad statements supporting roadmaps. The first is, roadmaps provide a view to all levels of an organization that goes beyond the immediate fires that need to be put out and keeping new fires from starting. The second comment was that roadmaps identify areas where collaboration may be needed in order to achieve leapfrog, not natural incremental, development.

Mr. Ray Kammer, former Director National Institute of Standards and Technology has said "We at NIST love roadmaps… Roadmaps help us guide our investments and to allocate our resources in accordance with U.S. industry's priorities. And the more detailed the roadmaps the better…"

Kammer also said, "The need for two way communication has not subsided. Technology and science are moving too fast. Global competitive conditions are too fluid. Opportunities are too fleeting, and the technology gaps we must bridge are too wide to leave communication to chance, or even to individual initiative. Both government and industry stand to gain from a more systematic and more proactive approach to surveying the technology landscape in electronics."

"From the government perspective, an example that pops quickly to mind is defense technology. As the Pentagon continues to transition toward greater reliance on a commercial technology base, there is an even greater need for regular communication between government and industry. Roadmaps facilitate this communication."

The Defense department must be alert to trends and developments and to basic research supporting the entire scope of electronic technologies. It must understand the manufacturing capabilities that underlie these technologies. It also must be quick to identify research and technology gaps—specialized needs likely to go unaddressed in the commercial sector. National Technology Roadmaps facilitate this need.

Roadmap Globalization

When they first started, all of the interconnection industry roadmaps had a domestic view of technology. As globalization has become a way of life all of the roadmaps are now global in their perspective. In fact the SIA roadmap went from being titled the "National Technology Roadmap for Semiconductors to the International Roadmap for Semiconductors in 1998 and the IPC roadmap is now the IPC International Technology Roadmap.

The ITRS is truly a global roadmap. The ITRS has working groups in the US, Japan, Taiwan & Europe. ITRS roadmap working meetings are held at international locations all over the world. NEMI is increasing the international participation in their roadmap this year and the IPC is also using input from Europe and Asia.

Roadmap Organization

The IPC roadmap layout is generally by technology level. There are sections on packaging substrates and assembly, product board substrates and assembly and backplanes. There are also separate sections on rigid and flexible circuits. In 2005 the IPC International Roadmap, for the first time, will have two different volumes, one volume focusing on trends and issues and one volume on related issues.

The Japanese JISSO roadmap is laid out based on product organization. There are complete separate sections on DVD's, Cellular phones, Notebook PC, etc. This is a very interesting layout and makes it easy to compare the technology needs of the different products. However, it makes it difficult to get a big picture view of what's happening in PCB technology for example.

The ITRS has a process flow organization. There are chapters on lithography, interconnect, front end processes, etc.

NEMI's roadmap utilizes a functional layout with sections on Business Technologies like Product Lifecycle Information Management and sections on Design Technologies like Modeling, Simulation, and Design Tools. NEMI also covers Manufacturing Technologies and Component Subsystem Technologies including packaging and product Interconnection substrates.

The make up of the teams participating in the roadmaps for each of these industries is also completely different. The semiconductor industry typically spends 10% of its revenue on R & D. Therefore the ITRS roadmap, one of the documents used to determine where semiconductor R & D should focus, attracts researchers. Researchers are optimistic people and generally will predict significant improvements in roadmap attributes over time. Some of the change predictions are made because the roadmap team really believes it can be done and some predictions may be an effort to continue to get more R & D dollars for the future. Contrast this to the PWB industry that spends less than 1% of its revenue on R & D. Researchers are not attracted to this industry and therefore this roadmap team is made up of manufacturing oriented engineers who are less optimistic about the future and worry about making daily yields and having enough plant capacity to meet schedules. Is it any wonder that the predictions for these two groups are different? The NEMI roadmap actually brings a third perspective into the equation. NEMI's roadmap has OEM new product planners as one of its core resources, and they actually bring another perspective to the process, a marketing perspective. Therefore when one team maps the same attribute as the other two we can easily get different sets of numbers! Table 1 below compares three different roadmaps.

