European Semiconductor Industry Conference

May 26-28, 1993
Munich Park Hilton Hotel
Munich, Germany

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PROGRAM

1993 EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE

Strategies and Directions for Growth
May 26–28, 1993
Munich Park Hilton Hotel
Munich, Germany

WEDNESDAY, May 26

1200 to 1400	**Registration**	*Foyer*
1400	**Welcome and Conference Introduction** Bipin Parmar Group Director and Conference Chairman European Semiconductor Group Dataquest Europe Limited	*Ballroom Section B*
1415	**Semiconductor Market Forecast and Company Analysis** Jim Eastlake, Mike Glennon and Adrian Walker European Seminconductor Group Dataquest Europe Limited	*Ballroom Section B*
1445	**Strategies and Directions for Growth** Kevin McGarity Senior Vice President Components Sector Texas Instruments	*Ballroom Section B*
1530	**Coffee Break**	*Foyer*
1600	**Videoconferencing** Drew Jamison European Marketing Manager PictureTel UK Ltd	*Ballroom Section B*
1630	**Dataquest Analysts Discuss Videoconferencing** Greg Sheppard Director and Principal Analyst Semiconductor Application Markets Worldwide Group Dataquest Incorporated	*Ballroom Section B*
1700	**Closing Remarks**	
1900	**Depart for Seehaus Restaurant**	

(over)

THURSDAY, May 27
EMERGING APPLICATIONS AND TECHNOLOGIES

0900 **Introduction** . . . *Ballroom Section B*
Bipin Parmar
Group Director, European Semiconductor Group
Dataquest Europe Limited

0915 **Hot Applications for the '90s** . . . *Ballroom Section B*
David Moorhouse
Industry Analyst, European Semiconductor Group
Dataquest Europe Limited

0930 **Opportunities In the Digital Compact Cassette Market** . . . *Ballroom Section B*
Gerry Wirtz
Senior Product Manager, Hardware and Software
Philips Consumer Electronics

1000 **Cellular Mobile Communications** . . . *Ballroom Section B*
David Williams
Business Strategy Director
Motorola, GSM Products Division

1030 **Coffee Break** . . . *Foyer*

1100 **Opportunities in Automotive Electronics** . . . *Ballroom Section B*
Mike Williams
Industry Analyst
European Semiconductor Group
Dataquest Europe Limited

1115 **Structure of Electronic Systems in Modern Automobiles** . . . *Ballroom Section B*
Otto Holzinger
Senior Vice President
Robert Bosch GmbH

1145 **Automotive Electronics—A Perspective Look at BMW** . . . *Ballroom Section B*
Josef Mahalek
Section Manager Electronics Development for
Safety and Comfort
BMW AG

1215 **Lunch** . . . *Marco Polo*

1400 **Advanced Marketing for Success** . . . *Ballroom Section B*
Steve Durbin
Senior Consultant
European Consulting Group
Dataquest Europe Limited

1430 **Strategies and Directions for Growth** . . . *Ballroom Section B*
Bill LaRosa
Director International Sales and Marketing,
Technology Products
IBM Corporation

1500 **Coffee Break** . . . *Foyer*

1530 **FOCUS SESSION: New Processor Architectures** . . . *Ballroom Section B*
Chairman: Mike Glennon, Dataquest Europe Limited
Rakesh Sood, Director of Marketing, Personal Communication Systems, AT&T Microelectronics
Jerry Rogers, President and Chief Executive Officer, Cyrix Corporation
Art Swift, Semiconductor Marketing and Sales Manager, Digital Equipment Corporation
Ray Gleason, Marketing Director, GEC Plessey Semiconductors
Hans Geyer, Vice President and General Manager, Intel Corporation
Les Crudele, Vice President and General Manager, RISC Microprocessor Division, Motorola

1730 **Closing Remarks**

1930 **Cocktails** . . . *Foyer*

2000 **Gala Dinner (Black Tie) and Vendor of the Year Awards** . . . *Ballroom Section C*

(over)

FRIDAY, May 28

EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

0900	**Introduction** Jim Eastlake Associate Director, European Semiconductor Group Dataquest Europe Limited	*Ballroom Section B*
0915	**Takao Nakano** Senior Executive and General Manager Mitsubishi Electric Corporation	*Ballroom Section B*
0945	**Bernie Vonderschmitt** President Xilinx Incorporated	*Ballroom Section B*
1015	**Heinz Hagmeister** Chairman JESSI	*Ballroom Section B*
1045	**Coffee Break**	*Foyer*
1115	**Jean-Pierre Liebaut** President and Chief Executive Officer Mietec Alcatel	*Ballroom Section B*
1145	**Hans-Dieter Mackowiak** Executive Director Sales Siemens AG, Semiconductor Group	*Ballroom Section B*
1215	**Pasquale Pistorio** President and Chief Executive Officer SGS-Thomson	*Ballroom Section B*
1245	**Closing Remarks** **Conference Adjourns**	
1300	**Buffet Lunch**	*Marco Polo*

1993 EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE
EVALUATION QUESTIONNAIRE

Munich, Germany
May 26-28, 1993

Thank you for attending our European Semiconductor Industry Conference. Would you please assist us in planning our next conference by completing and returning this questionnaire.

1. Please rate each presentation on a scale of 1 to 10 (where 10 is highest in terms of your approval):

	CONTENT (1 to 10)	DELIVERY (1 to 10)	COMMENTS (Use reverse side if necessary)
Eastlake, Glennon, Walker Semiconductor Market	______	______	______
McGarity, Strategies and Directions for Growth	______	______	______
Jamison, Videoconferencing	______	______	______
Sheppard, Dataquest Analysts Discuss Conferencing	______	______	______
Moorhouse, Hot Applications for the '90s	______	______	______
Wirtz, Opportunities in the DCC Market	______	______	______
Williams (D), Cellular Mobile Communications	______	______	______
Williams (M), Opportunities in Automotive	______	______	______
Holzinger, Structure of Electronic Systems	______	______	______
Mahalek, Automotive Electronics	______	______	______
Durbin, Advanced Marketing for Success	______	______	______
LaRosa, Strategies and Directions for Growth	______	______	______
FOCUS SESSION: New Processor Architectures			
Glennon	______	______	______
Geyer	______	______	______
Rogers	______	______	______
Sood	______	______	______
Gleason	______	______	______
Swift	______	______	______
Crudele	______	______	______
EXECUTIVE ISSUES: Strategies and Directions for Growth			
Nakano	______	______	______
Vonderschmitt	______	______	______
Hagmeister	______	______	______
Liebaut	______	______	______
Mackowiak	______	______	______
Pistorio	______	______	______

(over)

2. Overall meeting rating (1 to 10) ________

3. What did you like most about the conference? ____

____

4. In what areas do you think our conference could be improved? ____________________________

____

____

5. At our next industry conference, would you prefer more ________ or fewer ________ Dataquest speakers?

6. Suggestions for the theme for next year's European Semiconductor Industry Conference ________________

____

7. How would you rate the conference facilities (1 to 10)?

   Location ________ Guest Rooms ________ Meals ________ Meeting Rooms ________

8. How would you rate the Dataquest registration staff (1 to 10)?

   Courtesy ________ Efficiency ________

9. Comments: ____

____

____

____

10. Given a choice of venues for the 1994 Conference, would you prefer:

   London ______ Milan ______ Paris ______

Name and Company (optional) ____

Please hand this form to a member of Dataquest's staff.

FOR SPEAKER QUESTIONS

Name of speaker: ____
Title of speech: ____

If you have any questions, please write them down in the space provided below. A Dataquest representative will collect them at the end of the presentation.

No. 1: ____

No. 2 ____

ATTENDEE LIST

EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE

May 26-28, 1993

Munich Park Hilton Hotel, Munich, Germany

List of Attendees by Name

H Albrecht	Advantest (Europe) GmbH
Peter Anders	Samsung Semiconductor Europe GmbH
Roland Andersson	National Semiconductor (UK) Ltd
Willi Bacher	First Components GmbH
Pierre Bailly	IBM
Horst Barsuhn	IBM Germany Production GmbH
John Berry	Toshiba Electronics Europe GmbH
Alain Bismuth	LSI Logic
Alfred Borsig	Toshiba Electronics Europe GmbH
Volker Brademeier	Hitachi Europe GmbH
Gerhard Bruningk	Advanced Micro Devices GmbH
Fred Brunner	Oki Electric Europe GmbH
Rob Causey	Electronic Times
Keith Chapple	Intel Corporation
Cianci Cesario	Magneti Marelli spa
John Bjorn Clevestig	Texas Instruments Europe HQ
Les Crudele	Motorola
Franki D'Hoore	ASM Lithography BV
Jean-Philippe Dauvin	SGS-Thomson Microelectronics
Hans de Haan	VLSI Technology
Julien De Wilde	Alcatel Bell Telephone
Gunther Dengel	Philips Semiconductors
Daniel Dourneau	Alcatel Business Systems
Guy Dumas	JESSI
Doug Dunn	GEC Plessey Semiconductors
Stephane Dupuis	Intel
Steve Durbin	Dataquest

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Jim Eastlake	Dataquest
Geoffrey Eccleston	Cyrix International Ltd
Elizabeth Feder	Electronique International Hebdo
Carolo Ferro	Finmeccanica
Douglas Finke	Standard Microsystems Corporation
Greg Finney	ITT Components Distribution
Oliver Garside	McKinsey & Company, Inc.
John Gearing	Sony Semiconductor Europe
Hans Geyer	Intel Corporation
Hans-Jurgen Giffhorn	Wacker-Chemitronic GmbH
Bill Gilmour	Motorola European Semiconductor Group
Ray Gleason	GEC Plessey Semiconductor
Mike Glennon	Dataquest
Maxim Grancharov	Lucky Goldstar
Herbert Graus	Consumer Electronic Munich
Heinz Hagmeister	JESSI Office
John Hannah	Hitachi Europe Ltd
Gerhard Hausmann	National Semiconductor
Heiner Hirsch	Texas Instruments
Theo Holtwijk	JESSI Office
Otto Holzinger	Robert Bosch GmbH
Dragon Ilic	Hewlett-Packard
Mike Inglis	Motorola Ltd
Takashi Itasaka	Mitsubishi
Drew Jamison	PictureTel
Pat Jefferson	Mitsubishi Electric (UK) Ltd
Melissa Jones	Philips Semiconductors BV
Ken Jones	Sony Semiconductor Europe
Young-Joon Jun	Goldstar Electron Co. Ltd
Tetsuya Karikomi	NEC (Electronics) Europe GmbH
Tracey Kehne	Micron Semiconductor GmbH
Gerhard Kessler	Advantest (Europe) GmbH
Gary Kibblewhite	Europartners
Chang-Won Kim	Hyundai Electric Europe GmbH

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Tony King-Smith	LSI Logic Europe plc
Peter Kipp	Zetex GmbH
Eigo Koguchi	Nissin Electric Co. Ltd
Bill LaRosa	IBM Corporation
François Le Cain	LSI Logic GmbH
David Leith	Goldstar Electron Ltd
Robert Lennox	Consultant
Steve Lerner	Amkor Anam Europe Ltd
Jean-Pierre Liebaut	Mietec Alcatel
Robert Lineback	Electronic New/IDG
Klaus Lutz	Advantest System Engineering GmbH
James Lynn	Digital Equipment BV
Hans-Dieter Mackowiak	Siemens AG, Semiconductor Group
Josef Mahalek	BMW
David Manners	Electronics Weekly
Mitchell Martin	International Herald Tribune
Terry McCloskey	GEC Plessey Semiconductors
Kevin McGarity	Texas Instruments
Chris McAneny	Toshiba Electronics
Peter Mies	Mitsubishi Electric Europe GmbH
Bo Molander	Advanced Micro Devices GmbH
Detlef Moench	Hitachi Europe GmbH
Sean Murphy	Apple Computer Ltd
Takao Nakano	Mitsubishi Electric Corporation
Ferruccio Nebuloni	Italtel SIT
Eamonn O'Sullivan	EPSON Semiconductor GmbH
Colin Overton	Air Products
Robin Paling	Toshiba Electronics Europe GmbH
Hugo Patten	Mitsubishi Electric (UK) Ltd
Nick Phillon	LSI Logic GmbH
Pasquale Pistorio	SGS Thomson
Timothy Reynoldson	Department of Trade and Industry
Jerry Rogers	Cyrix Corporation
Frank Ryan	Industrial Development Authority

Dieter Schacht	Harris Semiconductor GmbH
Eric Schutz	Mietec Alcatel
Shunji Shimada	Hitachi Ltd
Fred Shlapak	Motorola Inc.
Roland Schmimmelbaur	GEC Plessey Semiconductors
Joop Sluis	Millipore SA Process Division
Rakesh Sood	AT&T Microelectronics
George Steinberger	Markt & Technik
Baerbel Stock	EPSON Semiconductor GmbH
Hidesuke Sugai	Mitsubishi Electric Europe GmbH
Art Swift	Digital Equipment Corporation
Tobias Thummler	Motorola GmbH
Rolf Thurnherr	Eurodis AG
Roland Triffaux	Xilinx
Matthew Trowbridge	Hitachi Europe Ltd
Graham Turner	Atmel Corporation
Giuliano Vinotti	OCG Microelectronic Materials
Bernard Vonderschmitt	Xilinx Inc.
Adrian Walker	Dataquest
Paul Werthner	Hyundai Electric Europe GmbH
Hartwig Westphalen	Sharp Electronics Europe
Stefanie Wihl	NEC Electronics Europe GmbH
Richard Williams	Goldstar
Mike Williams	Dataquest
Gerry Wirtz	Philips Consumer Electronics
Jurgen Wolgast	Harris Semiconductor
David Wollen	Dialog Semiconductor
Philip Wood	Hitachi Europe Ltd
Roger Woolnough	Electronic Engineering Times
Günter Ziegenbalg	Zentrum Mikroelectronik Dresden
Jean Zirphile	Solectron

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EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE

May 26-28, 1993

Munich Park Hilton Hotel, Munich, Germany

List of Attendees by Company

Advanced Micro Devices GmbH	Bo Molander
	Gerhard Kessler
	H. Albrecht
Advantest System Engineering GmbH	Klaus Lutz
Air Products	Colin Overton
Alcatel Bell Telephone	Julien De Wilde
Alcatel Business Systems	Daniel Dourneau
Amkor Anam Europe Ltd	Steve Lerner
Amtel	Graham Turner
Apple Computer Ltd	Sean Murphy
ASM Lithography BV	Franki D'Hoore
AT&T Microelectronics	Rakesh Sood
Atmel Corporation	Graham Turner
BMW	Josef Mahalek
Consultant	Robert Lennox
Consumer Electronic Munich	Herbert Graus
Cyrix Corporation	Jerry Rogers
Cyrix International Ltd	Geoffrey Eccleston
Dataquest	Steve Durbin
	Jim Eastlake
	Mike Glennon
	Adrian Walker
	Mike Williams
Department of Trade and Industry	Timothy Reynoldson
Dialog Semiconductor	David Wollen
Digital Equipment BV	James Lynn
Digital Equipment Corporation	Art Swift

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Electronic Engineering Times	Roger Woolnough
Electronic New/IDG	Robert Lineback
Electronic Times	Rob Causey
Electronics Weekly	David Manners
Electronique International Hebdo	Elizabeth Feder
EPSON Semiconductor GmbH	Eamonn O'Sullivan
	Baerbel Stock
Eurodis AG	Rolf Thurnherr
Europartners	Gary Kibblewhite
Finmeccanica	Carolo Ferro
First Components GmbH	Willi Bacher
GEC Plessey Semiconductors	Ray Gleason
	Roland Schmimmelbaur
	Doug Dunn
	Terry McCloskey
Goldstar	Richard Williams
Goldstar Electron Ltd	David Leith
Harris Semiconductor	Jurgen Wolgast
Hewlett-Packard	Dragon Ilic
Hitachi Europe GmbH	Volker Brademeier
	Detlef Moench
Hitachi Europe Ltd	John Hannah
	Matthew Trowbridge
	Philip Wood
Hitachi Ltd	Shunji Shimada
Hyundai Electric Europe GmbH	Chang-Won Kim
	Paul Werthner
IBM	Pierre Bailly
IBM Corporation	Bill LaRosa
IBM Germany Production GmbH	Horst Barsuhn
Industrial Development Authority	Frank Ryan
Intel	Stephane Dupuis
Intel Corporation	Keith Chapple
	Hans Geyer

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International Herald Tribune	Mitchell Martin
Italtel SIT	Ferruccio Nebuloni
ITT Components Distribution	Greg Finney
JESSI	Guy Dumas
	Heinz Hagmeister
	Theo Holtwijk
LSI Logic	Alain Bismuth
LSI Logic Europe plc	Tony King-Smith
LSI Logic GmbH	François Le Cain
	Nick Phillon
Lucky Goldstar	Maxim Grancharov
Magneti Marelli spa	Cianci Cesario
Markt & Technik	George Steinberger
McKinsey & Company, Inc.	Oliver Garside
Micron Semiconductor GmbH	Tracey Kehne
Mietec Alcatel	Jean-Pierre Liebaut
	Eric Schutz
Millipore SA Process Division	Joop Sluis
Mitsubishi	Takashi Itasaka
Mitsubishi Electric (UK) Ltd	Hugo Patten
Mitsubishi Electric Corporation	Takao Nakano
Mitsubishi Electric Europe GmbH	Peter Mies
	Hidesuke Sugai
Mitsubishi Electric (UK) Ltd	Pat Jefferson
Motorola	Les Crudele
Motorola ECID	David Williams
Motorola European Semiconductor Group	Bill Gilmour
Motorola GmbH	Tobias Thummler
Motorola Inc.	Fred Shlapak
Motorola Ltd	Mike Inglis
National Semiconductor	Gerhard Hausmann
National Semiconductor (UK) Ltd	Roland Andersson
NEC (Electronics) Europe GmbH	Tetsuya Karikomi
NEC Electronics Europe GmbH	Stefanie Wihl

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Nissin Electric Co. Ltd	Eigo Koguchi
OCG Microelectronic Materials	Giuliano Vinotti
Oki Electric Europe GmbH	Fred Brunner
Philips Consumer Electronics	Gerry Wirtz
Philips Semiconductors	Günther Dengel
Philips Semiconductors BV	Melissa Jones
PictureTel	Drew Jamison
Redakilon Elektronik	TBA
Robert Bosch GmbH	Otto Holzinger
Samsung Semiconductor Europe GmbH	Peter Anders
SGS-Thomson	Pasquale Pistorio
SGS-Thomson Microelectronics	Jean-Philippe Dauvin
Sharp Electronics Europe	Hartwig Westphalen
Siemens AG, Semiconductor Group	Hans-Dieter Mackowiak
Solectron	Jean Zirphile
Sony Semiconductor Europe	John Gearing
	Ken Jones
Standard Microsystems Corporation	Douglas Finke
Texas Instruments	Kevin McGarity
Texas Instruments	Heiner Hirsch
Texas Instruments Europe HQ	John Bjorn Clevestig
Toshiba Electronics	Chris McAneny
Toshiba Electronics Europe GmbH	John Berry
	Alfred Borsig
	Robin Paling
VLSI Technology	Hans de Haan
Wacker-Chemitronic GmbH	Hans-Jurgen Giffhorn
Xilinx	Roland Triffaux
Xilinx Inc.	Bernard Vonderschmitt
Zentrum Mikroelectronik Dresden	Günter Ziegenbalg
Zetez GmbH	Peter Kipp

FIRST DAY

WELCOME AND CONFERENCE INTRODUCTION

Bipin Parmar
Group Director European Semiconductors
and Conference Chairman
Dataquest Europe Limited

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WELCOME AND CONFERENCE INTRODUCTION

Bipin Parmar
Group Director European
Semiconductors and
Conference Chairman
Dataquest Europe Limited

Mr. Parmar is Group Director European Semiconductors for Dataquest, based in Denham, England. He has more than 15 years of experience in the electronics industry. Prior to joining Dataquest, Mr. Parmar was European Product Marketing Manager for ASICs at Fairchild Europe Semiconductor. Earlier, he was Strategic Product Planning Manager at Fairchild, responsible for launching the FACT advanced CMOS logic family and silicon system compiler technology. His previous marketing management experience was gained at General Instrument and General Electric Company plc in microcomputer and semi-custom/custom logic. Mr. Parmar also worked as Communications Systems Engineer at Marconi based in the Middle East and Far East. He graduated in Electronics and Communications Engineering from the University of Essex, England.

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SEMICONDUCTOR MARKET FORECAST AND COMPANY ANALYSIS

Jim Eastlake
Associate Director
European Semiconductor Group
Dataquest Europe Limited

SEMICONDUCTOR MARKET FORECAST AND COMPANY ANALYSIS

Jim Eastlake
Associate Director
European Semiconductor Group
Dataquest Europe Limited

Mr. Eastlake is Associate Director and Manager of Dataquest's European Semiconductor Group, based in Denham, England. He has more than 15 years of experience in the electronics industry. Prior to joining Dataquest, he was with Texas Instruments (TI), Northern European Semiconductor Division. In his most recent post at TI, he ran the European Distribution Program for the Linear Functions Business Group. Earlier, he managed TI's advanced bipolar logic families and was responsible for launching TI's programmable logic families and bit slice functions in Northern Europe. He also held a product marketing position for 8- and 16-bit microprocessors and peripherals. Mr. Eastlake graduated from the University of Newcastle upon Tyne, England with an honours degree in Physics.

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SEMICONDUCTOR MARKET FORECAST AND COMPANY ANALYSIS

Mike Glennon
Senior Industry Analyst
European Semiconductor Group
Dataquest Europe Limited

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SEMICONDUCTOR MARKET FORECAST AND COMPANY ANALYSIS

Mike Glennon
Senior Industry Analyst
European Semiconductor Group
Dataquest Europe Limited

Mr. Glennon is a Senior Industry Analyst for Dataquest's European Semiconductor Group and is based in Denham, England. He has 13 years of experience in the electronics industry. Prior to joining Dataquest, Mr. Glennon was with European Silicon Structures where he was North European Marketing Manager responsible for ASICs and software. Previous to this he was with Fairchild Europe Semiconductor, responsible for technical and marketing support of the advanced silicon compiler systems design tool. Mr. Glennon worked as an IC designer both at Fairchild Europe and previously Marconi. He graduated from the University of London with an honours degree in Electronic Engineering.

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SEMICONDUCTOR MARKET FORECAST AND COMPANY ANALYSIS

Adrian Walker
Industry Analyst
European Semiconductor Group
Dataquest Europe Limited

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SEMICONDUCTOR MARKET FORECAST AND COMPANY ANALYSIS

Adrian Walker
Industry Analyst
European Semiconductor Group
Dataquest Europe Limited

Mr. Walker is an Industry Analyst for the European Semiconductor Group based in Denham, England, where he is responsible for memory products and EDP. He has worked in the semiconductor industry for more than nine years in a variety of roles. Most recently he spent three years as market research executive at Hitachi Europe in charge of semiconductor market analysis. Prior to this, he held a planning and purchasing role responsible for memory products supply to Northern Europe. Experience was also gained in an internal sales environment dealing extensively with the UK distribution market.

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AGENDA

- Semiconductor market overview - Jim Eastlake
- Market analysis ASICs/Micros - Mike Glennon
- Market analysis memories - Adrian Walker
- Semiconductor investment - Jim Eastlake

THE MARKET IN 1992

- Weak Japanese market
- Strong US market
- The PC drives growth - micros/memories
- Asia/Pacific IC market catches Europe
- Trade action against Korean DRAMs

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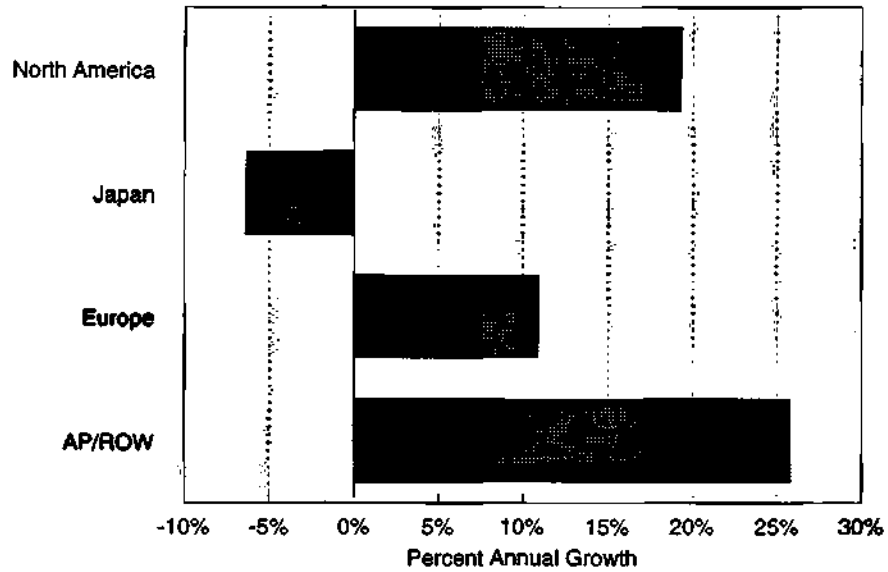
WORLDWIDE SEMICONDUCTOR MARKET
GROWTH RATES 1992



Source: Dataquest

EUROPEAN SEMICONDUCTOR MARKET SHARE

(Millions of Dollars)

1991 Rank	1992 Rank	Name	1992 Revenue	92/91 % Growth
1	1	Philips	1,138	-0.5
5	2	Intel	1,136	48.5
4	3	Motorola	975	25.6
2	4	Siemens	912	-6.0
3	5	SGS-Thomson	895	4.7
6	6	Texas Inst.	737	16.6
8	7	NEC	489	20.7
7	8	Toshiba	465	5.4
9	9	National Semi.	423	5.8
10	10	AMD	349	18.7

Source: Dataquest

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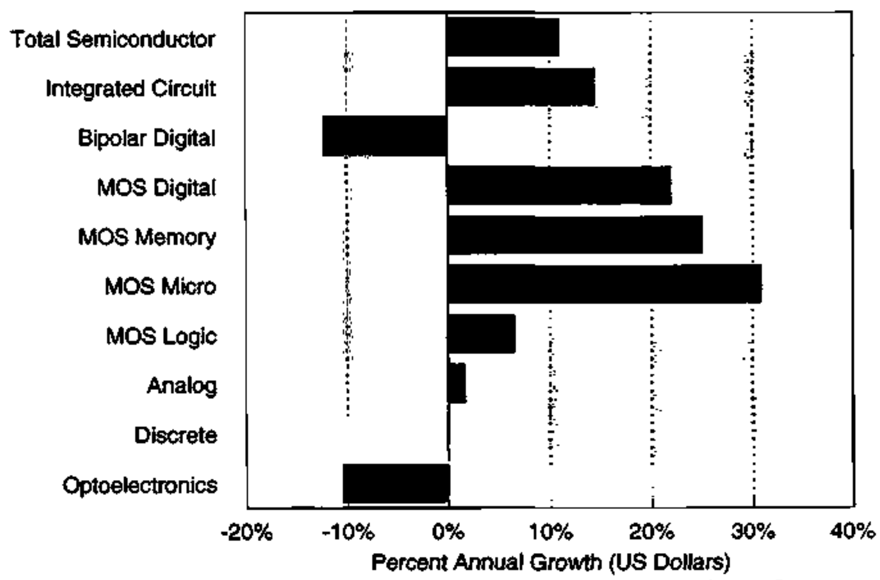
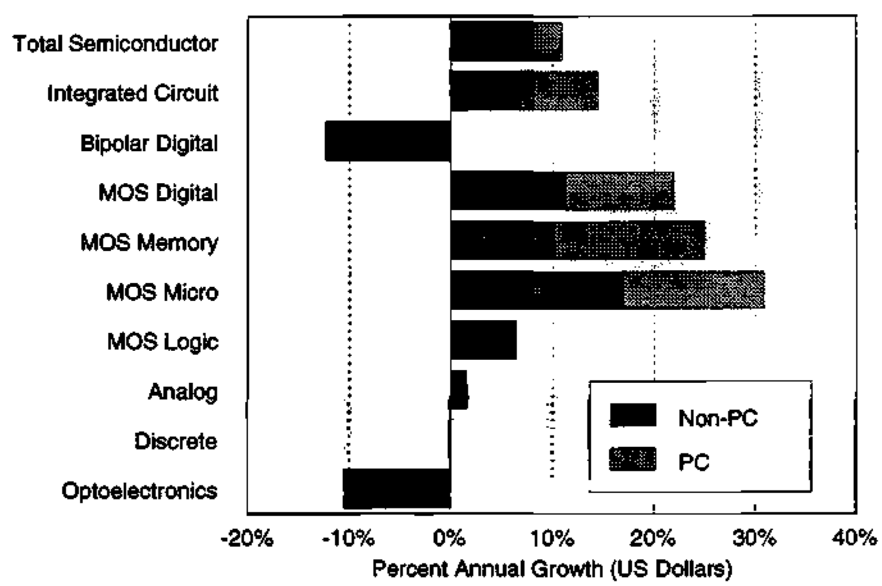
EUROPEAN SEMICONDUCTOR MARKET
PRODUCT GROWTH RATES 1992/91



Source: Dataquest

EUROPEAN SEMICONDUCTOR MARKET
PRODUCT GROWTH RATES 1992/91 - NO PC



Source: Dataquest

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IS THIS GROWTH SUSTAINABLE??

Yes - for at least the next two quarters!

- PC market strong
- Availability of 80486
- Major OEMs reporting no critical shortages
- "No-name" clones short of product
- No sign of inventory build up in US

FALSE SIGNS OF SLOWDOWN

- PC motherboard inventory building in Far East
  - Reason: shortage of processors for clones
- Order cancellations from disc drive companies
  - Reason: mixed problems caused by uptake of 486 machines

EUROPEAN SEMICONDUCTOR MARKET CONSUMPTION FORECAST

(Millions of Dollars)

	1992	1993	AGR 93/92	1997	CAGR 97/92
Total Semiconductor	12,218	14,599	19.5%	21,467	11.9%
Total IC	9,958	12,261	23.1%	18,749	13.5%
Bipolar Digital	426	371	-13.0%	228	-11.8%
MOS Digital	7,132	9,346	31.1%	14,941	15.9%
Memory	2,660	3,502	31.7%	6,480	19.5%
Microcomponent	2,723	3,924	44.1%	5,758	16.2%
Logic	1,749	1,920	9.8%	2,703	9.1%
Analog	2,400	2,544	6.0%	3,580	8.3%
Discrete	1,826	1,883	3.1%	2,084	2.7%
Optoelectronic	434	456	5.0%	634	7.9%

Source: Dataquest

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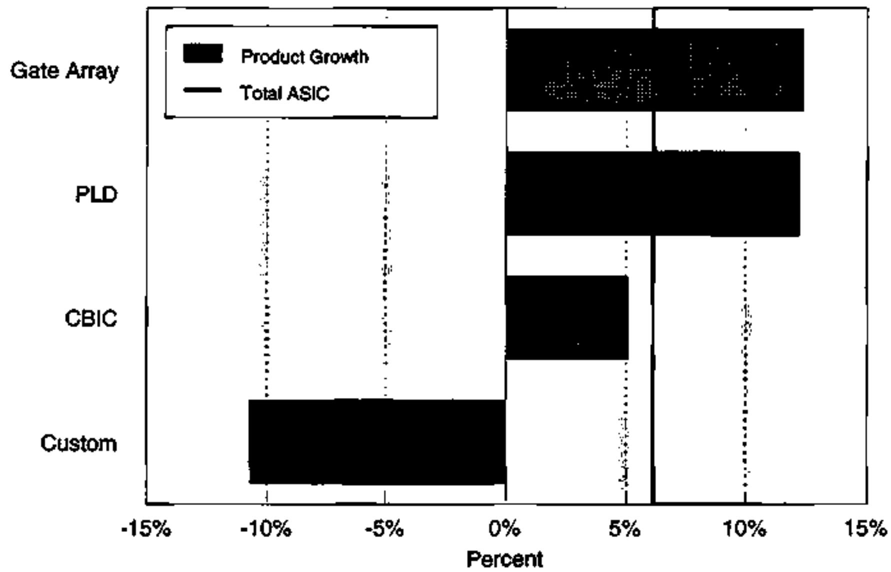
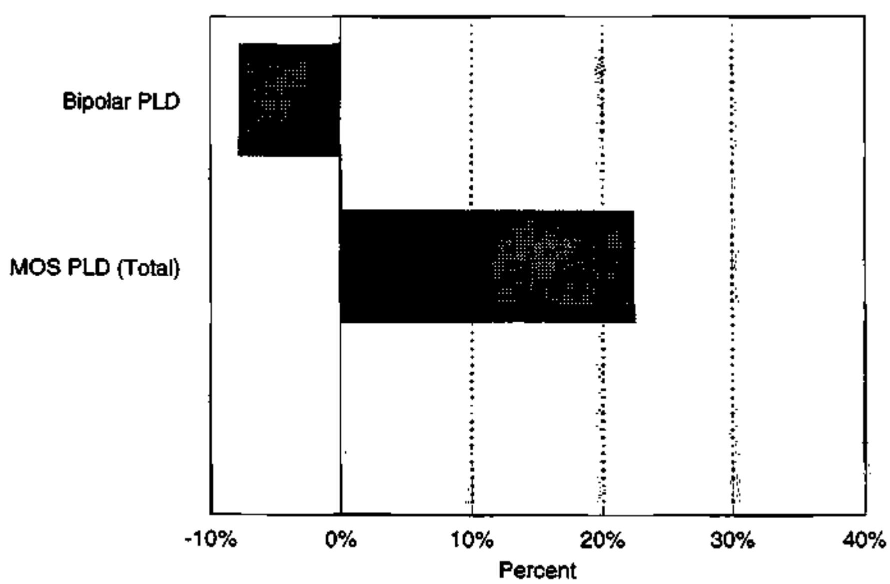
EUROPEAN ASIC MARKET
PRODUCT GROWTH-1992



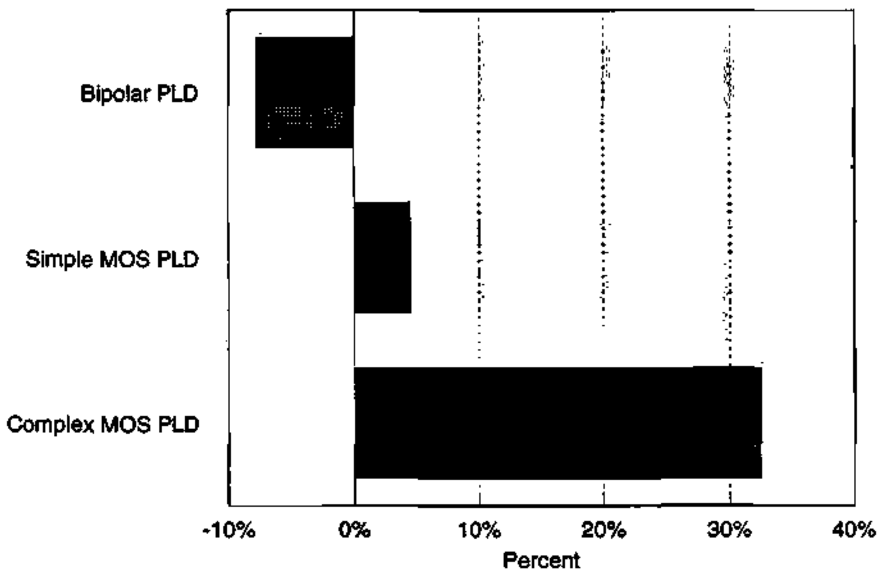
Source: Dataquest

EUROPEAN PLD MARKET
GROWTH-1992



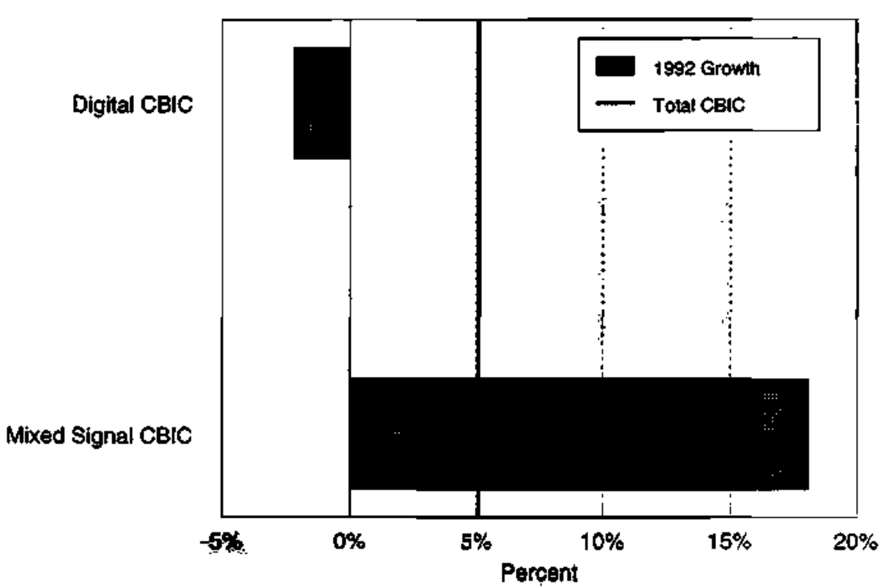
Source: Dataquest

EUROPEAN PLD MARKET
GROWTH-1992



Source: Dataquest

EUROPEAN ASIC MARKET
GROWTH-1992



Source: Dataquest

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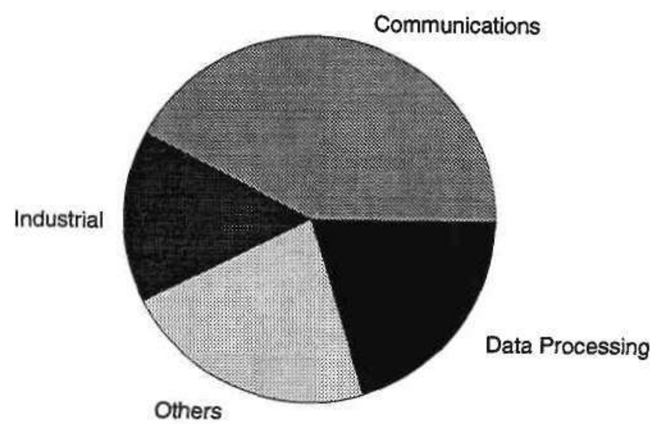
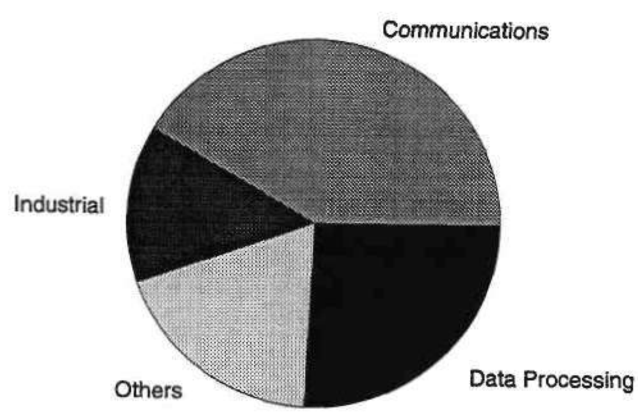
EUROPEAN ASIC MARKET
APPLICATIONS SHARE



Source: Dataquest

EUROPEAN GATE ARRAY MARKET
APPLICATIONS SHARE



Source: Dataquest

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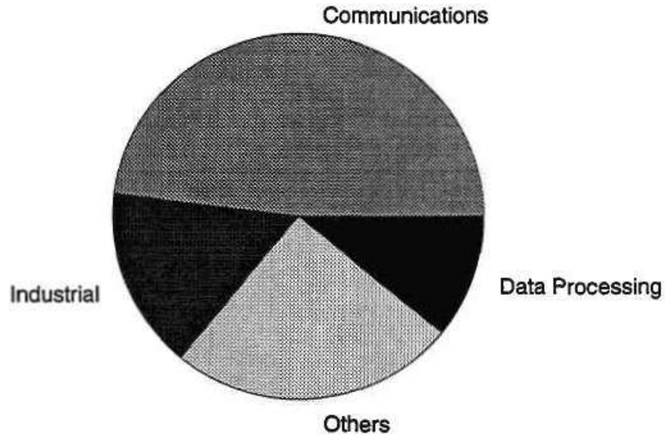
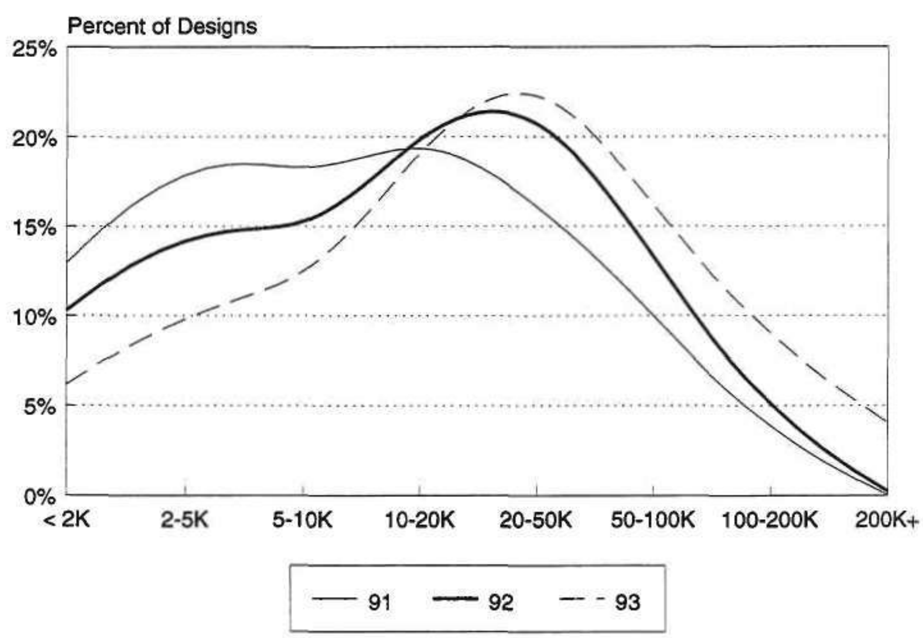
EUROPEAN CELL-BASED MARKET
APPLICATIONS SHARE



Source: Dataquest

GATE ARRAY DESIGN STARTS



Source: Dataquest

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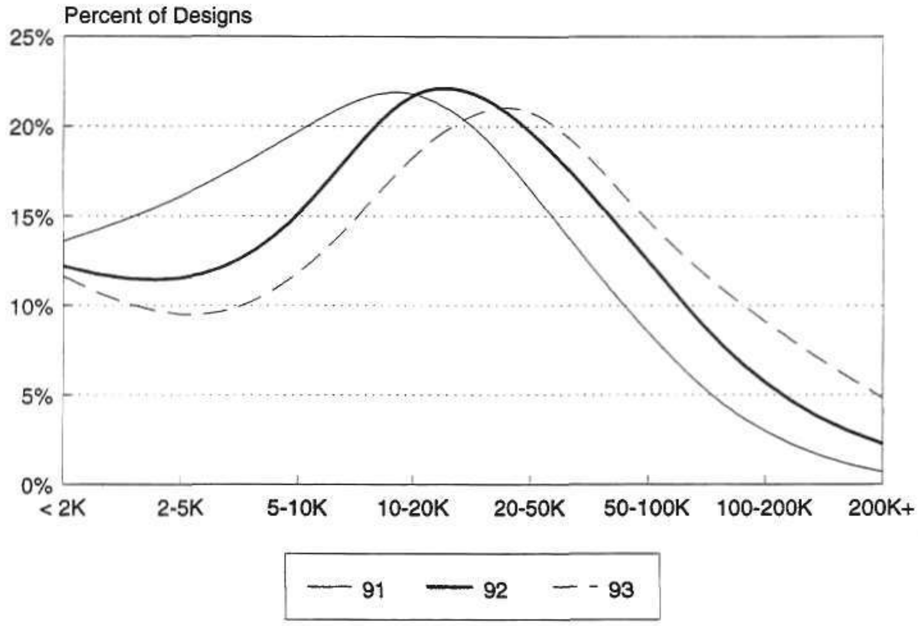
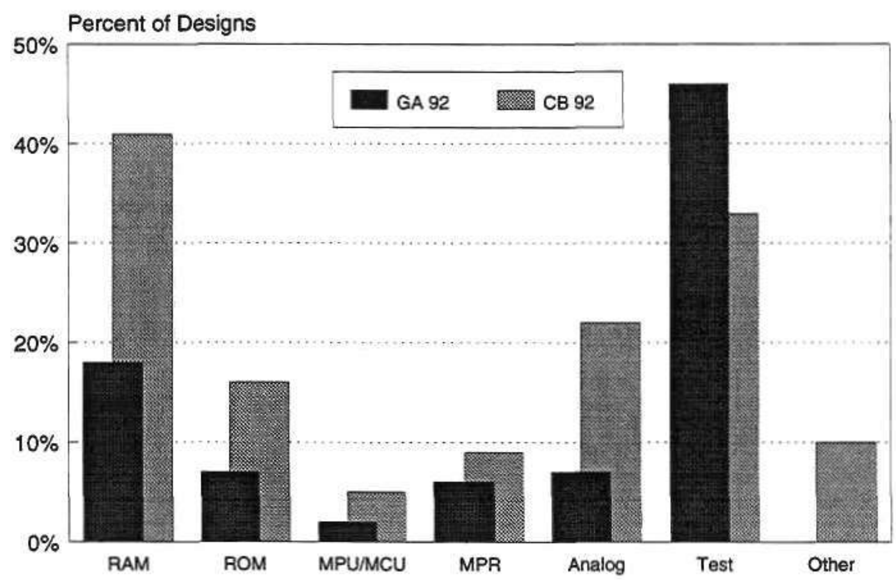
CELL-BASED DESIGN STARTS



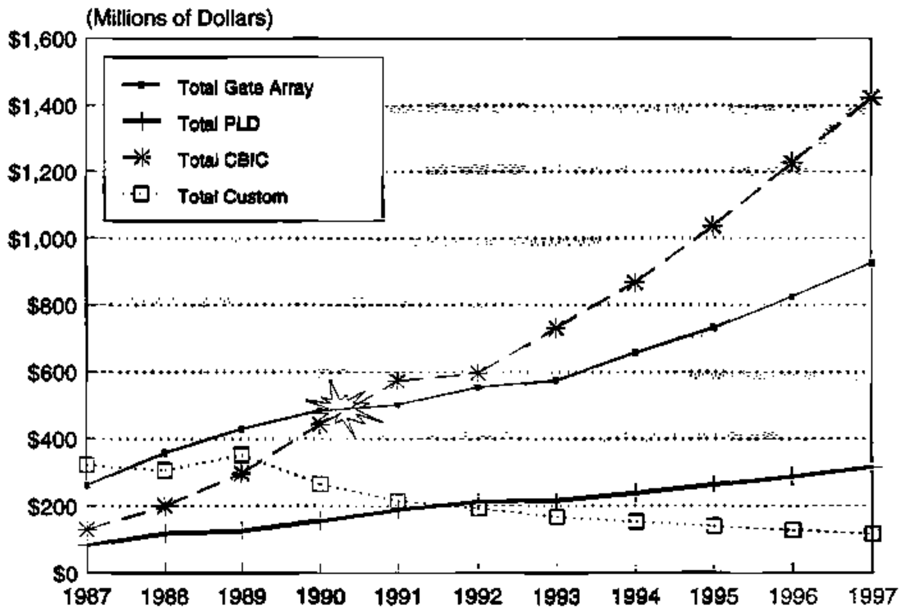
Source: Dataquest

ASIC DESIGN STARTS
MACRO CELL USAGE



Source: Dataquest

EUROPEAN ASIC MARKET



Source: Dataquest

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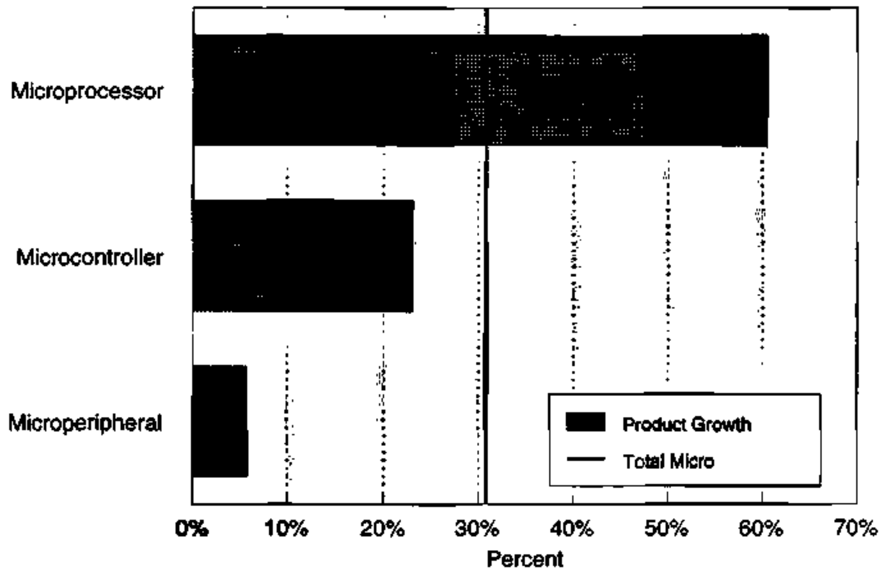
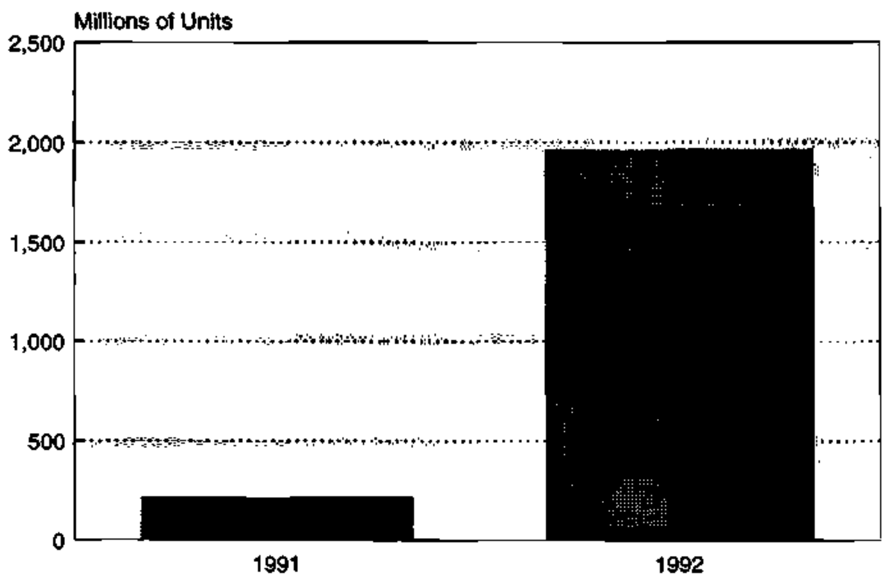
EUROPEAN MICROCOMPONENT MARKET
PRODUCT GROWTH-1992



Source: Dataquest

EUROPEAN PC UNIT SHIPMENTS
486 PROCESSOR SHARE



Source: Dataquest

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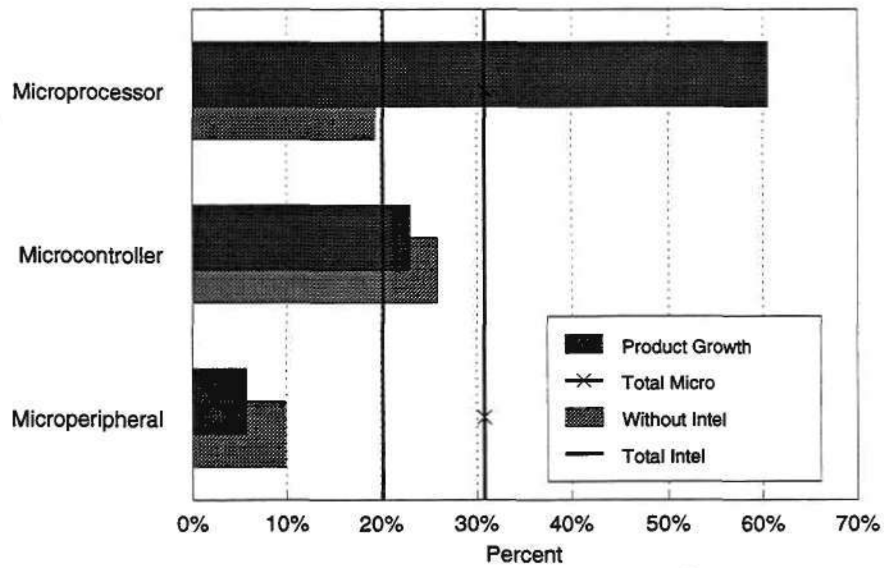
EUROPEAN MICROCOMPONENT MARKET
PRODUCT GROWTH-1992 (without Intel)



Source: Dataquest

MICROCOMPONENT APPLICATION TRENDS

- Car semiconductor content rising
  - Body electronics
  - Safety and convenience
  - As well as powertrain control

- Rising number of controllers
  - Driving need for Bus systems
  - Probably more than 1 Bus
  - Standards still not settled

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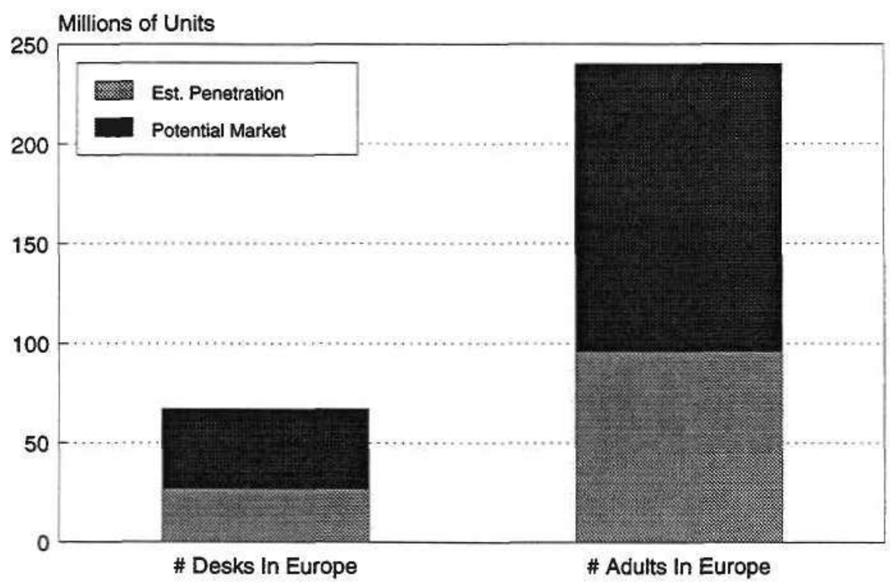
MICROCOMPONENT APPLICATION TRENDS

- Telecoms digitisation growing
  - Exchange: Exports now dominating
  - GSM: Late start but growing well

- Microcomponent and ASIC overlapping more
  - Cordless comms is one key area
  - Automotive controllers is another

EUROPEAN EDP POTENTIAL
PC versus PERSONAL ORGANISERS



Source: Dataquest

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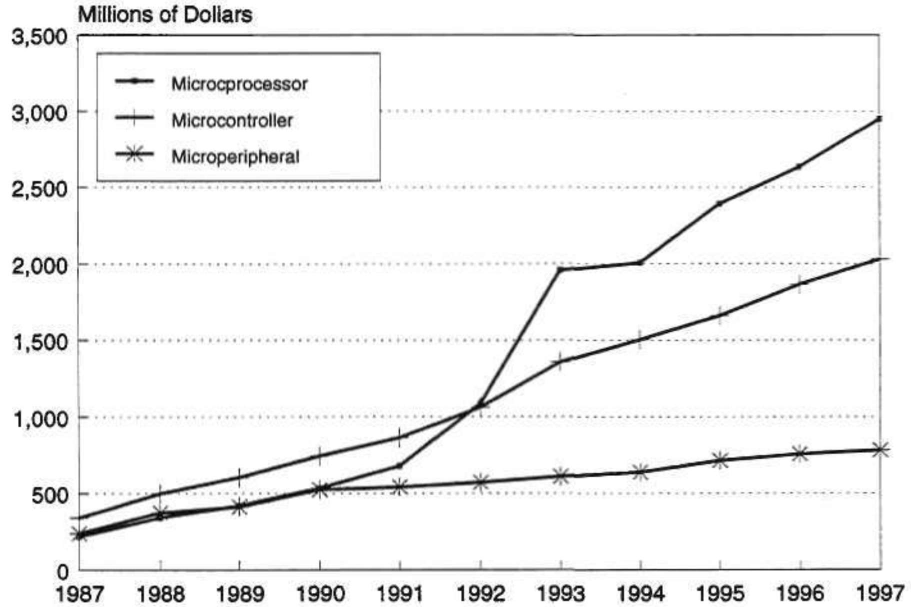
EUROPEAN MICROCOMPONENT MARKET



Source: Dataquest

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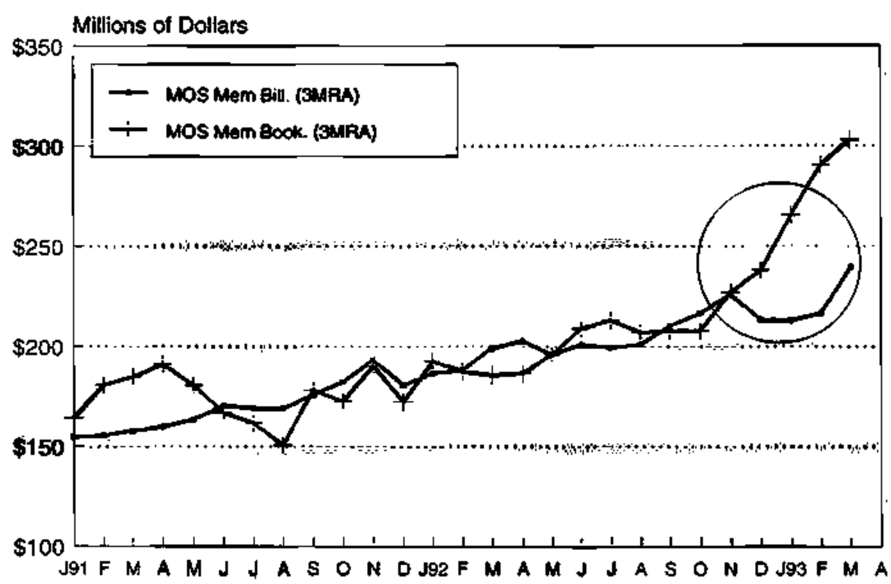
WORLDWIDE DRAM MARKET CONCENTRATION

(Percent of Total Market)

	1976	1980	1984	1988	1992
Top 1	26	19	15	19	14
Top 2	45	33	30	33	26
Top 5	84	66	65	64	54
Top 10	92	92	84	90	83
Suppliers	15	18	24	18	22
Total Market ($M)	$200	$1,030	$3,520	$6,708	$8,735
Supplier Avg. ($M)	$13	$57	$147	$373	$397

Source: Dataquest

W. EUROPEAN MOS MEMORY BOOKINGS AND BILLINGS 1991-1993 YTD



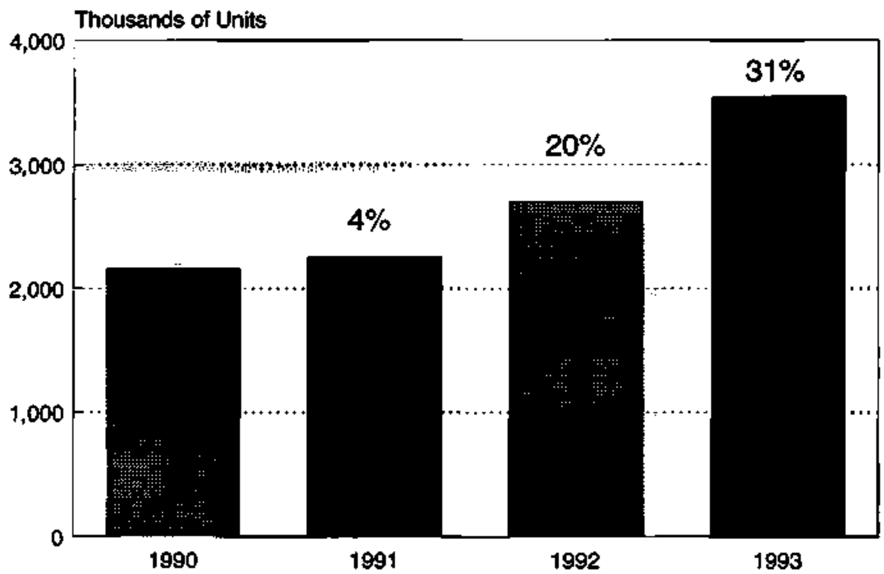
Source: WSTS/Dataquest

MOS MEMORY PRICES AND LEAD TIMES

Device Family	Average Selling Price Now	Average Selling Price Nov 1992	Lead Times Now	Lead Times Nov 1992
4Mx1 DRAM	$11.50	$10.51	14 wks+	8 wks
256Kx16 DRAM	$13.40	$13.00	16 wks+	12 wks
4Mx4 DRAM	$88.00	$93.84	12 wks	8 wks
1M Flash	$7.45	$5.97	26 wks+	8 wks
2M Flash	$16.00	$13.77	26 wks+	16 wks
256K SRAM (Slow)	$3.05	$2.94	6 wks	3 wks

Source: Dataquest DQ Monday Pricing Survey

1993-YEAR OF THE BIG NAMES
EUROPEAN PC PRODUCTION



Source: Dataquest

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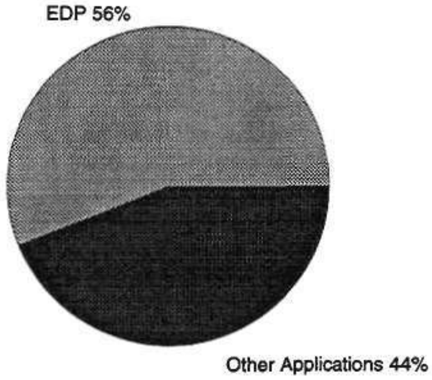
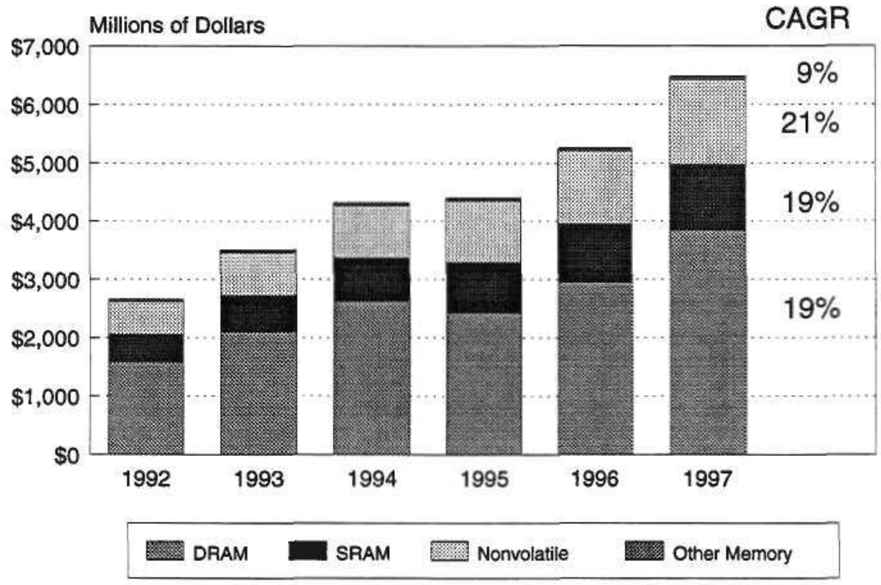
EUROPEAN MOS MEMORY MARKET
1993 SPLIT BY APPLICATION



EDP Memory 1993
TAM $1.9 Billion

Source: Dataquest

EUROPEAN MOS MEMORY MARKET
1992-1997



Source: Dataquest

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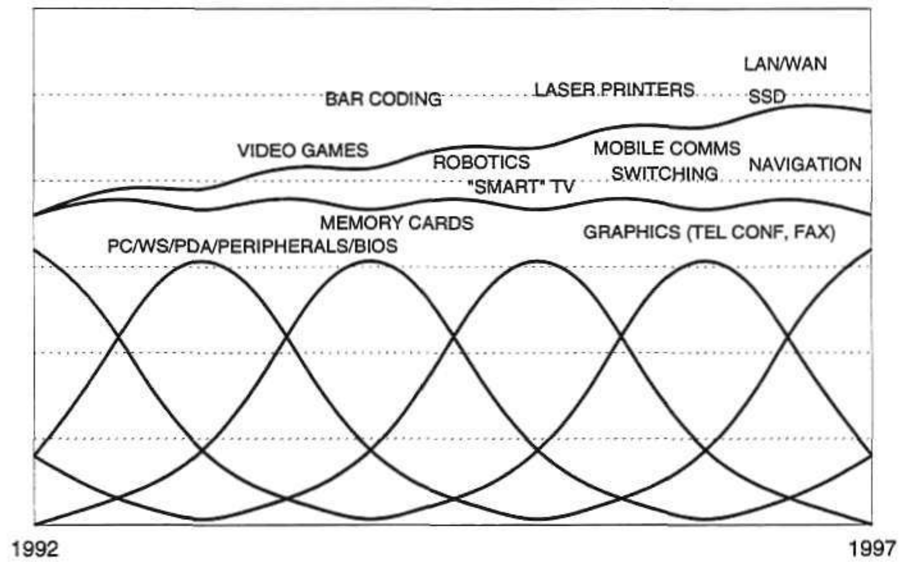
DEVELOPING APPLICATIONS
MOS MEMORY



16M DRAM DEVELOPMENT COST

ITEM	COST ($M)
Facility Cost	$350
Product/Process Development	$200
Variable Costs	$244
Total Costs	$794

Source: Dataquest

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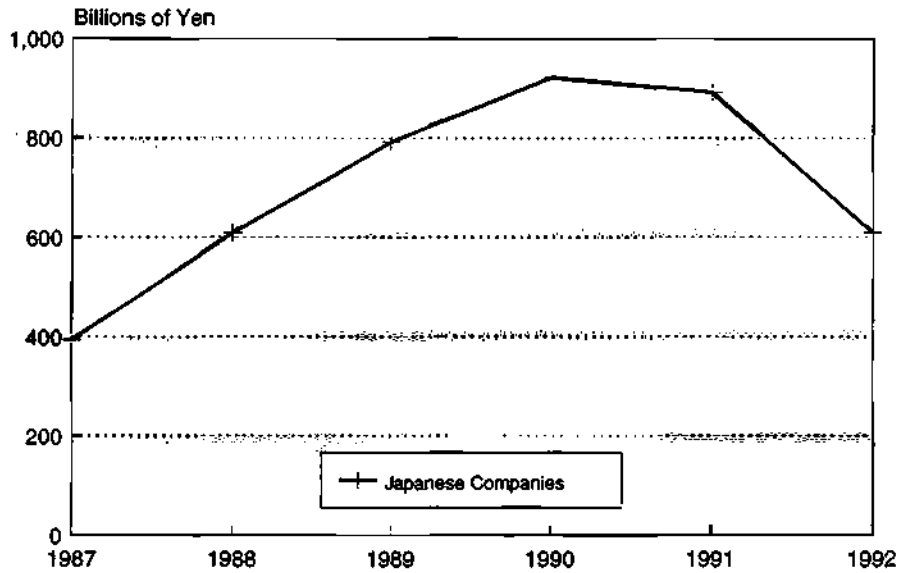
SEMICONDUCTOR CAPITAL INVESTMENT
BY JAPANESE COMPANIES



Source: Dataquest

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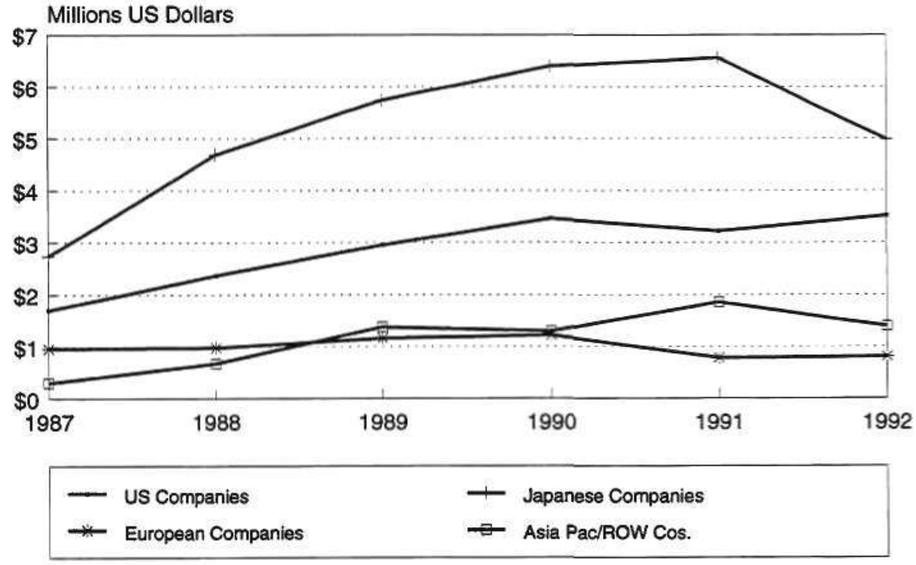
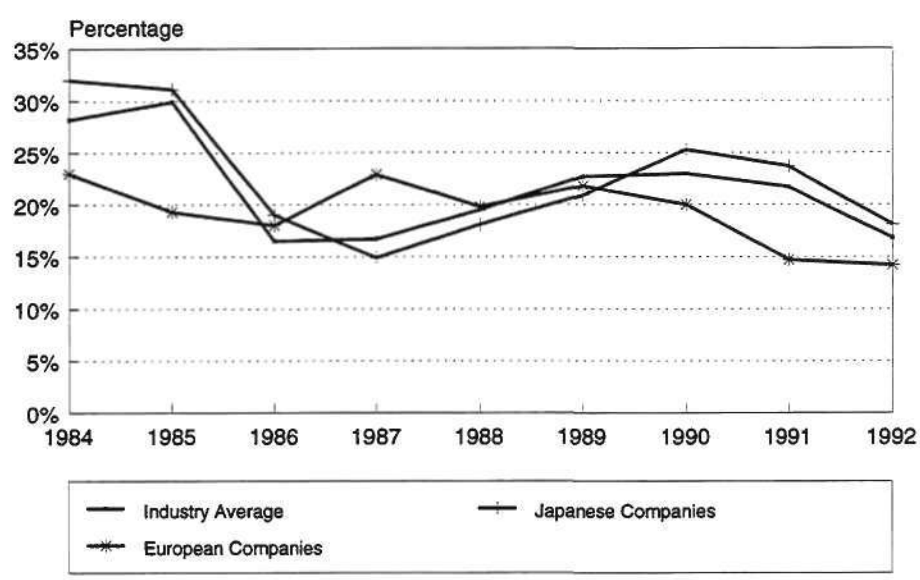
SEMICONDUCTOR CAPITAL INVESTMENT
BY VENDOR ORIGIN



Source: Dataquest

SEMICONDUCTOR INDUSTRY
CAPITAL INVESTMENT-TO-REVENUE RATIO



Source: Dataquest

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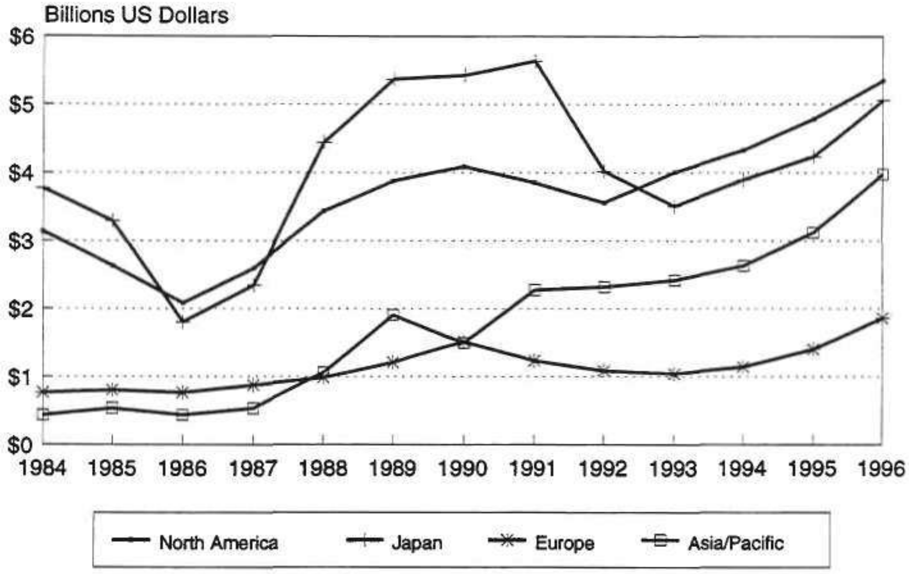
SEMICONDUCTOR CAPITAL INVESTMENT
BY REGION



Source: Dataquest

SUMMARY

- Strong semiconductor market
- Overlap between processor and controller applications less clear
- Future of ASIC in Europe in special cells
- Memory pervasion continues
- Timing of investment critical for Europe

STRATEGIES AND DIRECTIONS FOR GROWTH

Kevin McGarity
Senior Vice President
Texas Instruments, Components Sector

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STRATEGIES AND DIRECTIONS FOR GROWTH

Kevin McGarity
Senior Vice President
Texas Instruments,
Components Sector

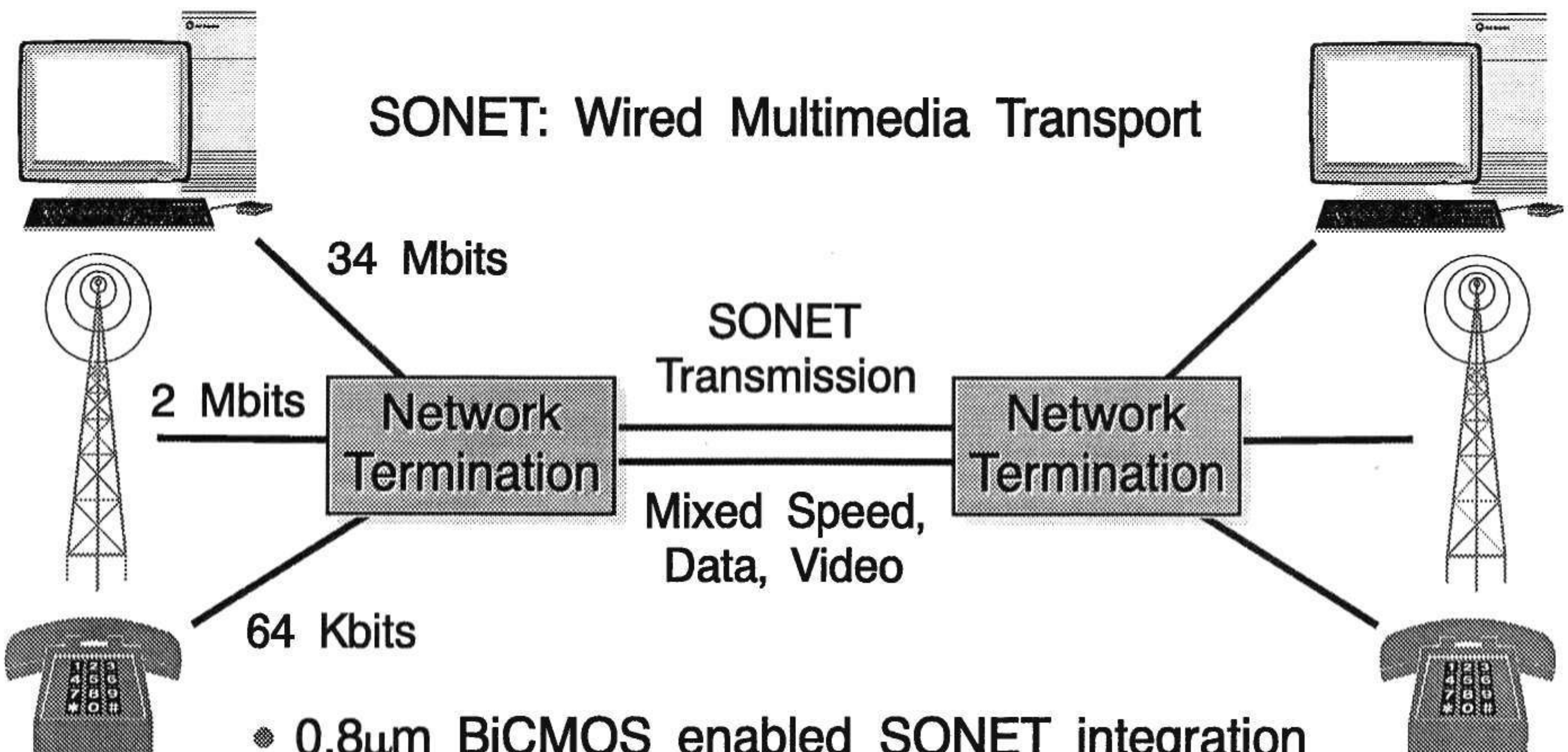
As Senior Vice President and Manager of Worldwide Marketing and Total Quality for Texas Instruments Components Sector, Mr. McGarity is responsible for sales, total quality, strategic marketing, market research, merchandising, and field technical marketing. His previous assignments include manager of North American marketing for semiconductor products as well as various operational and marketing positions in the United States and Europe. Before joining TI, Mr. McGarity spent five years in the United States Navy as a carrier pilot. He holds a B.S. degree in Electrical Engineering from Marquette University, United States.

Dataquest Europe Limited
EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE
May 26–28, 1993
Munich, Germany

TEXAS INSTRUMENTS

TRANSMISSION & SWITCHING

SONET + ATM

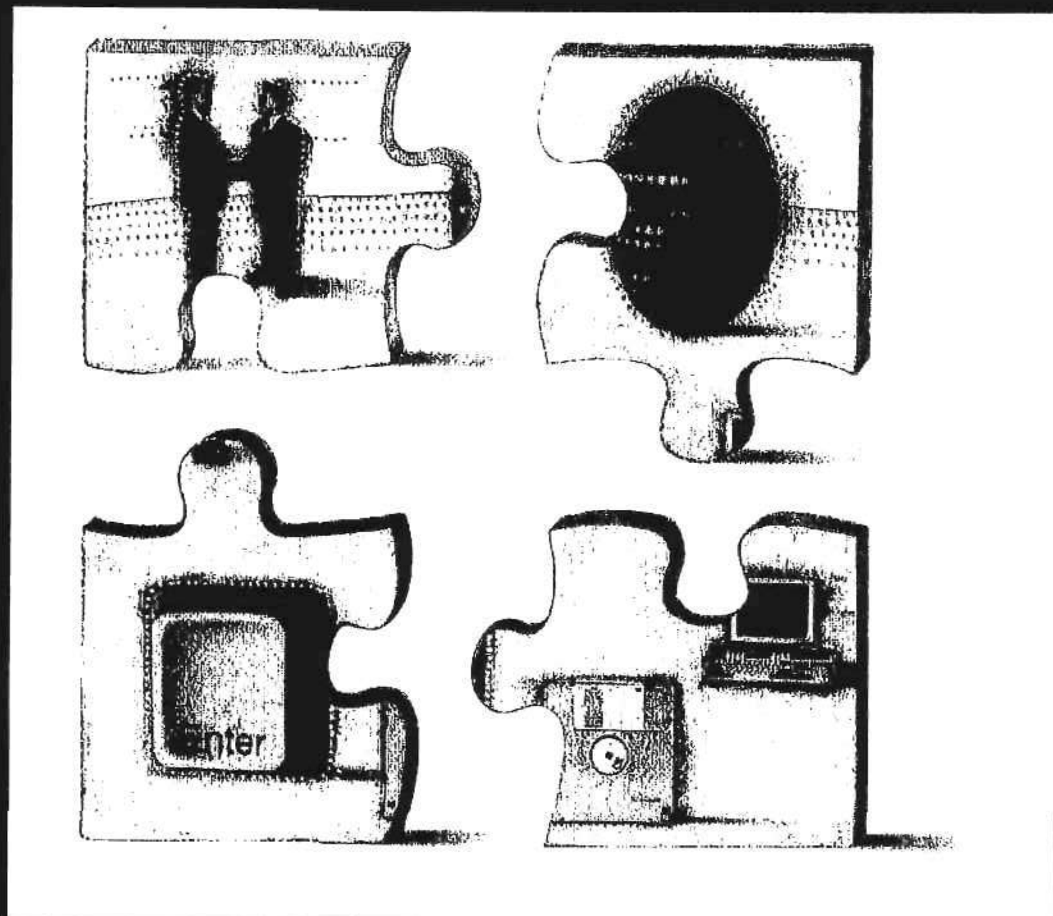


- 0.8μm BiCMOS enabled SONET integration
- 0.5μm BiCMOS enables ATM integration

TOTAL INTEGRATION

Service

Silicon Technologies



Information

Tools

A NEW MODEL

1980s

- Commodity Products
- Self-funded Capital Investment
- Traditional Supplier – Customer Relationships

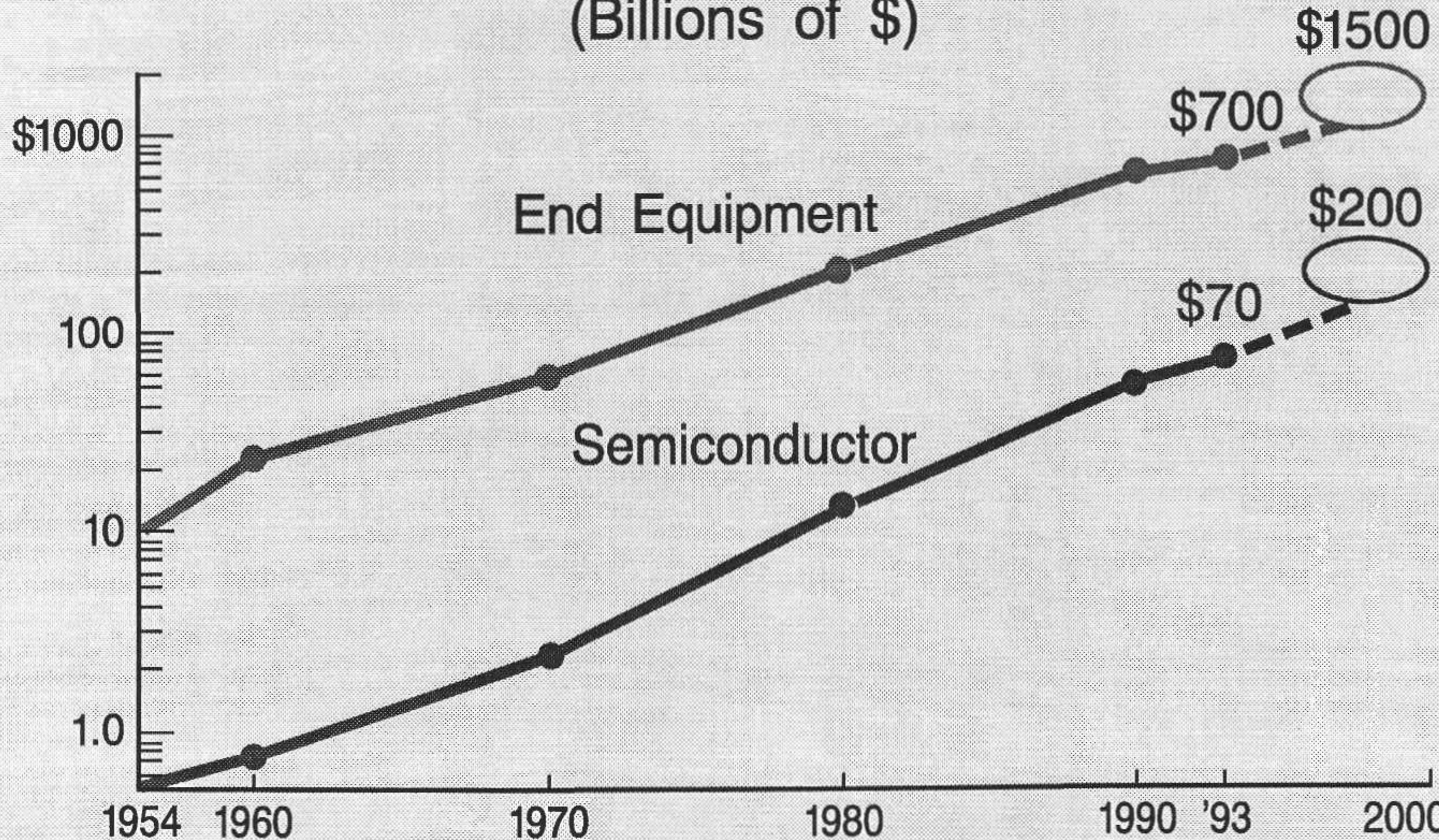
+

1990s

- Differentiated Value-added Products
- Third Party Shared Investment
- Virtual Integration with Customers

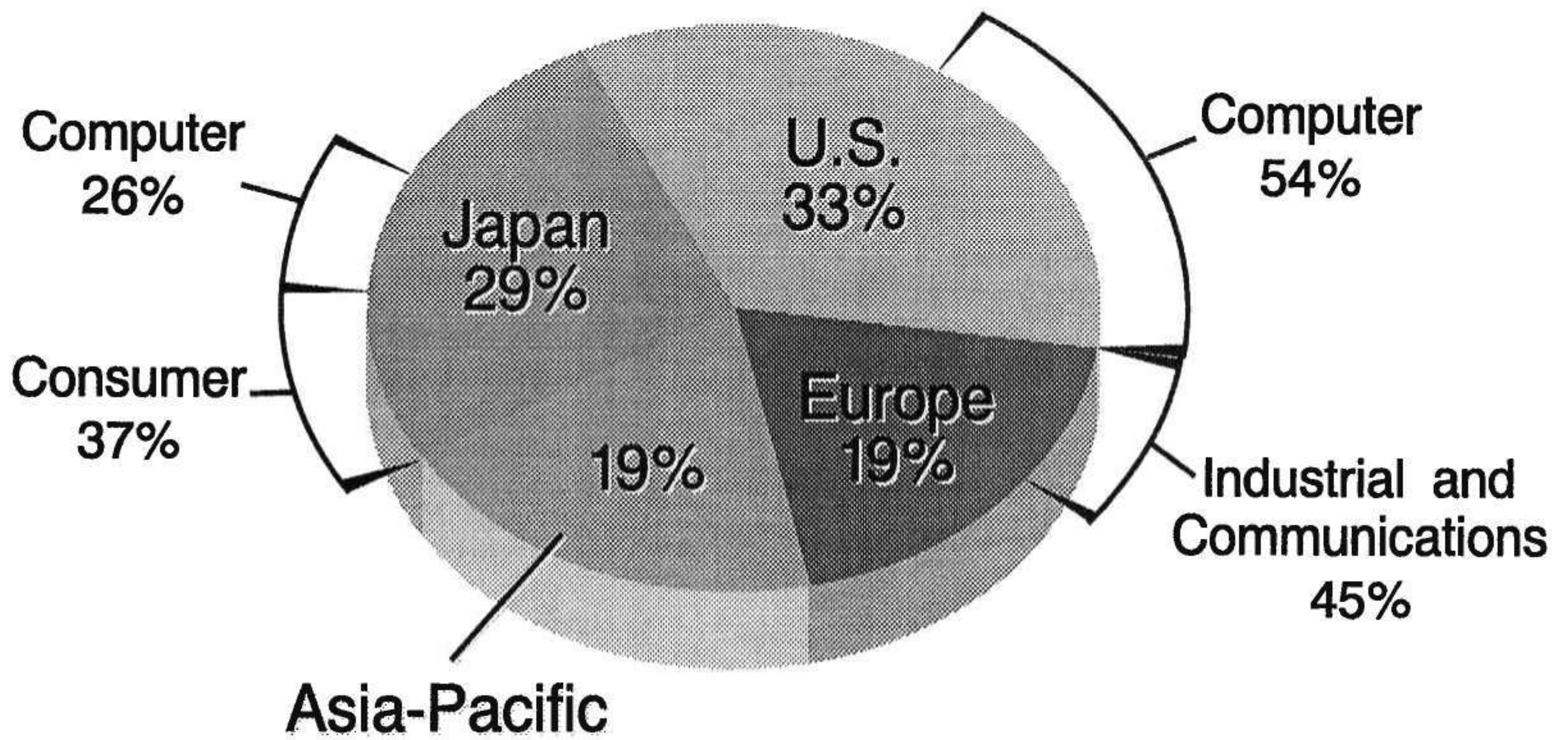
ELECTRONICS: ONE OF THE WORLD'S LARGEST INDUSTRIES

(Billions of $)



WORLD SEMICONDUCTOR MARKET

17% Growth in 1993



$70.0B

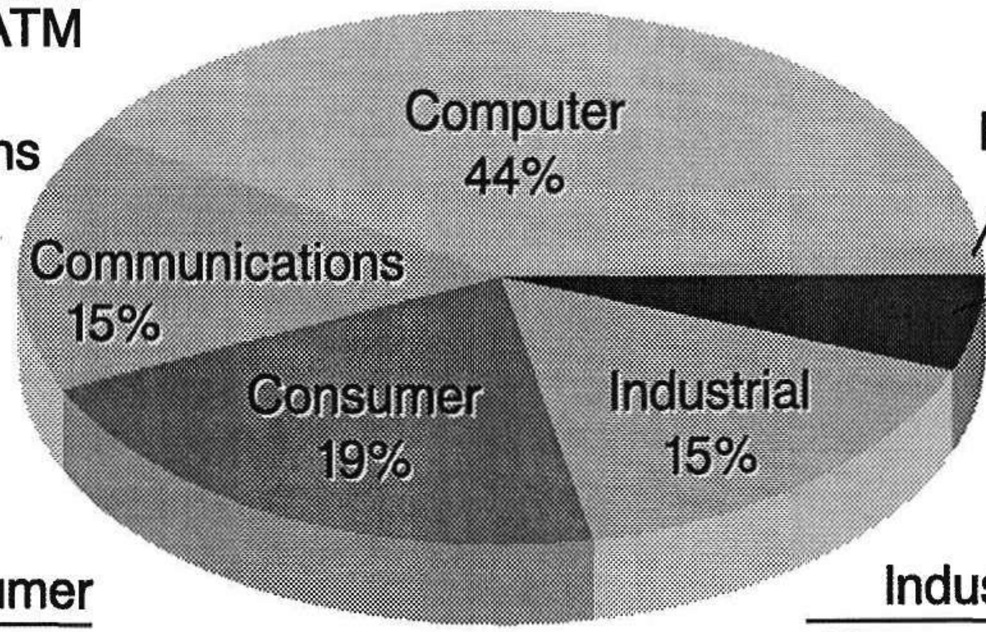
HIGH-GROWTH END-EQUIPMENT SEGMENTS

Computer

486 & Up PCs
Notebook PCs
RISC Workstations
Hard Disk 3.5″ & Smaller

Communications

SONET/SDH→ATM
Wireless Communications



Automotive

Body Control
Vehicle Control

Consumer

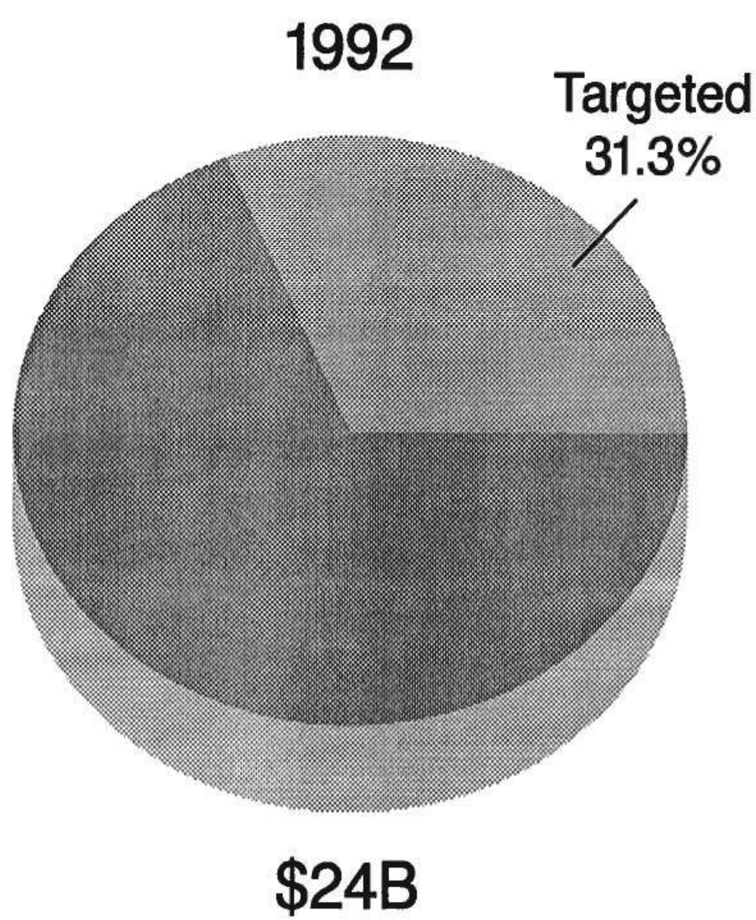
Digital Video

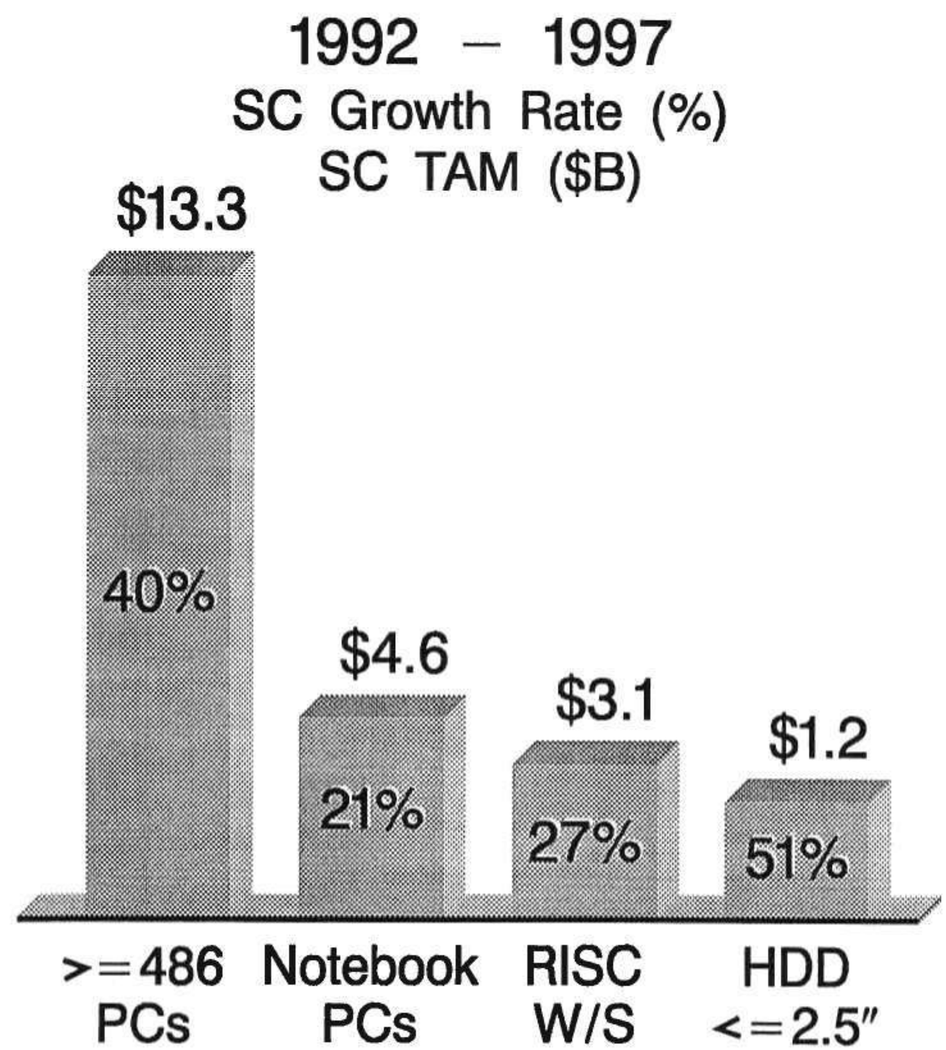
1997 SC TAM
$110B

Industrial

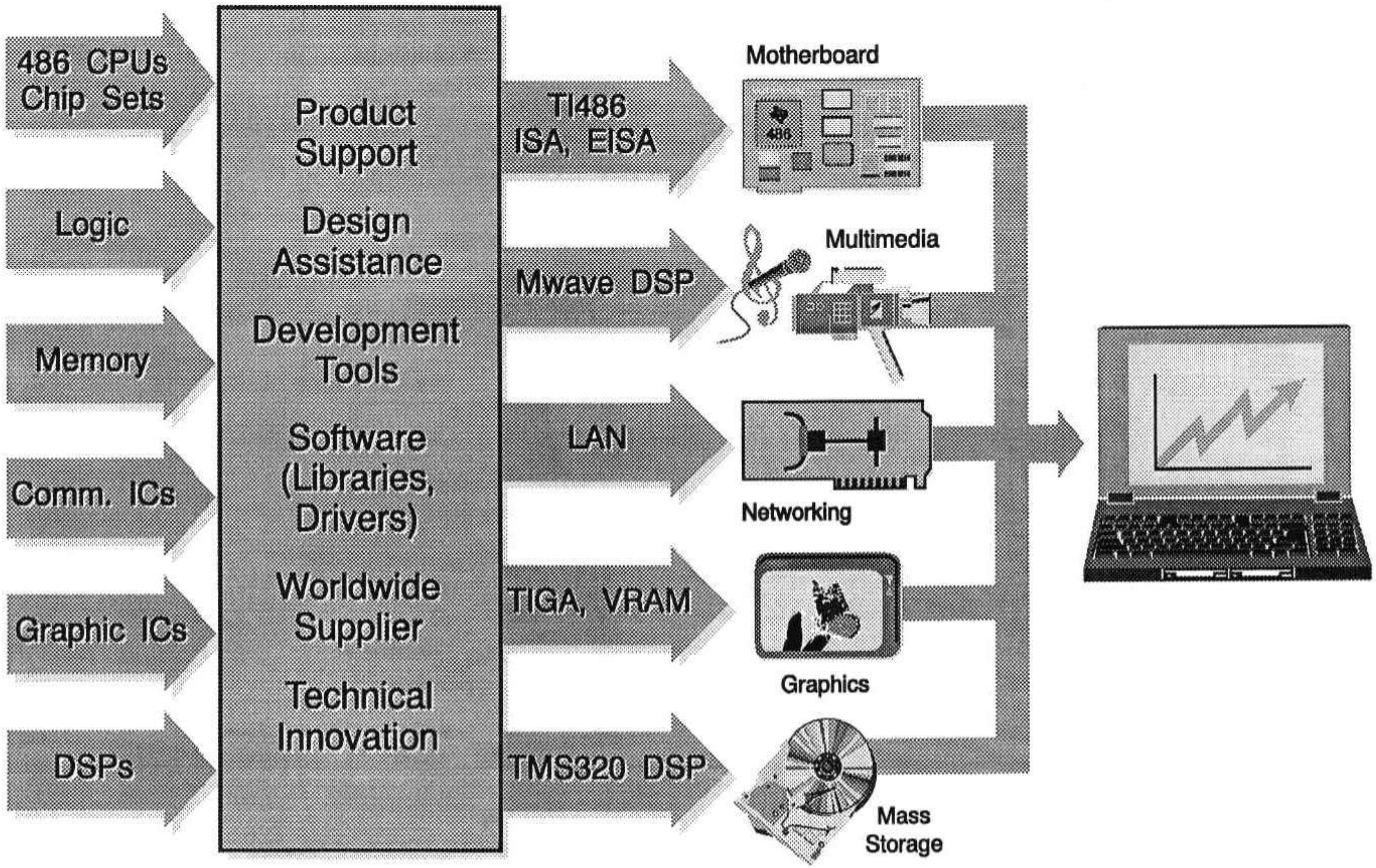
Home Control
Copier Imaging
Smart Cards
Motor Controls