Table 1 – Comparison of Three Different Roadmaps

	ITRS	NEMI	IPC	JISSO
Team Makeup	Senior Techs. • Mgmt • Eng.	Senior Techs. • Mgmt • Eng.	Senior Techs. • Mgmt • Eng.	Senior Techs. • Mgmt • Eng.
Team Skills/Exp.	Manufacturing Researchers	Product Managers	Manufacturing Process Dev.	OEM Team Fab Team
Industry R&D Invest	< 10%	4- 5 %	>1%	<5%
Government & Academia Participation	High	Some	Few	Some on survey review
Roadmap Purpose	R & D priority	Members info.	Prepare Industry	Prepare Japanese industry
Thesis	We Expect	We Need	We Believe	
Style	Technology Push	Market Pull	Market Pull	Market Pull

IPC Roadmap
The IPC roadmap focus is electronic interconnections including the processes for fabrication of the interconnection structure and materials plus the attachment, mounting and assembly of electronic components.

Created in 1993, the IPC International Technology Roadmap predicts what technologies will be state-of-the-art or become mainstream over the next several years, based on future end-product needs identified by original equipment manufacturers. It is written for managers as well as engineers involved in manufacturing, corporate strategy, long-range planning, and analysis.

Emulators or Product Sectors
All roadmaps use something as the basis of needs for the roadmap. Sometimes the needs basis is called a Product Sector (NEMI) and sometimes it is called an Emulator (IPC). These two terms are used interchangeably and both represent the needs of future OEM products described in various ways.

There are many ways to get product sector data and that is, in itself, a problem. One roadmap (NEMI) has had an individual who is a senior technologist for a company in the product area that owns the needs data collection process. I think it is fair to say that the technical philosophy of the company that the owner works for will permeate the data. If that company strongly believes in silicon integration it will show up in the needs data. If they trend more toward discrete components it will show up in the data. For 2004 and for their future roadmaps, NEMI has gone to a group emulator ownership. IPC roadmaps have always used a team of individuals knowledgeable of the product area and they jointly determine the needs data. Neither the single ownership nor group ownership method is more correct or incorrect than the other. They are just different. One can see that the team approach is more likely to generate more centric or average data, we can even call it consensus data, and it may be different than the data from one leading edge manufacturer. There is another way needs information is collected and that is by survey. This is a method used extensively in Japanese and European roadmaps. The survey data is generally collected by a third party and then analyzed and put into roadmap form. This type of data collection is very similar to the group owned emulator method and also produces a centric roadmap.

Start of Normal Production
Reviewing the following graphic in Figure 1 may give an understanding of another of the reasons for data differences. There is a well-known ramp up in the electronics business generally starting with the alpha tool and progressing through to the start of normal production (SNOP) and then up the ramp and into full volume production.

The difficult question for roadmappers is at what point on the curve do you put a number into one of the cells in the attributes boxes in a roadmap table? Some roadmaps require only one company, anywhere in the world to be at SNOP. Another roadmap likes to have a "few" companies in production. Typically there is a time lag between companies and this time lag could be reflected in the data entry points. Is one of these roadmaps incorrect? Not at all! It's just confusing and misleading to readers who don't understand these differences.

Will these differences disappear? Will all of these roadmaps get together? Probably not! These are different industries with different financial capabilities and infrastructures. Their roadmaps are designed to serve their own industry as they should.

A similar problem can exist in corporate roadmap understanding especially in the area of roadmap comparison. We need to understand the basis that the roadmap authors are working from. One OEM could be roadmapping the state of the art technology, another the leading edge technology and a third could be roadmapping their commodity, revenue center of gravity products. All these viewpoints are different and all will produce roadmaps with different information. Table 2 below compares corporate and industry technology roadmaps attributes.