WORLDWIDE COMPUTER MARKET

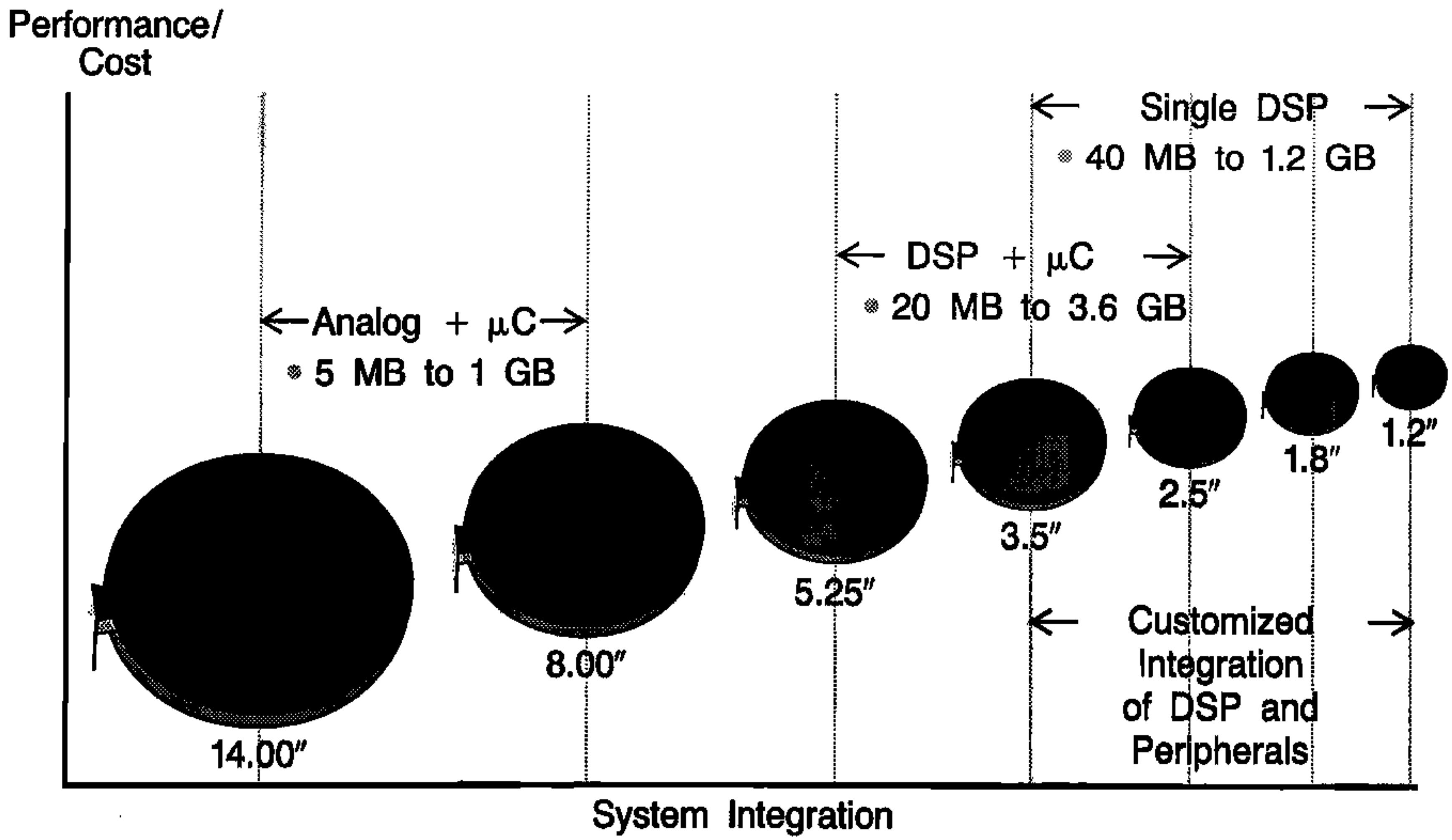




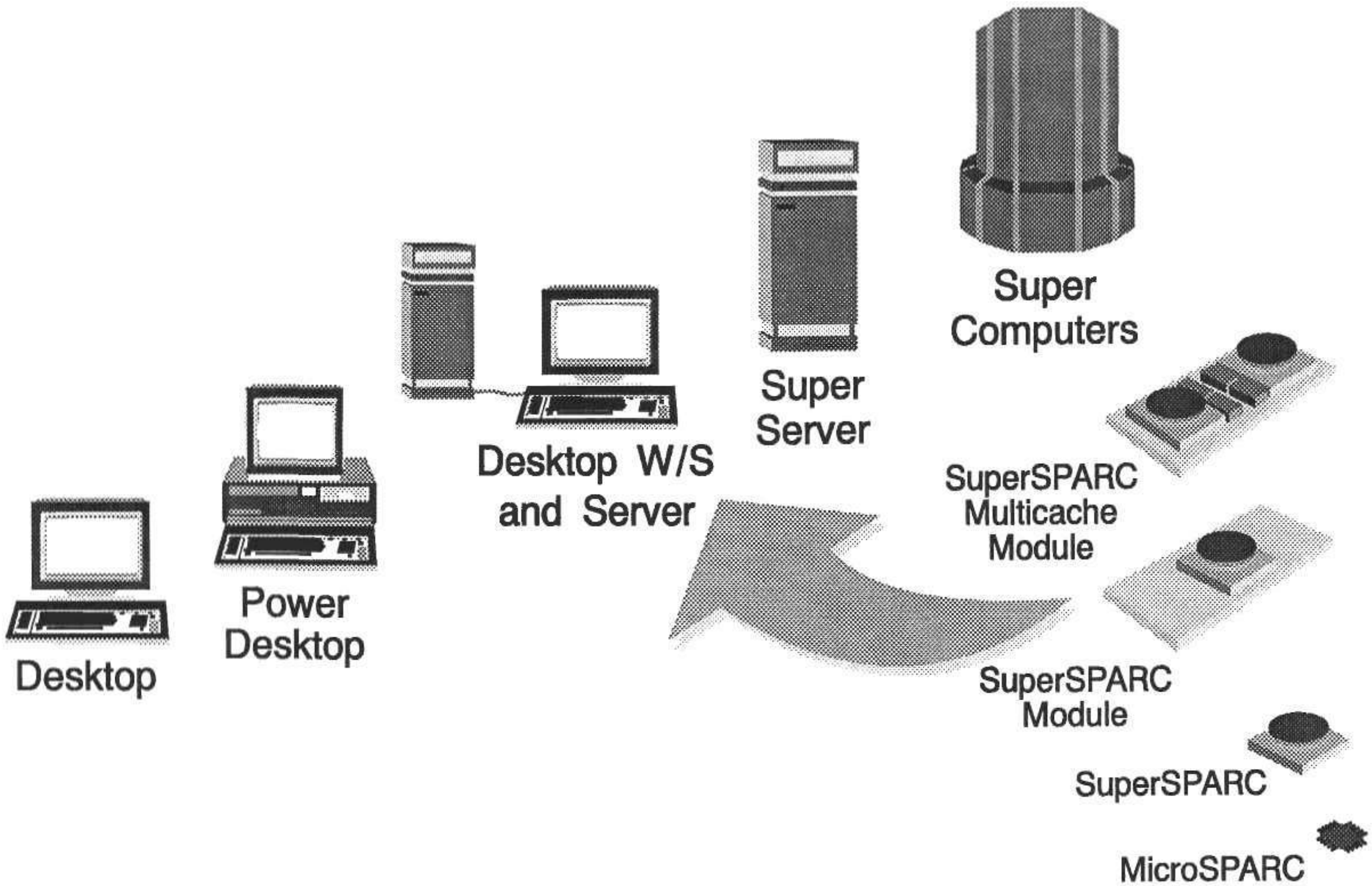
SEMICONDUCTOR INTEGRATION ROADMAP



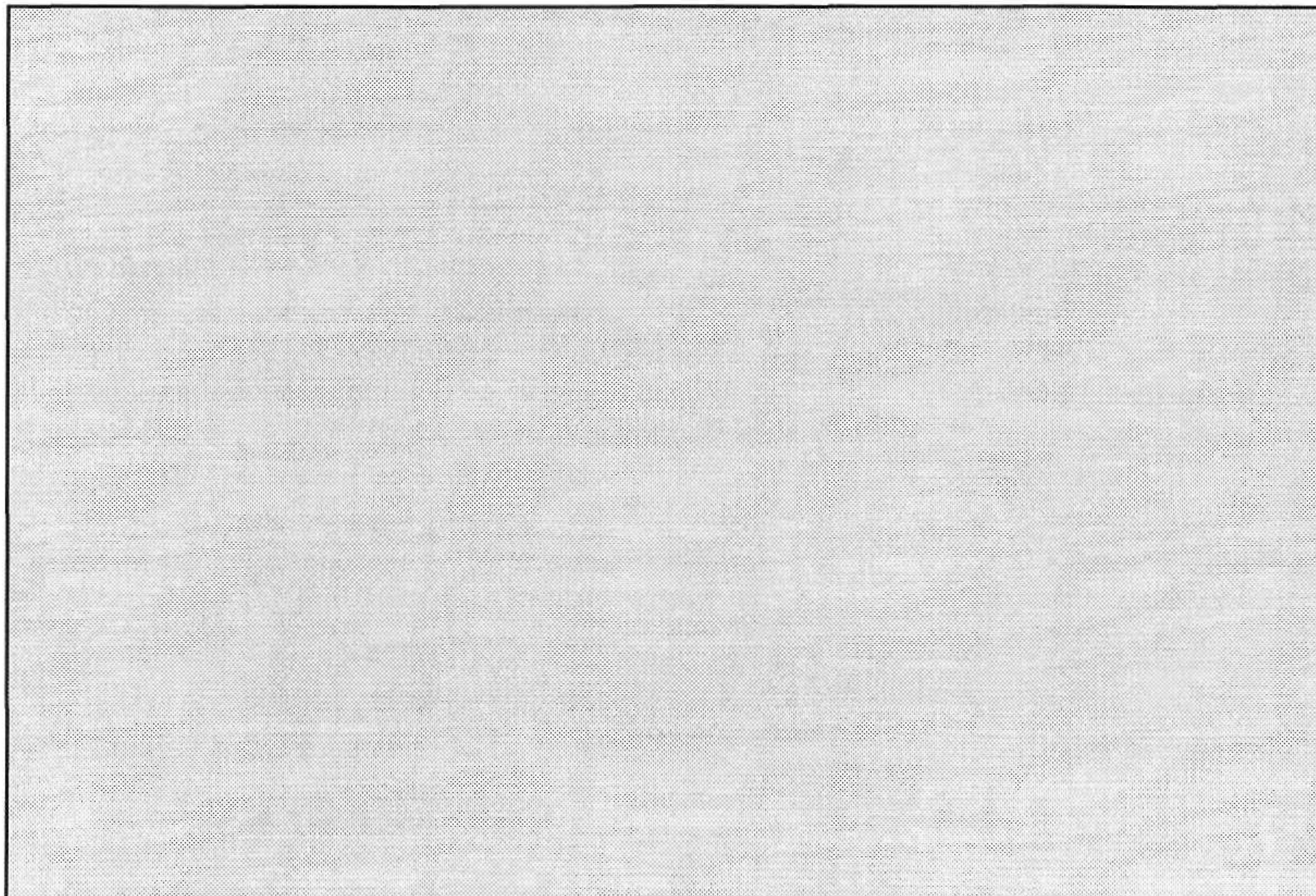
HDD MIGRATION



SPARC™ Workstation & Client Server Computing

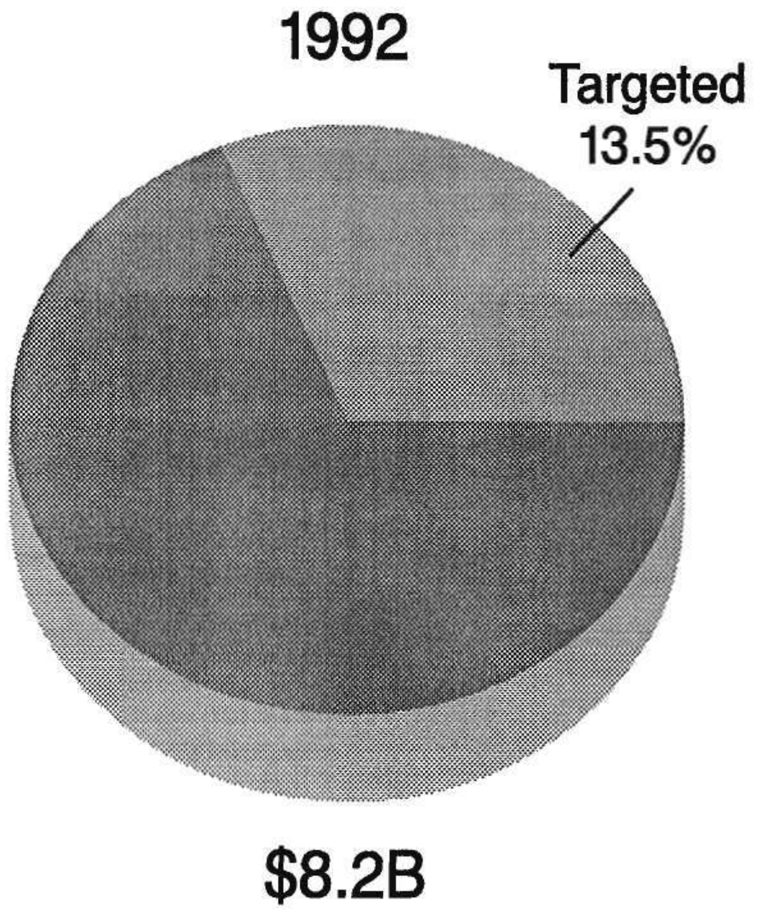


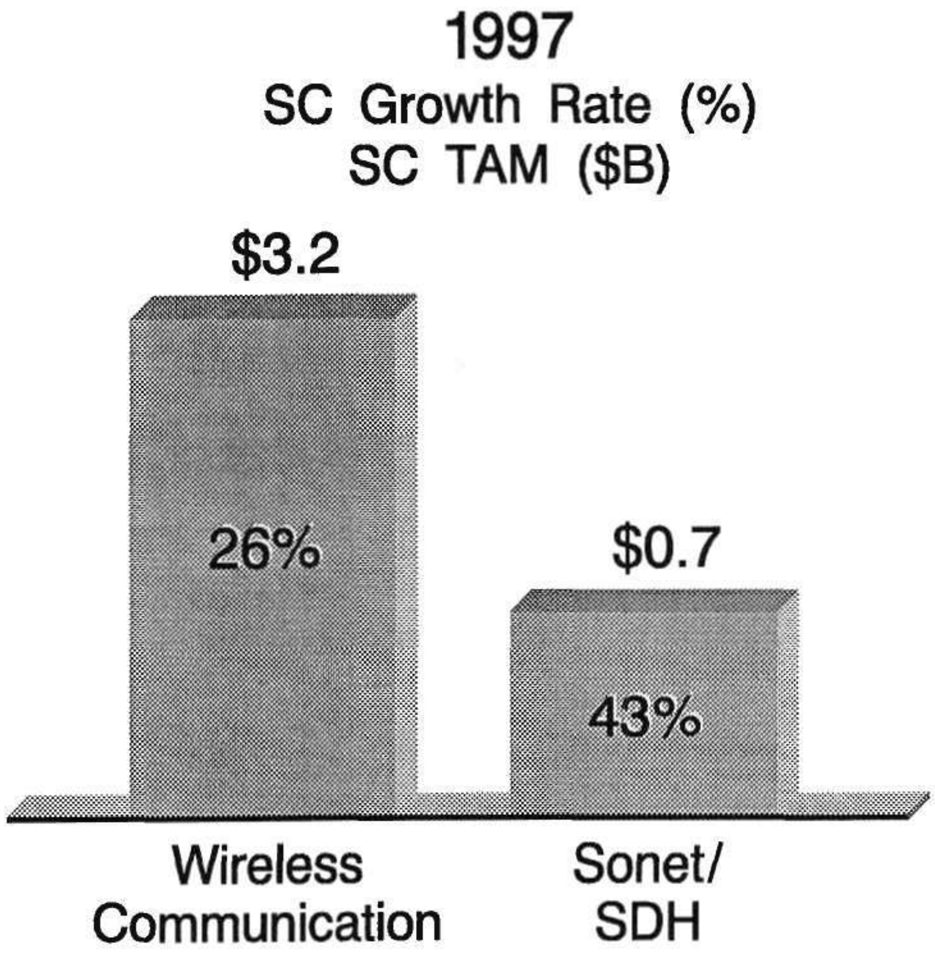
SUPER SPARC MULTICACHE MODULE



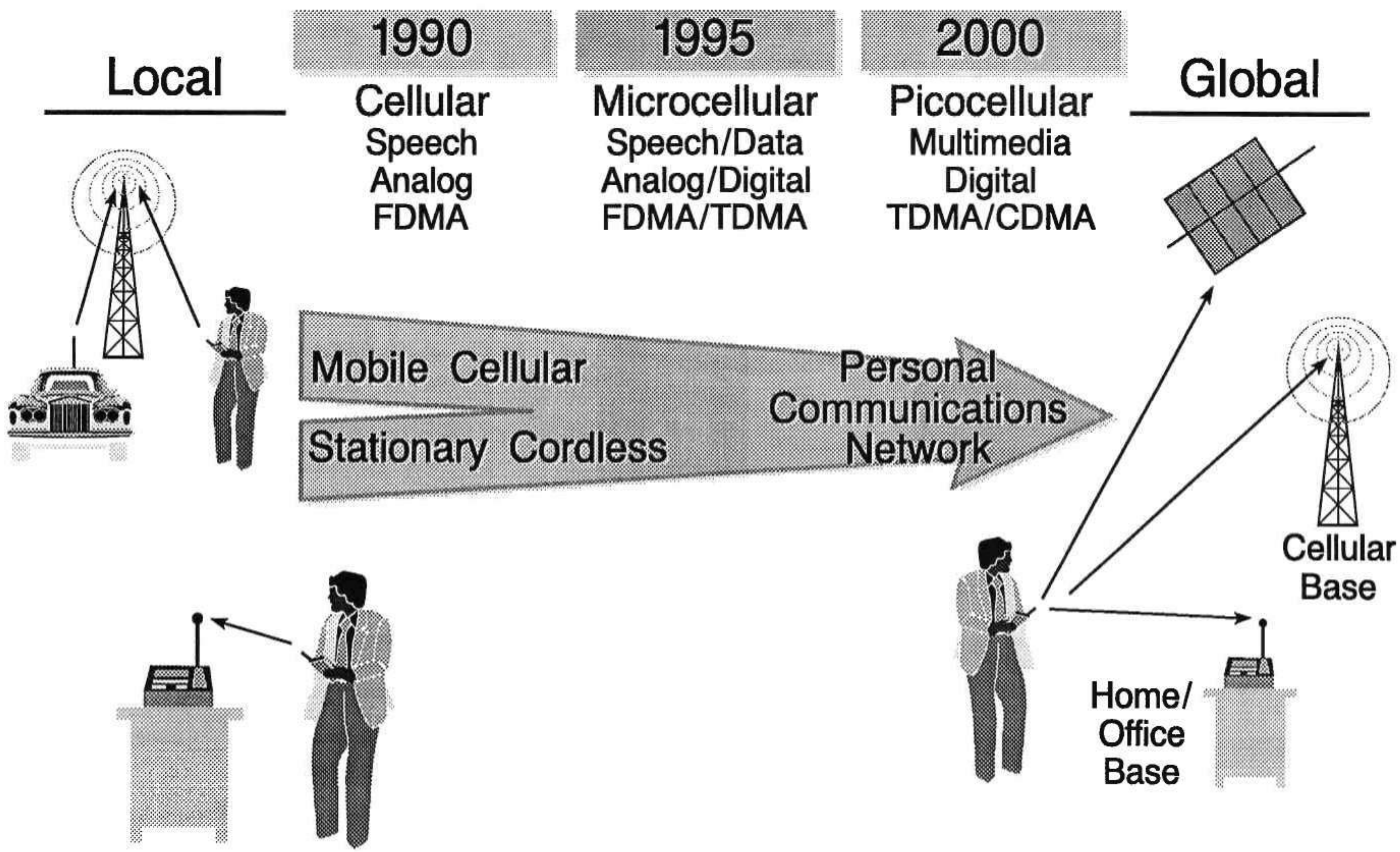
WORLDWIDE SEMICONDUCTOR MARKET

Communications



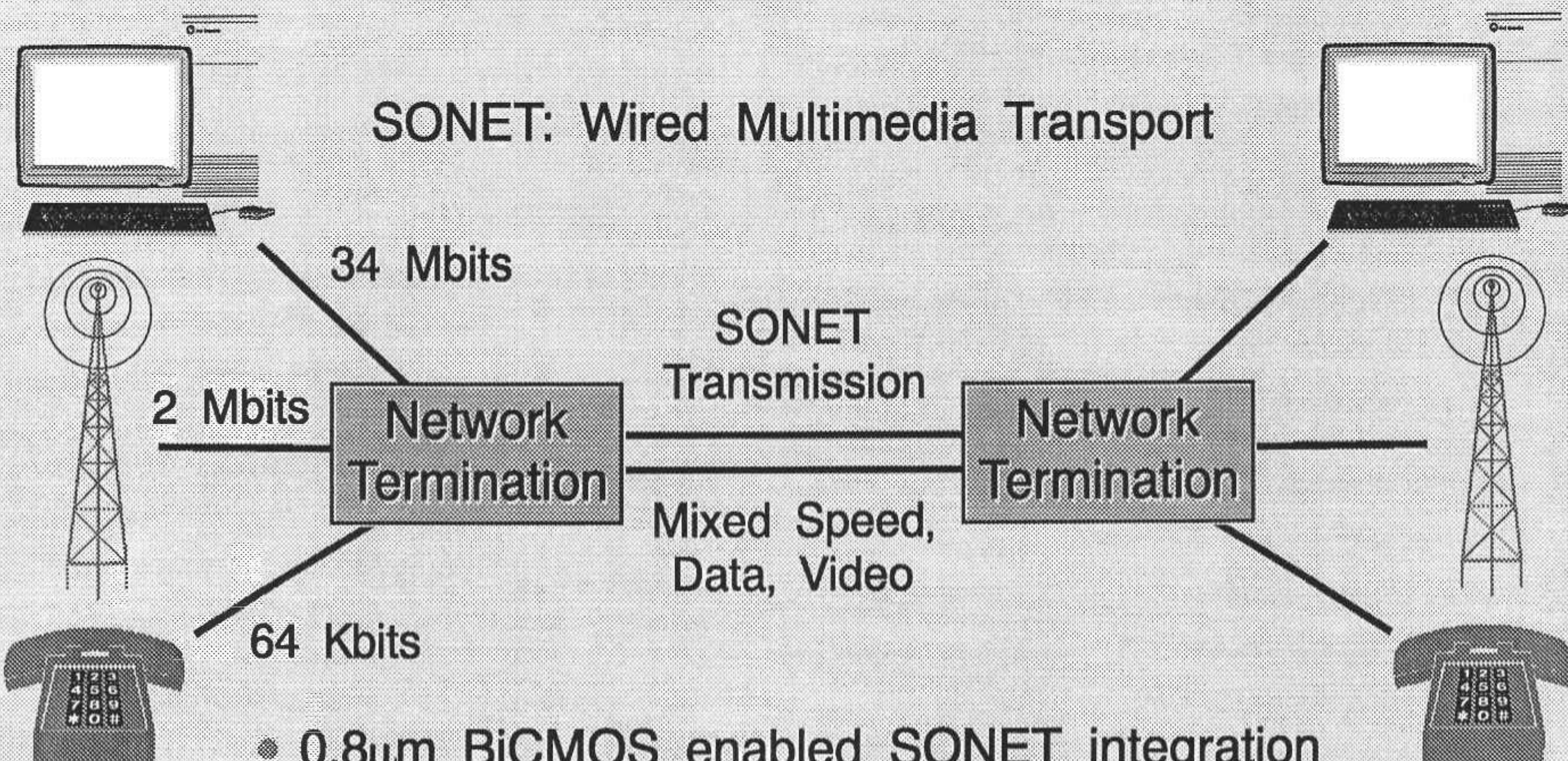


WIRELESS COMMUNICATIONS TRENDS



TRANSMISSION & SWITCHING

SONET + ATM



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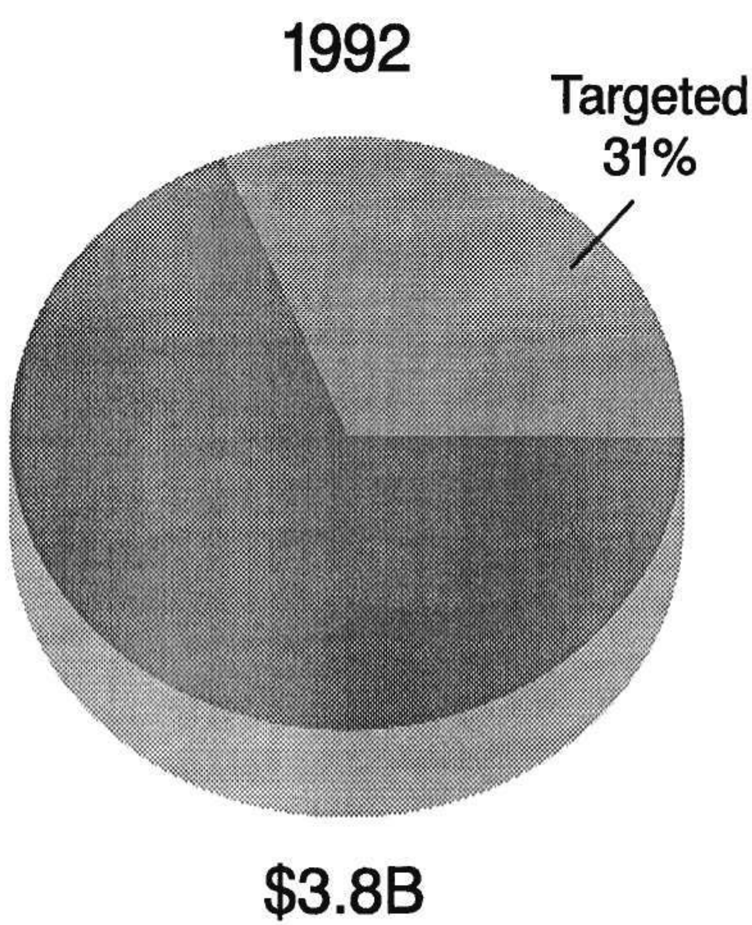
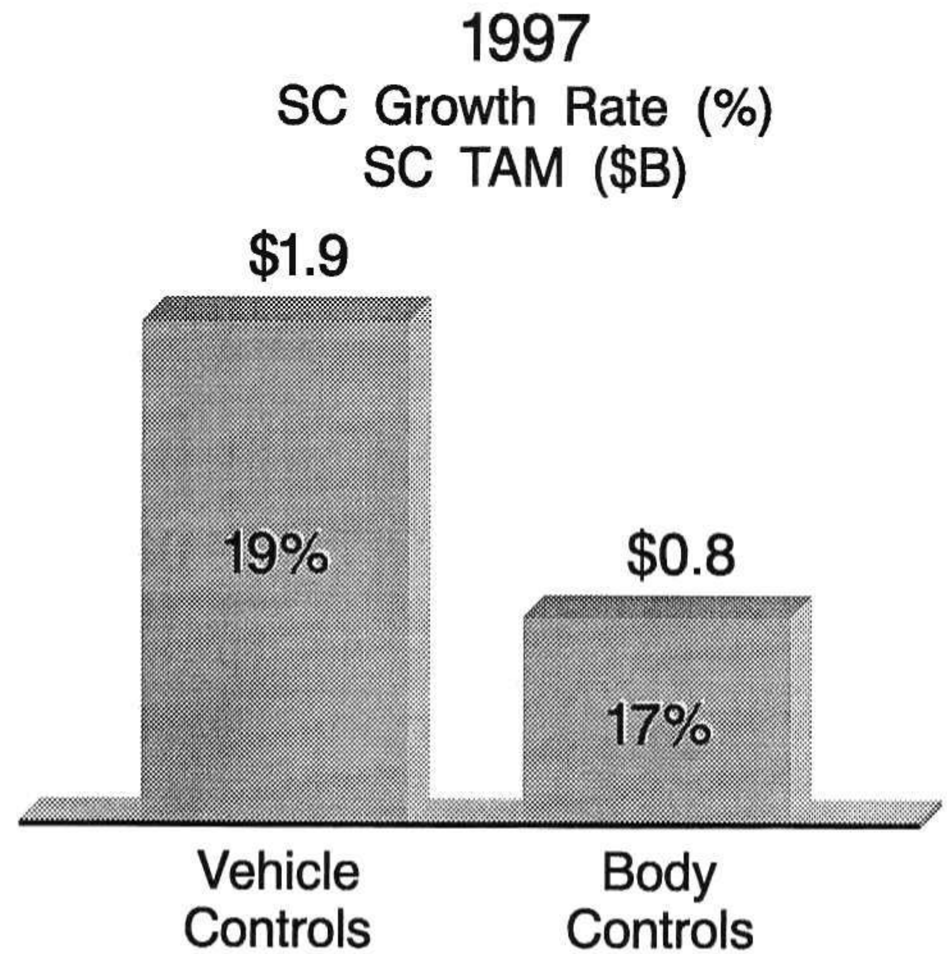
- 0.5μm BiCMOS enables ATM integration

WORLDWIDE SEMICONDUCTOR MARKET
Automotive





AUTOMOTIVE ELECTRONICS IN 2000

Powertrain Computer

Power-train control system

- Drive by wire
- Select by wire
- Variable valve timing
- 3rd-generation ECU
- Smart sensors, actuators
- Link between self-diagnosis device and dealer's computer

Body Computer

Interior environmental system

- Digital audio/AV
- Rear-seat video
- Biosensor (odor, drowsiness, etc.)
- Active noise control

Driving information system

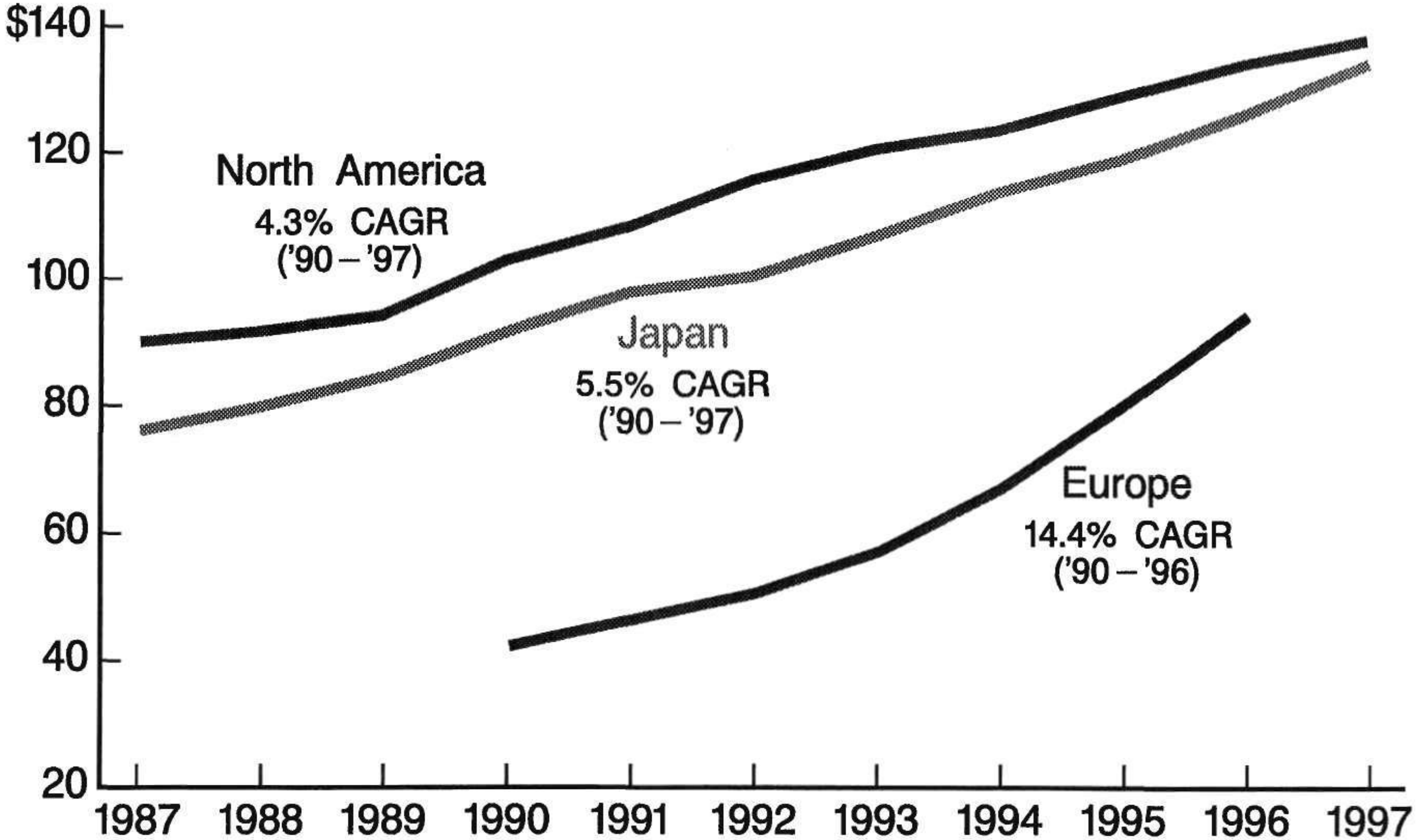
- Traffic information
- Car navigation
- Service/diagnostic information
- Voice recognition car telephone
- TV phone, facsimile
- Rear view CRT

Vehicle Computer

Vehicle Control System

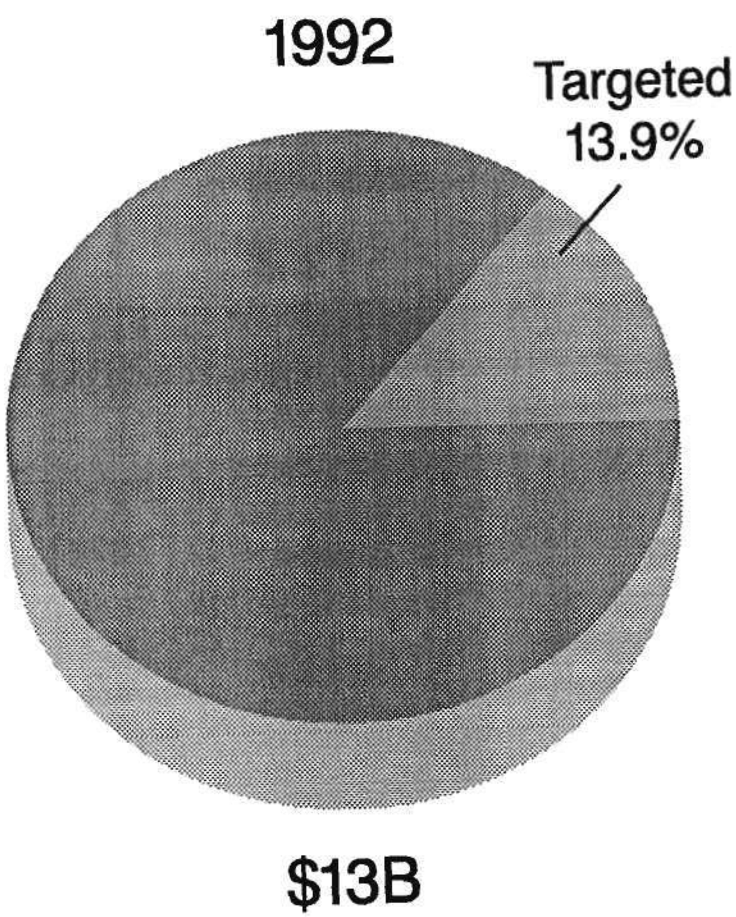
- Total chassis control (4WD, 4WS, ABS, traction control)
- Automatic brake control
- Radar speed control
- Road surface detection (image recognition)

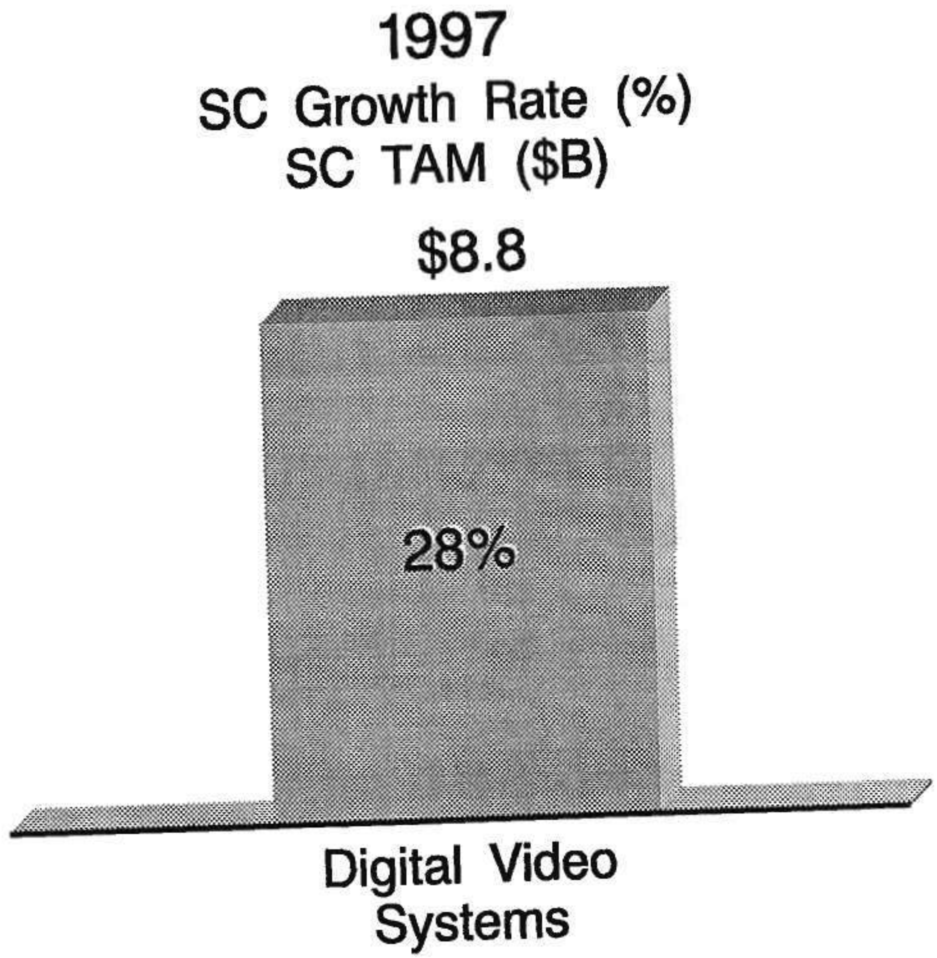
AVERAGE SC CONTENT PER VEHICLE



WORLDWIDE SEMICONDUCTOR MARKET

Consumer

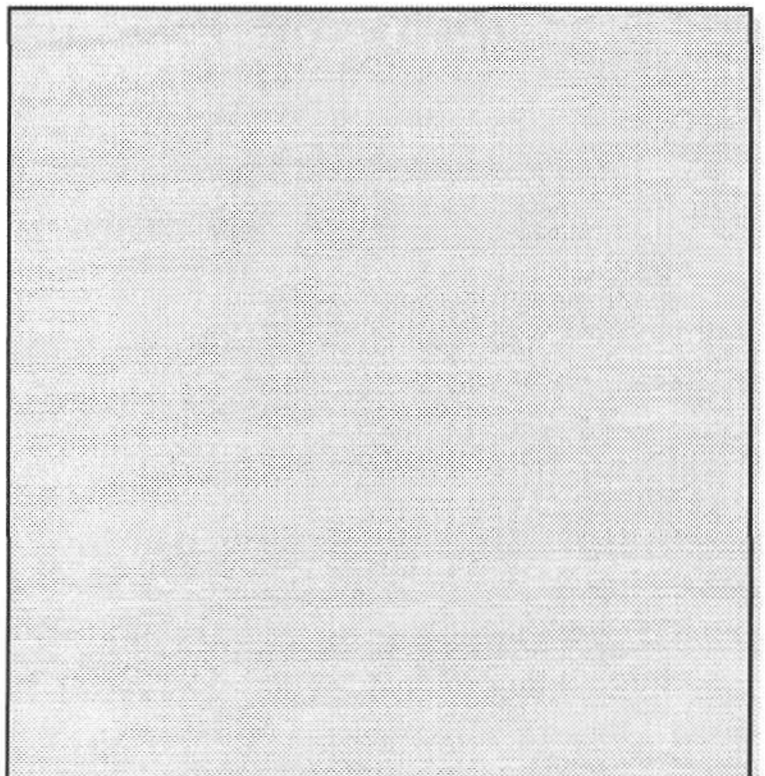




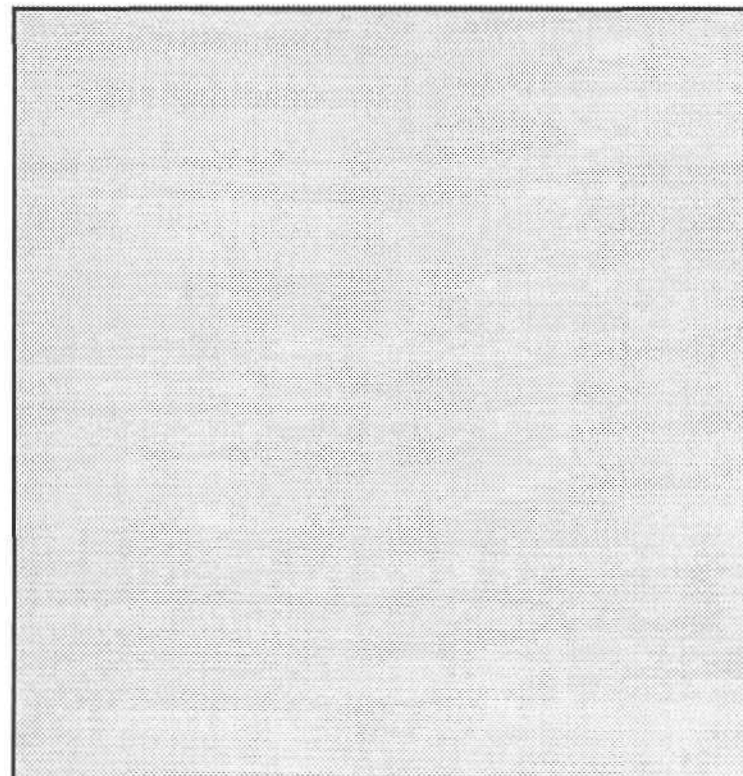
DIGITAL IMAGING TECHNOLOGIES

TI OFFERS TWO SYNERGISTIC TECHNOLOGIES TO FACILITATE DIGITAL IMAGING IN THE DISPLAY AND HARD COPY WORLD:

Digital Micro-Mirror Spatial Light Modulator Device (DMD)



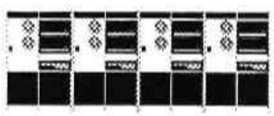
Single Chip Image Computer



DIGITAL MICROMIRROR DEVICE ELEMENT

WHERE SHOULD WE AIM OUR PRODUCTS & TECHNOLOGY?

20 – 30K Units



Rack Mount Systems

- Max speed
- High speed network

~70M Units

Desk Top Systems

- Max "air cooled" speed
- Integration for speed
- Low cost network

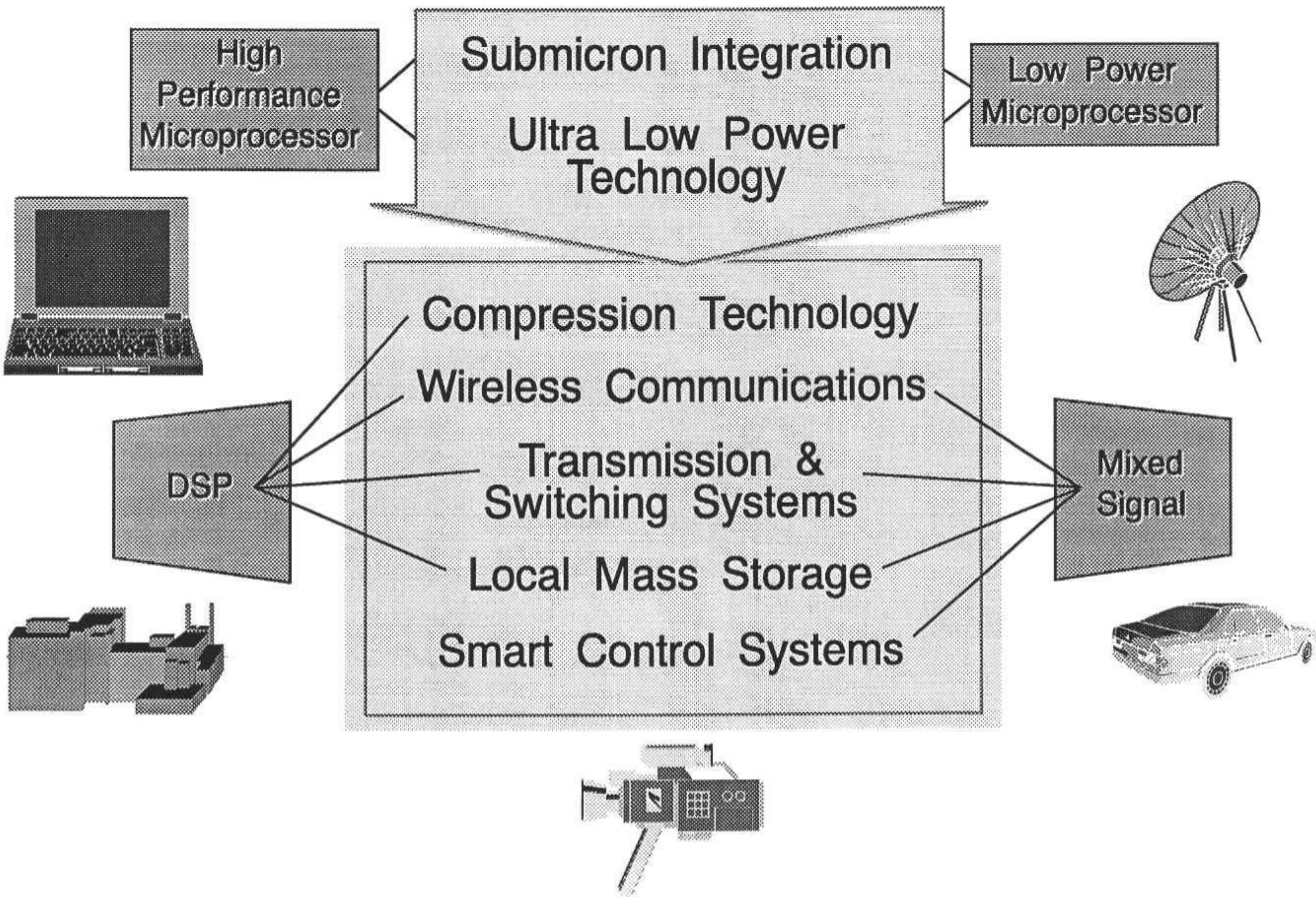
>400M Units

Hand Held Systems

- Battery life
- Miniaturization
- Integration for low cost
- Wireless network

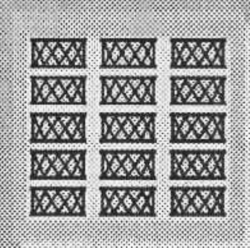
Key Care-Abouts

ENABLING SC COMPETENCIES



KEYS TO SUCCESS

Product On Time

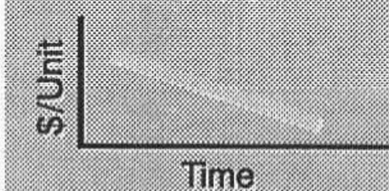


- Start early
- Dedicate resources
- Joint development

Capacity On Time

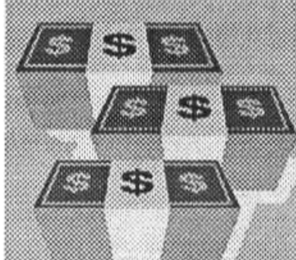
- Early facility investment
- Capacity before qualification
- Global capacity
- Multi-generation

Competitive Cost



- Particle reduction
- Aggressive shrinks
- Equipment volume purchase
- Automation and productivity

Shared Investments



- Reduce cost of capital
- Shared risk
- Customer relationship
- External sourcing

MANAGING THE GROWING COST TRENDS

Cost Reduction Knobs

- Yield Increase: 100%
- Utilization Improvement: 2X
- Wafer Diameter
- In Situ Multiprocess
- Modular Tools

Cost Increase Factors

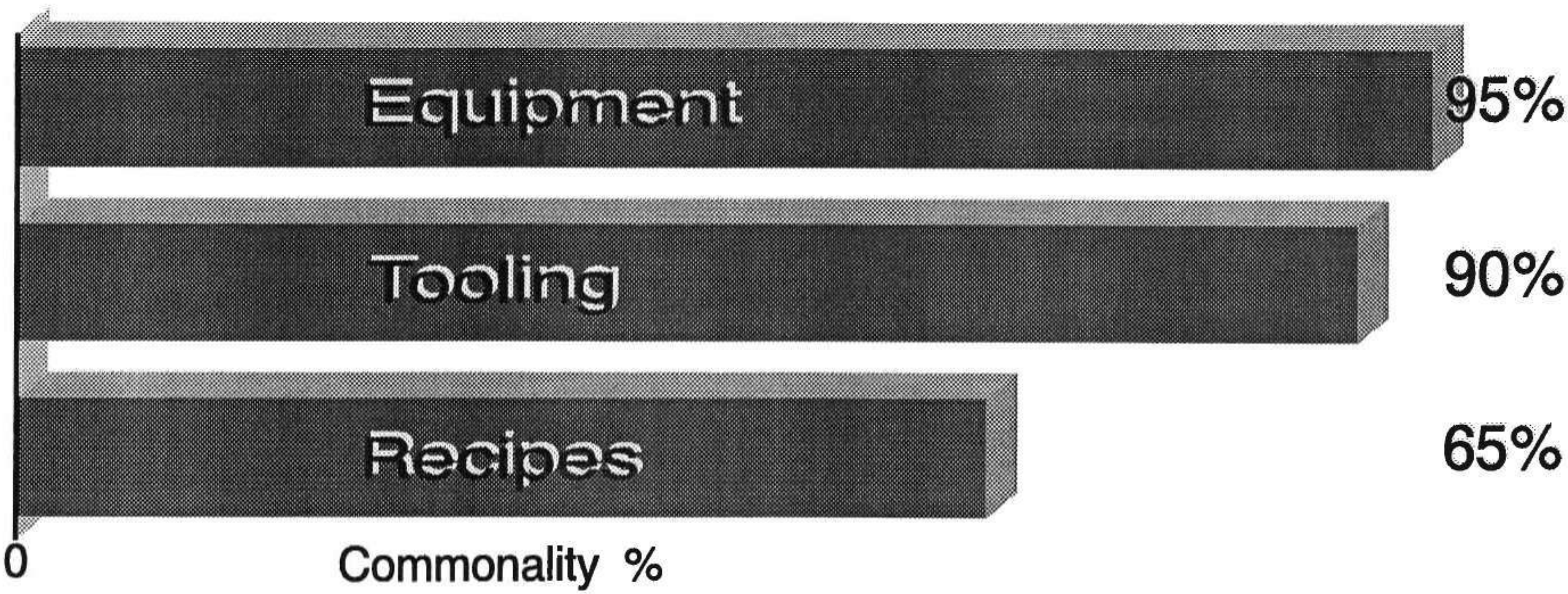
16–18x Increase in the '90s

- Capital Equipment: 4x/decade
- Clean Raw Material: 35%/gen
- Die Size Increase: 38%/gen
- More Process Steps: 25%/gen
- Higher Test Cost: 20%/gen

HARMONIZATION OF PROCESSES

Multiproduct Submicron Manufacturing

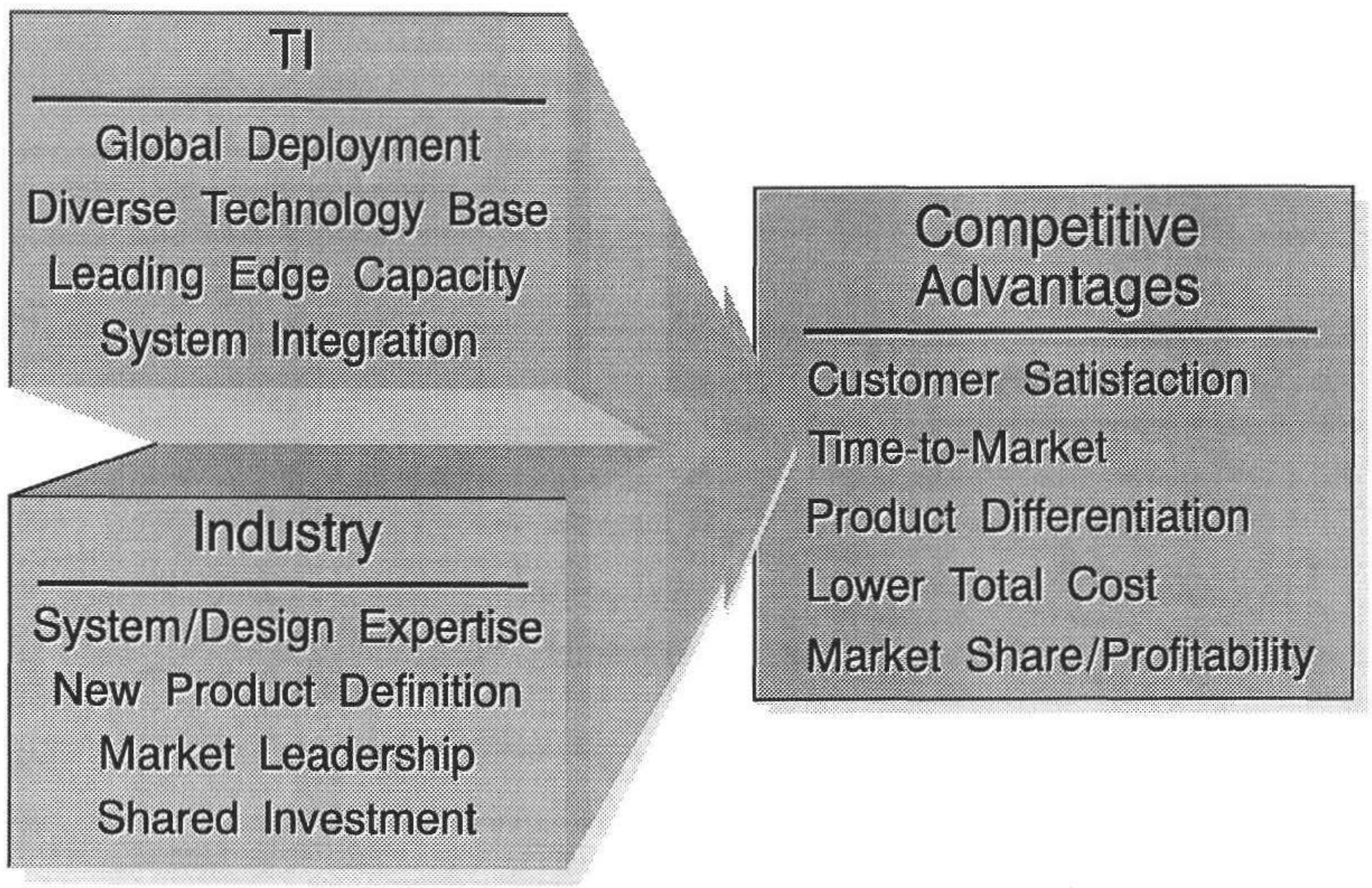
Goals: Extend fab lifetime
Achieve flexibility in fab loading
Produce competitive products with maximum resource efficiency



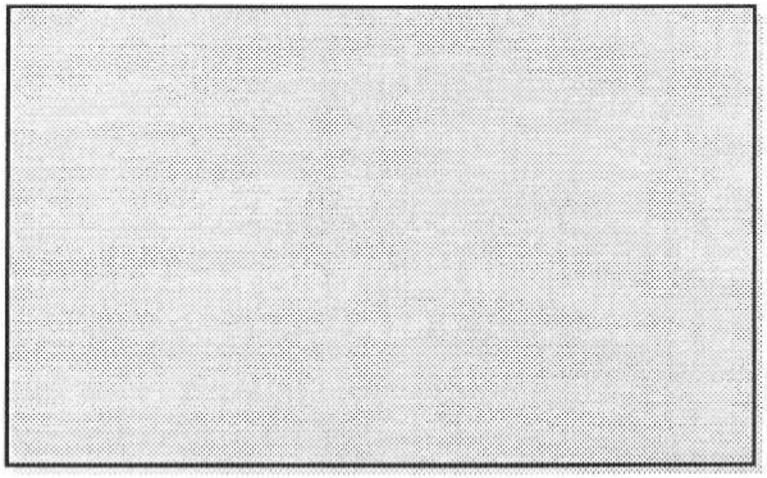
Standard Process Flows = DRAM, Logic, *Flash* EPROM

STRATEGIC RELATIONSHIPS

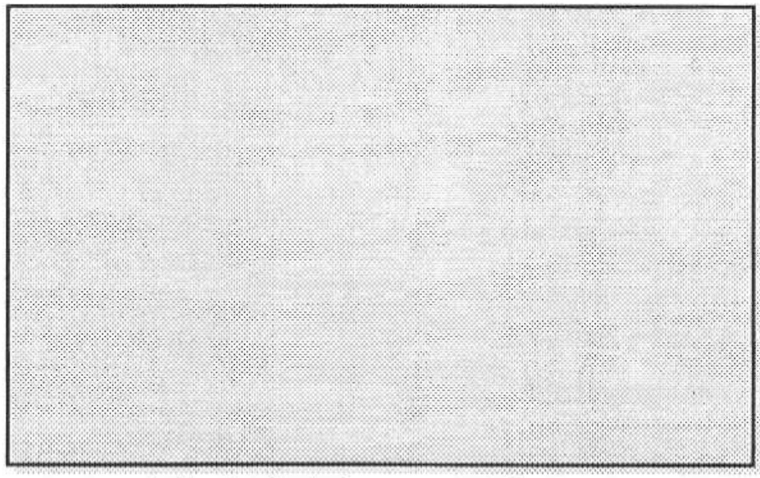
Virtual Enterprise



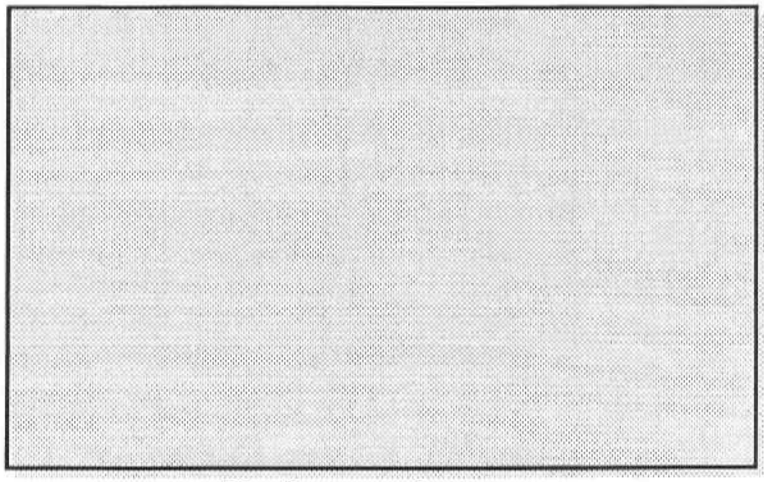
SHARED INVESTMENTS WAFER FABS



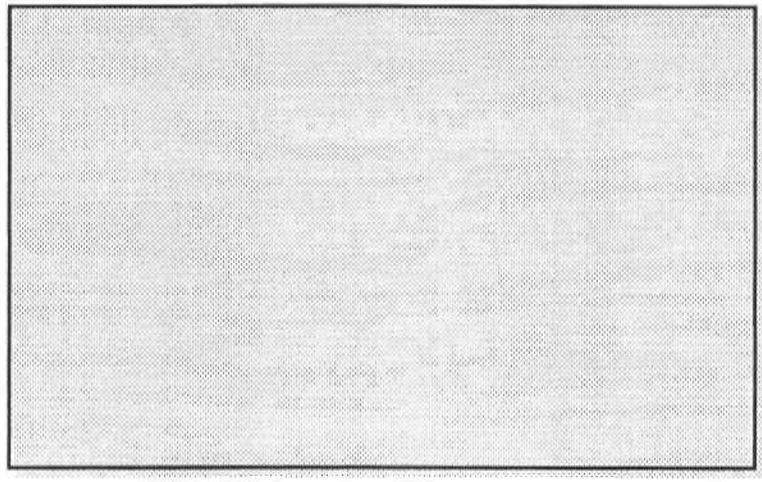
Avezzano – Italy



TI-ACER – Taiwan



KTI – Japan

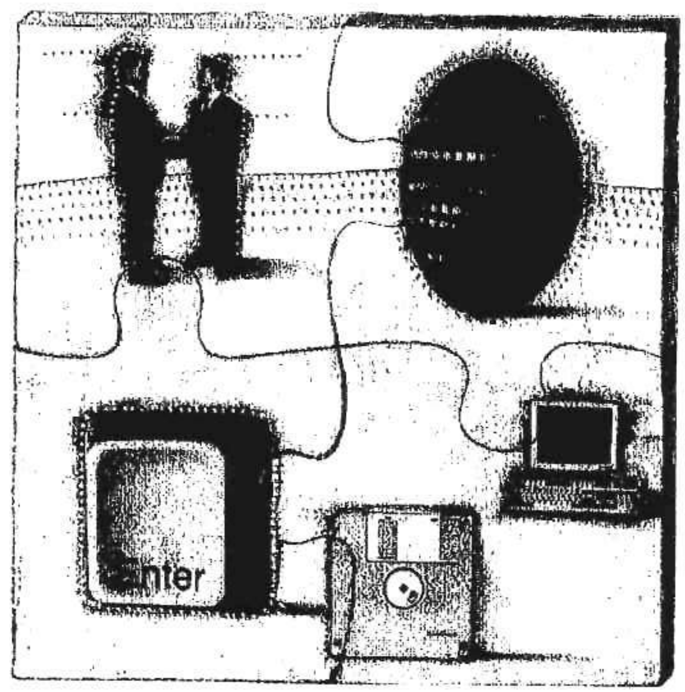


TECH – Singapore

TOTAL INTEGRATION

Service

Information



Silicon Technologies

Tools

VIDEOCONFERENCING

Drew Jamison
European Marketing Manager
PictureTel UK Ltd

Dataquest Europe Limited, a company of The Dun & Bradstreet Corporation
Roussel House, Broadwater Park, Denham, Uxbridge, Middx UB9 5HP / 0895 835050 / Tlx 266195 / Fax 0895 835260

VIDEOCONFERENCING

Drew Jamison
European Marketing Manager
PictureTel UK Ltd

Mr. Jamison has worked with PictureTel since its inception in 1984. He has held numerous job responsibilities including District Sales Manager, Sales Manager VARS and, most recently, European Marketing Manager, located in the United Kingdom. Mr. Jamison holds a B.S. degree in Business Administration from Northeastern University in Boston, Masachussetts.

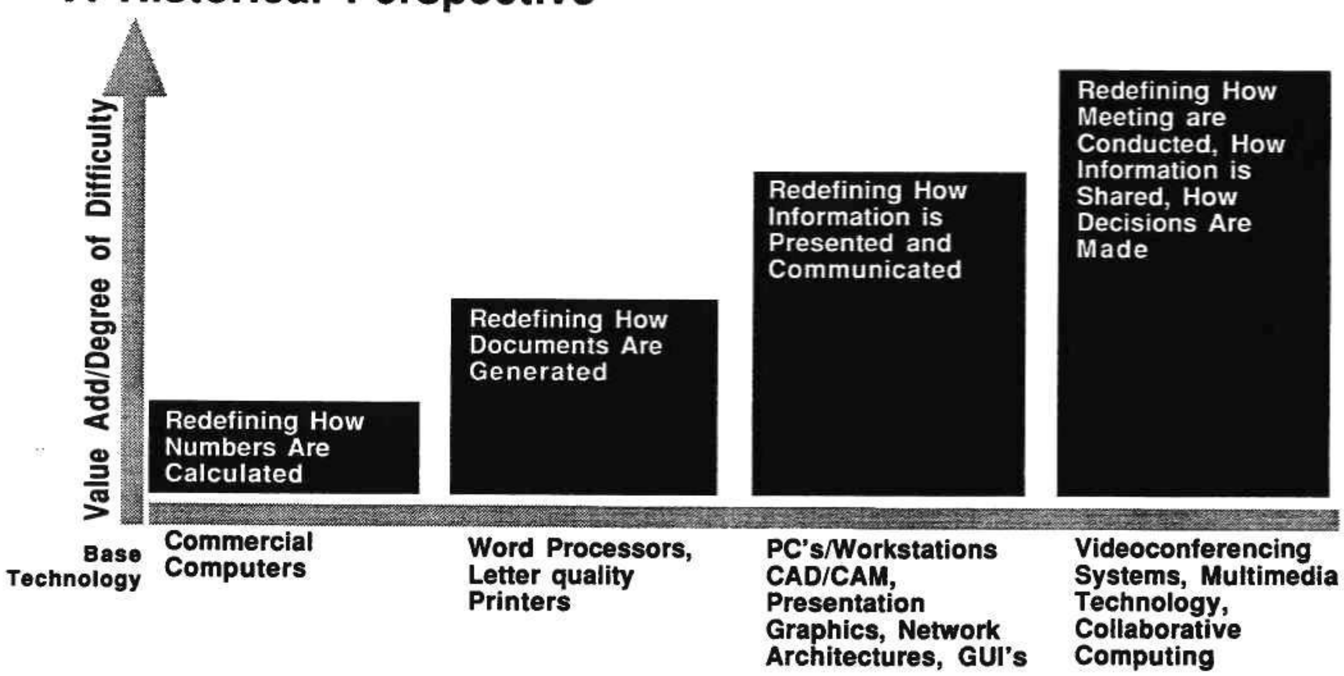
Dataquest Europe Limited
EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE
May 26–28, 1993
Munich, Germany

PICTURETEL
CORPORATION

Redefining the Way the World Meets

Redefining Process

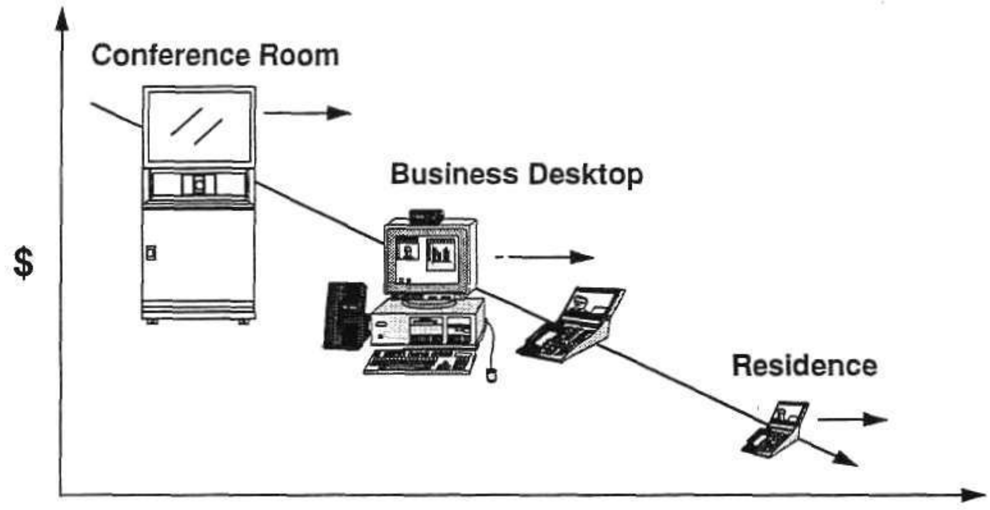
A Historical Perspective



PICTURETEL

Market Overview

- Business desktop visual communications systems is the next major market opportunity
  - Video-workstations
  - Videophones

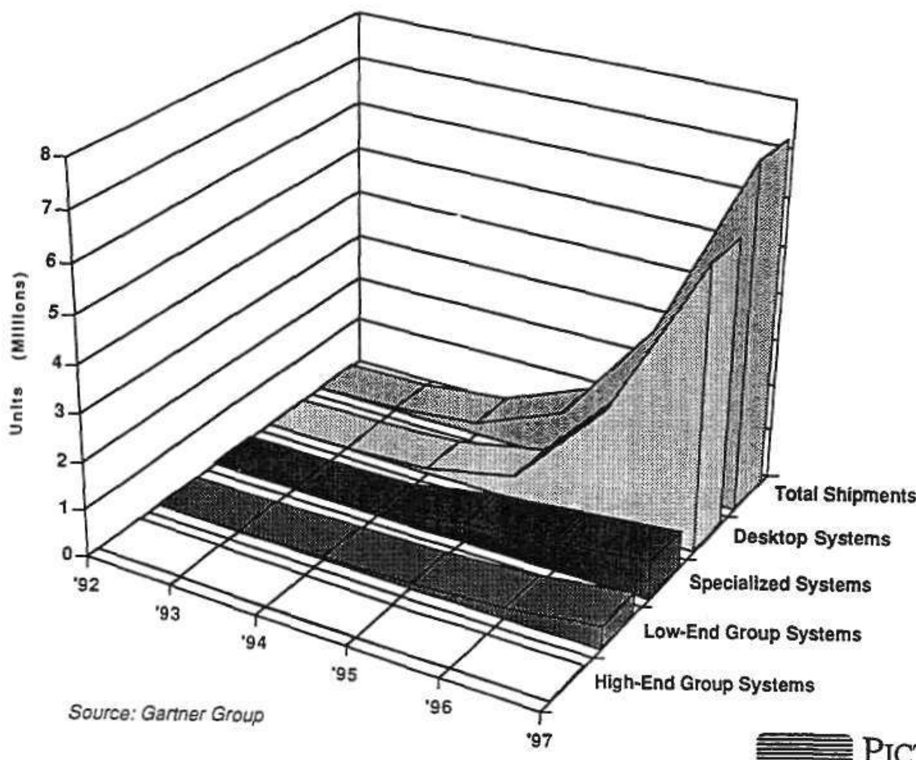


PictureTel Confidential

PICTURETEL CORPORATION

Videoconferencing Market Opportunity

Worldwide Unit Shipments

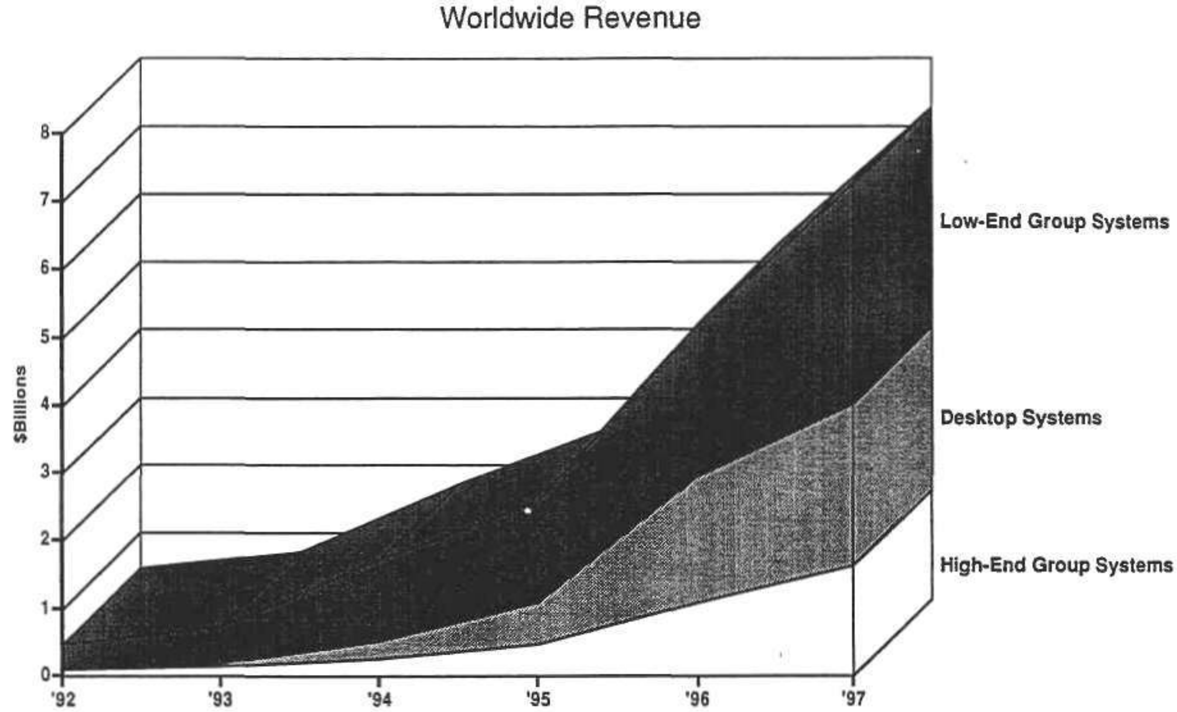


Source: Gartner Group

PictureTel Confidential

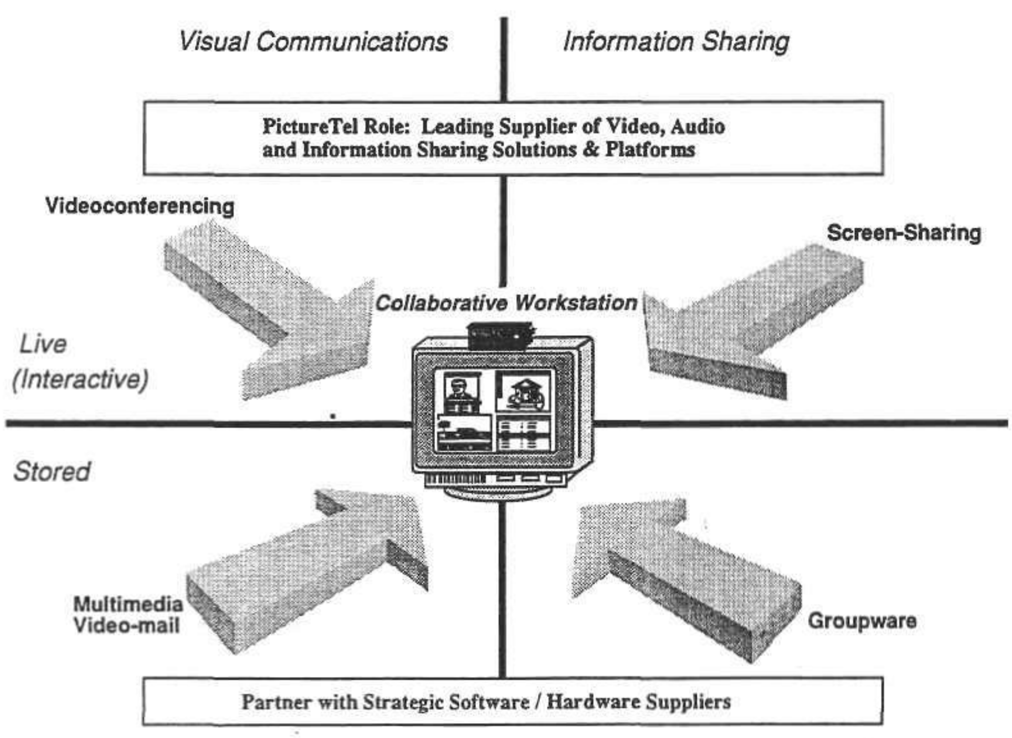
PICTURETEL CORPORATION

Videoconferencing Market Opportunity

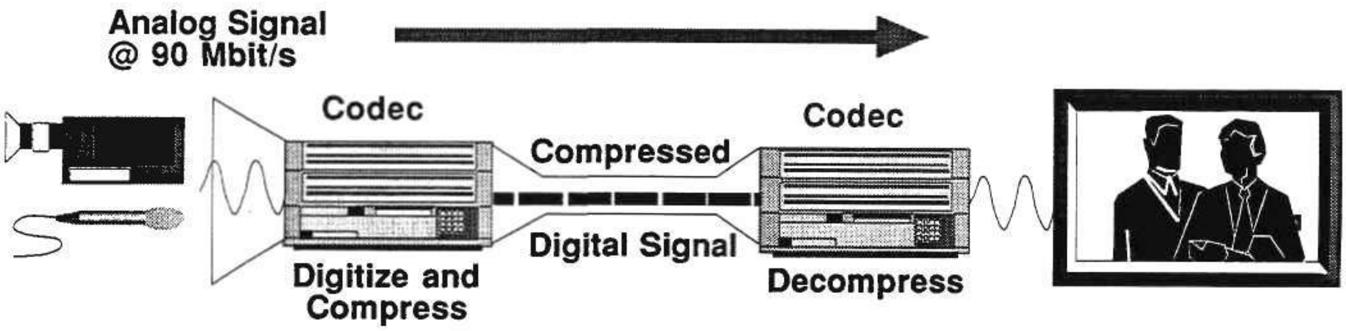


Source: Gartner Group

Collaborative Applications Merging at the Desktop

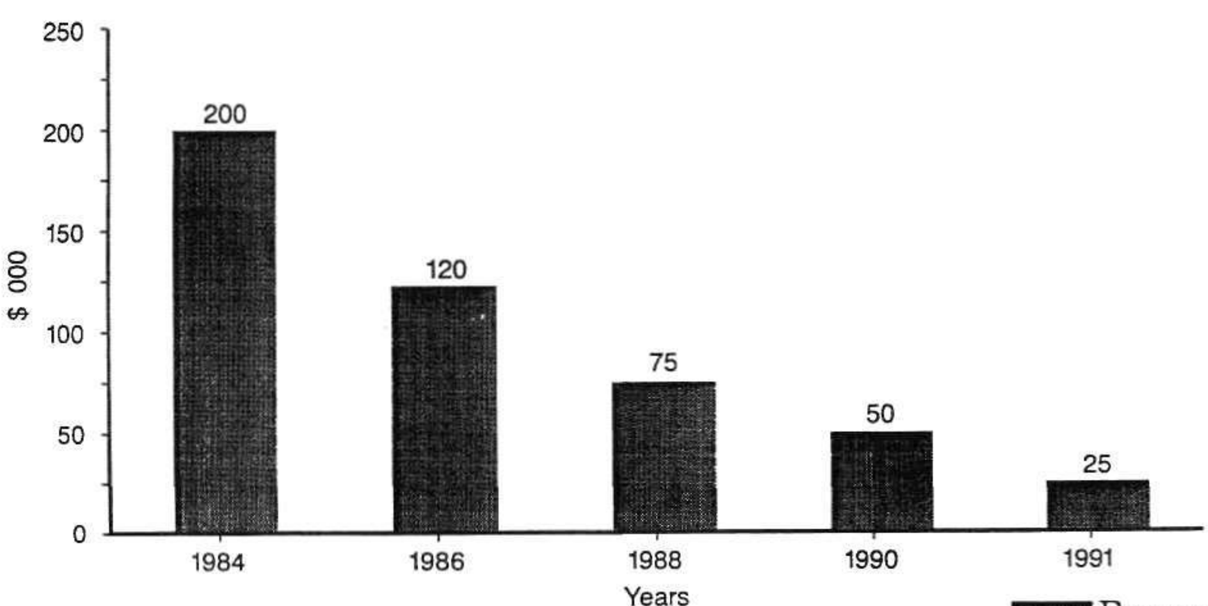


Compressed Video Technology



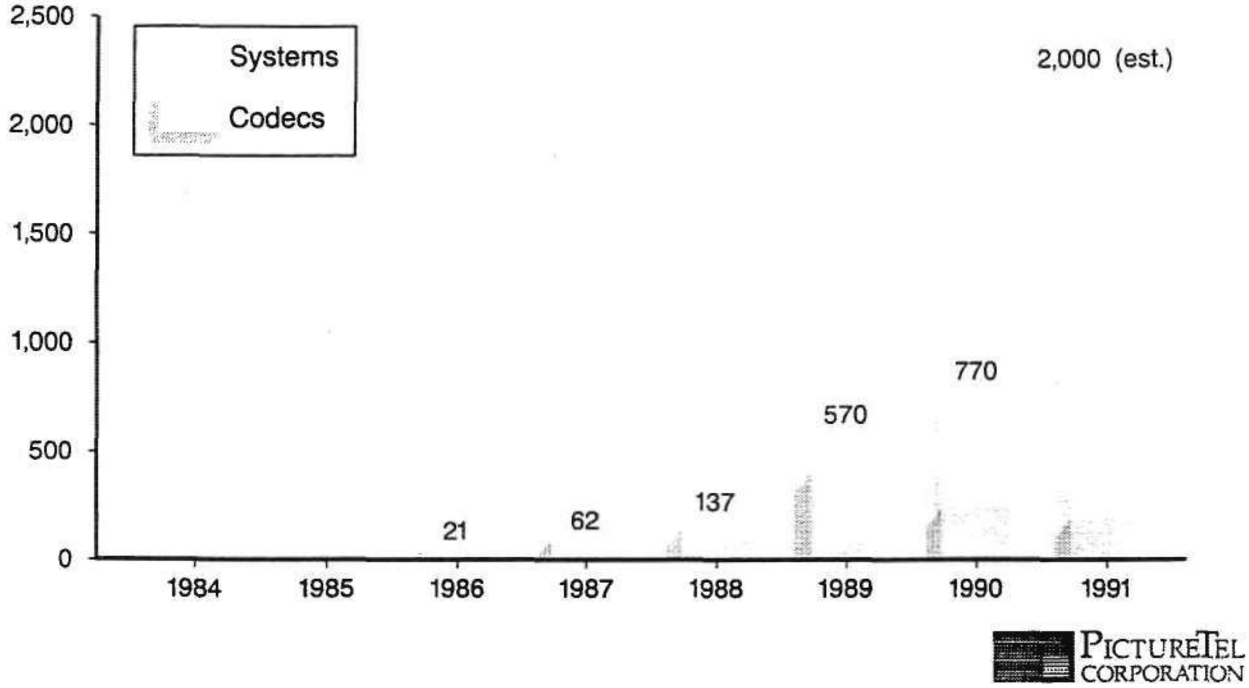
PictureTel

Equipment Prices Are Decreasing

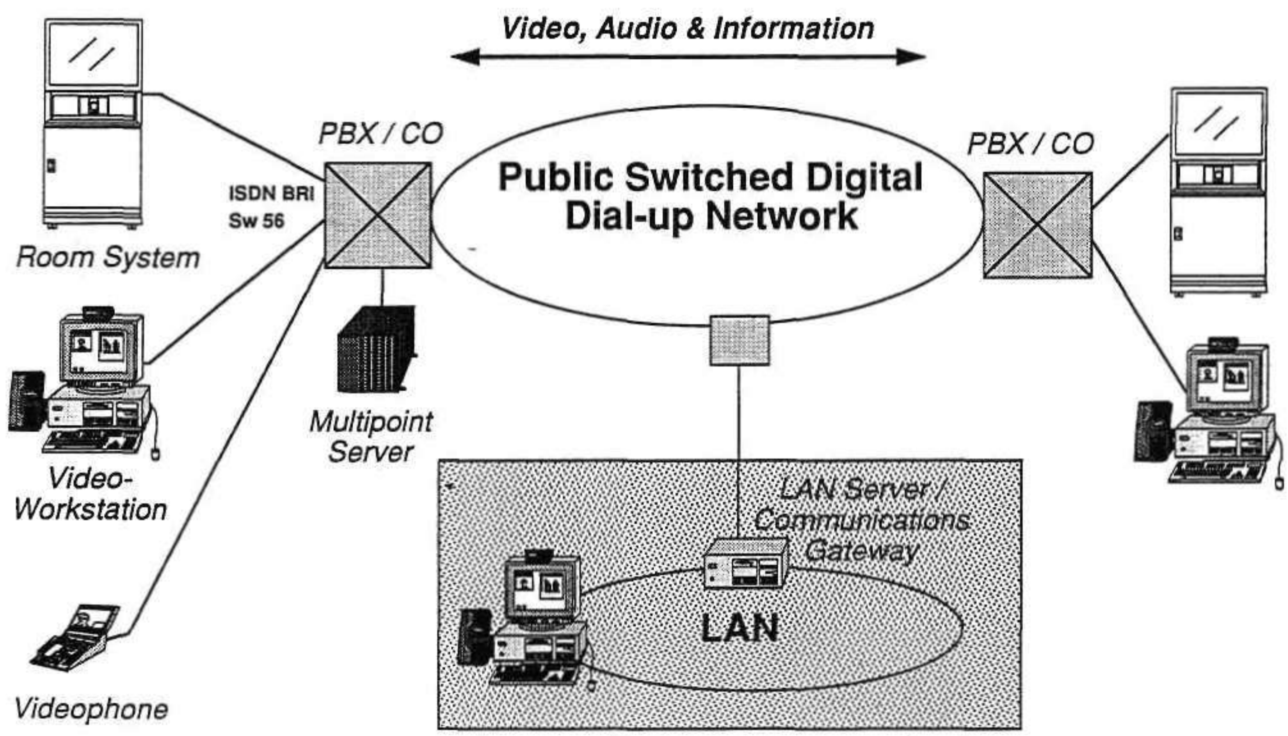


PictureTel Corporation

PictureTel's Annual Shipments



Supporting Network Infrastructure



DATAQUEST ANALYSTS DISCUSS VIDEOCONFERENCING

Greg Sheppard
Director and Principal Analyst
Semiconductor Applications Market
Dataquest Incorporated

Dataquest Europe Limited, a company of The Dun & Bradstreet Corporation
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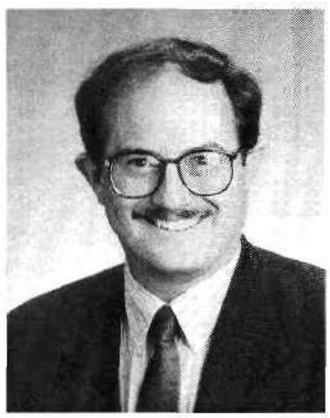
DATAQUEST ANALYSTS DISCUSS VIDEOCONFERENCING



Greg Sheppard
Director and Principal Analyst
Semiconductor Applications Market
Dataquest Incorporated

Mr. Sheppard is Director and Principal Analyst for Dataquest's Semiconductor Application Markets Service in North America. He is responsible for coordinating worldwide semiconductor applications research. Besides general applications trends, he specializes in multimedia, communications, and consumer applications. Before joining Dataquest, Mr. Sheppard was on the headquarters marketing staff of Fairchild Semiconductor Corporation as Manager of Business Analysis. He was also a board member of Worldwide Semiconductor Trade Statistics, Inc., and was Fairchild's liaison to the American Electronics Association. Earlier, he was a hardware design manager and a systems engineer at GTE Government Systems. Mr. Sheppard received a B.S.E.E./C.S. degree from the University of Colorado and an M.S. degree in System Management from the University of Southern California.

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EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE
May 26–28, 1993
Munich, Germany

Video Communications: People Are Seeing It and Believing It

Gregory L. Sheppard
Dataquest Incorporated

Dataquest®

G3002022

The Value Proposition

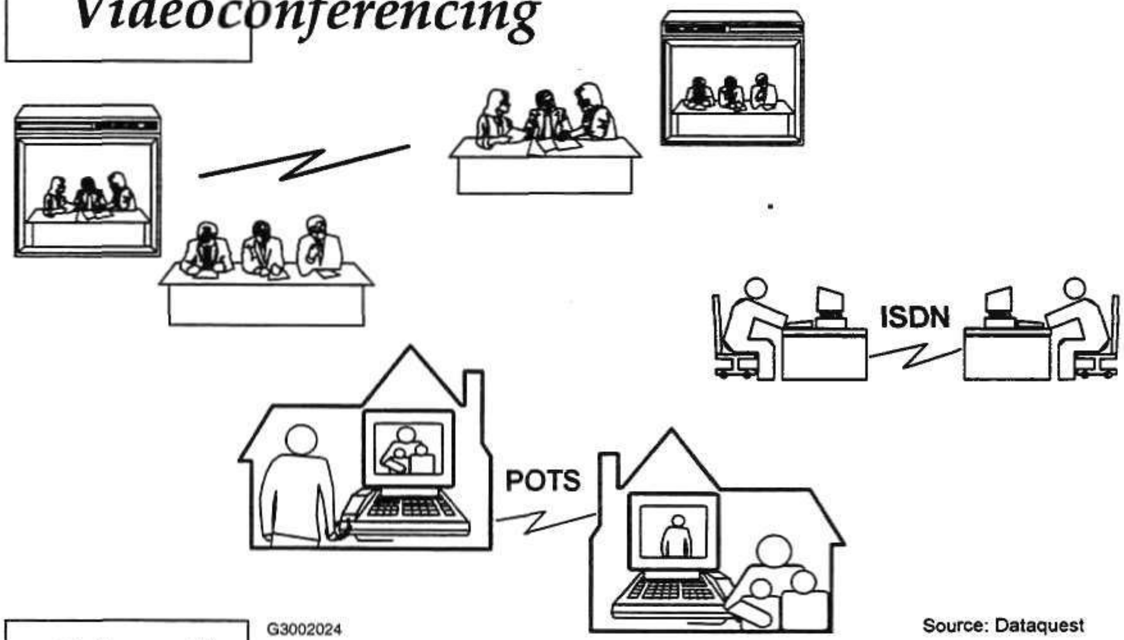
- Internal communications—planning, design, R&D, operations training, reviews
- External communications—customers, vendors, strategic partners, training, press (and analysts!)
- Distance learning
- Home (the camcorder generation)

Productivity (time, travel, intangible)
Time-to-market
Customer service
Market differentiation

Dataquest®

G3002023

Videoconferencing



G3002024

Source: Dataquest

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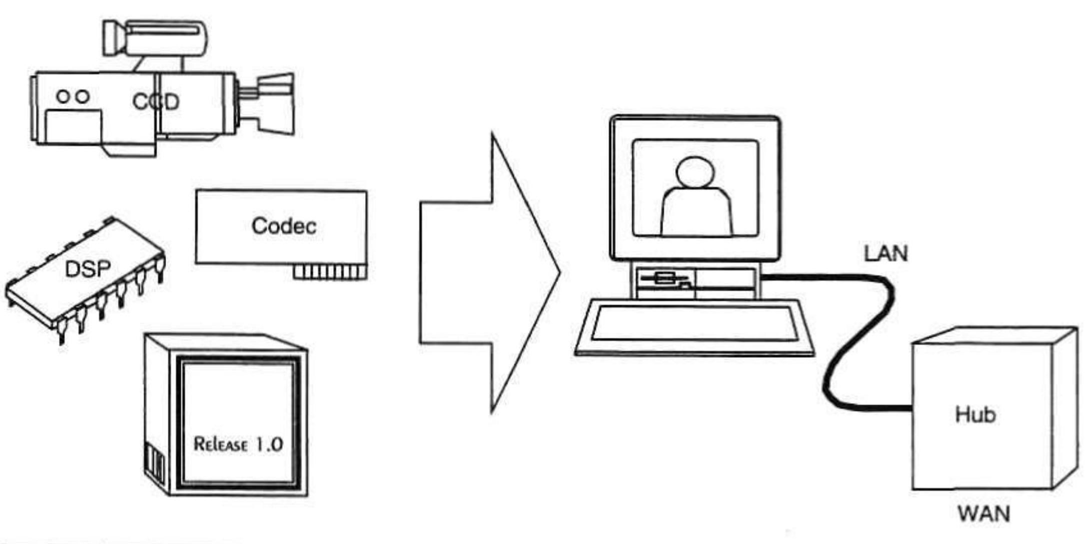
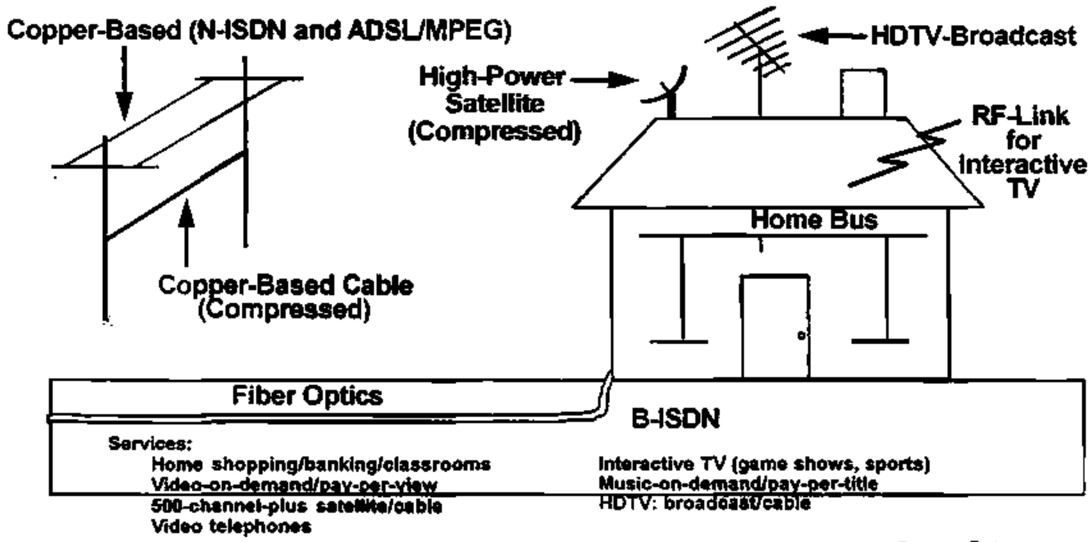
Desktop Getting Near



G3002025

Dataquest®

Evolution of Electronic Home Communications



G3002026

Source: Dataquest

Video Compression

- Computer
  - Software codec accelerators
  - Hardware's role
  - JPEG for still frame
- Consumer—MPEG I for FMV
- Communications
  - MPEG II for cable/DBS TV
  - MPEG X for telcos
  - Px64 and proprietary for conferencing

G3002027

Video Codec/Compression Semiconductor Offerings and Alliances

Semiconductor Company	OEM Patron
Graphic Communications Technology (GCT)	IBM Japan
Motorola	British Telecom/IBM
Intel	PictureTel (Canceled)
IIT	Compression Labs
LSI Logic	
GEC	Japanese OEM, Bellcore
NEC	Captive
NTT	Captive
Texas Instruments	Video Telecom
AT&T	Captive
SGS-Thomson	

Source: PictureTel, Dataquest

Dataquest

G3002028

Barriers and Opportunities

- Costs (terminal, line use)
- Standards (compression)
- Infrastructure (ISDN, better POTs, LANs)
- Sociological/logistical

Dataquest

G3002029

Dataquest Conclusions

- Movement toward standards has begun
- Market is moving from room systems to roll-abouts; desktop and consumer in evaluation
- Opportunities for codecs and other functions
- Alliances are in vogue

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DAY TWO

HOT APPLICATIONS FOR THE '90s

David Moorhouse
Industry Analyst
European Semiconductor Group
Dataquest Europe Limited

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HOT APPLICATIONS FOR THE '90s

David Moorhouse
Industry Analyst
European Semiconductor Group
Dataquest Europe Limited

Mr. Moorhouse is an Industry Analyst, European Semiconductor Group for Dataquest, based in Denham, England. He has been in the European electronics industry for the past 12 years. Prior to joining Dataquest he was Senior Consultant with the design house ID Devices, with responsibilities for product developments in fibre optic communications and speech synthesis systems. His previous marketing experience was with STC (Standard Telephones and Cables) Hybrids division as Product Marketing Manager and Applications Manager. Prior to STC he worked for GEC Avionics as a designer in high-speed serial data Bus systems used in military and civil aircraft. Mr. Moorhouse is a graduate from Salford University with a degree in Electronics.