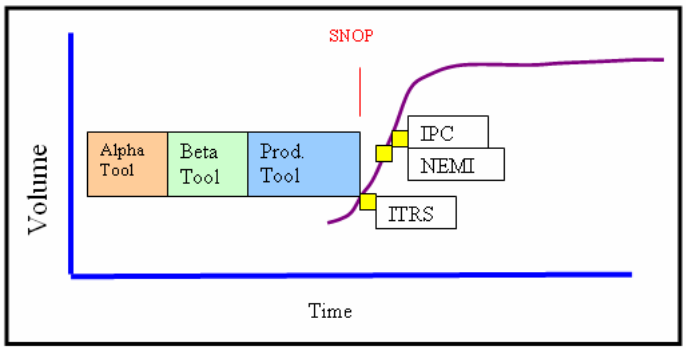

Figure 1 – Production Ramp up Curve

Table 2 - Comparison of Corporate and Industry Roadmaps

	Corporate TRM	Industry TRM
Diffusion	mid – 1980's	Early 1990's
Scope	One product or a family of products	A technology sector
Initiative & Development	A single company	Consortium of companies, national industry up to a whole international industry, public agencies, private consulting company
Utilization	Within a company	Companies of this consortium, whole national or international industry, other stakeholders.
Objectives	Optimizing R&D decisions, strategic planning for development of new products	Becoming more competitive by sharing R&D investments and results in the pre-competitive domain
Methodology	Compilation of technical documentation, internal workshop	Workshops with industrial and academic experts
Approach to the Future	Technology driven and/or market pull descriptive and narrative: What are we going to do?"	Technology driven forecasting and normative: "What will happen?" and "What shall we do?"
Time Horizon	Short term, typically 5 years	Medium term, typically 5 to 10 years

Specific IPC Roadmap Differences

There are several additional factors that set the IPC roadmap apart for other roadmaps. First it is focused only on interconnect substrate technology and it is the only roadmap that has this singular focus. The IPC roadmap also is unique in that it is purposely operational level in detail. What this means is that the IPC roadmap presents data at the operational level of the manufacturing floor. One example of the level of data is the roadmap information on silver film used in imaging. The IPC is the only roadmap that gives this level of information.

The IPC roadmap uses emulators as does other roadmaps. The IPC roadmap has used the emulator concept since 1995 and has continuously updated the emulator data content and the number and type of emulators to match the changing face of the market place. IPC has several emulators that are common to other roadmaps and several emulators that are IPC roadmap unique. The emulator description data is broken into four segments:

- Current from 2004-2005,
- Near Term 2006-2008,
- Mid Term 2009-2010, and
- Long Term 2011-2014.

The data is divided into four different categories. These are the categories most desired by interconnect engineers. The first category is Design Issues, the second is Printed Board Technology Issues, the third is Board Assembly Technology Issues and the last category is Board and Assembly Purchasing Issues.

The IPC roadmap is the only roadmap that does an objective analysis of the current emulators and compares the information contained in them to each other. This analysis is published as part of the roadmap and is available to all readers.

One factor that is very significant and different about the IPC roadmap is that it provides two points of reference data for each time frame. There is a Revenue Center of Gravity (R.C.G) point and a State of the Art Point (S.O.A.)

Several OEM's have commented about their like of this characteristic and how each is used differently in the corporation. Engineers for example use the S.O.A. data for future needs while the purchasing people use the R.C.G. number in their activities.

Forecasting Is Easy

Forecasting is easy. Making accurate predictions, however, is trickier. The IPC Roadmap, in short, is a look at OEMs' needs in the coming decade, and how those needs translate to PWB requirements. Its predictions are based on forecasts by dozens of major OEMs. One question constantly asked by roadmap readers is "how good have your predictions been in the past"? Other roadmaps ignore have discussed validation. Some just ignore their track record and some have had non published reviews. In 2002 the IPC roadmap included for the first time a complete chapter on validation of the data. The information for validation comes from the IPC PCQR^2 database. Comparison of the world wide capability of PCB manufacturers is mad to the roadmap projections for both S.O.A. and R.C.G. numbers

It's relatively easy to plot old projections and then lay over that the actual achievements by industry and say you have validated your roadmap. The problem is if your projections are too easy you may make all of them and still not have a quality roadmap and vice versa, if your projections are to aggressive an industry may miss all of them and still be doing a good job. *Roadmaps may be very precise (in predicting goals that are actually achieved) but at the same time be inaccurate (the best possible goals may not be attained).*

What's new in the roadmap for 2004-2005? Optoelectronics is covered in depth, both at the packaging and product board levels. PWB fabrication continues to be a focus of the roadmap with this year's roadmap increasing its coverage. The component assembly chapter has significantly increased the detail at the operational level and the backplane technology is expanded. The emulator narrative section is expanded so that the reader can better understand the decisions made be the emulator teams.

Conclusion

Roadmaps are valuable tools for planning and control of a business or industry. They are a mechanism to use in planning a future and reviewing a track record, but like all tools they must be understood by the user and used properly for maximum results. The IPC roadmap is directly aimed at the needs of the interconnect industry and provides a view of the industry that is not available anywhere else.