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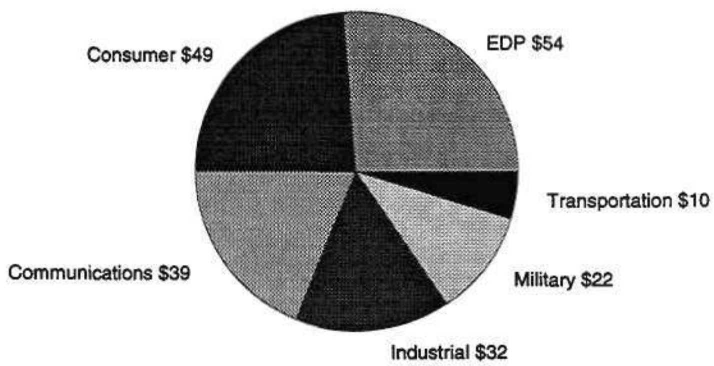
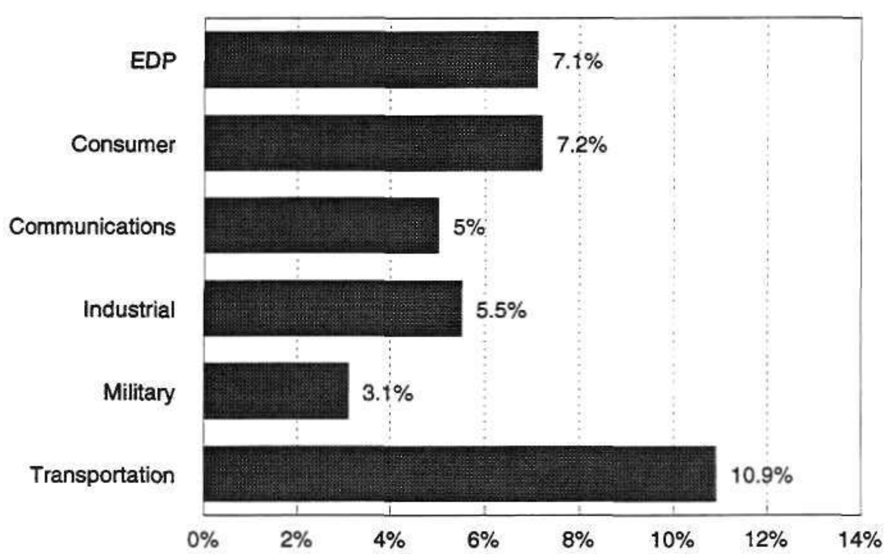
EUROPEAN EQUIPMENT PRODUCTION



Total 1992 Production
$206 Billion

Source: Dataquest

EQUIPMENT PRODUCTION GROWTH
CAGR 1992-1997



Source: Dataquest

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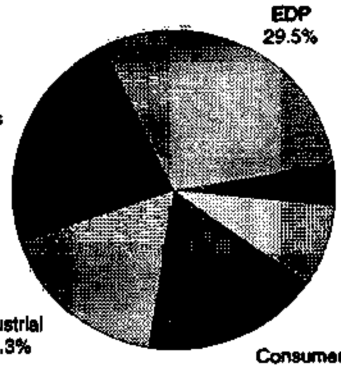
EUROPEAN SEMICONDUCTOR MARKET



Source: Dataquest

OPPORTUNITY ANALYSIS

TAM - Total Available Market

DAM - Designable Available Market

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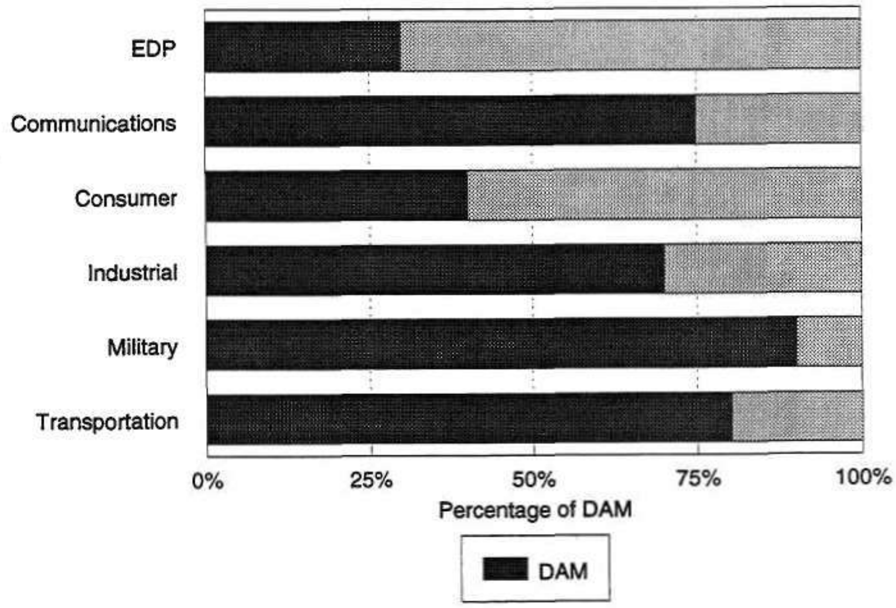
DAM AS A PERCENTAGE OF TAM



Source: Dataquest

1991 WORLDS TOP TELECOMS COMPANIES

RANK	COMPANY	1991 ($M)	COUNTRY
1	Alcatel	15,530	France
2	AT&T	10,340	US
3	Siemens	9,880	Germany
4	Northern Telecom	8,180	Canada
5	NEC	6,690	Japan
6	Ericsson	6,670	Sweden
7	Motorola	6,650	US
8	Fujitsu	3,300	Japan
9	Bosch	3,250	Germany
10	GPT	2,200	UK/Germany
12	Italtel	2,120	Italy
13	Philips	2,090	Netherlands
16	Ascom	1,450	Switzerland
19	Nokia	1,240	Finland

Total European Companies Worldwide Share 49.8%

Source: Dataquest

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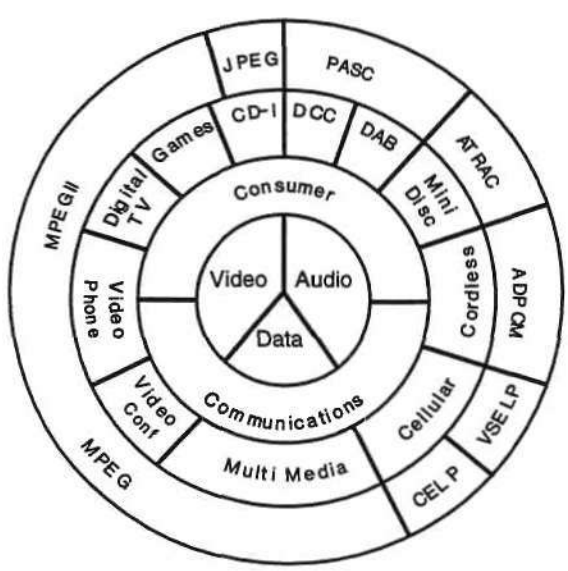
FOCUS OF THE '90s

COMPRESSION APPLICATIONS



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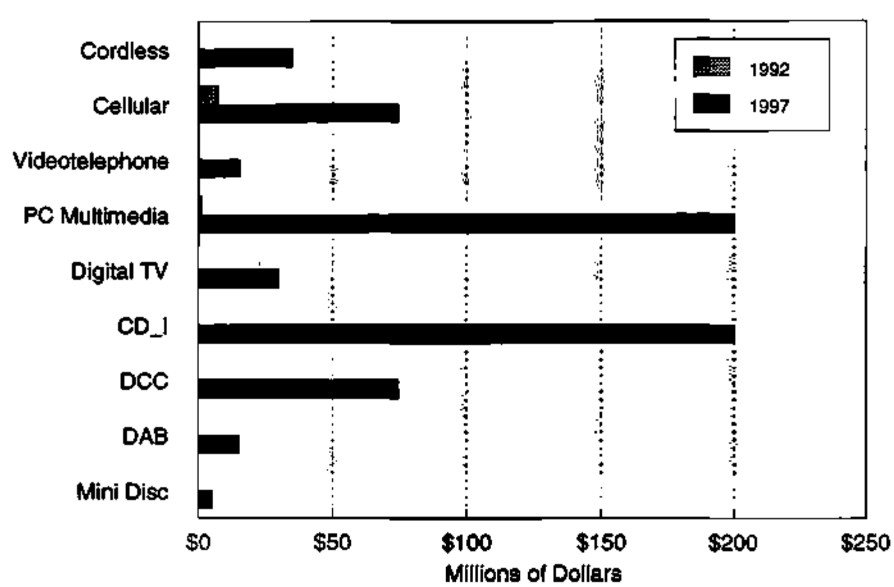
SEMICONDUCTOR COMPRESSION MARKET

(Millions of Dollars)

	1992	1997
Compression TAM	$8	$650

Source: Dataquest

SEMICONDUCTOR COMPRESSION ENGINE MARKET



Source: Dataquest

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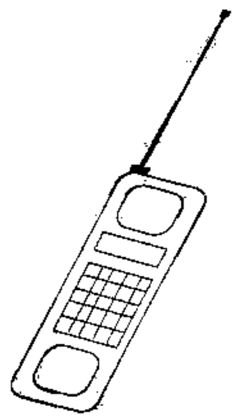
GSM



EUROPEAN GSM NETWORKS

- Austria
- Belgium
- Czech Republic
- Denmark
- France
- Finland
- Germany
- Greece
- Hungary
- Iceland
- Ireland
- Italy
- Luxemborg
- Norway
- Portugal
- Slovakia
- Spain
- Sweden
- Switzerland
- Turkey
- United Kingdom

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GSM-THE WORLD STANDARD

MIDDLE EAST

- Qatar
- U.A.E.
- Lebanon
- Kuwait
- Oman
- Bahrain
- S. Arabia

AFRICA

- Cameroon
- Egypt
- Ghana
- Nigeria
- S. Africa
- Algeria
- Morocco
- Tunisia
- Kenya

ASIA\PACIFIC

- Australia
- China
- Hong Kong
- India
- Malaysia
- New Zealand
- Singapore
- Thailand
- Sri Lanka
- S. Korea
- Taiwan

Source: Dataquest

GSM STATUS

Rapid Production Evolution

- 1992 Mobile
- 1992 Transportable
- 1993 Hand Portable (250 g)
- 1994 Hand Portable (150 g)

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GSM STATUS

1992 Substantial Fall in Handset ASP

- 1992 ASP $2,500
- 1993 ASP $1,500

GSM HANDSET MARKET

(Thousands of Units)

	1992	1993	AGR 93/92	1997	CAGR 97/92
European GSM Market	100	650	650%	4300	212%
ROW GSM Market	5	35	700%	1100	290%

Source: Dataquest

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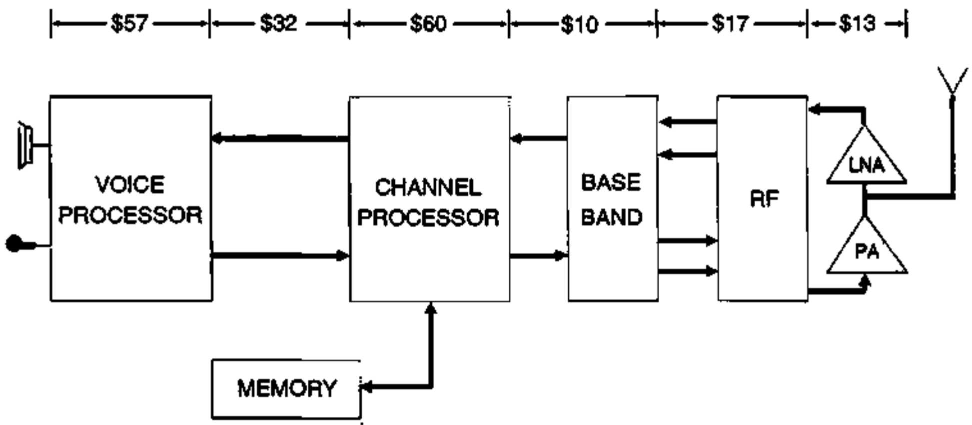
1993 GSM SEMICONDUCTOR COST

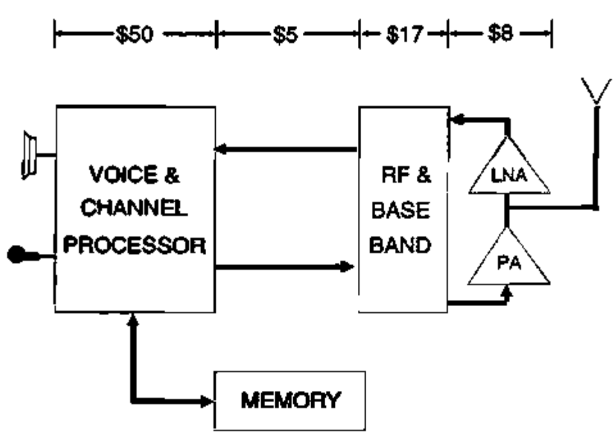
Total Semiconductor Cost - $195



Source: Dataquest

1997 GSM SEMICONDUCTOR COST

Total Semiconductor Cost - $80



Source: Dataquest

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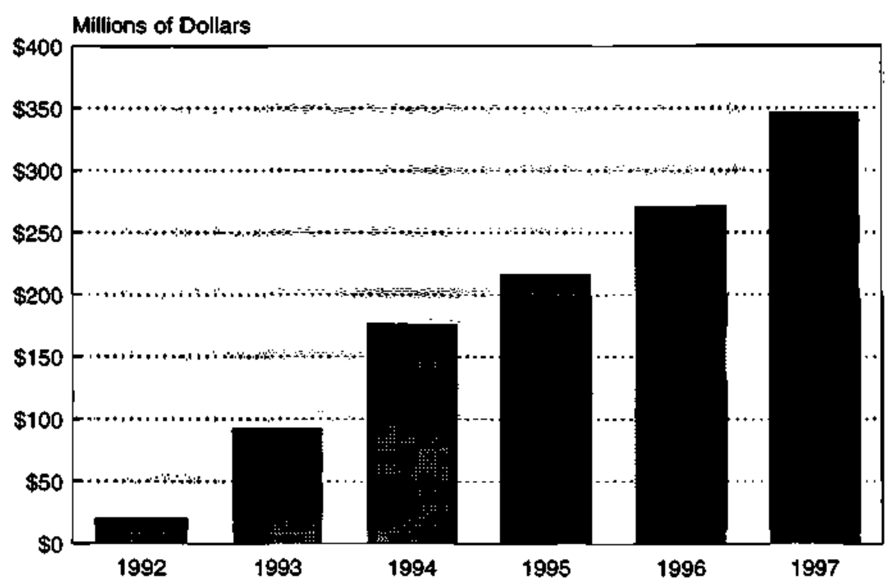
GSM SEMICONDUCTOR VENDORS

- Analog Devices
- AT&T
- Cirrus
- Hitatchi
- Fujitsu
- LSI Logic
- Motorola
- Philips
- Siemens
- Sony
- SGS-Thomson
- Texas Instruments
- Toshiba
- VLSI Technology

Source: Dataquest

EUROPEAN GSM HANDSET
SEMICONDUCTOR FORECAST



Source: Dataquest

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OPPORTUNITIES IN THE DIGITAL COMPACT CASSETTE MARKET

Gerry Wirtz
Senior Product Manager
Philips Consumer Electronics

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Senior Product Manager
Philips Consumer Electronics

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DIGITAL COMPACT CASSETTE, THE SUCCESSOR OF THE MUSIC CASSETTE

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Digital Compact Cassette has been set up to become the logical successor for the music cassette. Before, however, we could have a clear idea about the market for the new DCC-system a lot of issues had to be addressed.

Some these issues will be outlined, be they all illustrate that the process of innovation involves much more than technical developments alone. In this context I will also refer to another innovation in process: Digital Audio Broadcast.

* The standardization process.
* The market reason for a digital tape system.
* The technology choices.

The best way to explain to you the vital importance of the standardization process is to give you a bit of an historic overview how and when Philips embarked on the development of DCC.

Most of you probably know that Philips was with the forerunners of the DAT development. This development started in the period of time that digital electronics became an option in consumer electronic products.
It was logical to consider next to the CD-system, digital alternatives for a tape system.

In time more companies joined in the discussion which ultimately resulted in a big standardization conference for the R-DAT system in which 84 companies participated.

It were, however, predominantly crews from research and pre-development who were involved in the standardization. CD was not yet in the market and the effects and benefits of digital technology were not yet commonly understood by non technical people.
For the technicians the market-benefits of digital technology seemed clear: Digital technology was supposed to deliver better quality. So the effort was to concentrate on top sound quality .

In the mid eighties the standard and the technology were ready to be implemented into products. For the first time market issues were addressed at length. The picture was not encouraging.

First products were very expensive, price-wise more in line with new video-products than with an audio recorder.
Moreover, research and development had been concentrating on the recorder application. Technically that was the most eye-catching function. And was not the analogue tape system called a compact cassette recorder? Under-rating the playback side of the new system went as far as that software manufacturers were excluded from the DAT discussions.
By the time the DAT technology was standardized it proved to be a problem to manufacture music tapes with the required flexibility, speed and price.

This is largely due to a choice for the helical scan format. To ignore the requirement for pre-recorded cassettes and underrate the importance of the playback applications proved to be a fatal misunderstanding of the market for compact cassette.

The compact Cassette market has developed to a very massive market, of which 75% of the hardware sold is used for mobile playback. An application which is driven by the sales of 1 Billion pre-recorded cassettes sold every year.

Ability to record is of course an essential feature of the system. Whether or not applied by all consumers, it does deliver the promise that tape for playback can be easily obtained.
The core function of the cassette system however is the possibility for consumer to listen to his music wherever he goes. Either by car, on foot, at home or at holiday, he will have some cassette player available to play his favourite music.

In our view, replacement of the music cassette by DAT would prove impossible. DAT is too much developed as a top quality recorder for stationary use. Without pre-recorded cassettes, sales of (portable) players cannot develop. Without portable players, sales of recorders are only of interest for recording freaks. In addition the cost price projections of the system were not in tune with the compact cassette market. To phrase this differently: it is insufficient to introduce a new digital recording product, instead a new music-cassette system is required.

DAT is not the only example of a technology which was very skilfully standardized, but unfortunately beside the market requirements.
Somebody once characterized this DAT-activity as a discussion which spent half hour on marketing and three years on technical issues

Learning from our experience in setting world standards
for Compact Cassette and Compact Disc, and the problems with DAT, we could draw up a list of essential ingredients for a successful world standard for a new digital music carrier.

- Active support in the standardization process from both major hardware and music industries, involving next to technicians, marketing and industrial participants from day 1. Consequently we only started the standardization of DCC when we had full support and participation of the music and C.E. companies.
- Solution of the copyright problem, home taping and piracy. Instead of fighting each other, hard- and software industries shall jointly co-operate for the same market and customer. This problem required a lot of time and energy. The ultimate compromise reached, the SCMS system made it possible to jointly continue work on music systems, which require a recording function. With SCMS home recording remains possible, but the rate with which copies proliferate is substantial less
- Practical control of the standard.

  Compact Disc has learned us the great benefits for the consumer, and therefore ultimately the market development of active monitoring of adherence to the standard from the licensees. It has greatly enhanced uniformity of operation and quality; CD means for the consumer standard high quality and simple to access music. The Compact Cassette standard, however, we gave away for free in 1963 to create a world standard. Because it was never supervised this standard could not create an image of reliability.

The DAT-standardization adventure with 84 companies learned us beside slow progress, lack of power to make choices, the number one requirement in successful product management. Making choices appears even more important for successful system management. The un-manageable standardization with 84 companies resulted in too many compromises which created incompatibility.

Moreover, participants felt free to implement the DAT standard at will which turns a standard in a mere recommendation.
Experienced and with these ingredients in mind we started to define the ideal system to replace the music cassette.
This time, however, we worked the other way around; first the essential system ingredients were defined. Later the technology to built such a system was looked for.

Three questions were central in the analysis of defining the ideal system:

* Why innovate the cassette system?
* What in the cassette system needs to be innovated?
* How should this innovation take place?

<u>Why innovate?</u>
<u>What are the market reasons for a new DCC system?</u>
The fact that a variety of new technologies are becoming available cannot be the only reason for innovation. As long as everybody is happy with the current analogue system there is little reason for change. Looking at the massive annual sales quantities of cassette (2.6 billion) and cassette machines (200 million) it would seem everybody is very happy with the analogue system. If, however, we look at <u>market trends</u> we get a different picture. Hardware sales have stabilized over the last couple of years. Most market segments, apart from stereo head-phones, are in a replacement phase. We see no growth. Consumers are merely

replacing existing cassette functions, which indicates that the cassette players are purchased more to complete an audio system than as the main attraction. The predominant reason why consumers include the cassette function in their choice is because they have so many cassettes.

Average every household has a library of 50 to 60 cassettes.
Sales of pre-recorded cassettes have been constantly growing over the last decades. But, as has been forecasted by us, sales growth levelled off in 1989 and went into decline since.
This picture is familiar to us. By the end of the seventies we saw the same trend for the markets of LP and turntables. Several years before the introduction of the CD consumers started to loose interest in the LP, reflected in a declining sales level. Sales volumes of turntable remained stable for a number of years (people still possessed extensive libraries of LP's) but then also started to decline. We call it the life cycle of a music carrier. After being in the market for three decades the consumer starts to loose interest despite the constant flow of brand new music titles. This by the way underlines that the consumer is not only buying the musical contents; the physical presentation of the carrier is also relevant.

If music cassette is losing interest will CD replace the music cassette?
Certainly not. Also here we have valuable experience. When by the end of the seventies LP started to decline some expected that the music cassette would easily compensate for the lost sales quantities. They expected that the MC market which showed a constant healthy growth (very similar to CD now) would just take over from LP. In reality nothing of that kind happened, the sharp change from a growing to a declining LP-market did not resulted in any change of growth of the musicassette market.

The main reason is that there is not one music market but two: a dual carrier market:

- The disc the collectors item, for active, foreground use in the home.
- Cassette for the road.

The consumer is perceiving both media as different, not compatible. The main differences are:

- The disc, as the foreground medium, often used actively where of course the random track access is very important. The disc with its jewel like image, which makes it the collectors format. The CD is even perceived as vulnerable, precious, although the technology is rather robust. But people do not even like fingerprints on their disc because, they <u>want</u> to see it as a precious collectors item.

- The tape is much more used as a background medium, passively e.g. when driving your car. With cassette the issue is much more to provide continuously and as long as possible a musical background. The related image is of a much more sturdy and robust carrier you feel comfortable with to take with you, throw in your car, and which is simple to operate with one hand.

Media wise, the cassette is actually closer to the radio, as the alternative, continuous program the consumer can decide on himself, than to the CD as the collectable.

The reason for innovation is in short: We see a tape system which fulfils a specific function in the market, which is massively used in a very passive way but which despite its large volume is losing interest.

Here we ran into the second question.

What is to be innovated?

It is good to realize that an annual sales volume of 2.6 billion underlines a tremendous popularity. After the lightbulb, Compact Cassette is probably the most successful consumer electronic product.

Cassette, therefore, must have a lot of attractive features which should be maintained in the new system. Market research indeed indicates that most features like seize, weight, playing time an the way of operation of the cassette system score very high.

Basically there are three points which rate low:

- Image

  Cassette lost its appeal. It is no longer seen as the miraculous device which will operate everywhere, but as an old-fashioned piece of plastic without any shine or attractiveness.

  It is pre-dominantly because of image why cassette starts to loose ground.

- Sound quality

  The sound quality is perceived as out of range with modern audio equipment. It is important to refer to the average sound quality perception which is not the high-end-Hifi-deck-with-Dolby and a high grade cassette, but a low cost deck with a lot of wow and flutter and a lot of distortion tape hiss an lack of stereo image.

- Durability

  Cassette warp, tapes are breaking or otherwise get jammed.

To select the technology for this innovation is not obvious. Central is the decision to go tape or disc. It is possible to make tape or disc functionally to a large extend overlapping by adding extra electronics, e.g. a disc system by nature not shock-proof can be improved by adding a lot of solid state memory;

a tape system, by nature a streamer and not a random access technology, can be improved by powerful winding motors, solid state memory chips and clever μ processor control. It is, however, obvious that such extras do not help to reach low cost markets. The new technology must, however, have a costprice perspective to ultimately replace the entire compact cassette system, including the low cost applications.

Price levels for these applications are very tough targets.
From the perspective of the recording industry it is essential that the new system has the prospective to integrally substitute the music cassette; a new carrier in the market will in first instance just increase operational costs because of extra inventory and obsolescence. It therefore is essential that ultimately price levels of the hardware can drop sufficient to reach mass market to ensure that the new carrier can replace the old one. With this in mind it is only logical to go for tape, which by nature better fits the tape driven compact cassette system. A tapestreamer provides the most important features for this market , a long playback time of 2 hours and shockproof performance, automatically, without the need of a lot of extra circuitry.

But there is another even more important reason to use tape: the obtain the interest of a by nature very passive consumer crowd to cater for something new.

Here we run into the third question:

How to innovate MC?

Replacing the MC is different from the LP/CD case.
The purchase behaviour for cassette makes a consumer on average only buy 1 cassette per cassette player.

For compact disc, and previously LP this number is 7 discs. The difference between cassettes and discs in perception extends to a much more passive buying behaviour in case of cassette. Therefore much more hardware in use is required to establish a mature cassette music- market. At its peak a park of 180 million record players resulted in a market of 1 billion records, and the current CD-player park of 150 million players again created a market of 1 billion CD's.
But cassette sales of 1 billion are generated by 1 billion cassette machines in use. This enormous park needs to be converted into the new digital machines sufficiently fast. Suppose we would repeat the exceptional success of CD with the new system. This would "only" bring us 150 million players in use in the year 2002, ten years after the introduction, leaving 850 million cassette players unchanged, but probably also no longer used.

Therefore, sales of the new digital cassette hardware has to develop at least 3 times as fast as what was accomplished with CD.

The only way to make hardware sales develop 3 times as fast as the CD case is by making the new technology backwards compatible: The new machine must include a compact cassette function to playback the analogue cassette. This implies that the new system is not only addressing the typical innovator, the guy who will always buy what is new, but also the regular consumer of which each year 200 million come to the shop to replace their existing cassette machine; their main motive to still specify a cassette function is to play their existing library.

Any new, not compatible, technology would at least require 10 to 15 years to grow into mature market quantities. In replacing the music cassette, however, it is not just the issue to build up the new market, it is also the issue to build up with sufficient speed, because the very function is the availability of various different cassette players in a particular household. From consumer perception one cassette machine does not make sense; the core function is to have options to play your cassette in your car, at home or when travelling.

Also therefore, the system shall again include the main four ingredients of the actual analogue compact cassette system:

- pre-recorded cassettes together with
- blank cassettes which will be recorded pre-dominantly on
- home cassette decks and a great variety of
- portable cassette players to playback music wherever the consumer goes,

from the start to make it an interesting system for the consumer.

Next to the basic technology choice to go tape, the other main choices can be fairly easy explained.

Choice of tape. Because cassette used also extensively outdoors recording density on tape shall not be stressed, and use of standard low coercive tape is vital. In DCC we apply as a minimum a wavelength on tape of 1 u.

Tape speed. I explained the importance to make DCC backwards compatible. It implies that the DCC mechanism can also act as a compact cassette mechanism. The obvious choice for tape speed for DCC is to use the same as for compact cassette. This results in availability of a great number of various types of mechanisms for DCC at very cost effective price levels.

Track format. The requirement for pre-recorded software makes the use of high speed duplication necessary. This specifies a linear track format.
The need to (quickly) reach mass markets and therefore attractive costprice levels specifies the application of relaxed mechanical tolerances to limit the number of tracks to 8.

Error Correction. Choices made sofar define the available data rate from tape. To derive to the actual information rate to be used for audio coding, the error correction capacity has to be chosen. Again, since we talk outdoor applications, in poorly controlled environments we shall make a very robust system. We use 47% of the data stream for error correction.

The audio quality

The requirement to reach top end HiFi markets specifies a CD sound quality.
Comparing the rate between CD, 1.5 Mbit/s, and a system as specified before indicates:

53% of 8(tracks) x [1μ (wavelength) x 4.7(cm/s) (tapespeed)] = 384 Kbit/s

Consequently a new coding had to be developed which is 4 times as efficient as the traditional PCM encoding used in CD. This new coding is called PASC (= Precision Adaptive Subband Coding).
The most eye catching difference between PASC and traditional coding methods (PCM) is that PASC is making use of psycho-acoustical principles. Here we find a technology relation to DAB.

It is good, however, to realize, before to expand somewhat on this most interesting subject of psycho-acoustical encoding, what the objectives are for DCC and how these objectives are realized.

Comparing the difference in bit rate between CD and DCC the objective is simple. The same acoustical result with a bit stream which is one fourth of that in CD or a coding which is 4 times as efficient. The better efficiency is realized by applying two principles which each deliver roughly 50% of the required improvement:

- PASC uses a highly intelligent and therefore more efficient "adaptive" notation
- PASC applies psycho-acoustical principles; PASC no longer tries to follow all the characteristics of the (analogue) microphone signal, but instead models the signal in accordance with the receiver, the human ear.

The "microphone signal" sofar always has been our objective; however, despite the ongoing research to make perfect microphones, the microphone functions differently from our ears.
The source signal contains much, which is there, for every other reason than to create a difference in sound impression; in-audible components.
Before we had developed the PASC encoding system we could only guess the

outcome in terms of audio quality.

Reducing the data rate means in principle less room for encoding. But if simultaneously the efficiency of the notation is improved, the precision of the coding is improved and the amount of information to encode is reduced, it becomes unpredictable whether the new encoding will over- or underachieve with respect to CD.

Moreover, the encoding quality cannot be measured. Our technical methods of measuring and qualifying an audio signal are based on traditional (analogue) systems. These methods measure for DCC a bandwidth of 5 Hz up to 22 kHz a signal to noise and total harmonic distortion, measured in accordance to IEC of 92 dB and a dynamic range of 18 bit or 108 dB.
But these measurements with single frequencies do not describe the dynamic behaviour or the real audio quality of the system.

This phenomenon is well-known to our industry; designing a good HiFi system requires a lot of fine tuning by listening.
To develop and qualify the PASC coding we first had to develop a new measuring method by means of listening panels.

What can we achieve with the new PASC coding technology?
To be honest we do not exactly know yet. Subjective qualification cannot be the measure. An objective measure while still relying on listening panels to test if the DCC sound can be identified from the CD sound under a variety of best possible listening conditions.

The PASC encoding has been developed up to the point that people cannot identify what is CD and what DCC sound.

Recently my colleagues from Decca have come to the conclusion that potentially, based on some first results, the DCC PASC algorithm is be so good in quality that it might be a better alternative for master tapes than today's 16 bit U-matic.

The 18 bit performance can be easily demonstrated to be superior to the U-matic but obviously cannot be the only criterium. Experiments in which over 100 serial copies are made with DCC show a astonishing stability of the process. Apart from logarithmic increase in quantization noise the linearity of the signal is unattached.

Sofar about the main technology choices we had to make prior to setting up the system standard.

Despite all the work and effort put into development of these new technologies, from a marketing perspective a more, if not the most relevant issue is to create a new appeal for the cassette system.

Neither the word digital, nor the improved sound quality are sufficient to call it a brand new system.

This is primarily achieved via the new cassette. The overwhelming support for the DCC system today is also largely because of the looks of the cassette. This has started with the first presidents of record industries and is still today reflected in market acceptance tests done in a variety of countries.
The basic dimensions of the cassette have not been changed; they prove to be ideal, just large enough to present itself as a serious software carrier but small enough to fit the average shirt pocket. The cassette is somewhat slimmer shaped and completely flat.

All DCC players will be auto reverse by standard. The cassette therefore only requires holes to access the reel spindles at one side. The top is completely closed. In case of a pre-recorded cassette a paper graphic artwork is sealed under a transparent window. Cassette and window are fused together by means of ultrasonic welding thus providing a rigid construction.

The cassette looked at from the front is often referred to as a miniature CD-box, even including such a spine.

What are the relations between DCC and DAB.

Both DCC and DAB make use of the new generation of digital audio encoding methods. For DCC we have chosen for the subband coding method, we call PASC. The choice of Subband coding over Transform coding was not for a very significant reason. It is our impression that subbandcoding is less sensitive to propagation of errors than transform coding.

PACS falls in the within the ISO-MPEG standard, but it is good to realize that this does not mean that ISO-MPEG systems are identical to PASC.

From a standardization point of view the coding in DCC and ISO-MPEG or DAB/ Eureka 147 are also rather different. In the DCC standard the encoding algorithm is carefully standardised. This rules out that all kinds of different algorithms resulting in different allocation of bits, and therefore a different sound quality can be made. The DCC-algorithm is extensively tested in conjunction with the various music industries, and is the only version which can be guaranteed.

In the ISO-MPEG standard the decoding (subband) principle is standardised. This allows for a far greater range of encoding solution with distinct different quality levels. ISO-MPEG defines three decoding principles, 3 layers.

Two of these, layer 1 and layer 2, specify a subband decoding principle. PASC would fall under layer1.

We are frequently asked why we have not strived for one common standard for both DCC and DAB. Through my extensive explanation of the complexity of the standardization process I hope I could make clear to you how important it is to specify from the market backwards, not from the technology forwards. The DCC market is very large, more than large enough to carry research and development for specific chips to handle the coding and decoding. Moreover, because of the active participation in the DCC project of various recording industries, the supply of software and therefore a fast growth of the system can be guaranteed.
With Digital Broadcast large scale investments on LSI development are more difficult as a wide availability of digital radio software is less defined.
With DCC we had to move fast and make difficult and sometimes drastic standardization choices. In a Eureka or ISO construction such decisions are difficult to realize.

Of course Philips supports in parallel to DCC, research and standardization going on for audio bit reduction in ISO and Eureka 147, which aims at digital audio broadcast. The data rate for those systems will be lower than the 384kBit/second for DCC, either 128 k, 96 or 64 kbits/second per channel. These differences between DCC PASC coding and subband encoding for DAB applications with lower bit rates concern the way the allocation information is computed. Because of the lower bit rates, a different computation of masking thresholds and a more effective coding of the quantized samples scale factors and allocation information are required in case of DAB.
One of our objectives in the standardization for DAB is to achieve that the relation of the DAB coding to PASC, being also a subband based coding, can be such that the same decoding hardware can handle both systems. For this reason, layer1 and layer2 have been specified in close relation. Handling both applications with one chip set would be very interesting from a market point of view. It would mean that e.g. a car-radio/DCC combi would work with one chip set for both DCC and

DAB. It could bring the digital radio hardware into the market even before a wide scheme of digital transmitters. Decisions to modify the layer2 standard in this respect might seem a slightly better technical proposal, they risk however, that the extension of DCC-decoding chips require so much more silicon to contain the DAB algorithm that it will not be implemented by most manufacturers. This would in my view have more negative consequences on the introduction of DAB, than missing out on the minor technical improvements.
I also seriously question if it is wise to exclusively work with 48kHz sample rates, where all pre-recorded software, both CD and DCC, use 44.1kHz.

There are various other interesting related issues for both DCC and DAB. I will mention one important point of overlap. In DCC we standardized a text-information system. The recording industry is currently in the process of programm the tapes with background information in a defined format. This standard will influence the kind of displays which will be integrated on the products. It is obvious that an eventual text information system in DAB could greatly benefit from both the available (text)-software as well as the development of the market of audio products with a display. Also here we encounter the standardization problem; proposals to suggest that the broadcaster will make a sub selection of the attached information and mingle it with his own textual info. In practice this could very well prove to be killing for the text mode option for Digital Broadcast ! It would mean that the broadcaster needs to get active for every line of text he offers which we can hardly expect to happen.

I would like to close with a rather personal point of where I encounter a relation between DCC and DAB.

BIT REDUCTION SYSTEM, DATA COMPRESSION SYSTEMS, these are the terms my fellow engineers from the DAB institutes proudly throw into the world.

But for non-technical people it automatically leads to the impression of inferior quality. Music which is reduced or compressed, how would you feel if a technician is going to compress or reduce your (musical) work?
Even many technicians have mentally come to the conclusion that these new coding systems can at best approach CD-sound quality. Many are not aware the sound quality can also simply be better! In my view it is essential that in communication to the public we avoid these words and use more appropriate terms as "more efficient coding " etc.

DIGITAL COMPACT CASSETTE

To replace

the musicassette

in due time

WORLDWIDE ANNUAL SALES 1991

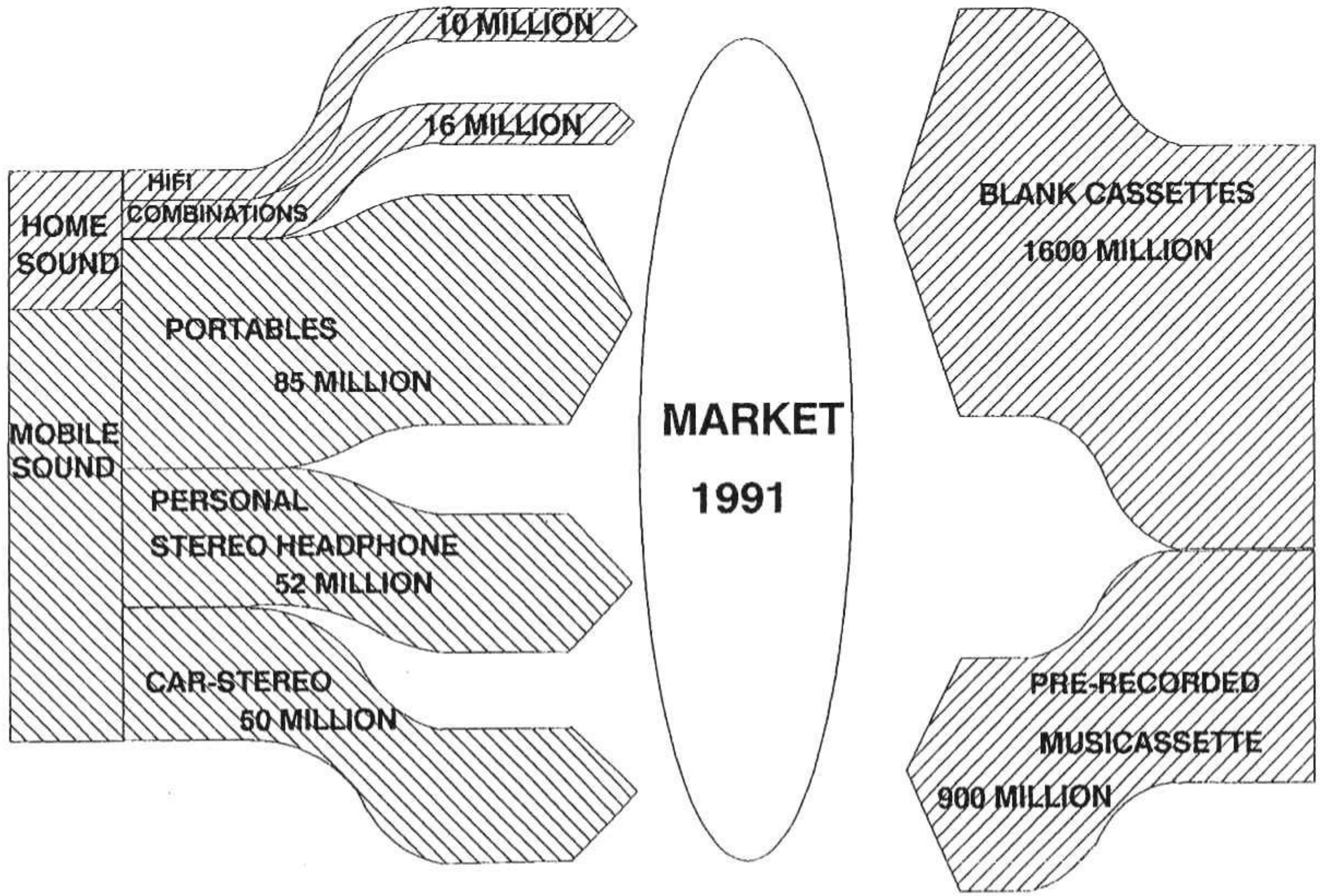
(all brands)

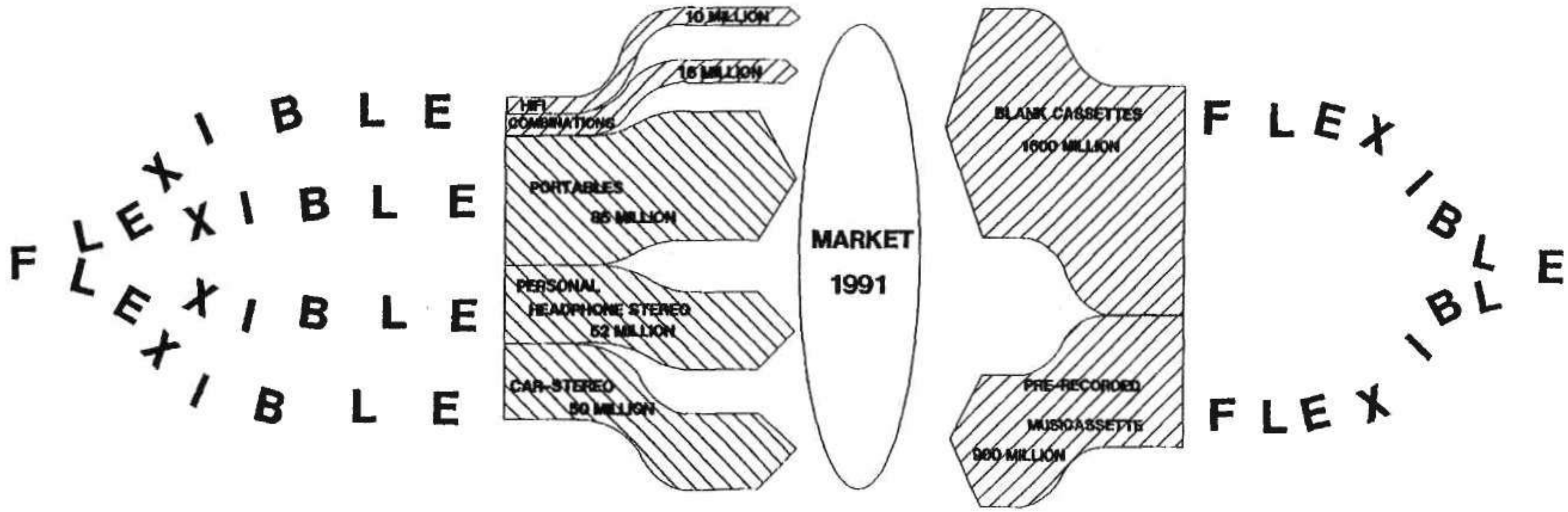
900.000.000 Musicassettes
1,600,000,000 Blank Cassettes
213,000,000 Cassette functions

1.000.000.000 Compact Discs
39.000,000 CD players (all functions)

Average ownership

3 cassette players
and
60 cassettes
per western/japanese household


HOME SOUND
MOBILE SOUND
HIFI COMBINATIONS
10 MILLION
16 MILLION
PORTABLES
85 MILLION
PERSONAL STEREO HEADPHONE
52 MILLION
CAR-STEREO
50 MILLION
MARKET
1991
BLANK CASSETTES
1600 MILLION
PRE-RECORDED
MUSICASSETTE
900 MILLION

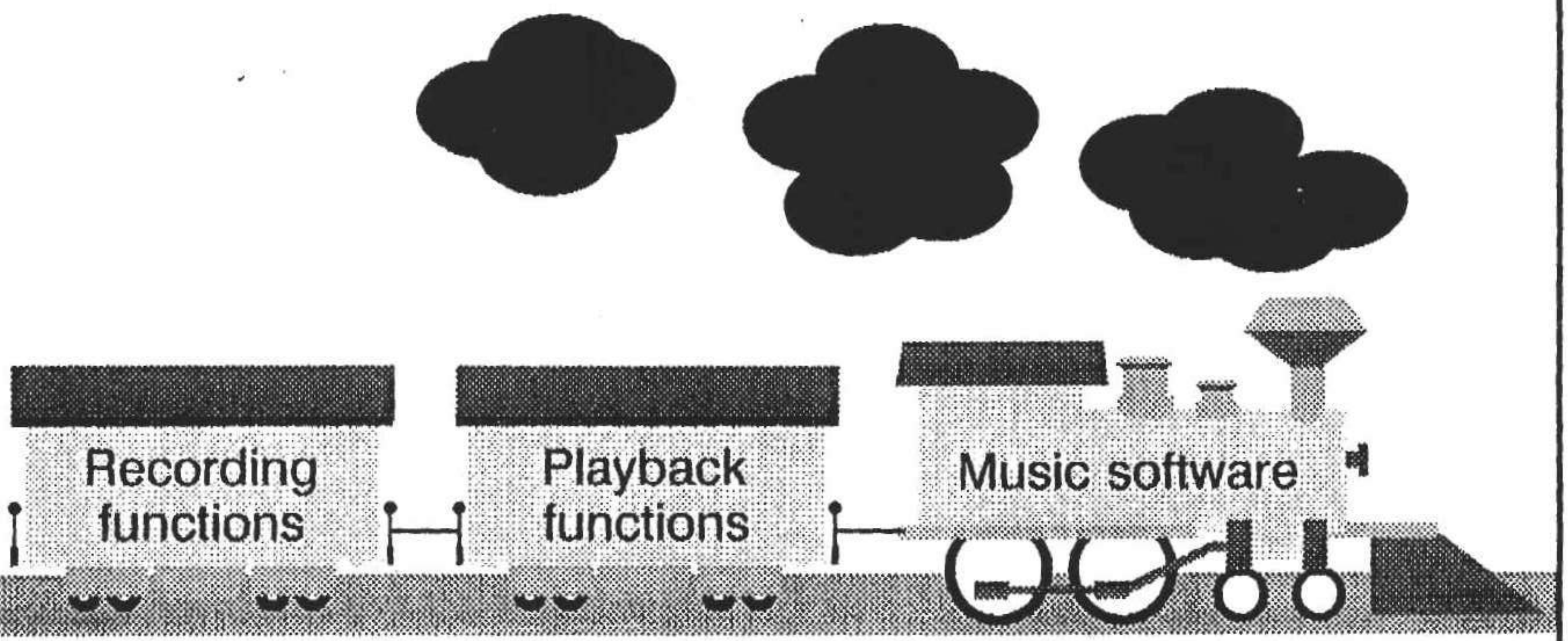


SYSTEM

MC is a FLEXIBLE **SYSTEM:**
The consumer can play his cassette wherever /whenever.

Home recording is very important, but pre-recorded drives the market
Most cassette-functions are bought for replacement reasons

Great number of cassettes in consumer libraries, keeps the market going.
(60 per household average)


Recording functions
Playback functions
Music software

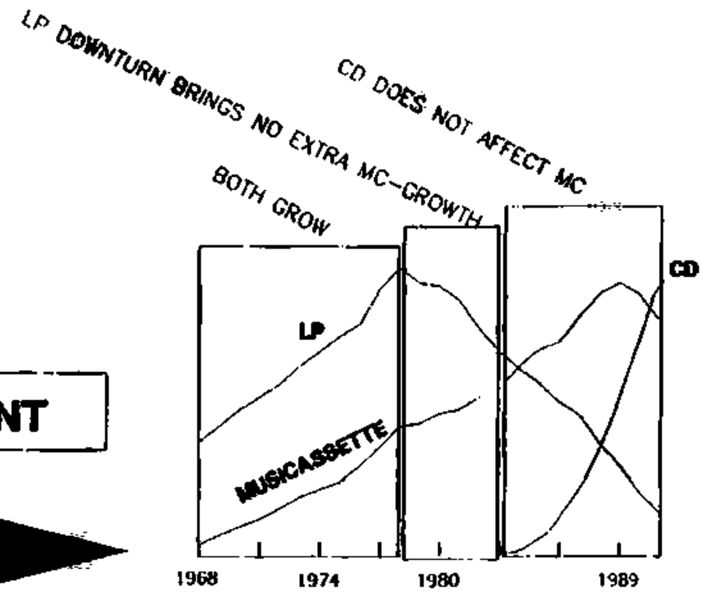
COMPACT CASSETTE

−	+
IMAGE	HANDLING
SOUNDQUALITY	WAY OF OPERATION
DURABILITY	SIZE
	WEIGHT
	PLAYING TIME

DUAL CARRIER MUSIC MARKET

Different buying motives
Different customers
Different application
Differences per country

DISC/TAPE MARKETS DEVELOP INDEPENDENT



DISC = COLLECTORS ITEM

"FOREGROUND MEDIUM"
ACTIVE USE IN "LIVING ROOM"
RANDOM ACCESS
JEWEL LIKE IMAGE
COLLECTION
DELICATE (IMAGE)
SOPHISTICATED PACKAGE

CASSETTE = CONVENIENCE ITEM

BACKGROUND MEDIUM
PASSIVE USE "IN THE CAR"
CONTINUOUS PLAY
WHEREVER / WHENEVER
INSTANTLY ACCESSIBLE, "HANDS ON"
ROBUST, SHOCKPROOF
EASY TO HANDLE

CHANGE FROM MUSICASSETTE TO DCC:
A DIFFERENT CASE FROM CHANGE OF LP TO CD

SMALL GROUP OF ACTIVE PEOPLE
WITH INTEREST......

180 M TURNTABLES → **1,000 M. LP's (1978)**

120 M CD-PLAYERS → **1,000 M. CD's**

......BUY MANY DISCS

A LARGE GROUP OF PASSIVE PEOPLE
YOU CANNOT INFLUENCE ....

1,000 M. CASSETTE PLAYERS → **1,000 M. CASSETTES**

.......BUY FEW CASSETTES

**ABILITY TO PLAY EXISTING LIBRARIES IS ESSENTIAL
FOR THIS (PASSIVE) MARKET**

Suppose DCC would grow like CD:

This would result in 2001, after 9 years of exceptional success
into "only" 120 Million players in use,
thus leaving 900 Million cassette players unchanged

SALES OF DCC HARDWARE HAS TO GO 3X AS FAST AS CD-CASE

DIGITAL dcc COMPACT CASSETTE

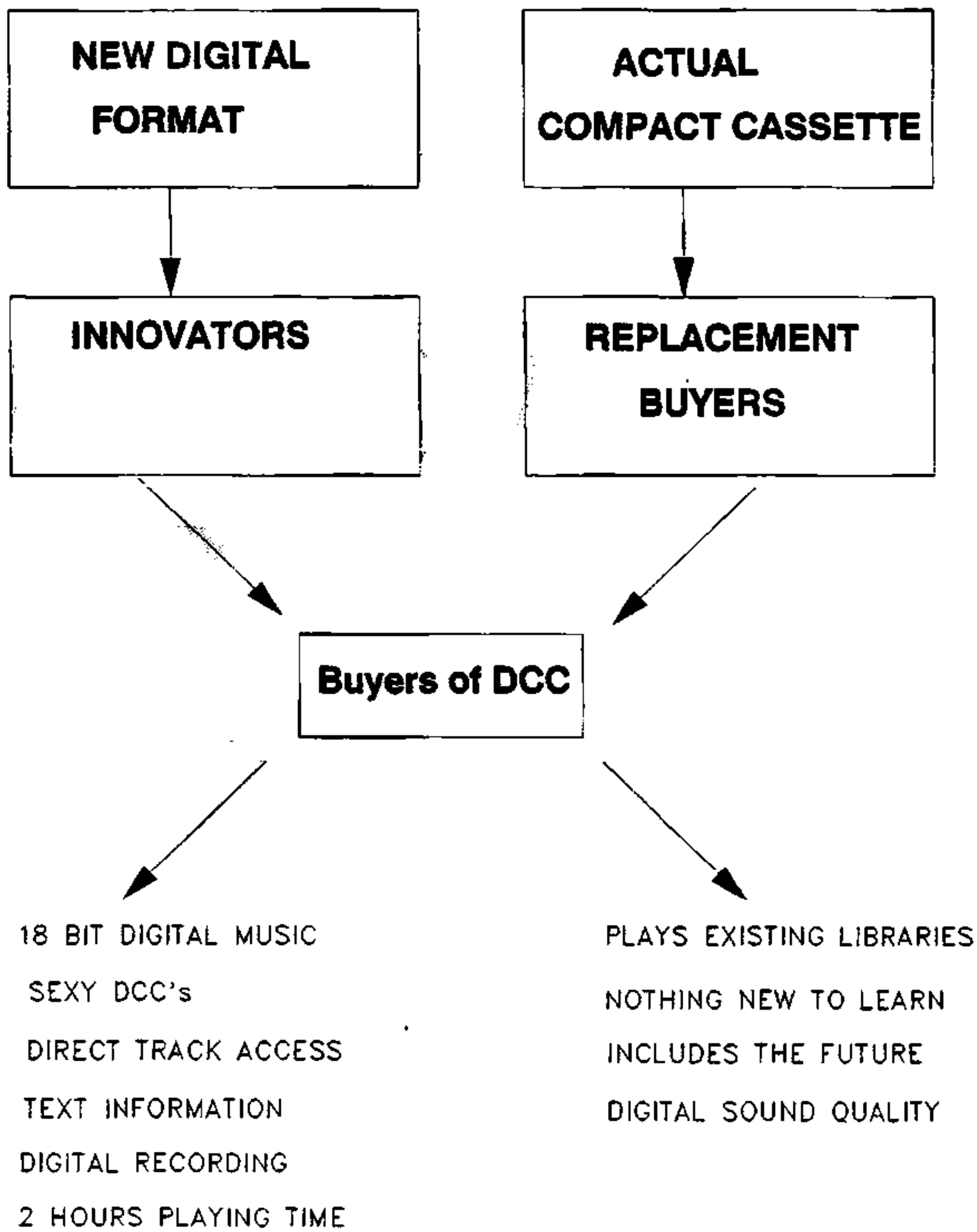
is

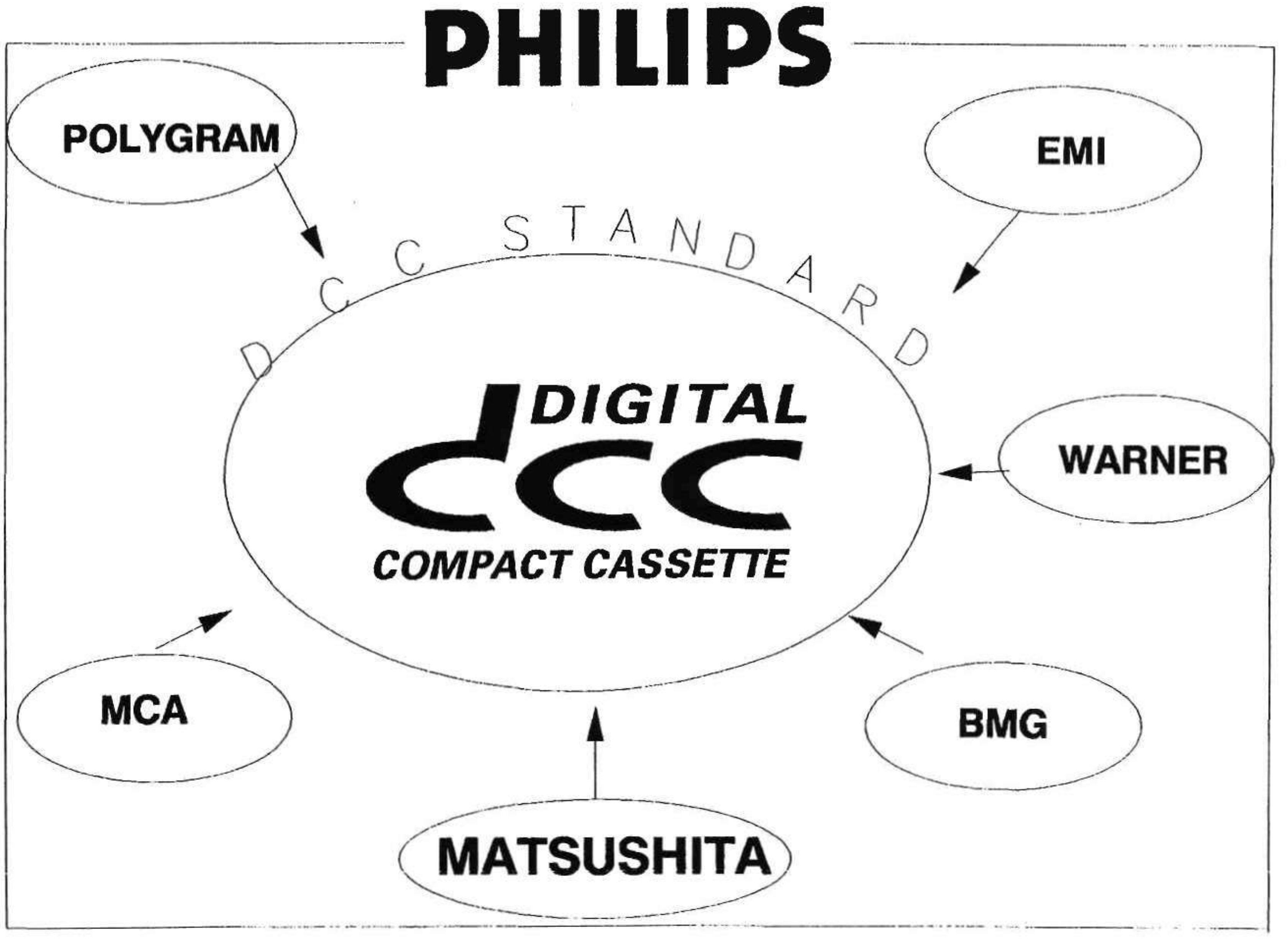
MUSICASSETTE COMPATIBLE

A DCC player can playback the existing musicassette

(The existing compact cassette player can not playback the DCC cassette)

DIGITAL dcc COMPACT CASSETTE




PHILIPS
POLYGRAM
EMI
DCC STANDARD
DIGITAL
dcc
COMPACT CASSETTE
WARNER
MCA
BMG
MATSUSHITA

CELLULAR MOBILE COMMUNICATIONS

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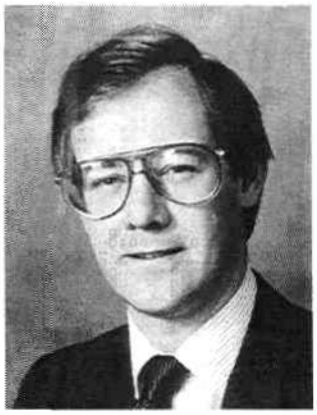
CELLULAR MOBILE COMMUNICATIONS



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Mr. Williams is Business Strategy Director for Motorola—GSM Products Division (GPD), which has worldwide product responsibility for the development and manufacture of GSM cellular infrastructure systems. He is based at the European Cellular Infrastructure Headquarters in Swindon, England and is responsible for product marketing, technical marketing, strategic planning and software strategy for all products within GPD. Prior to joining the Cellular Infrastructure Division, Mr. Williams was General Manager of Motorola Government Electronics Group in the United Kingdom, with additional responsibility for Southern Europe. Before coming to Motorola, Mr. Williams spent 10 years with Plessey Network and Office Systems in various senior management positions, and before this was in sales and marketing with the BTR group of companies, covering world markets.

Dataquest Europe Limited
EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE
May 26–28, 1993
Munich, Germany

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European Cellular
Infrastructure Division

EMERGING APPLICATIONS AND TECHNOLOGIES

Cellular Mobile Communications

David Williams

Business Strategy Director

Motorola

European Cellular Infrastructure Division

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What is Cellular Mobile Communications?

- A fully automatic, high capacity, wide area radio based telephone system
- Serving mobile, portable and fixed subscribers
- Employing frequency reuse with handover

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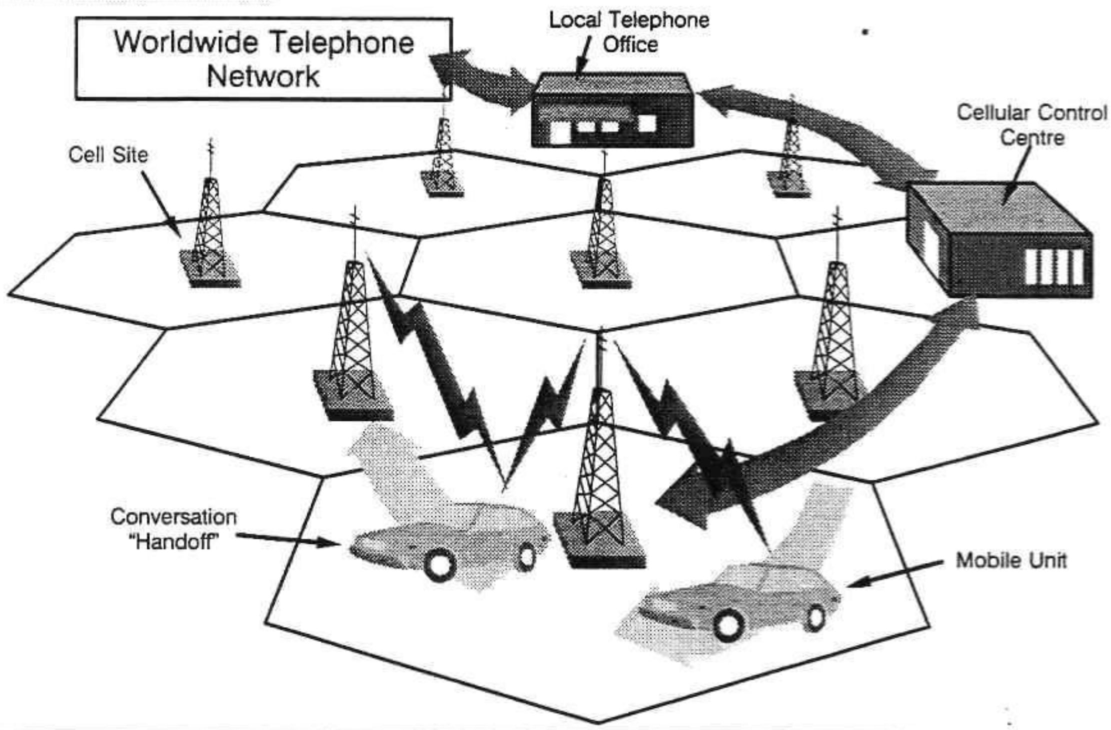
The Cellular Concept



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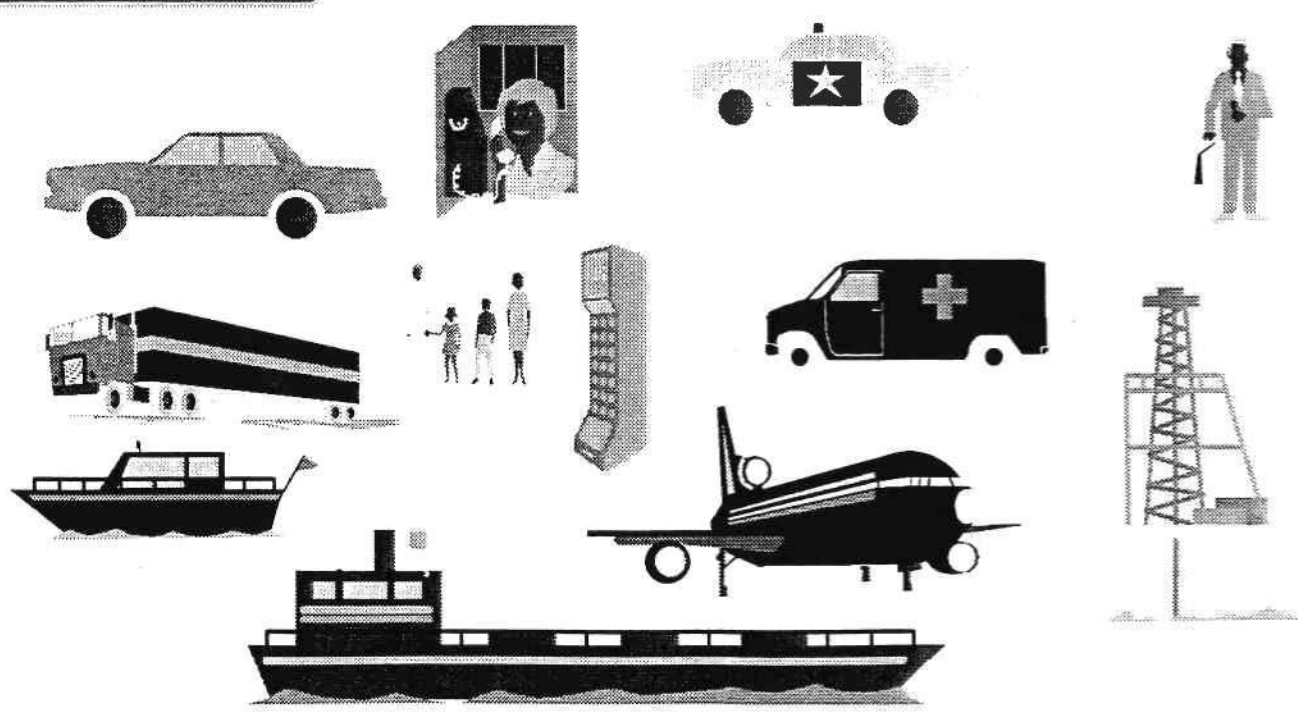
Applications



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The Role of the Semiconductor in Cellular Technology

- Infrastructure
- Handsets
- Mobile Switching Centre
- Ancillary Cell Site Equipment
- Test Equipment
- Operations and Maintenance Centre
- Installation

- Engineering Development Tools
- System Planning Tools
- Software Development Tools
- Factory Automation
- Manufacturing/ Assembly Lines

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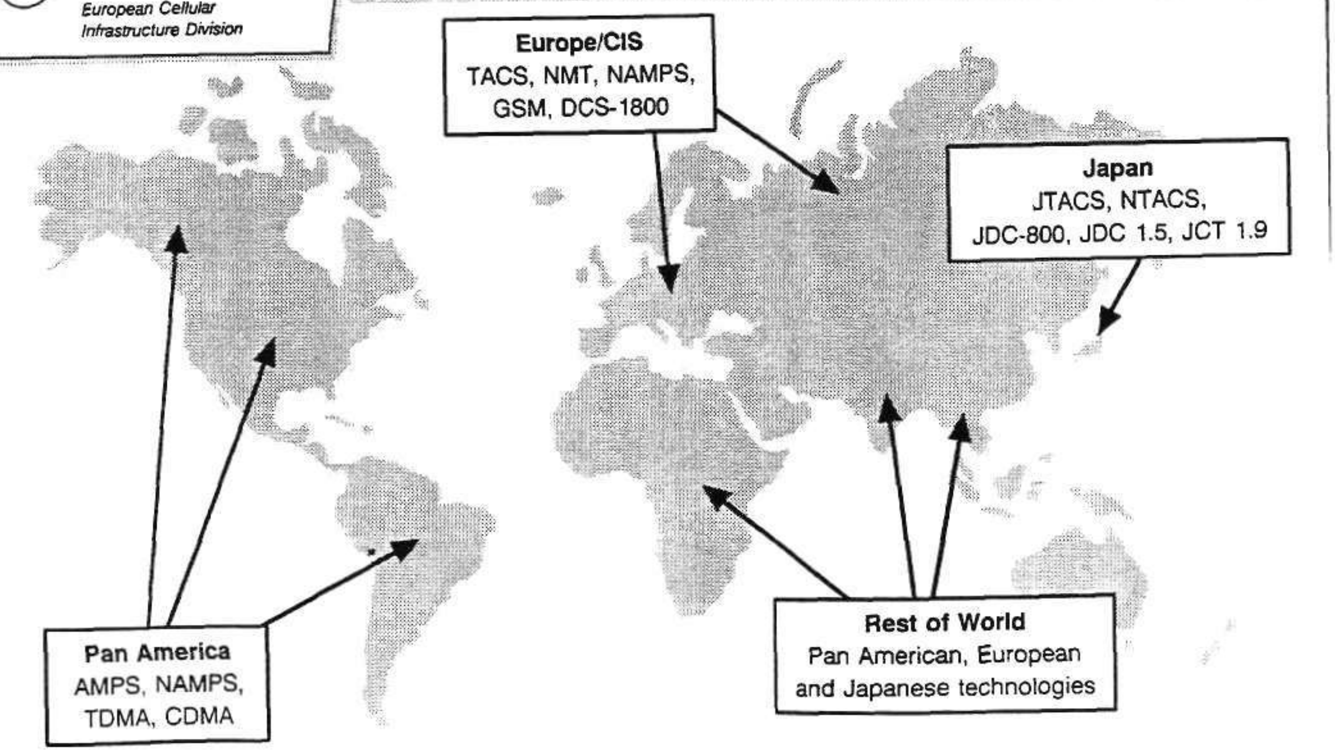
Worldwide Cellular Technologies



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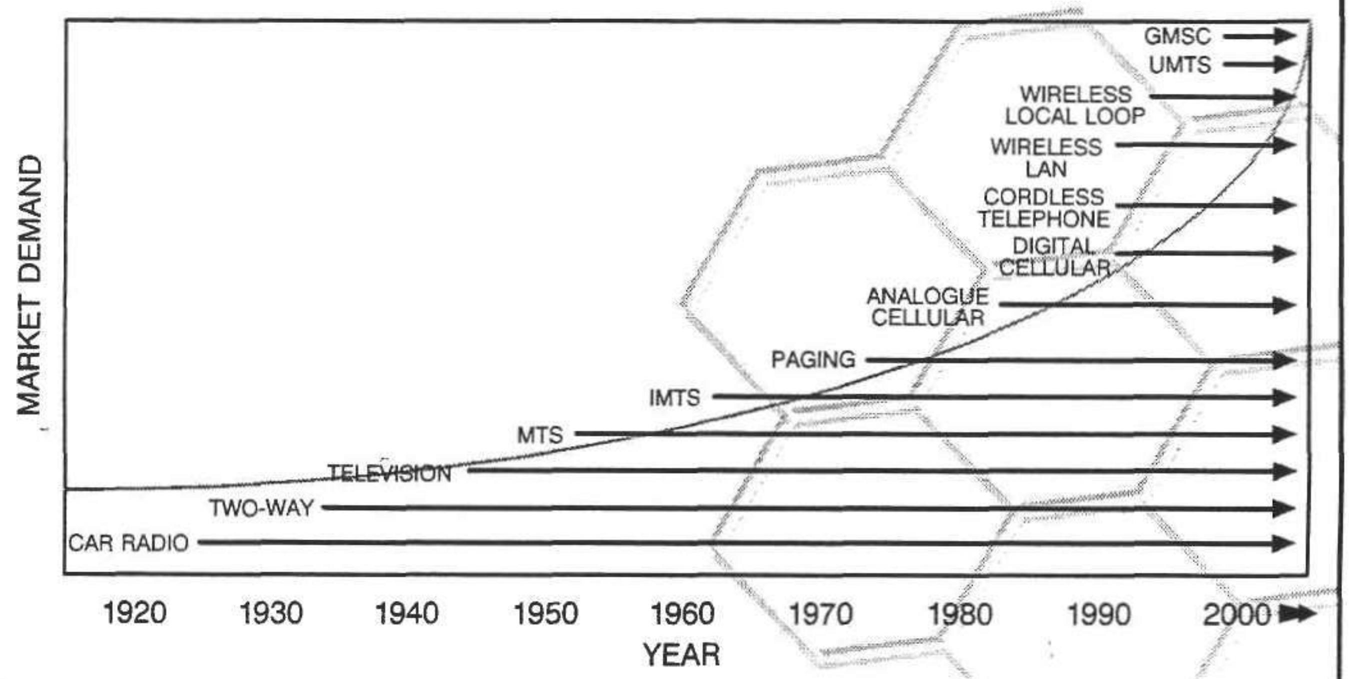
Wireless Evolution



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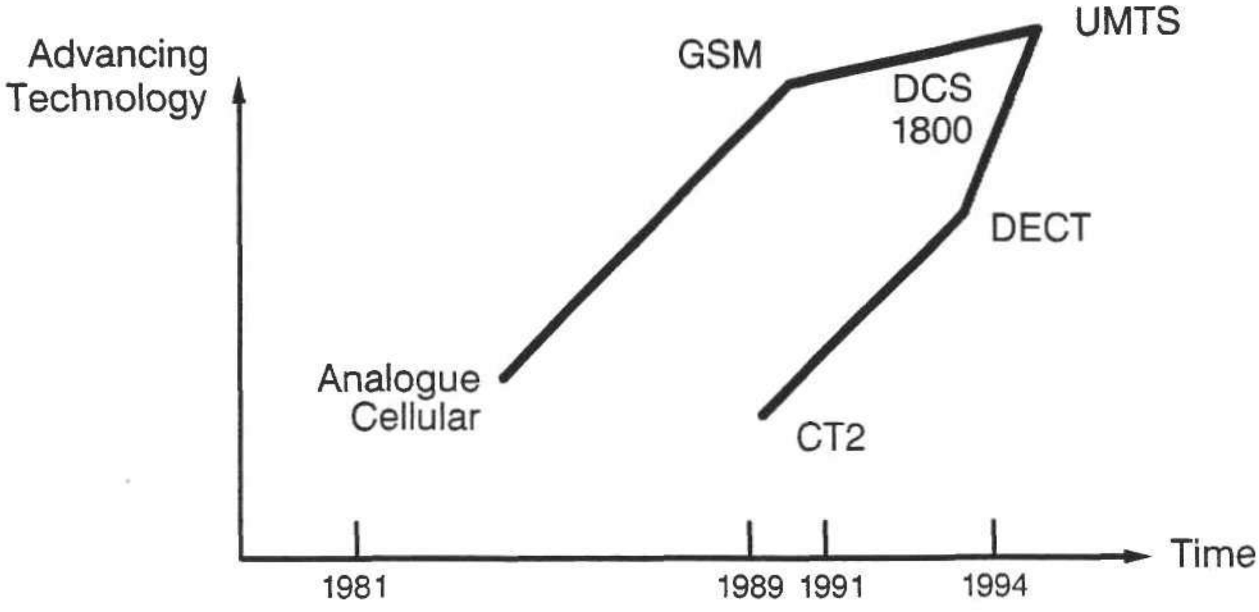
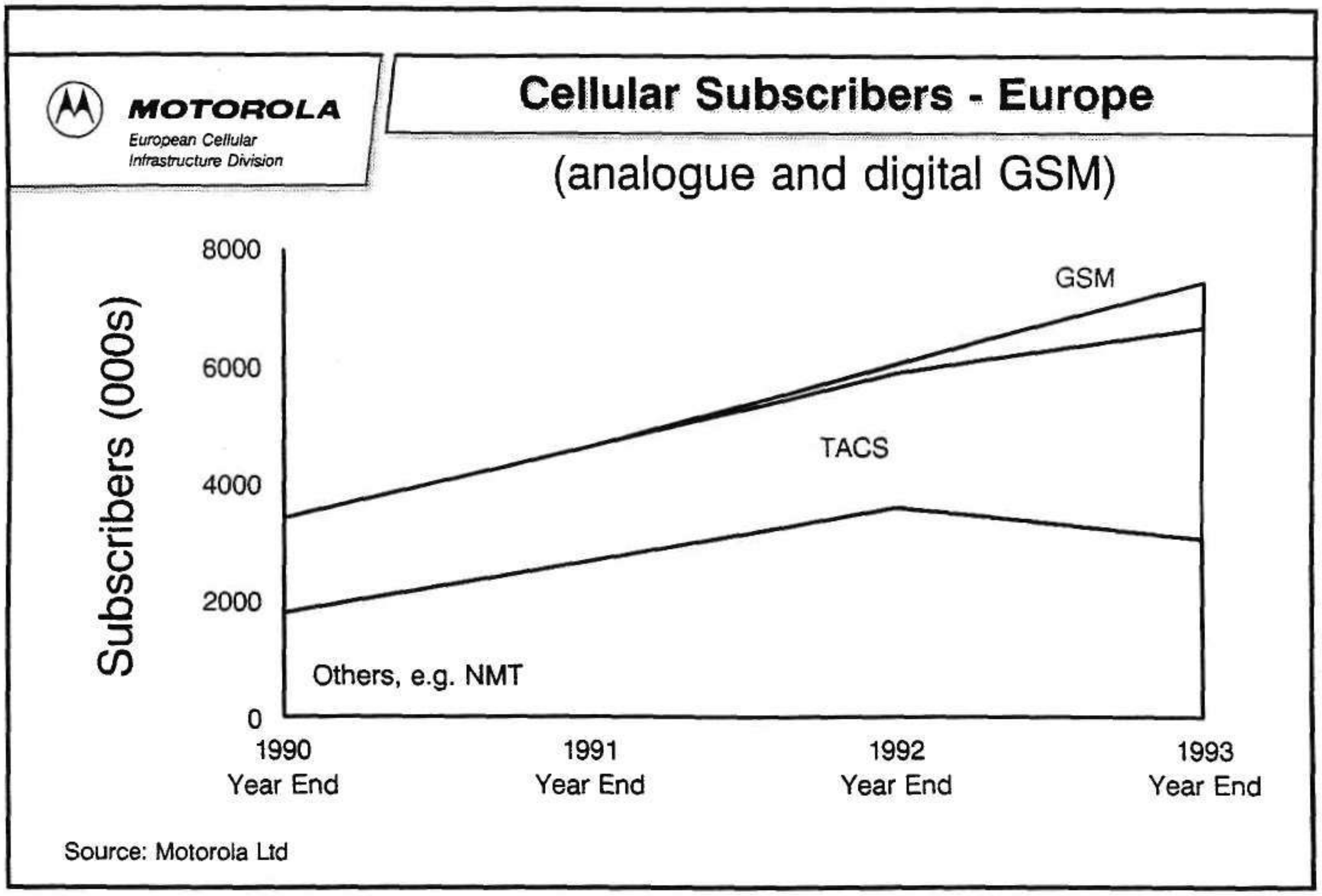
Projected Development of Mobile Communications



Source: CIT Research, London, U.K.


MOTOROLA
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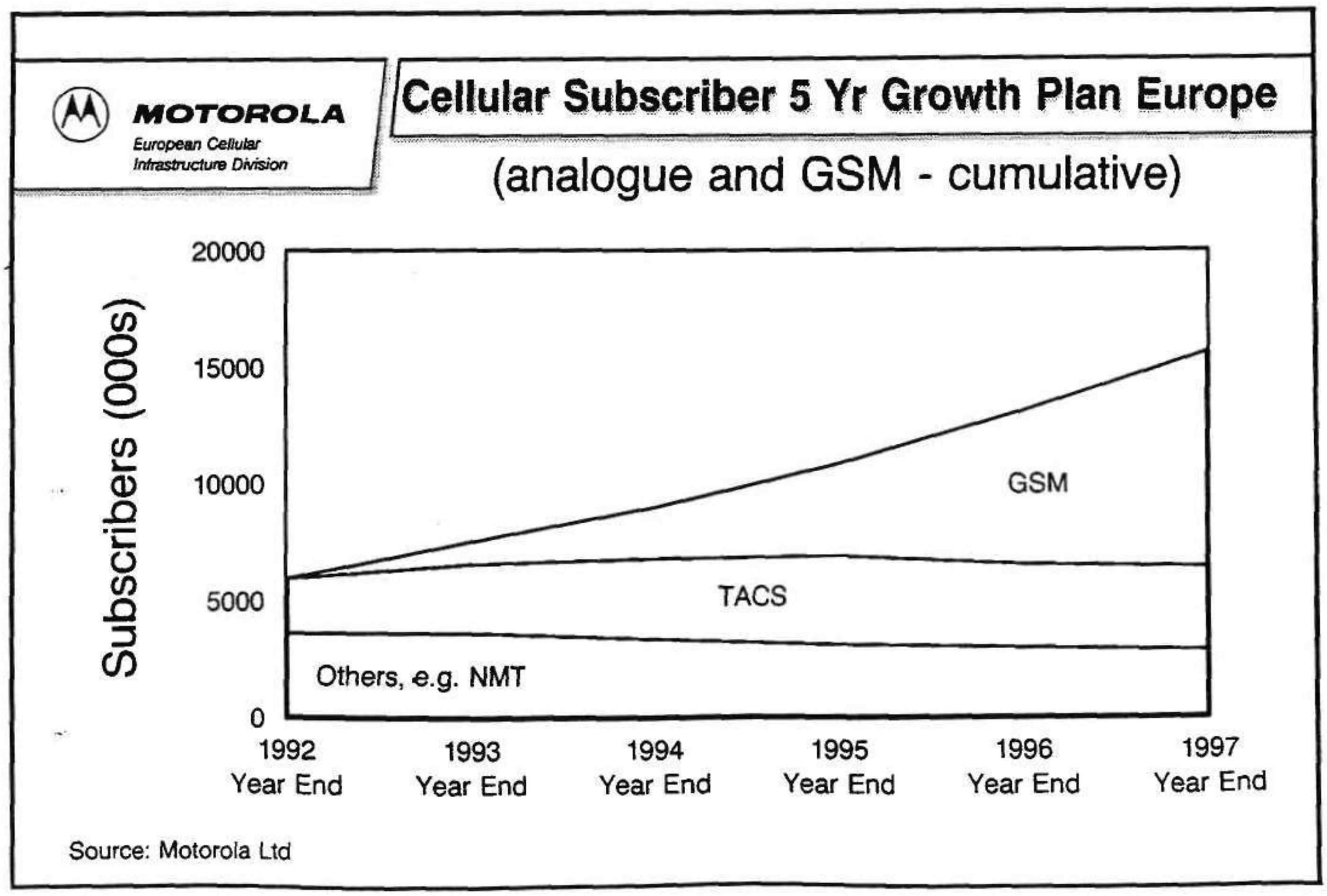
Cellular Subscribers - Europe
(analogue and digital GSM)
Subscribers (000s)
8000
6000
4000
2000
0
GSM
TACS
Others, e.g. NMT
1990 Year End
1991 Year End
1992 Year End
1993 Year End
Source: Motorola Ltd


MOTOROLA
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Cellular Subscriber 5 Yr Growth Plan Europe
(analogue and GSM - cumulative)
Subscribers (000s)
20000
15000
10000
5000
0
GSM
TACS
Others, e.g. NMT
1992 Year End
1993 Year End
1994 Year End
1995 Year End
1996 Year End
1997 Year End
Source: Motorola Ltd

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GSM

Global System for Mobile Communications

Feature	Benefit
Single European cellular standard	Pan-European (international) inter-operation
Open Standard	Economy of scale/ multi-vendor market
Spectrum efficient	Greater subscriber capacity for limited available frequencies
ISDN compatibility	Meets long term telecommunications requirements
Digital transmission	Improved call quality

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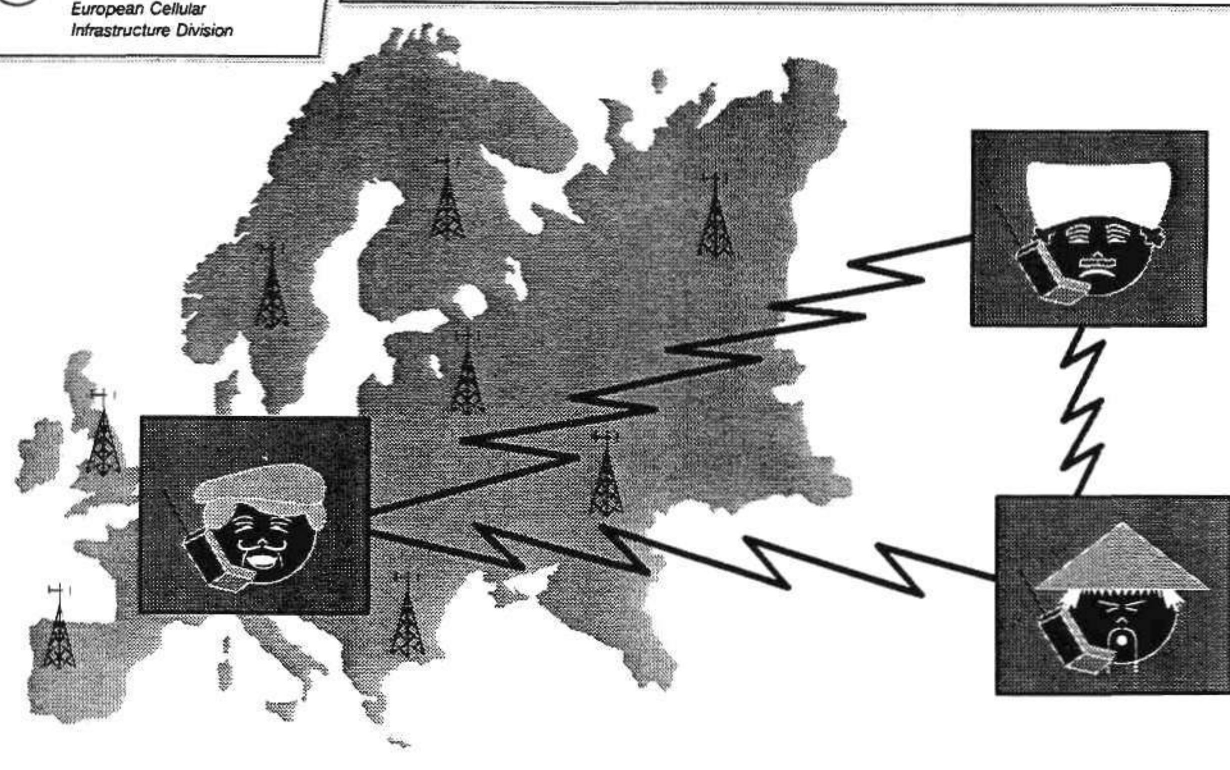
GSM

System in Operation



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GSM Features and Services

Phase 1

- Telephony
- Emergency calls
- Roaming in Europe
- Subscriber SIM card
- Short message service
- Facsimile Group 3
- Call forwarding
- Full encryption
- Data services
- Call barring

Phase 2

- Packet mode data
- Call waiting/hold
- Advice of charge
- Data transmission
- Multi party service
- Half rate speech & data
- Calling party identification
- Closed user group
- Call broadcast short messages

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DCS 1800

- GSM functionality at 1.8 GHz using same air interface
- Mobile, residential, business and pedestrian phone
- New operators emerging in Europe
- Compact portables not yet available

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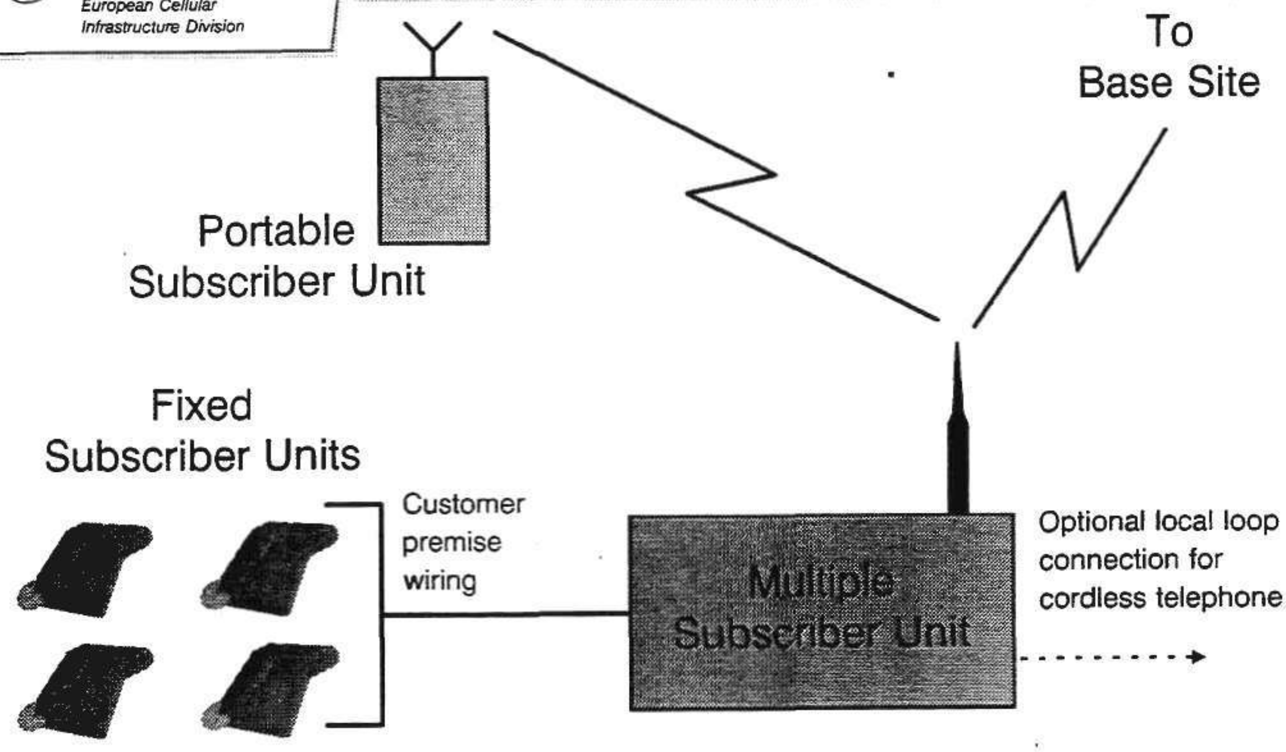
Digital Wireless Local Loop



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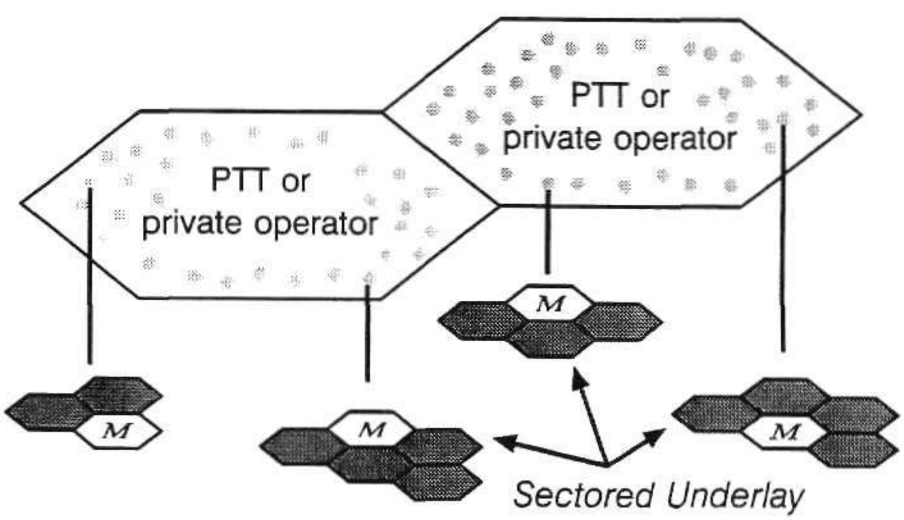
Digital Microcellular Solution

Exisiting Large
Cell Networks



- An underlay network of microcellular cellsites incorporated within standard digital cellular network
- Provides enhanced capacity handling within existing networks

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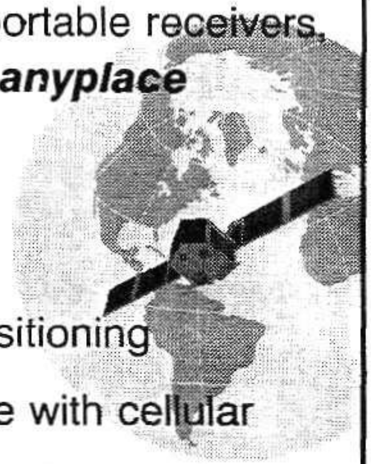
Global Mobile Satellite Communications

- Global Mobile Satellite Communications utilises portable receivers, providing communications to ***anyone, anytime, anyplace***



- Two-way digital high quality voice transmission
- Global paging/messaging
- Facsimile services
- Data transmission
- Global roaming
- Global positioning
- Dual-mode with cellular
- "Modem to the world"
- Global dial tone

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Universal Mobile Telephone System UMTS

- Third Generation Cellular
  - Worldwide Standard
    - Combining European UM TS and American FLM PTS
  - Worldwide Access
    - Common Frequency Allocation
  - Satellite/Terrestrial Radio Access from Single Mode Terminal
  - Additional Services
    - ISDN(2B + D) + Partial Access to Broadband
  - Additional Network Compatibility
    - B/ISDN, UPT, Intelligent Networks
  - May be an Evolution from GSM/DCS 1800 rather than an entirely new system

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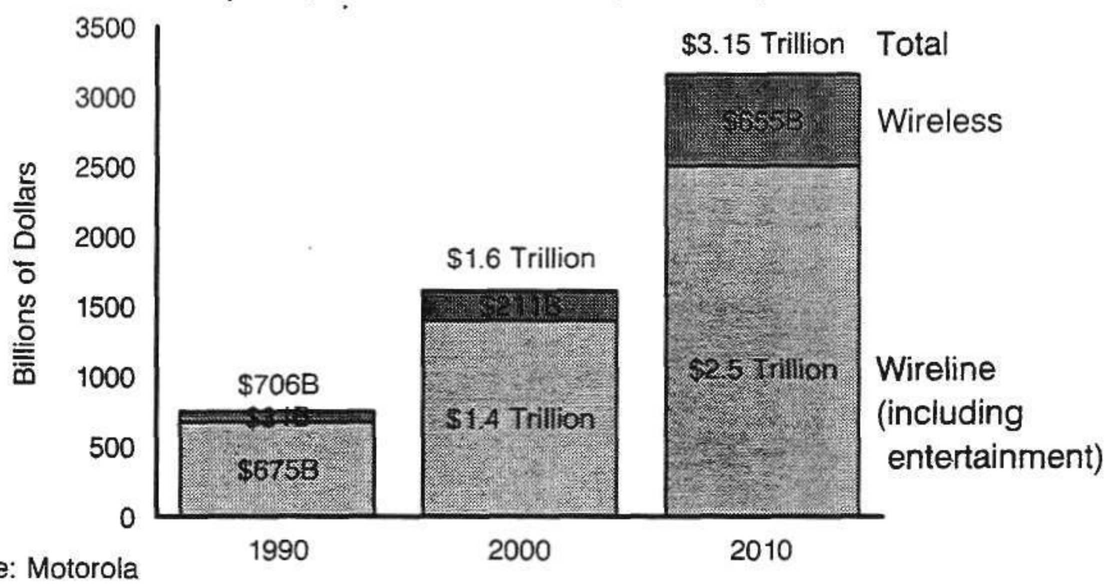
This Wireless World

- Telecommunications:
  $3.1 Trillion market in 2010

$655 Billion will be wireless



Source: Motorola

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The Wireless World

- $655 Billion will be wireless in 2010

You'll call a person, not a location

The role of the semiconductor is crucial in achieving this quest

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Summary

- The cellular revolution is gaining momentum
- Global systems are emerging
- Person to person communications
- GSM, DCS 1800, GMSC, UMTS . . . the evolution of a revolution
- Is this the shape of the future?

OPPORTUNITIES IN AUTOMOTIVE ELECTRONICS

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OPPORTUNITIES IN AUTOMOTIVE ELECTRONICS

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Mr. Williams is an Industry Analyst for Dataquest's European Semiconductor Group and is based in Denham, England. He is primarily responsible for the automotive application markets research and covers specific areas of research in the computer and consumer segments. Prior to joining Dataquest, he was with Aidcom International, the consumer marketing research company based in London. Mr. Williams studied Computer Management at the Institute of Data Processing Management in London.

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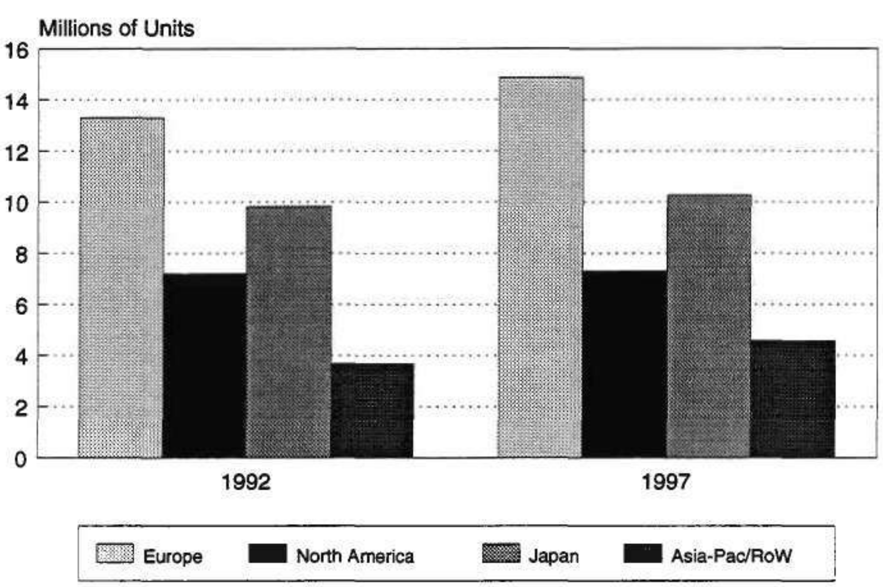
May 26–28, 1993
Munich, Germany

AGENDA

- Automotive Industry Overview
- Automotive Electronic Equipment Markets
- Automotive Semiconductor Market
- Future Opportunities

GLOBAL CAR PRODUCTION
EUROPE IS NO.1!



Source: Industry Estimates

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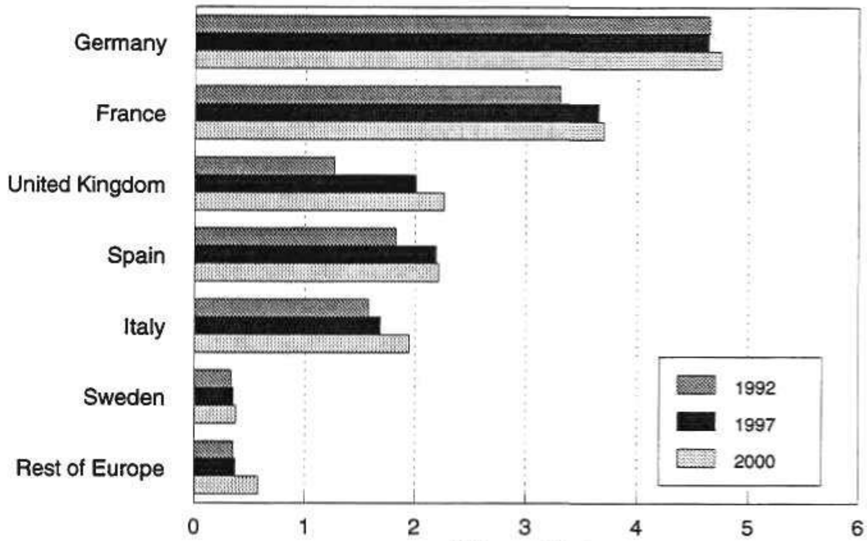
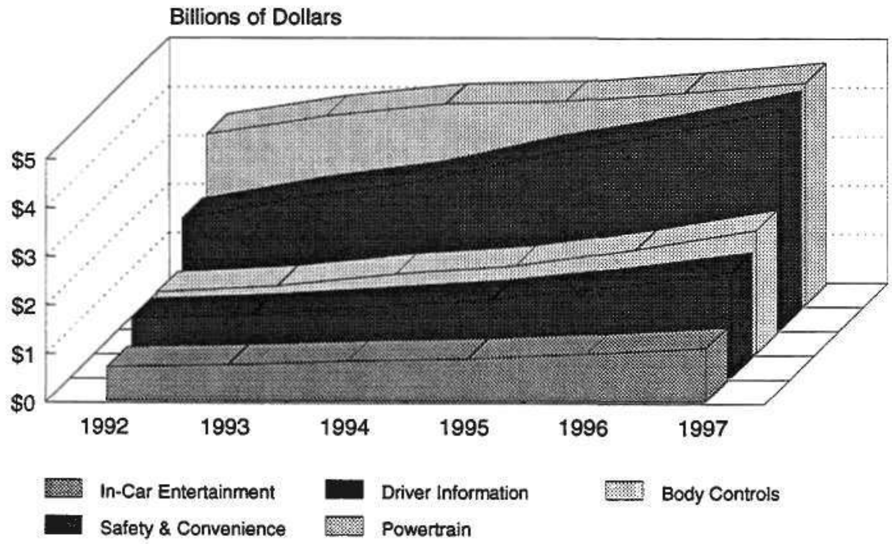
EUROPEAN CAR PRODUCTION FORECAST
COUNTRY ANALYSIS



Source: Automotive Industry Estimates

AUTOMOTIVE ELECTRONIC EQUIPMENT MARKET
END-USER MARKET REVENUES



Source: Dataquest

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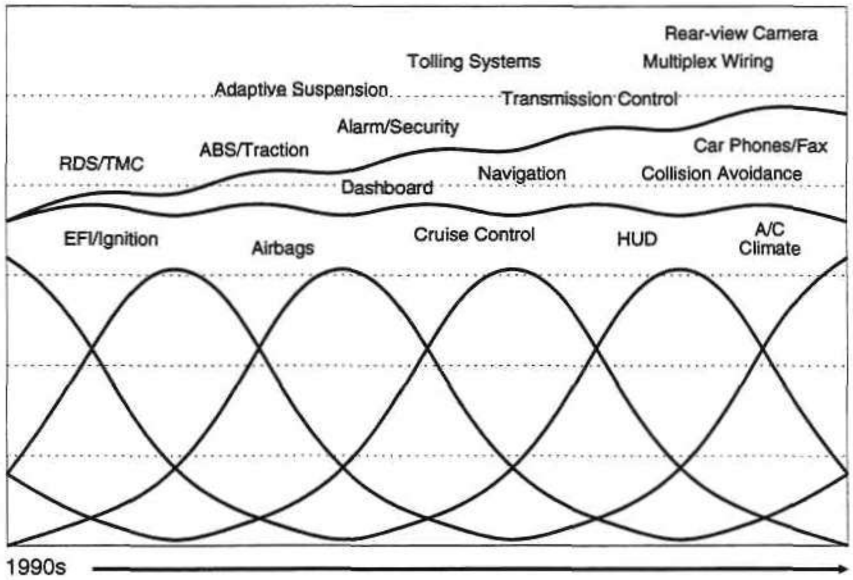
FUTURE SEMICONDUCTOR APPLICATIONS
GROWTH AREAS



Source: Dataquest

GROWTH FACTORS

LEGISLATION
- Antilock Braking Systems
  (for trailers & commercial vehicles)
- Electronic Fuel Injection
  (for fuel emmission regulations)
- Airbags
  (Passive Restraint Systems regulations)

MARKET EVOLUTION
- High end/Luxury Car features spreading down the range

INNOVATION
- Black-box, Global Positioning Systems, etc.

OTHER FACTORS
- Competition
- Local government policy (eg tolling systems)

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AUTOMOTIVE SEMICONDUCTOR CONTENT

(In US Dollars)

1992	
	Engine Control
$25	Electronic Fuel Injection
$10	Electronic Ignition
	Dashboard
$9	Speedometer/Tachometer
$3	Clock
$5	Car Radio
$7	RDS/TMC
$15	MUX Central Locking
$22	Antilock Braking System
$96	Estimated Total Value

Source: Dataquest

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AUTOMOTIVE SEMICONDUCTOR DEMAND FORECAST

1992		1997
	Engine Control	
$25	Electronic Fuel Injection	$15
$10	Electronic Ignition	$5
	Cruise Control	$10
-	Transmission Control	$20
-	Climate Control (A/C)	$10
	Dashboard	
$9	Speedometer/Tachometer	$5
$3	Clock	$2
-	Mileometer	$5
-	Diagnostics	$15

Source: Dataquest

AUTOMOTIVE SEMICONDUCTOR DEMAND FORECAST

Continued...

1992		1997
$5	Car Radio	$5
$5	RDS/TMC Radio Cassette	$5
$15	MUX Central Locking	$8
-	MUX Window/Door Locking	$5
-	MUX Mirrors	$5
$22	Antilock Braking System	$10
-	Traction Control	$10
-	Airbag	$8
$96	Estimated Total Value	$143

Source: Dataquest

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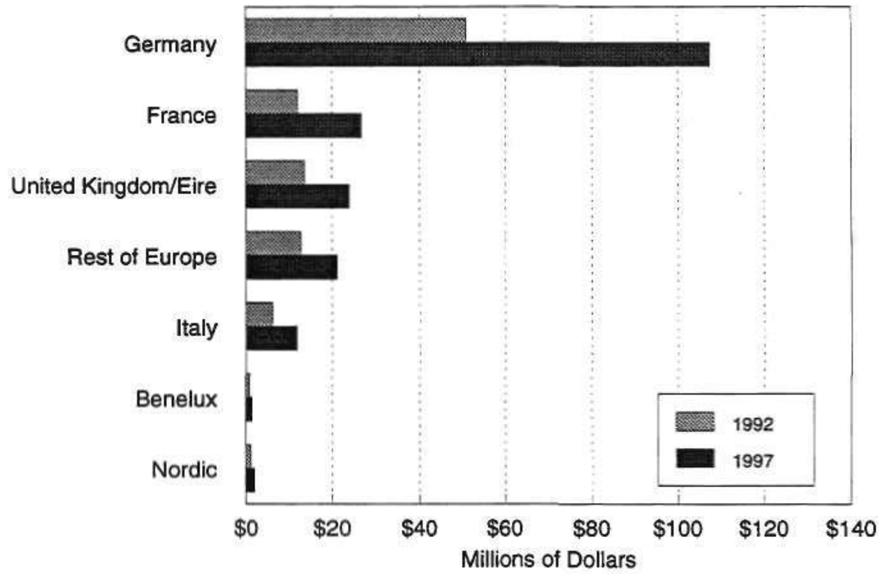
EUROPEAN AUTOMOTIVE ELECTRONICS INDUSTRY
LEADING OEM AND AFTERMARKET SUPPLIERS

OEM	Major Customers	Key Products
Robert Bosch	Mercedes, BMW, Ford, VW-Audi, Volvo, Rolls-Royce, etc	ABS, airbag, radio, relays, alternators, ignition, EFI, etc
Valeo	PSA Peugeot-Citroen, Renault, Lancia, etc	EFI, ignition, ABS, dashboard, climate
Magneti-Marelli	Fiat, PSA Group, Lancia, Ferrari, etc	ABS, EFI, ignition dashboard, climate
Mannesmann (VDO & Fichtel Sachs)	Volkswagen-Audi, BMW Vauxhall, Karmann, SEAT SA, Opel, etc	Dashboard, climate, tacho/speedometers, Cruise, etc

Source: Dataquest

SEMICONDUCTOR CONSUMPTION FORECAST
COUNTRY ANALYSIS



Source: Dataquest

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STRUCTURE OF ELECTRONIC SYSTEMS IN MODERN AUTOMOBILES

Otto Holzinger
Senior Vice President
Robert Bosch GmbH

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STRUCTURE OF ELECTRONIC SYSTEMS IN MODERN AUTOMOBILES

Otto Holzinger
Senior Vice President
Robert Bosch GmbH

Dr. Holzinger is Senior Vice President of Corporate Advanced Engineering and R&D Coordination Automotive Equipment at Robert Bosch GmbH. Prior to this he was Chief Engineer, Test Equipment Division. Dr. Holzinger has also been Head of R&D at Zeiss Oberkochen/München, Germany and a member of research staff at SEL, Stuttgart. He received an M.S. degree and a Ph.D in Physics from the University of Stuttgart, Germany.

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May 26–28, 1993
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Dr. Otto HOLZINGER
Robert Bosch GmbH

March, 1993

Structure of Electronic Systems in Modern Automobiles

1. Automotive Electronics

Both, the individual driver and government's laws make demands on today's automobile that can only be fulfilled by applying the performance capabilities of modern electronics. These demands concern safety, fuel consumption, toxic emissions, handling and driveability, and last but not least, comfort. A new and rapidly growing field is communication. More communication requires an improved driver-car interface.

2. Technical Problems

One problem is the possibility of electronic systems to fail spontaneously without any forewarning. However, the capabilities of electronic systems in this case allow circuits to be designed in such a way that failure will imply no hazard to the driver or the car. Even emergency modes of operation may be possible with a certain amount of extra expenditure. Self-test capabilities and a watchdog integrated in the µC-chip are helpful. IC-structures with fail-stop capabilities have to be developed.

Nevertheless, failure rates should be kept as low as possible. If, in a control unit encompassing 250 individual components, the failure rate is to be kept below 0.1 %/year, that's to say that a single component may have a failure rate of less than 1×10^{-9} per hour. With more and more electronic systems in a car the failure rate has to be further reduced by a factor of 5 to 10. If this is to be achieved, all parameters influencing failure must be analyzed carefully, taken into account and minimized.

An excellent possibility to reduce failure rates is, of course, to reduce the number of components. This means the change from single components to hybrid circuits or customized ICs. Although the failure probability of a complex component is still higher than that of a simple component, the gain in reliability is considerable, as the number of components and the number of connections are reduced drastically. In the future therefore integration is a "must" to preserve reliability.

However, high reliability is not only a technical problem but also a problem of organization. This means that development, production, quality control, and aftersales service must be well organized and their effectiveness monitored constantly.

EMI

Another difficult problem likely to become even more worrisome in future are faults due to electromagnetic interference. Sensor signals of a few mV must be processed and modern digital circuits with clock frequencies of several MHz must be operated. On the other hand, loads are switched with currents of the order of 2 to 20 A. Cables are run in common units. In cars, in addition, ignition sparks of several kV are generated; moreover, there may be radio transmitters on board and, last but not least, cars may move in the vicinity of strong wireless transmitters or radar stations. None of these external factors must give rise to faults in the systems. The disturbance generated by a system, in turn, must be as small as possible, both in order not to disturb adjacent systems and diminish the quality of wireless reception.

Especially microcontrollers and their memories generate high frequency noise. The sharp edges of the clock pulses, the simultaneous switching of registers and memory are the main reasons. In ASµCs for automotive use therefore all pulses at the I/O-pins should have smothed edges, external memory should be avoided to shorten the connecting leads and switching should be distributed over different time slots.

3. Teamwork

It would take too much time and it would be too complicated to develop a vehicle equipped with all the modern systems at one place. It is necessary to split up the whole into several subsystems with defined interfaces to allow simultaneous development. Besides, it is more economic to include suppliers with their development capacity and their special know-how in the development process and they, in turn, have to cooperate closely with the companies from which they get the more complex parts like for instance ICs. So there will be a strong relation from the car manufacturer to the suppliers and from them to the semiconductor firms. The pressure of worldwide competition demands shorter development times and lower development and tool costs as well as reasonable prices and an effective manufacturing.

The car manufacturer has to face the enormous task to coordinate, plan and control effectively the numerous development engineers in the different sections of his own company not to mention those of his suppliers. Pressure of time, financial limits or changing market requests make matters even more difficult. It is not easy to decide whether to manufacture the different parts and systems in house, to buy unchanged components or to develop special items with a partner. Each possibility has its owns pros and cons. Doing it in house is in many cases the more costly way but it results in unique parts. Various suppliers guarantee reasonable buying conditions and the security of supply. On the other hand: high development and tool costs call for confinement to only one partner. All this is not only true with regard to the relations between car manufacturer and its direct supplier but also between supplier and its sub-supplier.

Even though there is apparently no accordance in the different companies' policies a certain trend is recognizable. More and more there are worldwide business connections (global sourcing) - but with a restricted number of suppliers. And with these a longterm close partnership is desired.

It is not desirable to limit the number of suppliers to only one for a certain system but with regard to a certain project i.e. a certain car-type the development should be made with one supplier who delivers 100 % during the whole production period (lifetime contract).

This proceeding is possible only with bigger supply companies with several production plants to have a reasonable security of supply. In addition the cooperation with powerful independent suppliers is profitable: The worldwide sales to many customers increases volume and allows the distribution of development and tool cost to a high number of items.

All this is also valid for the relations between systems engineers and IC suppliers. One may either buy standard ICs or develop - with or without an IC-supplier - custom-specific ICs. The third possibility of developing and manufacturing in house ICs is very often not favourable because of the high costs and volume required. It may be a recommendable solution to have a special group which designs - alone or in collaboration with a semiconductor company - ICs and have them manufactured in a silicon foundry. Especially the close collaboration of systems engineers and semiconductor designers helps to find optimal solutions (but also here one have to keep in mind that an appropriate number of items is required).

4. Architecture of Future Electronic Systems in Vehicle

In many passenger cars the electronic functions are combined in one ECU, the most straightforward solution we can think of. But - as explained before - there is a considerable increase in the number and scope of electronic systems installed in automobiles, and no end of this development is as yet in sight.

So an integration of those subsystems in one ECU and one µC is no longer possible. An undesirable interference is almost unavoidable. Indeed, there is the danger of loss of control and of inadequate detection of couplings after modifications.

And - very important - it does not support the cooperation described before. On the whole, longer periods of development and of application and, thus, less flexibility will result, which will have negative impacts on the competitiveness of automobile manufacturers.

Hierarchical System

The hierarchical structure defines the mutual interdependences and the paths of information. In a strictly hierarchical system, each module has only one higher-level module and exchanges data only with it and with the modules at the next lower level, respectively. Modules of the same hierarchical level are completely independent of each other and do not exchange any information.

This hierarchical structure not only reduces the number of interfaces, but also cuts down - to a theoretical number of two - the participants in the discussions necessary to agree on interfaces.

Moreover, it clearly shows interdependences and responsibilities. At the top there is the car manufacturer bearing overall responsibility for the vehicle. Over the next lower levels responsibility is increasingly scaled down to smaller and smaller subareas.

However, not only responsibilities but also rights are defined. This is to say that anybody responsible is free in designing downstream modules as long as the interface is kept constant in accordance with the agreements made. In this way, the different functional units in a company manufacturing automobiles can work with several suppliers, in a productive and effective way with a minimum of expenditure being required for harmonization. On the one hand, responsibilities are clearly defined while, on the other hand, freedom is available for parallel development and improvements. In fact, improvement would suffer in the absence of this latitude. This structure also allows in-house know-how to be protected to a certain extent, both by the car manufacturer and by his suppliers.

The logical structure outlined above must not be mixed up with the physical execution. The modules and hierarchical levels must not be equated with sheet metal boxes. It may quite well be a software module as part of a larger software package, or a hardware structure together with other hardware structures on the same board. Also the communication paths are in no way identical with a point-to-point wiring system. The data exchange can be arranged through a common bus or, if the software modules share the same microprocessor, through defined storage spaces.

However, the data exchange should be standardized, both in terms of hardware and of contents, as far as possible. Only physical values in common units are allowed as data, e.g. rotational speed in revolutions per minute. So standardized data reduces the number of conventions required and adds to development reliability.

The advantages in terms of engineering and organization inherent in the concept outlined above are evident. The economic aspects are more problematic, however.

But it is a concept which holds when the proportion of electronics in the motor vehicle will continue to increase. It supports the cooperation and simultaneous engineering of car manufacturers and suppliers.

5. Multiplex data buses

The idea of sequentially transmitting a large number of signals through a single wire (i.e., usually a pair of wires) has been discussed for quite a long time and is already being carried out to a small extent. This method is known as multiplex data transmission.

When different data are transmitted on one line by means of a multiplex bus, of course, the type of transmission - analog or, as in general, digital - the type of addressing, the transmission sequence, the error detection and error treatment, etc, must be precisely defined. This complete set of definitions is known as the communication protocol.

To make effective data transmission possible, agreements must also be reached on the actual transmission medium (copper wire, fibre optics), the speed of transmission and the format of the signals on the medium (voltage, impressed current, etc). This is referred to as the "bus coupling", or the "physical layer".

"BUS" means a type of wiring in which all stations are interfaced in the same way. All stations therefore have access to all data. Multiplex systems in motor vehicles are practically always designed as bus systems.

The circuit which is used to fulfil the protocol and the physical layer (an IC as a rule) is called the bus interface. This interface may be a single IC or directly integrated into a microprocessor. Very often in such a case the interface circuit is further supplemented by a variable amount of logic and memory to relieve the microcomputer of the system. Additional circuits of this type are especially recommended for high through-put of data. They do, however, also increase considerably the chip size, and consequently, the chip costs, of the interface. With low data rates, these extra circuits are mostly not used, this work being carried out by software in a peripheral microprocessor.

CAN - a modern bus protocol

Bosch have developed a protocol known as "CAN" (Controller Area Network) which can meet practically all requirements with an astonishingly small chip area, and which can be incorporated in a data transmission system in a motor vehicle. CAN is, for example, suitable for transmitting high speed data in the area of driveline components, chassis and the mobile communication systems. It is compact for integration and cost-effective to enable its use within body systems such as air-conditioning, seat adjustment, in different controls in the door, etc. where cost is a more important factor than speed. Two types of physical layer were developed to suit different data transmission rates: one for data transmission between 100,000 and 1 million bit/second as a bus for systems handling timecritical data, the other between 10,000 and 100,000 bit/second, for a low speed bus.

Depending on the physical layer and the memory and logic requirements for message processing, a range of different CAN modules have been developed. These are designed either as stand-alone modules or integrated in microprocessors of different performance. All these modules, however, have the same CAN protocol.

CAN modules are manufactered by various semiconductor firms and are generally available. Up to this date, Bosch has issued CAN licences to the following firms: Intel, Motorola, Philips, Siemens, SGS-Thomson, NS and NEC.

It is, of course, expedient for such protocol to be standardised. ISO, International Standards Organisation, is planning to introduce CAN as a single standard for high speed transmissions (over 125,000 bit/second) and together with the French VAN protocol and the US J1850 protocol as a standard for lower speeds. CAN will be used in the USA in the future for commercial vehicles and is under discussion for fast data transmission in cars. The use of J1850 is envisaged for slow transmission in cars in the USA.

It is necessary to point out that the availablity of a bus system does not yet enable it to fully replace the cable harness. Many sensor and actuator signals are not yet "busable". To rectify this situation, part of the electronics must be fixed "in situ", i.e. in the immediate vicinity of the associated sensors and actuators or actually integrated into them. Fitting the electronics "in situ", naturally, requires small, robust contructions with low heat transmission resistance.

Interference-protected

Bus lines, if they consist of copper wire, naturally act as transmitting and receiving antennae in a vehicle. Suitable protective circuits can be used at lower frequencies (below 100,000 bit/second), and the bus can therefore be designed in the form of an unscreened two-wire line. At higher speed these measures can only be used to a limited extent, and screening is therefore recommended.

The use of optical fibres would, of course, completely solve the radiated interference problem. The coupling of transmitters and receivers as well as connections and junctions, however, under vehicle conditions, have up to now either not been reliable enough, or are still too expensive. These problems are currently being examined all over the world. It can therefore be expected that in a few years' time, reliable and reasonably-priced connections will be available.

6. Conclusion

We should keep in mind, that the additional functions are not to burden the driver, the reliability of the vehicle should not suffer and cost must be acceptable for the customer, because the customer has the final decision about function and options of the vehicles.

AUTOMOTIVE ELECTRONICS—A PERSPECTIVE LOOK AT BMW

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AUTOMOTIVE ELECTRONICS—A PERSPECTIVE LOOK AT BMW

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Mr. Mahalek is Section Manager Electronics Development for Safety and Comfort, and is located at BMW's FIZ (R&D center) in Munich, Germany. He is responsible for the development of body electronics for basic functions, trim options, passive safety (airbag electronics), security (anti-theft devices), and ASIC development with partners of the semiconductor industry. In the more recent past his responsibilities have included electronics development for automatic transmission at BMW. Prior to joining BMW, Mr. Mahalek worked for Telefunken Electronic as a development engineer for TV UHF tuners and for automotive electronics.

Dataquest Europe Limited
EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE
May 26–28, 1993
Munich, Germany

AUTOMOTIVE ELECTRONICS - A PERSPECTIVE

LOOK AT BMW

JOSEF MAHALEK
BMW AG

1. INTRODUCTION

In 1985 there began a new era in the electronics development at BMW, starting developing the electronics in house at BMW. We have acquired substancial experience in the optimisation of system performance and in the treatment of the electrical/electronic equipment as one whole interconnected network. This over-view is possible only at the car manu-facturer.

BMW has concluded that there are flaws to the concept that an expert independent supplier, mating its expertise to the economies of scale gained by supplying similar components to a cluster of vehicle assemblers, is the most efficient route for the industry to take.

We believe that assemblers could end up, instead, paying inflated prices for unnecessarily complex parts developed as a compromise between the widely varying needs of several car manufacturer.

The main goals during the development are not to provide a greater amount of electronics, but to make

1. electronics more effective and reliable and
2. to refine it to the best functionality for the user's benefit.

The higher demands in the future on performance, safety and comfort, individuality and exclusive functionality in the car, can be satisfied only by the help of electronics (see fig. 1 and 2).

Quality of development and reliability of components and systems are naturally the most important matters (see fig. 3).

The functional complexity, quality and reliability standards of modern cars places tougher demands than ever before on the automotive electronics systems. They must therefore be rugged and reliable enough to prevent electrical faults in the harshest environments and to withstand the effects of electrical pollution in the form of electromagnetic interference.

But on all these, we must take into consideration, that power of innovation and competitiveness are presuming also a certain amount of risk acceptance and absolutely no fear of technique.

2. HIGHLIGHTS OF THE TECHNOLOGICAL AND FUNCTIONAL INNOVATIONS

Optimisation of performance requires integrating the whole vehicle as one system rather than a grouping of individual modules. In this way a cost-effective solution can be created which guarantees the required performance and maximum flexibility.

The BMW 850i represents a new blend of luxury and performance with a claim to technological leadership through the following highlights of electrical/electronic innovations (see figure 4).

3. MULTIPLEX WIRING IN THE BMW 850I

In designing the electronics for the large number of new functions in the BMW, there was a necessity to apply a new network strategy.

Over the last 20 years, there have been a number of different proposals for multiplex techniques in the car. In the last few years, some car manufacturers have introduced multiplex wiring systems in their new and luxury models, for example Mercedes Benz S-class, Mitsubishi DIAMANTE, Mazda EUNOS COSMO etc.

The major advantage of a multiplexed interconnection system is its inherent intelligence, i. e. signals are available, linkable and can be tested logically.

- Using multiplex where it makes sense, means multiple systems in areas where they can replace a greater number of control lines and where signals can be combined to create new functions or to increase the security of existing functions. This "open" system can be expanded at any time of need, changing only a small part of the communication software for the new addresses. Such multiplexing is not only harness-specific, but at first it is function-specific.

The 850i contains multiplex systems in the following three areas:

- instrumentation communication (I-Bus, bidirectional, open and expandable system; see fig. 5);
- body electronics (bidirectional communication between the basic module and door, sunroof and relay modules; see fig. 6);
- door (unidirectional between the basic module and power window switching block -> ASIC).

3.1. MULTIPLEX IN THE INSTRUMENTATION COMMUNICATION (SEE FIG. 5)

3.2. MULTIPLEX IN THE BODY ELECTRONICS

Figure 6 shows the topology of the body electronics multiplex system which is not yet a self-configuring network, because it still requires a dedicated or fixed configuration information for a given application. This configuration and application information is implemented by coding the system at the end of the assembly line or in the service station.

The main characteristics of the body electronics development were:

- application of an operating system for all basic functions;
- development of the function software in the programming language "C";
- modular software concept;

- sufficient memory capacity for future additional functions and modifications, without loss of system transparency;

- portability of the software modules for standard functions in future units;

- development of a software simulator to operate as an interactive development tool. It is compiled on a PC and enables the user to test, via high level instructions, various code options in order to optimize the functional compatibilities;

This "star"-architecture of the body electronics multiplex network is the result of satisfying very different requirements such as:

- reducing the amount of cables in some critical areas (e. g. realising the necessary functions with conventional wiring, there would have been over 60 cables between the driver's door and body, so that the mechanical rigidity of the door was not assured for the hole bearing the high pole connector plug;

- combining functions and signals at different places in the body in order to create redundancy of some important functions or to realise new functions (software); it could be mastered almost without supplementary cost.

- example of redundancy: if one of the door modules breaks down, the basic module can guarantee an emergency operation of the power window.

3.3. POWER WINDOW SWITCH BLOCK

Introducing the electronics for the serial transmission of the 15 switch signals into the housing of the mechanical switch block, an integration of electromechanical and electronic parts could be realised.

There are 6 switches with two steps (first step ⇒ normal operation; second step ("kick down") ⇒ automatic operation or "one-touch function") 3 switches with one step. These 15 signals are multiplexed by two cascaded integrated circuits (ASICs) in bipolar technology, which transmit the signals via one single line to the basic module. The other three cables are: +, - and search illumination of the switch buttons. There is no need for more cables in this area. The cost of the electronics is very low in comparison with the cost which would have been necessary in a point-to-point wiring of the switches.

The first step in the stepwise development of multiplex wiring systems, represents a compromise between cost, reliability and complexity at this time and it seems to be the best way to lead to a complete multiplex system for the whole vehicle.

4. NEW TECHNOLOGICAL STEPS IN THE INTEGRATION OF ELECTRONICS INTO MECHANIC/ELECTROMECHANICAL COMPONENTS

In order to improve system reliability and cost effectiveness during the development there were solved some problems through a new quality of system integration. Placing the electric control unit together with switches, sensors, actuators within the electromechanic device, there could be obtained an essential improvement of performance and a total system cost reduction.

4.1. ELECTRIC SUNROOF MODULE

Through the integration of electric motor, incremental sensor, electronics and power switch into one single module, there remains only the mechanical coupling of the motor axle with the magnetic wheel of the Hall incremental sensor. This can be done during the assembly of the sunroof with vent position.

This assembly can be made free, i. e. without any special mechanical adjustment. Relating the position counter to the end positions of the sunroof is made automatically in a "self-adjustment run" after assembling the sunroof and connecting the battery, the serial communication link and the operating switch.

4.2. SEAT HEATING MODULE

The third example of system integration is represented by an "intelligent" seat heating switch. Figure 7 shows the conventional system and the integrated system. Simplifying the architecture of the system through integration, there was a possibility to create a better functionality and at the same time to reduce system costs and to improve reliability.

Modern technological achievements made such an integration possible. The "electronic heart" is an ASIC in CMOS technology and SO16W SMD-package. This ASIC is situated on a thick film hybrid board. The combination of the hybrid board with 2 small PCBs, 2 switches, 3 LEDs, 1 PowerMOS transistor with heat sink is housed in the package of the switch. This special construction technology used different modern technologies in the synthesis of electronics and mechanics, in order to realise an optimum of cost effectiveness, high functionality and reliability.

4.3. ELECTRONIC BRAKELIGHT SWITCH

The fourth example of mechatronics is a successfull synthesis of small signal electronics, a power output with heat sink for loads of up to 130 W and precision mechanics. It is a frictionless and soundless, contactless and chatterless electronic brakelight switch with hall circuits. It has full redundancy with a second channel as a "test"-switch, a much better endurance (more than 1.5 million switching cycles at 130 W etc.).

Although in its first realisation it is still expensive and for this it is applied at first in the top models, it demonstrates its suitability for absolute reliability in safety-relevant systems and will be perfect and cost-optimised in the future (see fig. 8).

5. KEY FACTORS OF SUCCESS IN AUTOMOTIVE ELECTRONICS

Based on the report of Dr. Ziebart from 1992 [2] there are essentially four main trends of change in the 90s refering to system structure of electronics in future cars:

5.1. SYSTEM LEADERSHIP MUST BE IN THE HAND OF THE CAR MANUFACTURER

For the overall car quality the path of integration plays the most important role. The total system know how is only with the car manufacturer, who can make the right development concept, taking into account all possibilities of integrating.

BMW has already designed modular electronic control systems for its new cars, which are much simpler, more flexible and cheaper to produce than current systems.

In the running, actual developments, BMW made a quality leap in developing electronic systems from the following points of view:

- considering the whole car as one network;
- integrating electronics and mechanics in new mechatronic parts;
- considering subassemblies or subsystems as a "functional island" and optimising the hard- and software for this

local application, but in relationship with the whole network. So we could cut the cost of the system by up to two-thirds.

5.2. REQUIRED SKILLS CHANGE FROM ELECTRONIC CIRCUIT DESIGN TO SOFTWARE AND IC-DESIGN

Nowadays software engineering takes more than 70 % of the development work and the development costs. In the future this relation will be greater. The functionality, the availability and serviceability of a microcomputer based system depends mainly on software. For this reason, it is necessary to apply structural methods during the design.

New techniques and technologies like "fuzzy logic" or "neural systems" will be realised and require new environments. The method to design the complex system of the future car must become a Systems Engineering Approach.

In order to save space, weight and cost, to improve the quality and reliability and to reduce the IC variety, nearly all ICs on an ECU will be ASICs. This requires deeper connections to the semiconductor manufacturers (see fig. 9 and 10).

Now as before, the semiconductor technology is the main driving force behind most electronic advancements.

5.3. ELECTRONIC SYSTEMS INTEGRATION NEEDS AN ADAPTED RELATIONSHIP BETWEEN CAR MANUFACTURER AND SUPPLIER

The car manufacturer defines the system, designs the software and develops the main ECUs.

The optimised combination of mechanical and electronic components in the peripherals is one of the most important future development objectives. Mechatronics needs a new typ of supplier, who not only develops electronics **or** mechanics, he integrates electronics **and** mechanics.

Last but not least, a typical electronic problem formulates the fourth statement:

5.4. FIND THE OPTIMUM LIFE CYCLE FOR ELECTRONIC SYSTEMS

Car development times in Europe are about 4 years and the average life cycle of a car model is 7 to 9 years. Microelectronic systems double their functionality every 18 months.

The necessary consequence is, that we need a decoupling of the life cycles of the car from that of the electronics. We must innovate electronics more frequently and have to insert some redesigns.

This leads to the requirement, that the ASIC prototypes, yesterday designed in months, today in weeks must be available in days in future.

6. CONCLUSIONS

6.1. NECESSITY OF OPTIMISED SEMICONDUCTOR SOLUTIONS FOR THE AUTOMOTIVE INDUSTRY

The chips for automotive applications have to be designed for the stress and strain in automotive use and have to work reliably even at the limits. They have to be protected against polarity reversal and be surge-proof and short-circuit proof over a wide temperature range. They have to withstand load-dump and jump-start pulses and to offer diagnostics as well as all the benefits expected of design for minimised EMI and RFI sensitivity.

Additionally, other very important characteristics of automotive semiconductors are:

- lowest possible power consumption;
- lowest power dissipation;
- lowest stand-by current consumption.

6.2. THE NEEDS OF THE AUTOMOTIVE INDUSTRY IN THE NEAR FUTURE WILL BE SEMICONDUCTOR SOLUTIONS FOR:

- an entire spectrum of mixed mode ASICs (analog, digital) and power ICs for smart peripherals (sensors and actuators);
- DSP (Digital Signal Processors) and RISC processors for audio management, communication and safety systems;
- enhancement of existing anti-theft devices (burglar and intruder detection) and immobilisers by intelligent access control and vehicle identification.

6.3. THE MAIN TRENDS IN THE DEVELOPMENT OF AUTOMOTIVE ELECTRONICS ARE:

- increasing number of integrated electronics in typical mechanical or electromechanical devices, i. e. switches => mechatronics
- increasing number of multiplex systems in the car - standard or application specific buses
- introduction of smart sensors and smart actuators in connection with mechatronics, multiplexing and harness-specific construction => possible only at the car manufacturer, because of his knowledge at all interconnected systems in very close cooperation with the semiconductor industry and the supplier.

The conclusion of all said up to now is that the automotive industry requires:

- new levels of cooperation between semiconductor industry, suppliers and car manufacturer to assure the requirements of high reliability and quality;
- excellent cost performance;
- strategic alliances (partnerships) for a dedicated technology to meet fast changing system requirements and system updates at all stages - from development and prototyping through to production and field service.

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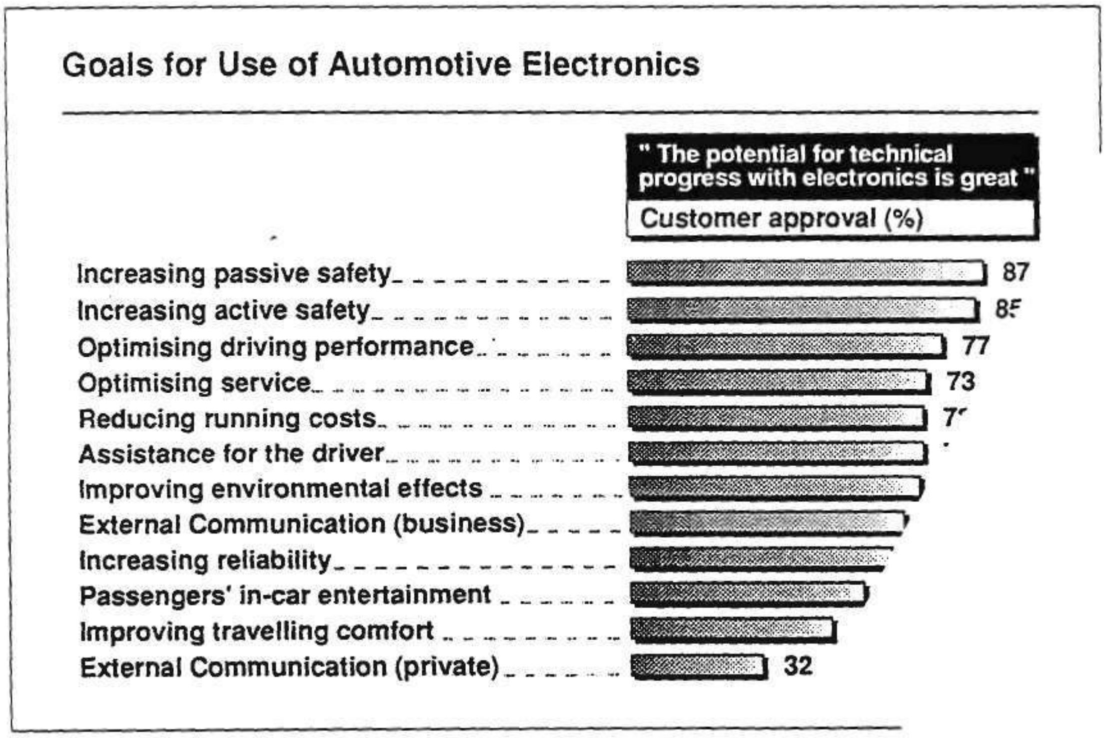

figure 1

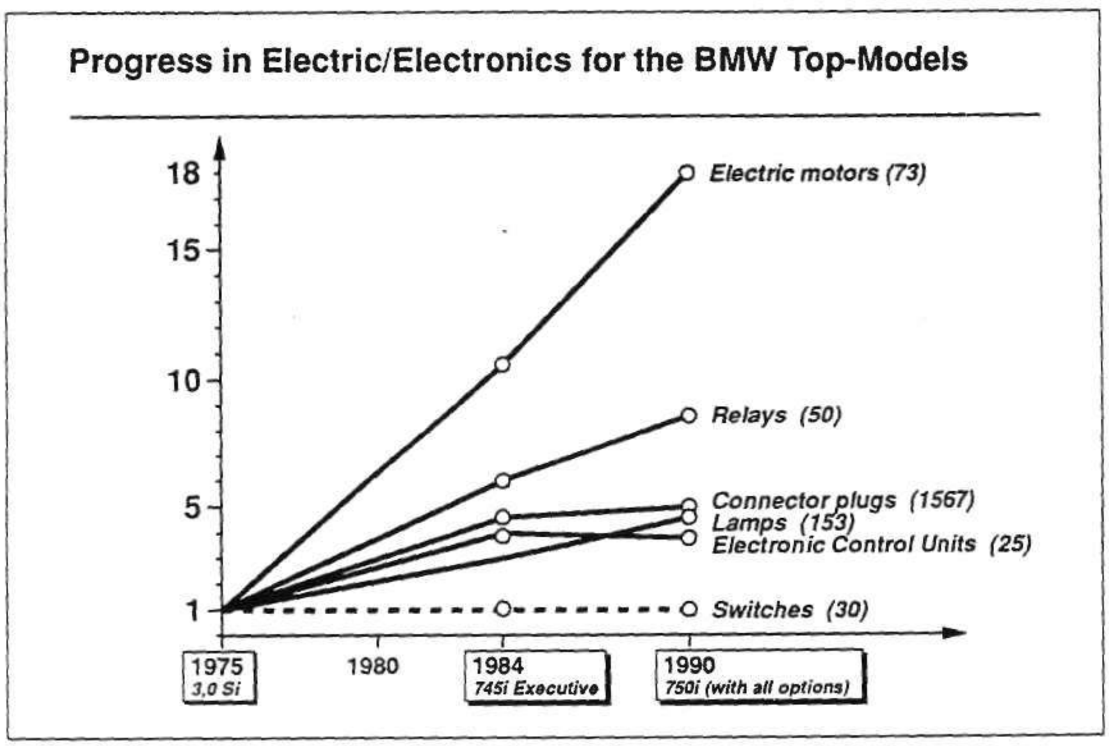

figure 2

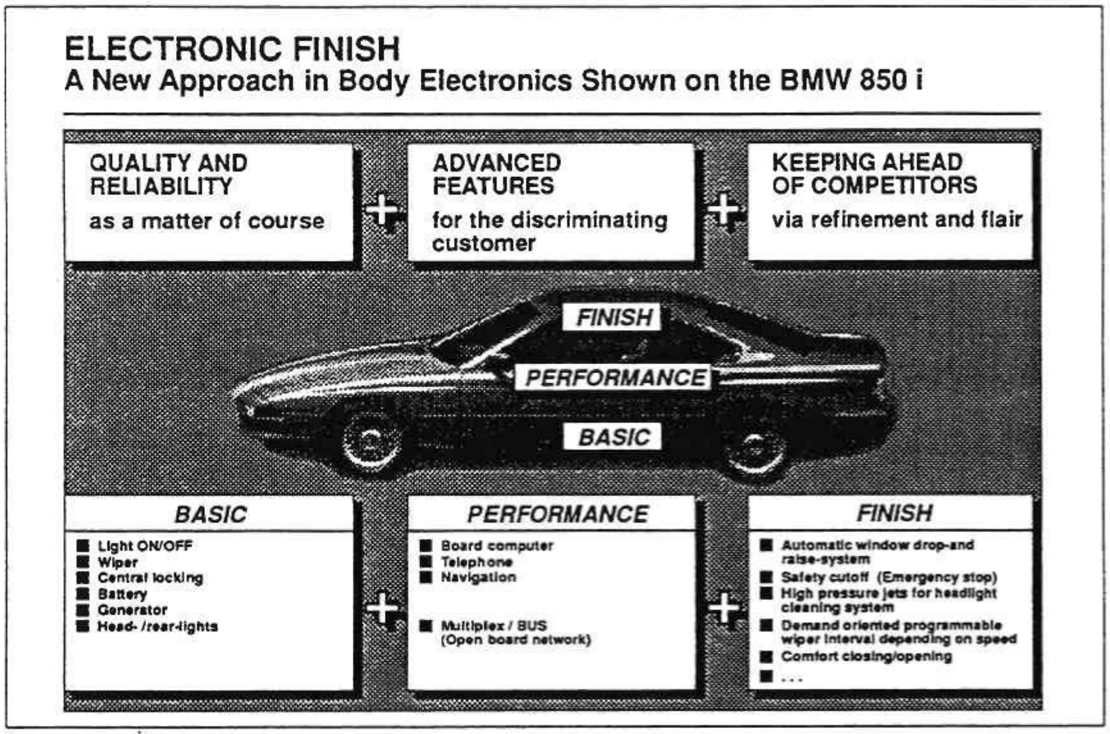

figure 3

HIGHLIGHTS
of "Electronic Finish"

- Multiplex technology (a development which was demanded by our time) in the following areas :
  - instrumentation communication (bidirectional)
  - body electronics
  - door
- Demand-oriented programmable wiper interval dependent on road speed
- Automatic window drop- and raise-system, providing optimal sealing, reducing wind noise to a minimum level
- Emergency stop (safety cutout) to prevent fingers being trapped in front windows and sun roof when operating automatically ("One-touch-function")
- Automatic closing of the windows at speeds > 150 km/h
- Different model versions, trim options, feature changes; after sales additions can be programmed (coded) on the assembly line and by service
- Improved fault diagnostics in service
- Electrically adjustable steering column with entry support and memory
- Comfort - closing and - opening of all windows and sunroof by holding the key in the proper direction/position
- Pressure controlled moving pump jets (spray nozzles) for headlight cleaning system
- Disconnection of electrical loads after parking the car (16 minutes after the last event at the car)
- Non visible switch for boot (trunk) lid opening
- AUC - Automatic air recirculation control
- New generation of "electronic" vehicle connection plugs

figure 4

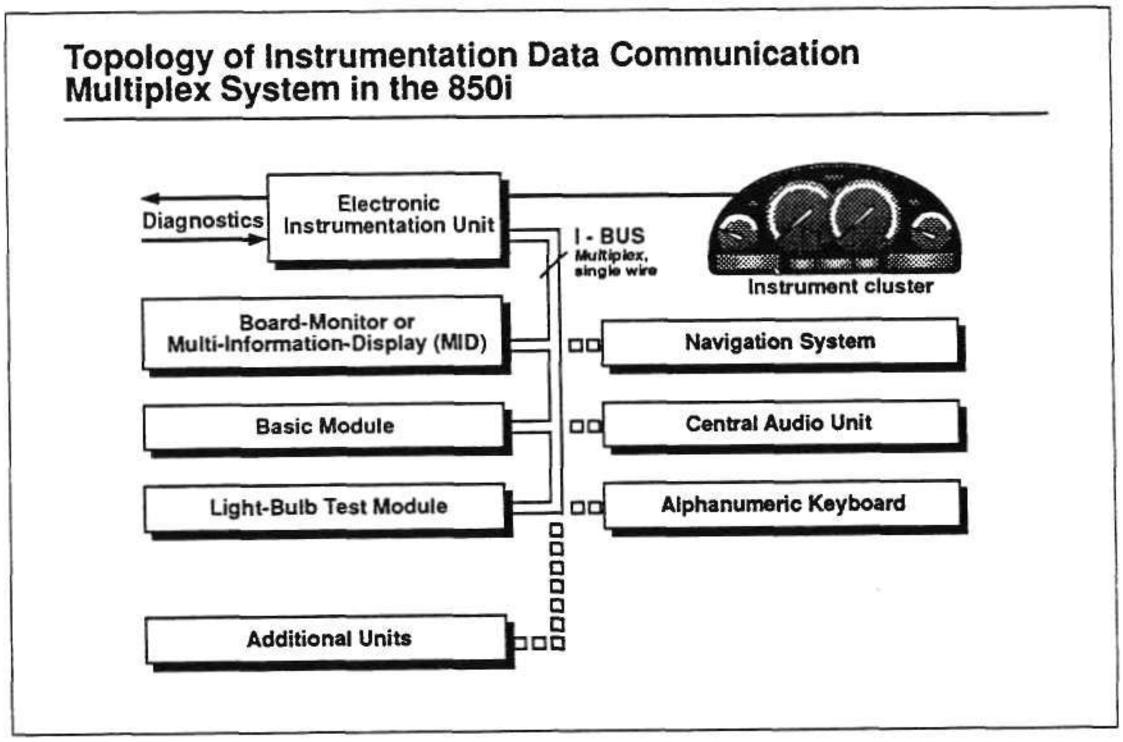

figure 5

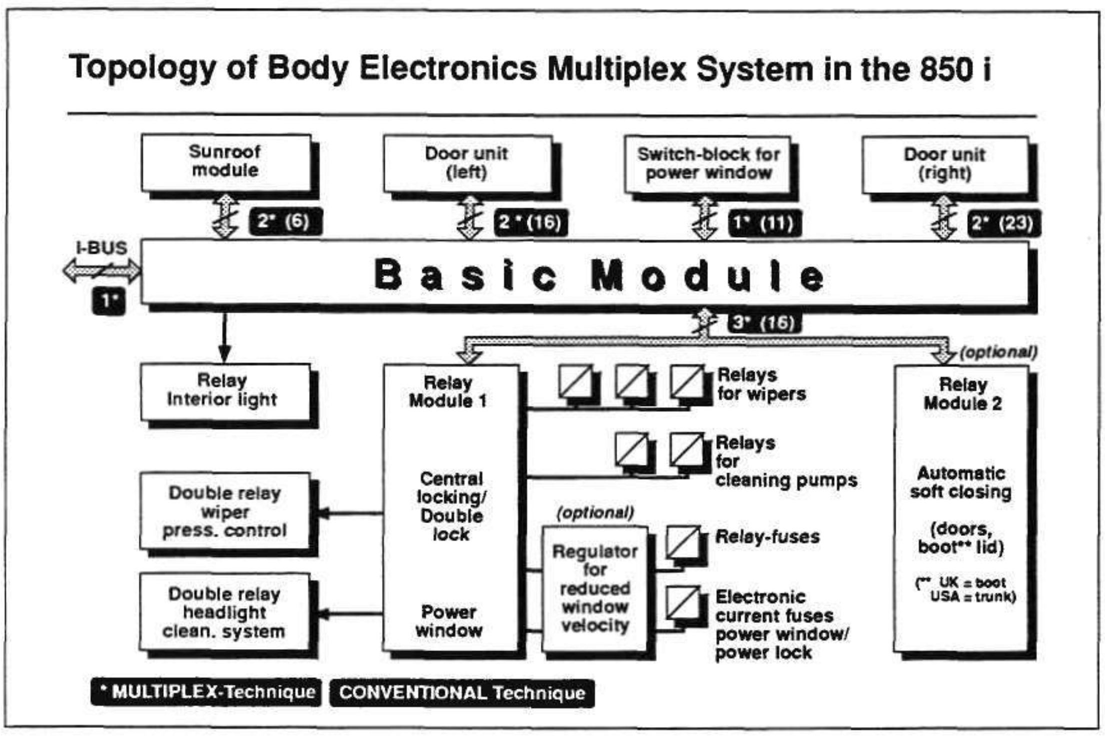

figure 6

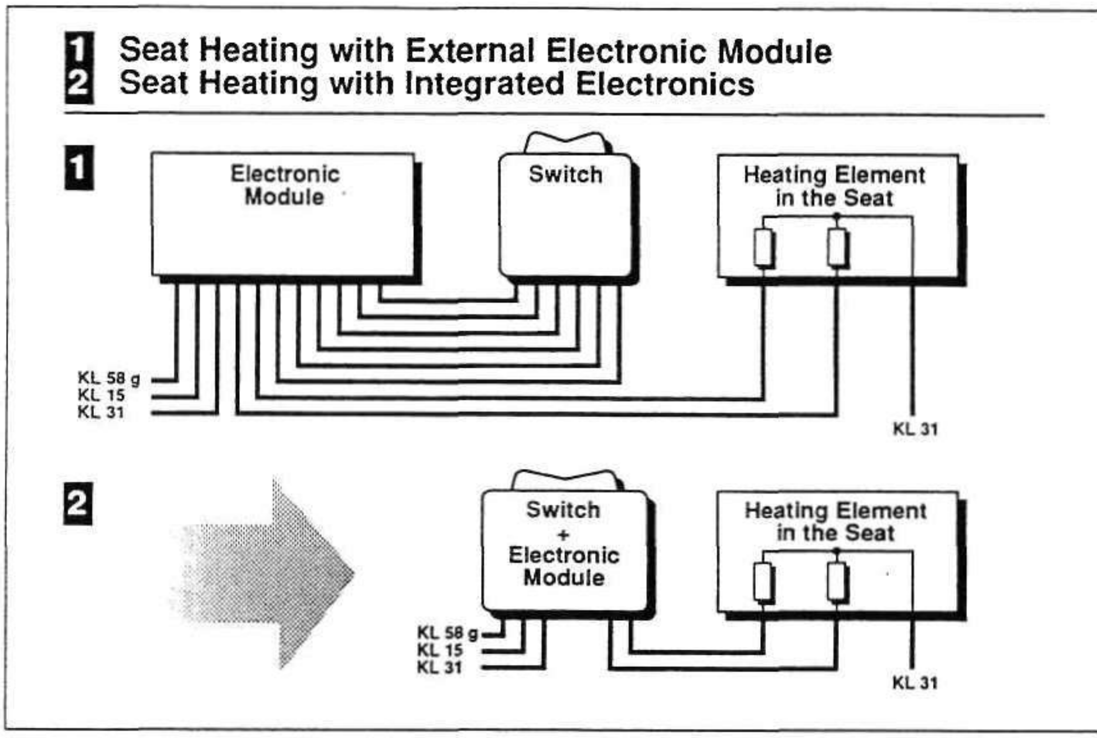

figure 7

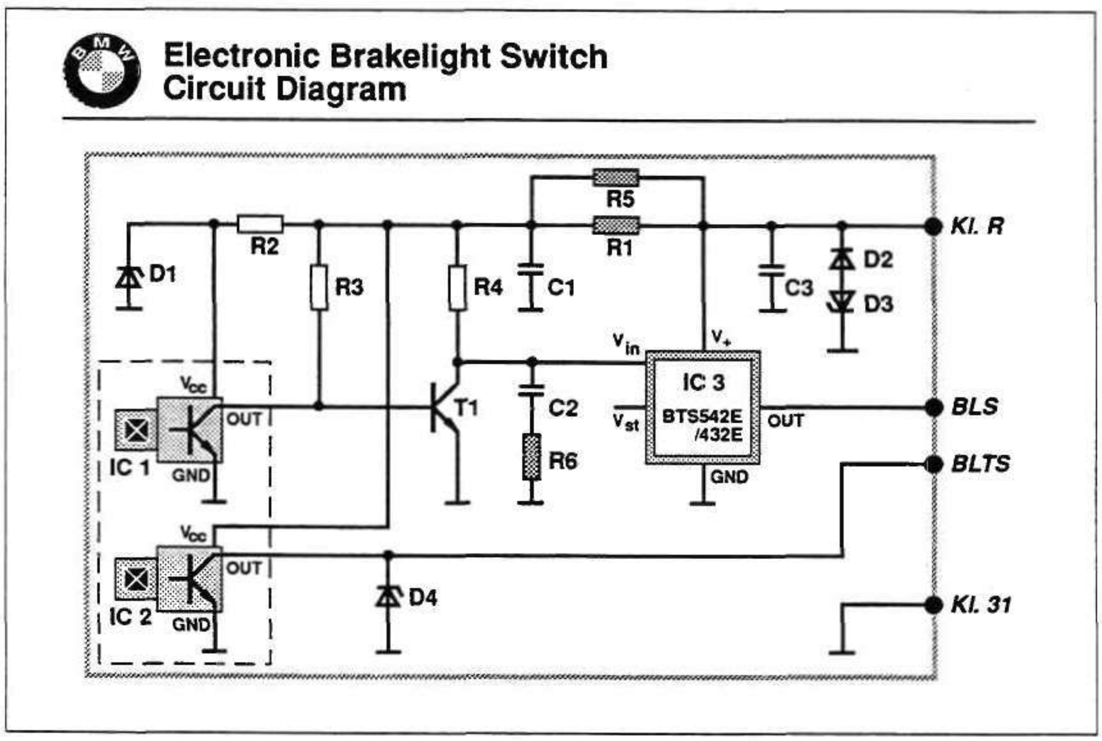

figure 8

BMW ASIC-Development (1)

ASIC	IC-Manufacturer	Functionality
U 6050-6056	TELEFUNKEN	Multiplex Class A
AD 22001	Analog Devices	Lamp Monitoring Comparator
100.01	ELMOS	Wiper Control
100.02	ELMOS	Programmable Watchdog-Timer
100.03	ELMOS	MOSFET-Driver
100.05	ELMOS	Seat Heating ASIC
100.07-100.16	ELMOS	Input/Output ASICS (Low/High-Side)
100.17	ELMOS	Ripple Counter and H-Bridge Driver
100.18	ELMOS	Heat Control
100.19	ELMOS	Instrumentation Driver
100.20	ELMOS	BUS ASIC (I-,K-, MI-, P-Bus)
TA 50120	Harris	Injection Valve Driver
TA 50259	Harris	General Purpose Quad Driver

figure 9

BMW ASIC-Development (2)

ASIC	IC-Manufacturer	Functionality
MC 33192	MOTOROLA	Stepper Motor Controller
TY 93061	MOTOROLA	Bus-ASIC
L 4936/L 4938	SGS-Thomson	Dual Multifunction Volt. Regulator
L 9743-05	SGS-Thomson	Input ASIC
L 9842	SGS-Thomson	Output ASIC
U514	SGS-Thomson	Mirror Driver
U 578	SGS-Thomson	Ripple Counter
KM 2128A	SGS-Thomson	Ignition Interface
VN 16B, VND 10B	SGS-Thomson	Lamp Driver Family
BTS430K	Siemens	High-Side Switch
SEC 51C805	Siemens	Embedded Controller
TLE 4728	Siemens	Stepper Motor Driver
BTS 425, BTS 620	Siemens	Lamp Driver Family
TPIC 0106	Texas Instruments	Intelligent 2.5A H-Bridge

figure 10

ADVANCED MARKETING FOR SUCCESS

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ADVANCED MARKETING FOR SUCCESS

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Mr. Durbin is a Senior Consultant with Dataquest's European Consulting Group and is based in Denham, England. In this position he manages and contributes to a variety of consulting projects in the high-technology field. He is a specialist in IT marketing and communications. His work has also involved the identification of new market opportunities for IT suppliers comprising marketing approach, product requirements, timing and outline costs of entry. Prior to joining Dataquest, Mr. Durbin spent three years working for PA Consulting Group where much of his work focused on marketing issues surrounding the networking and telecommunications services markets. He began his career with ICL where he was latterly a major account development manager for one of ICL's UK corporate accounts. Mr. Durbin received a BA Honours degree in French from the University of East Anglia.

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May 26–28, 1993
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AGENDA

- Semiconductor Market Worldwide
- Worldwide Trends
- Winners and Losers
- Marketing For Success
- Marketing Case Studies
- Successful Companies Will Be ...

SEMICONDUCTOR MARKET WORLDWIDE

- Adjustment to capacity taking place
- Japan and Europe continue to decline
- US and Asia/Pacific showing growth
- Spending is restrained generally

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WORLDWIDE TRENDS

- Contract manufacturing
- Joint ventures and strategic alliances to:
  - Increase production capacity
  - Strengthen product portfolios
  - Increase worldwide presence
  - Spread costs
- Emergence of Asia as third-largest semiconductor market
- Focus on distribution

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WINNERS AND LOSERS

Winning companies will have addressed all of the following to a satisfactory level:

- Volatile market giving rise to need for:
  - Greater focus
  - Global perspective
  - Plan for overseas sales, marketing and distribution agreements

continued ...

WINNERS AND LOSERS

- Businesses must be:
  - Willing to develop new markets and educate users in product and design services
  - Customer-led

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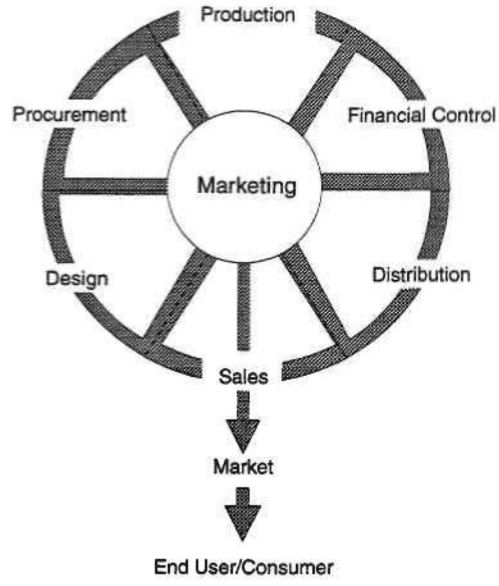
MARKETING FOR SUCCESS

The Role of Marketing...



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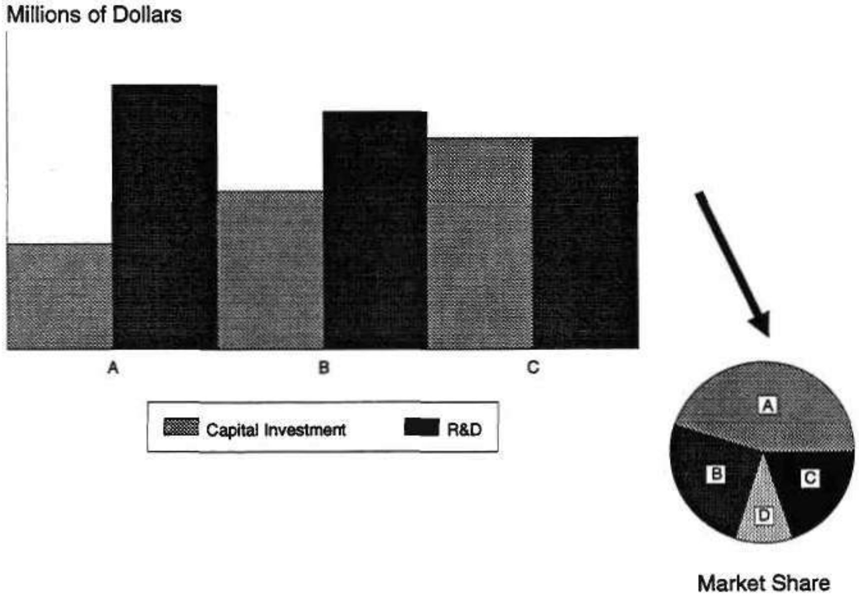
MARKETING CASE STUDIES

RELATIONSHIP BETWEEN CAPITAL INVESTMENT, R&D SPEND AND MARKET SHARE



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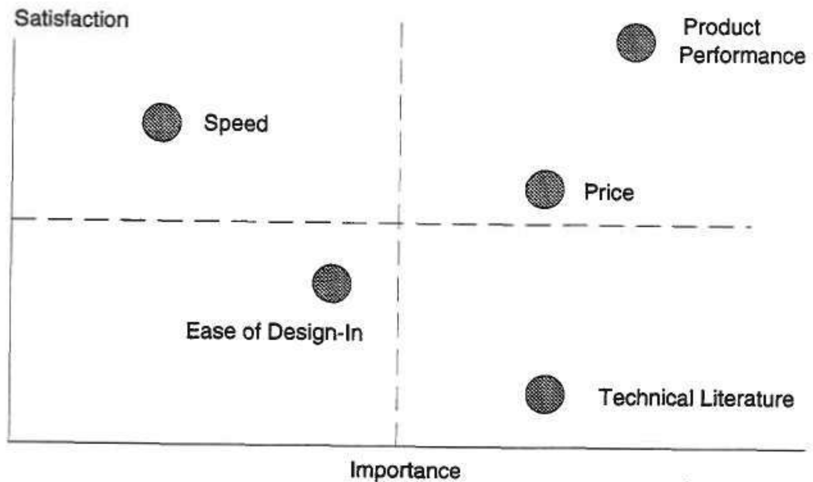
MARKETING CASE STUDIES
IMPORTANCE versus SATISFACTION



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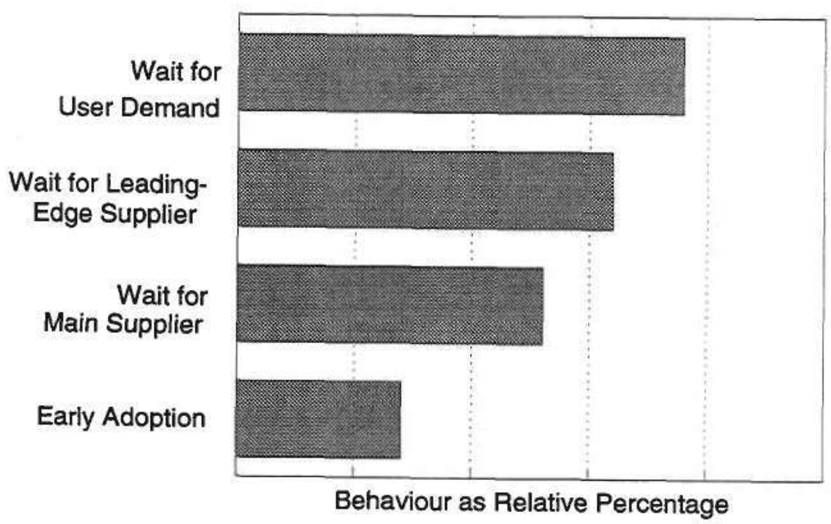
MARKETING CASE STUDIES
NEW PRODUCT PLANNING



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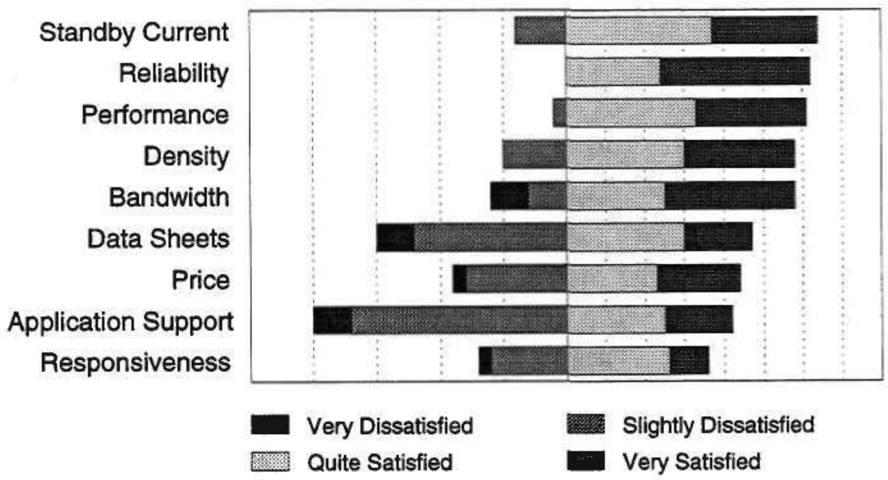
MARKETING CASE STUDIES
CUSTOMER-LED FOCUS



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SUCCESSFUL COMPANIES WILL BE ...

- Highly focused and flexible
- Aggressive in building strategic alliances
- Willing to develop new markets

And will have ....

- Global marketing perspective
- Highly focused marketing plans
- Detailed understanding of ultimate customer needs

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STRATEGIES AND DIRECTIONS FOR GROWTH

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STRATEGIES AND DIRECTIONS FOR GROWTH

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Mr. LaRosa is Director, international OEM sales and marketing, for IBM Technology Products. He has 25 years of experience in electronics sales and marketing, including more than 20 years in international markets. His work experience combines 20 years at General Electric (GE) with experience in entrepreneurial start-up ventures, numerous engineering and sales management positions. Most recently he was Vice President, GE Electronics World Trade. He also founded and ran his own sales and marketing company, LEAD Group International, and was also President of American Motion Systems. Mr. LaRosa holds a BSEE degree in electrical engineering from Manhatten College and an MBA in business administration from Pace University.

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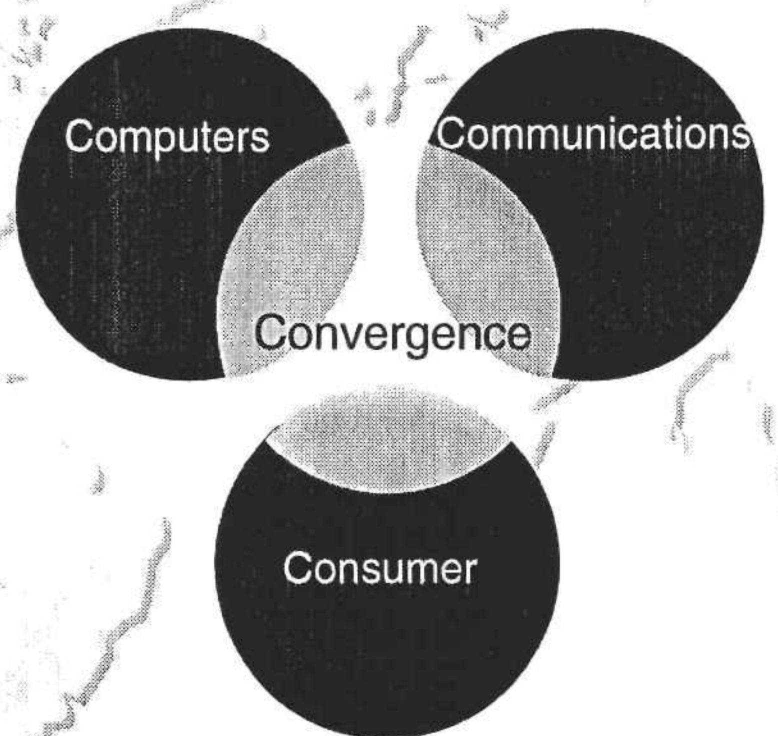
Strategies & Directions for Growth

IBM Technology Products
G. William LaRosa
May 27, 1993

Transitions

1960's	Transistor to IC
1970's	Hardwired Logic to Microcomputer
1980's	Standard Product to ASIC
1990's	ICs to Subsystems

The Convergence Market



- Changing the component paradigm
- Forcing more complex and portable systems

The New Component Paradigm

- Subsystems on a Chip/Module/Card
  - Smaller
  - Lower power
  - More complex
  - More standardized

- Increasingly demanding markets
  - Shorter life cycles
  - Faster ramping to volume
  - More ASSPs

Drivers of the New Component Paradigm

System suppliers must:

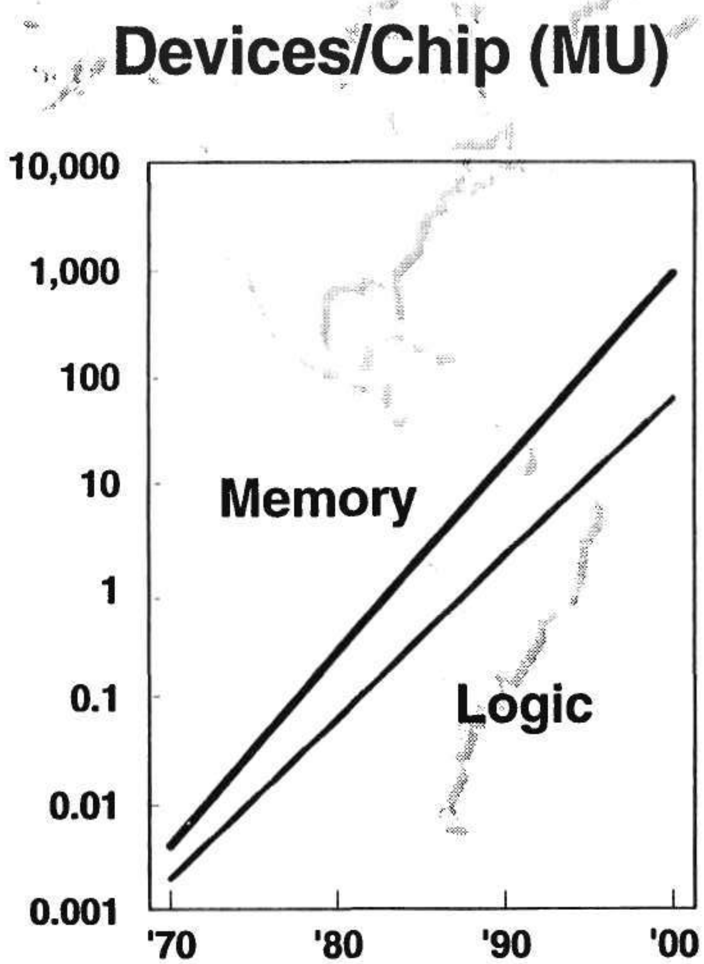
- Accelerate cost reductions
- Accelerate technology improvements
- Increase system complexity

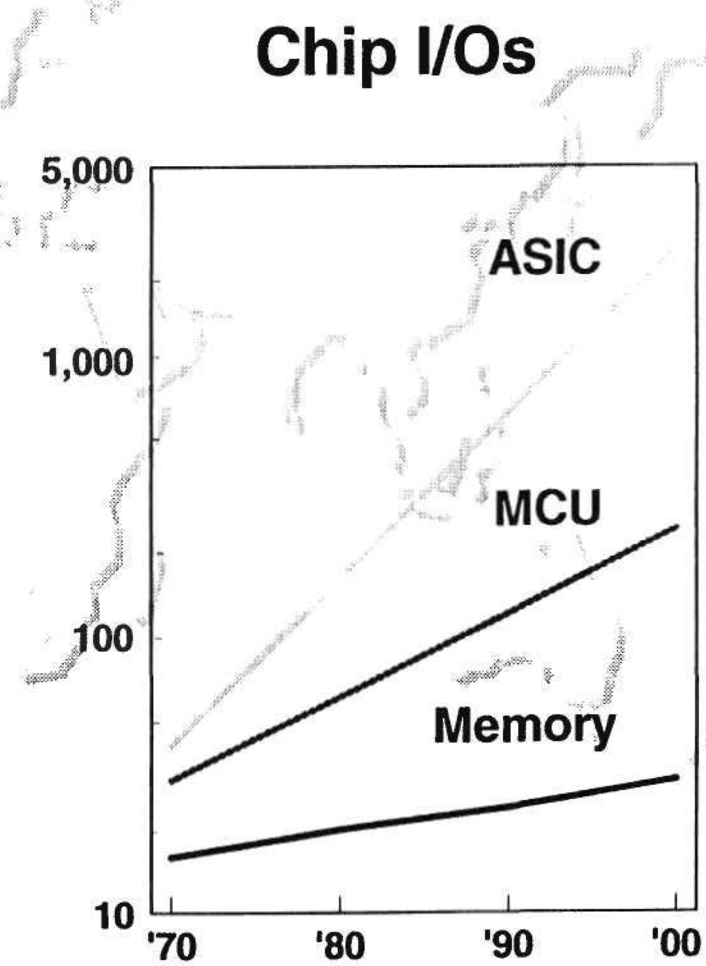
- Component suppliers must:
  - Recognize ICs (silicon) fast becoming a commodity
  - Seek value-add for higher profits
  - Recognize the chips to subsystem transition

Critical Issues

- **Technology Balance**
  - ICs progressing rapidly
  - Design, packaging & interconnecting becoming the limiting factor
- **Investment / Return Unbalance**
  - Technology & Fab investments up
  - Returns shifting to I/P owners
- **System Suppliers "Losing Control"**
- **Shifting / More Complex Distribution Channels**

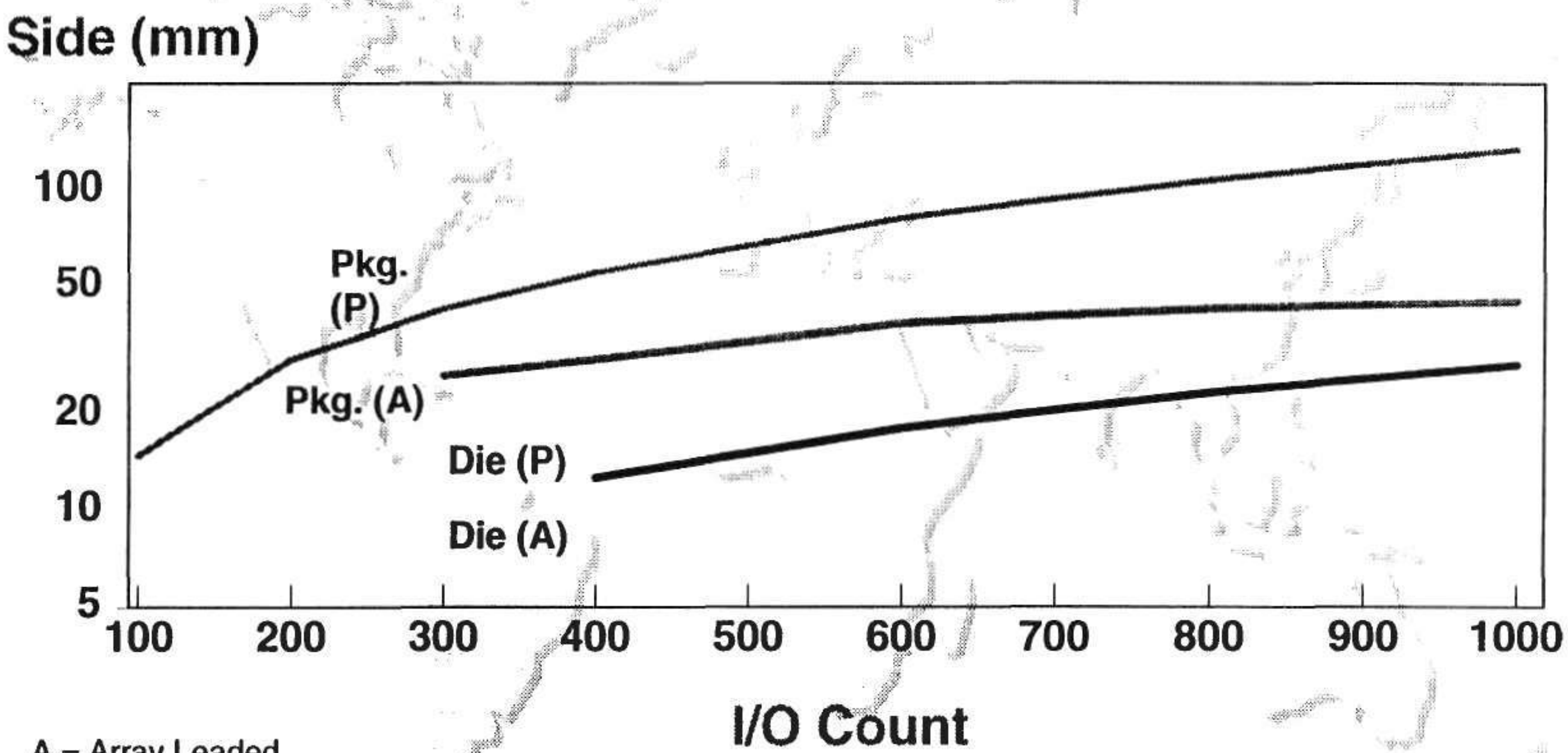
Increasing IC Complexity





Source: ICE

Technology Leverage:
I/O Limited Die & Package Sizes



A = Array Leaded
P = Peripheral Leaded

1" die, 4" packages @ 1000 I/Os

The T/A Dilemma

- ***T***echnology oriented companies are generally ROA starved
  - Fewer willing / able to continue rate of investment
  - Frustrated by commodity / foundry role
- ***A***pplication oriented companies are generally profitable
  - Close to customers
  - Leading edge research
  - Generally fabless

Resolution Strategies

- T/A JVs
  - "50/50"
  - Revenue/profit belong to JV
  - "T" co. : Fab & distribution
  - "A" co. : Products & marketing

- Fab / Technology Consortia
  - Equity investment in R&D & PP&E
  - Expense / output proportional to equity
  - New players must "buy in"

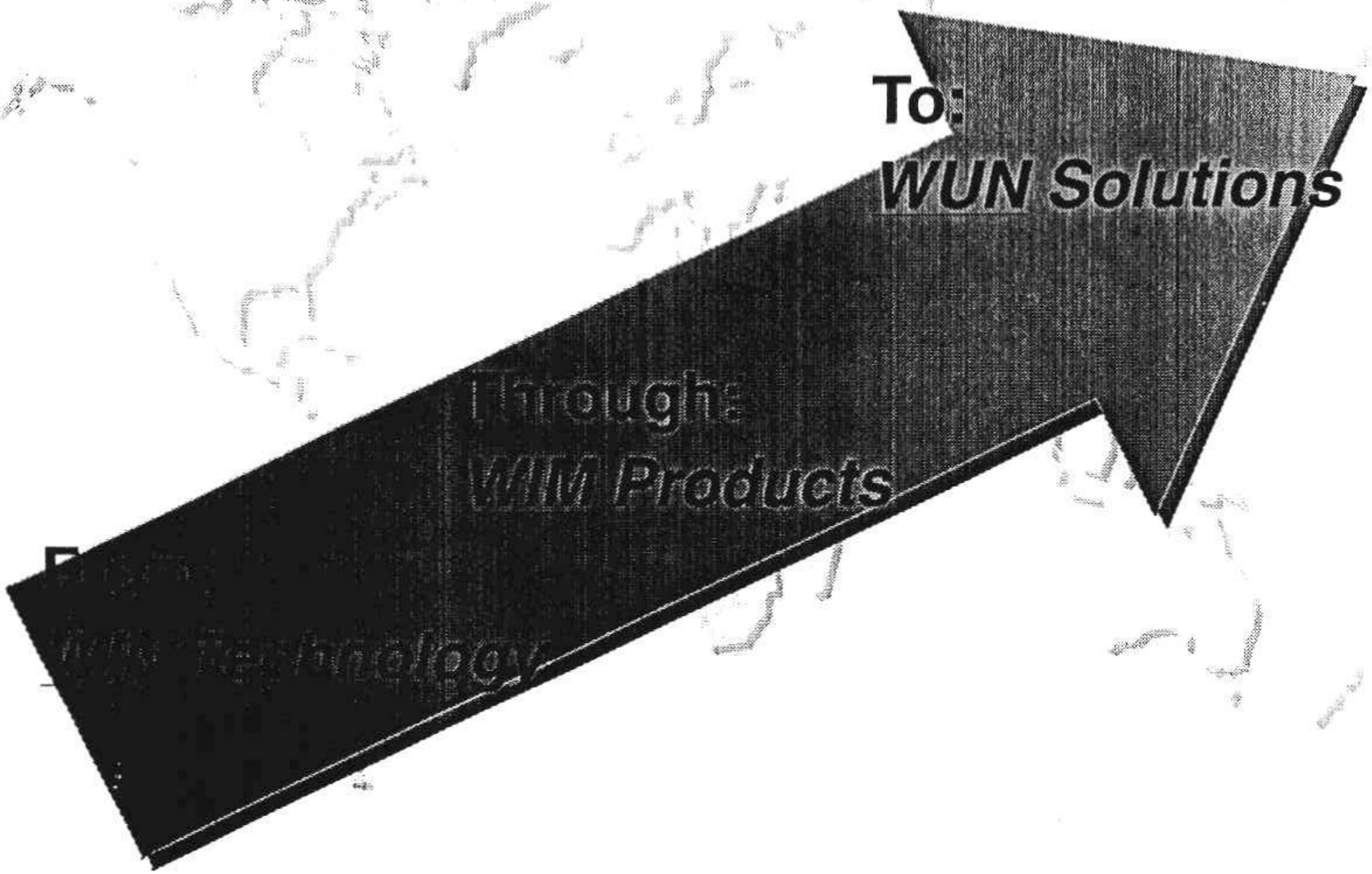
P & I Resolution Strategy

- **Prognosis**
  - I/Os will reach 1000
  - Unmanageable speed, size, heat & cost
- **Resolution**
  - Flip-chip/BGA technology
  - MCMs/Advanced PWBs
- **Problem**
  - Slow to adopt technology advances

Technology Breakthroughs

1960	Automated transistor line
1964	SLT & Flip-Chip (C4) technologies
1967	1 Transistor DRAM structure
1971	All solid state memory computer (370)
1974	E-beam direct write on wafer production
1979	Multi-layer ceramic multi chip modules
1980	Thermal conduction module
1987	1MB DRAM (3090, DASD)
1992	16MB DRAM (AS/400)

"Opening" Strategies



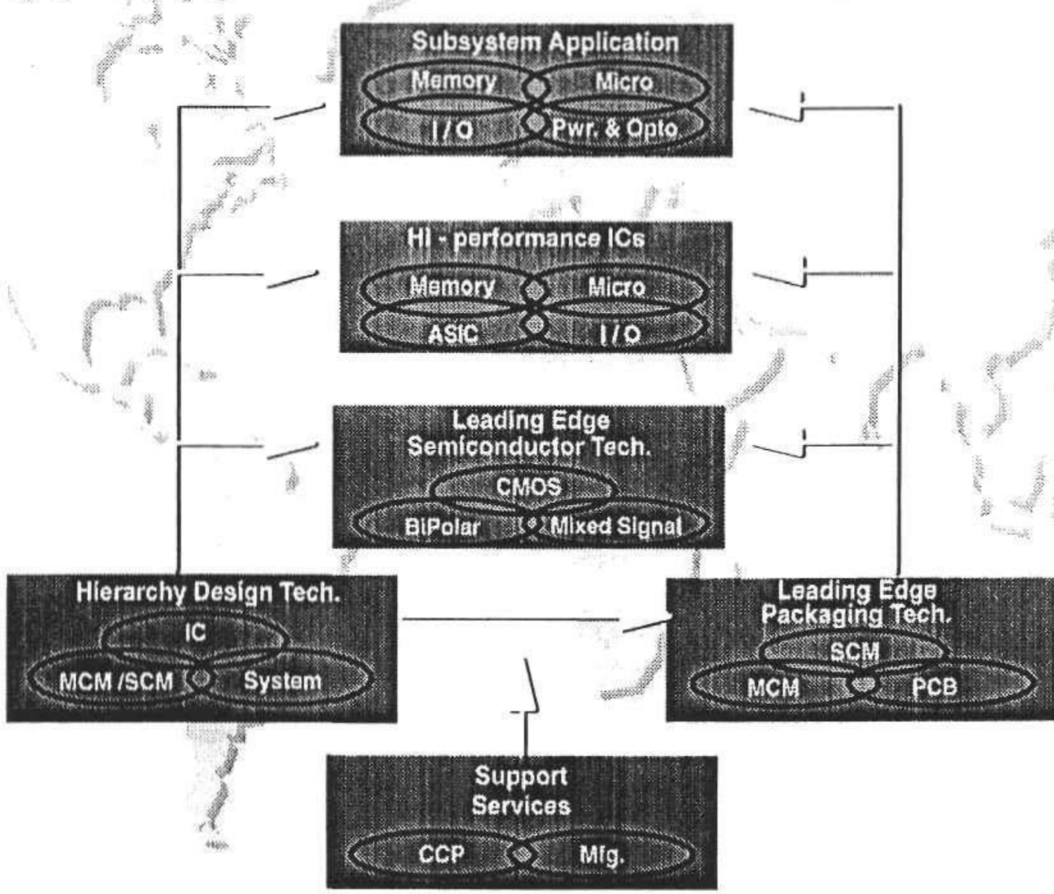
Basic Merchant Strategy

Capitalize on: Combined leadership in silicon
AND Packaging
WW production capabilities
High end quality / technology

Aimed at: The *Convergence* Market

By offering: Sub system solutions
Market-driven T/A Co. JV / Alliances

Technology Leverage



Subsystem success requires
Packaging & Silicon leadership

Alliance Strategy

FROM	TO
Technology Driven	Market Driven
Risk & Cost sharing	Penetrate new markets
Technology sharing	Match complementary capabilities
"Pre-competitive cooperation"	"Cooperative competition"

Customer Issues & Resolutions

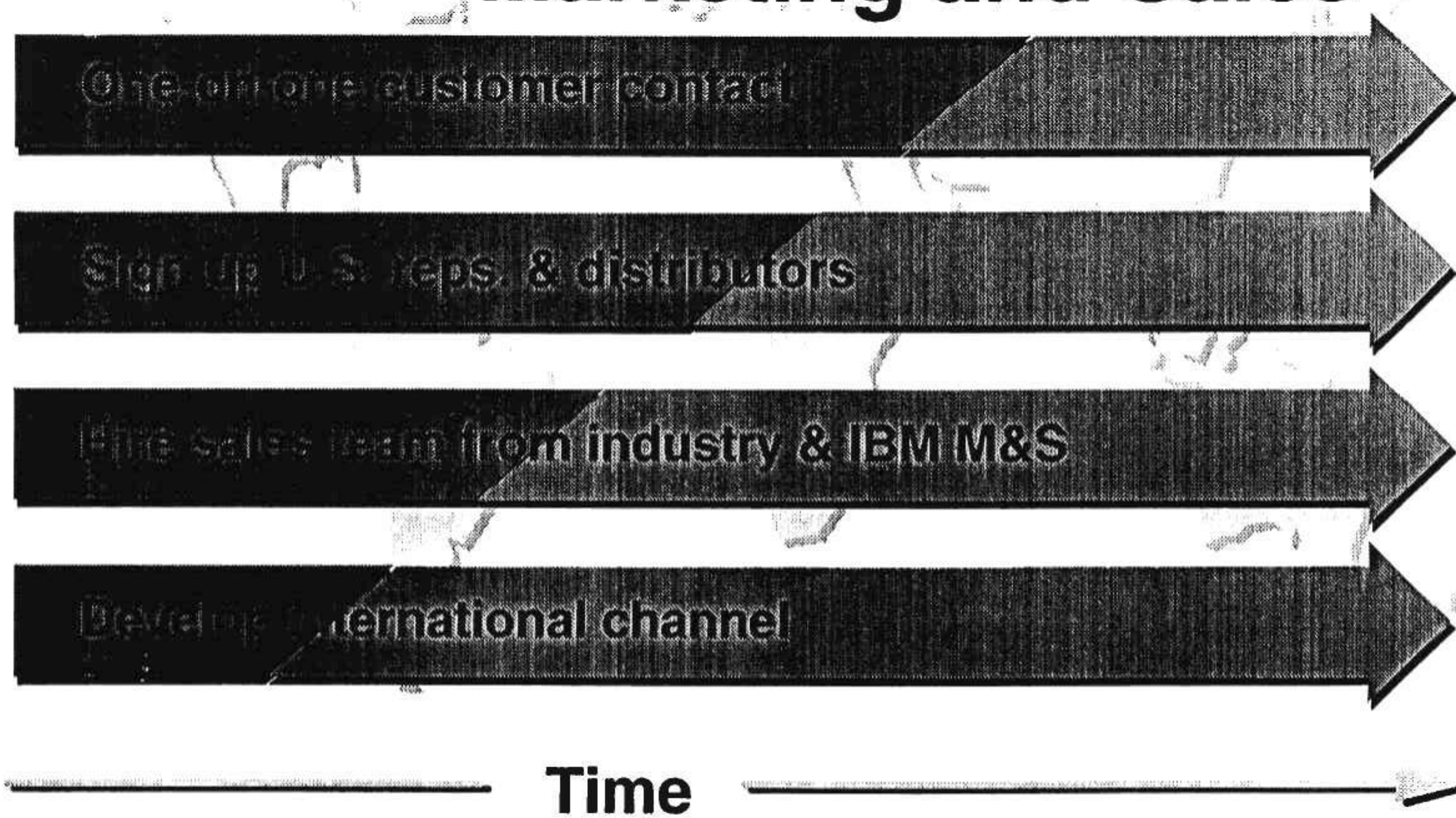
Issues	Resolutions:
OEM Customers worry about: "Lying down with the lion"	• Guarantee access to technology & capacity • Strategic alliances • Proof by example
IBM internal customers worry about: "Giving away the crown jewels"	• Royalties to IBM IP owners • Market acceptance pullthrough benefits

Customer Issues & Resolutions

Issues	*Resolutions*
Sales & Disty channels	"Gene" splicing
Merchant "know-how"	• Distributors & Mfg. reps • Training & market interaction
"Saleable" product line	• Subsystems • Customize • Meet industry standard

"Opening for Business"

Marketing and Sales



Conclusions

The subsystem Component Paradigm

- **Driven by system complexity / cost**
  - Solution for the systems supplier
  - Solution for the s / c supplier
- **Need broader technology emphasis**
  - Particularly P&I
- **T/A Co. JVs**
  - Makes technology / fabs affordable
  - Balances return & investment

FOCUS SESSION:
NEW PROCESSOR ARCHITECTURES

Hans Geyer
Vice President and General Manager
Intel Corporation

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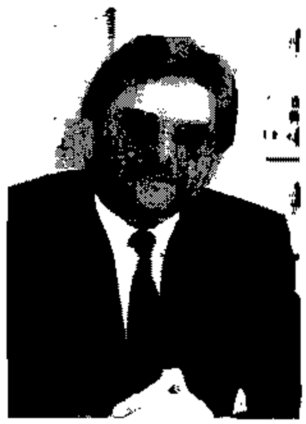
Roussel House, Broadwater Park, Denham, Uxbridge, Middx UB9 5HP / 0895 835050 / Tlx 266195 / Fax 0895 835260

FOCUS SESSION: NEW PROCESSOR ARCHITECTURES



Hans Geyer
Vice President and
General Manager
Intel Corporation

Mr. Geyer is Vice President of Intel's Microprocessor Products Group and General Manager of the Intel386/Intel486 Microprocessor Division. He has held various positions within Intel, including FAE-specialist for computer architecture and Technical Marketing Manager for the German region; European Marketing Manager for telecommunications products; Marketing Manager for microprocessors and peripheral controllers in Europe; and Assistant Manager and Manager of components marketing Europe. He was then appointed Director and General Manager Europe before taking over his current position. Prior to Intel, Mr. Geyer was involved in hardware and software development for intelligent and point-of-sales terminals at Siemens AG, Germany. He studied Computer Science and Mathematics at the Technical University of Munich and holds a Masters Degree (Diplom-Informatiker) in Computer Science.

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May 26–28, 1993
Munich, Germany

DATAQUEST 1993 EUROPEAN SEMICONDUCTOR CONFERENCE

Hans G. Geyer
Intel Corp.

The Future of Computing

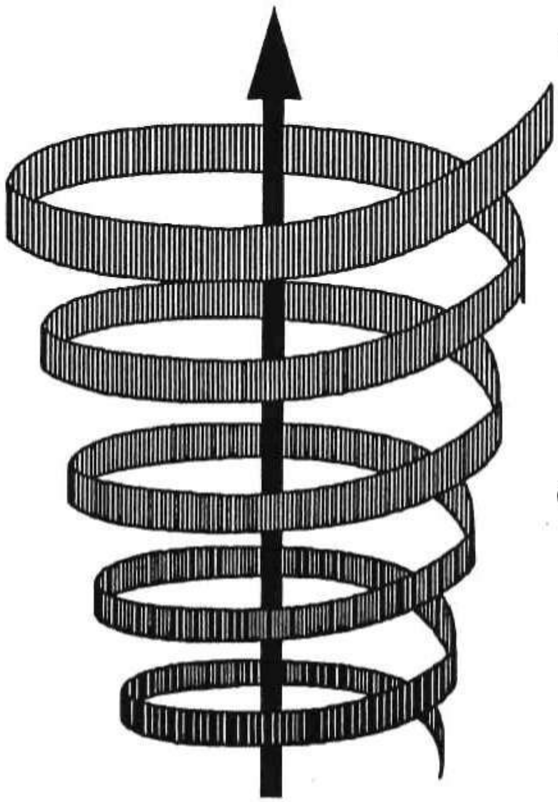
- Downsizing
- Natural Data Types
  - Video
  - Sound
  - Handwriting
- Home Market for PCs Grows Fast
- Handhelds and Portables are Incremental Market - Not Replacement of Desktops

NEW USERS, NEW USES -
50M PC's IN '95

Processor Consequences

- More and More Performance
- <1W Power Consumption
- Need for Huge S/C Manufacturing Capacity
- Consumer Marketing
- Tremendous Advantages for Common Architecture from Top-To-Bottom
  - Data Formats
  - Human Interface
  - Binaries

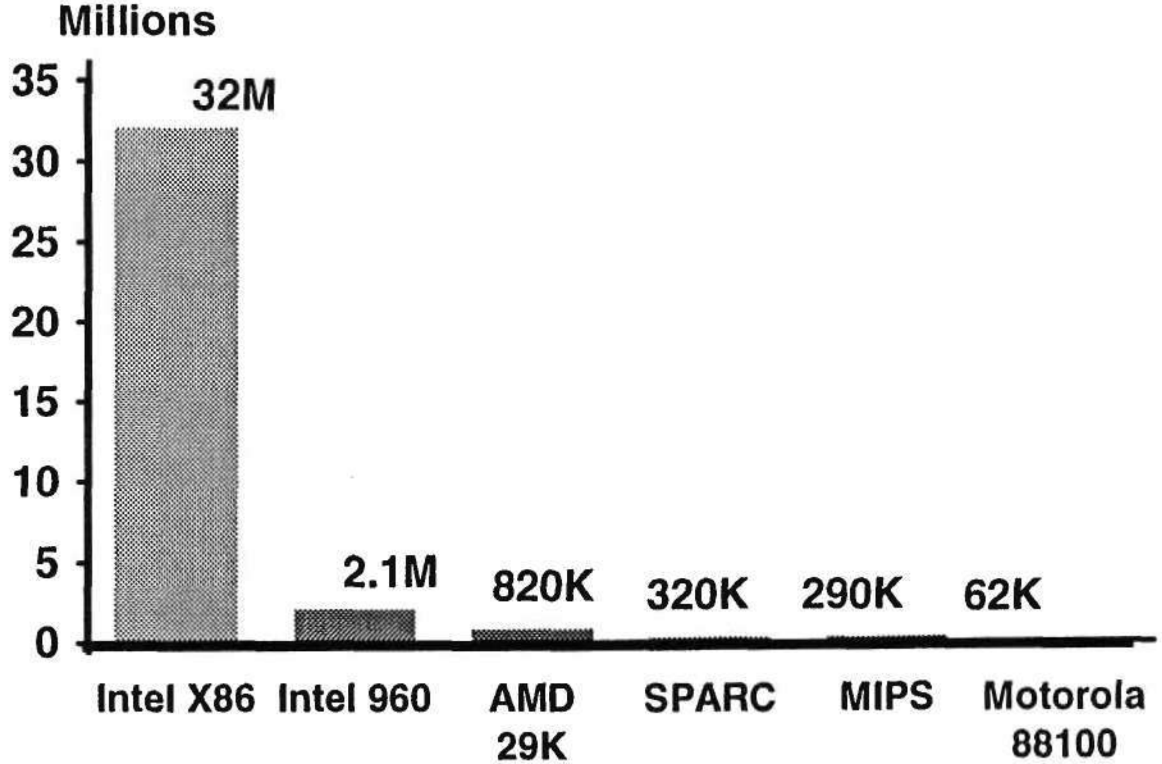
The Software Spiral



- New Software Requires More Performance - More Available Performance Allows New Software

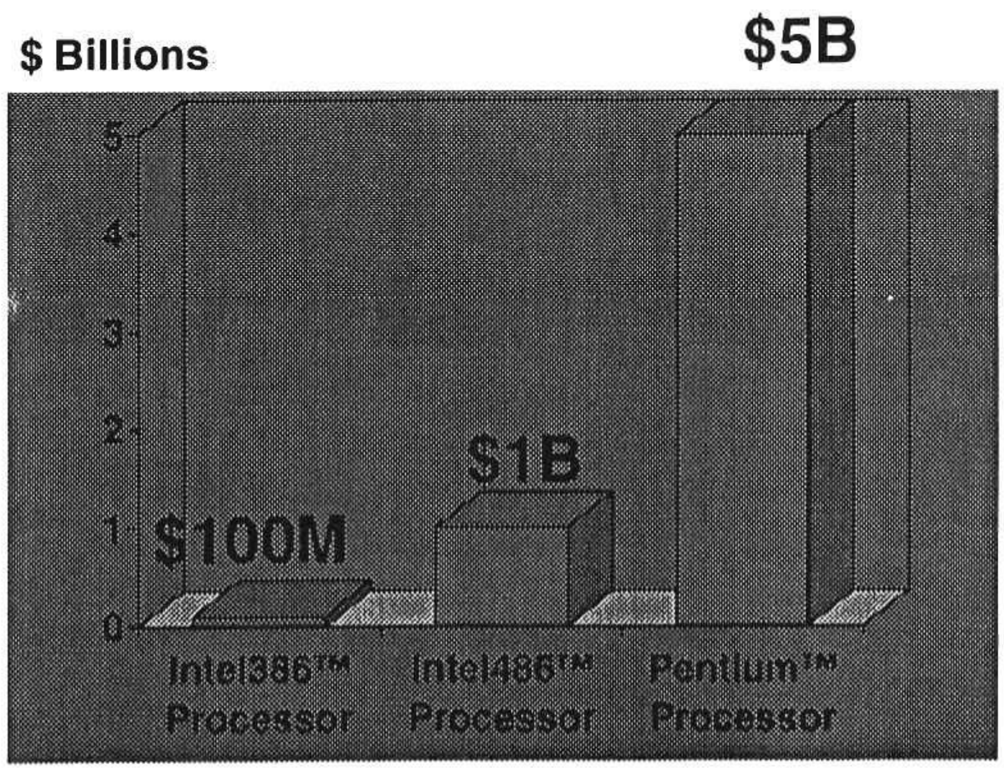
- Software Creates Hardware Volume - Hardware Volume Attracts Software

1992 Microprocessor Units RISC vs X86

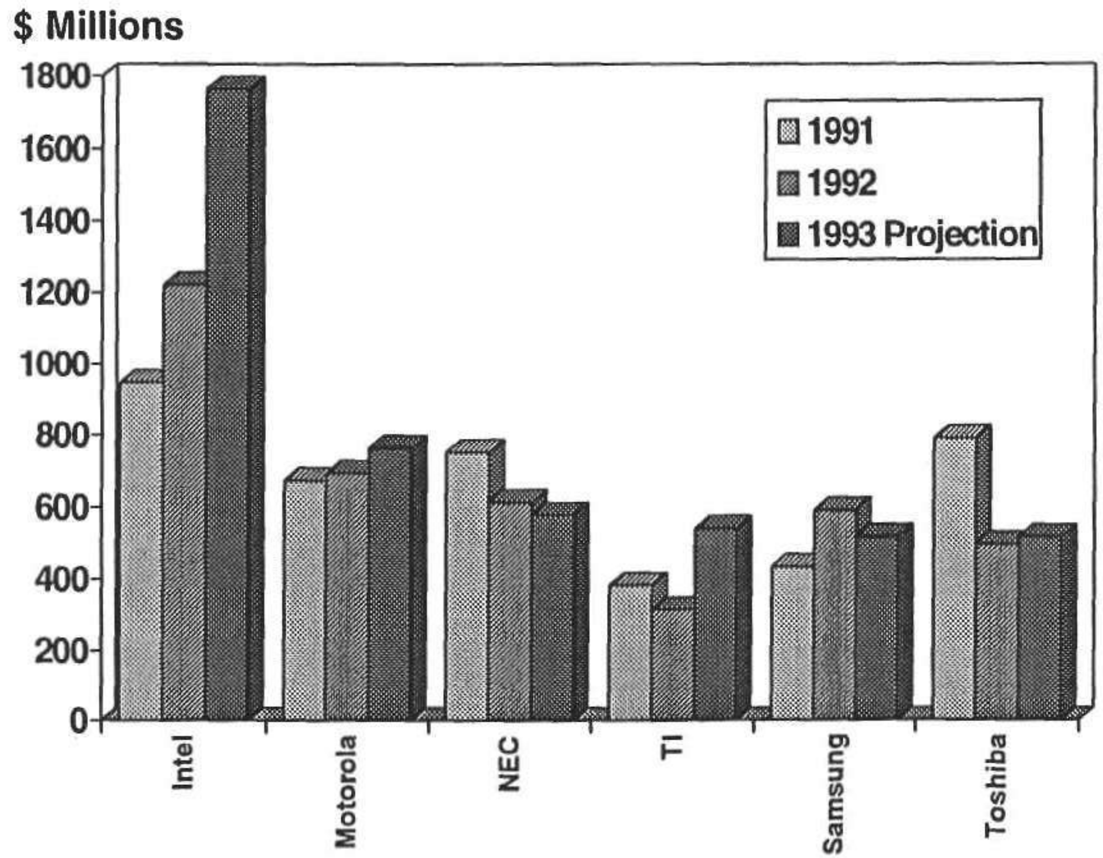


Source: RISC Management January 1993, Dataquest

Manufacturing Costs for Peak Volumes

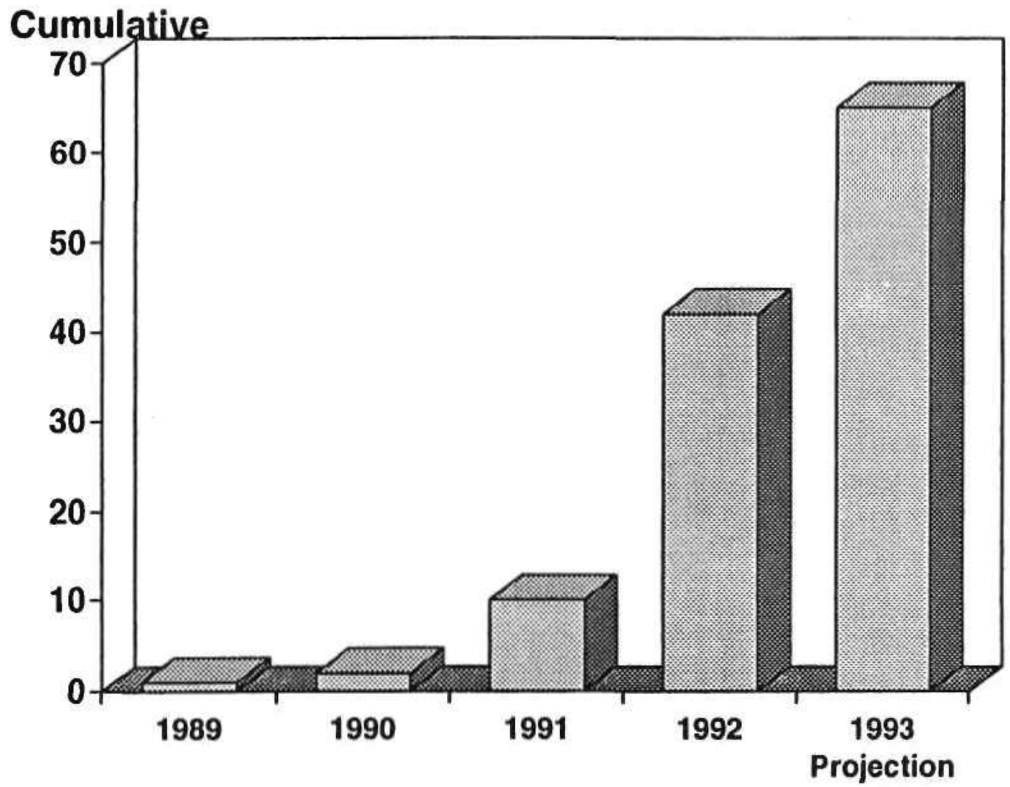


Top Capital Spenders



Source: Dataquest and Intel Corp.

Intel486™ Proliferations



Pentium™ Processor

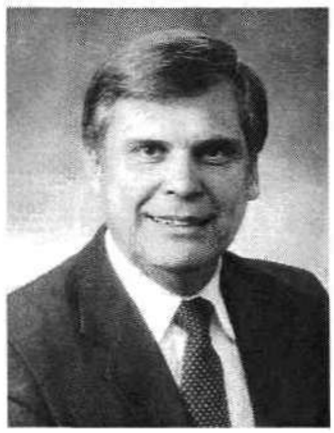
- 64.5 SPEC*int*92
- Several Hundred Thousand Units in '93
- Several Million Units in '94
- Intel486™ CPU Based Computers are Upgradable to Pentium™ Processor Technology

FOCUS SESSION: NEW PROCESSOR ARCHITECTURES

Jerry Rogers
President and Chief Executive Officer
Cyrix Corporation

Dataquest Europe Limited, a company of The Dun & Bradstreet Corporation
Roussel House, Broadwater Park, Denham, Uxbridge, Middx UB9 5HP / 0895 835050 / Tlx 266195 / Fax 0895 835260

FOCUS SESSION: NEW PROCESSOR ARCHITECTURES



Jerry Rogers
President and
Chief Executive Officer
Cyrix Corporation

Mr. Rogers is a cofounder, President and Chief Executive Officer of Cyrix Corporation. Before founding Cyrix, Mr. Rogers was Vice President of Texas Instruments' Microprocessor Division, responsible for microprocessor, digital signal processing (DSP) graphics, and Token-Ring products. In this position he helped Texas Instruments to gain a 60 percent market share for DSP and established the company as a dominant force in graphics for second-generation PCs and in Token-Ring technology. He had responsibility for design, marketing and manufacturing for a wide range of products, and supervised over 4,000 people located in six facilities worldwide. Mr. Rogers holds a B.S. in Computer Science from the University of Houston, Texas.

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May 26–28, 1993
Munich, Germany

Cyrix

Advancing the Standards

DATAQUEST ELEVENTH ANNUAL EUROPEAN
SEMICONDUCTOR CONFERENCE
MAY 1993

Cyrix

AN X86 WORLD?

Cyrix

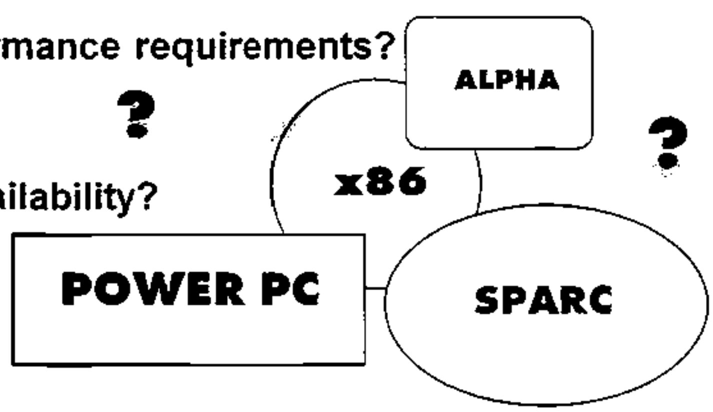
ADVANTAGES OF X86

- ESTABLISHED MARKET STANDARD
- INTEGRATION OPPORTUNITIES
- CUSTOMER REQUIREMENTS

OEM BUSINESS DECISION

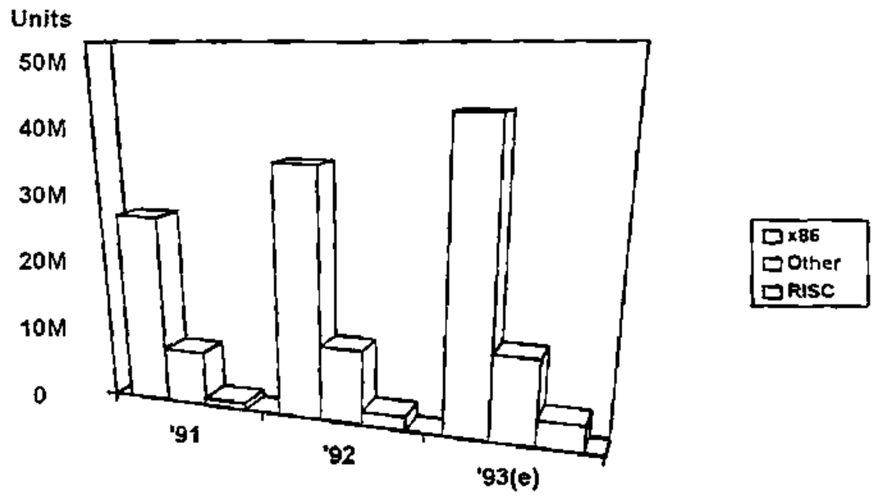
Future performance requirements?

Software availability?

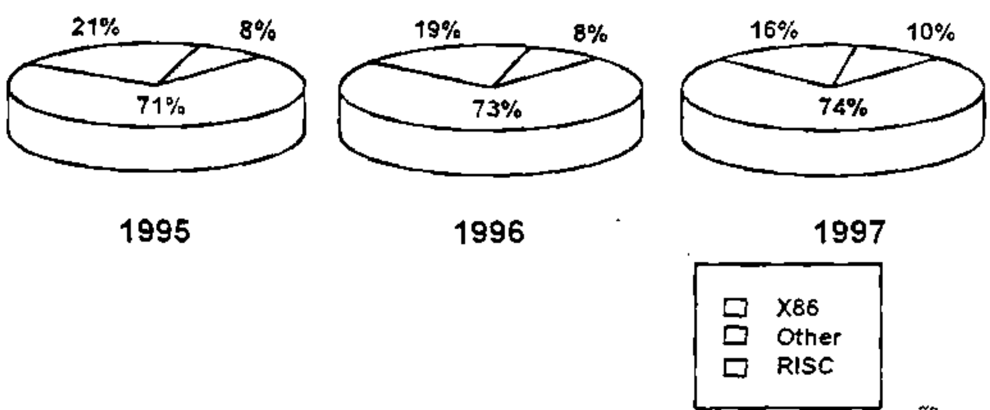


End user price point?

WHAT ARE THE TRENDS?



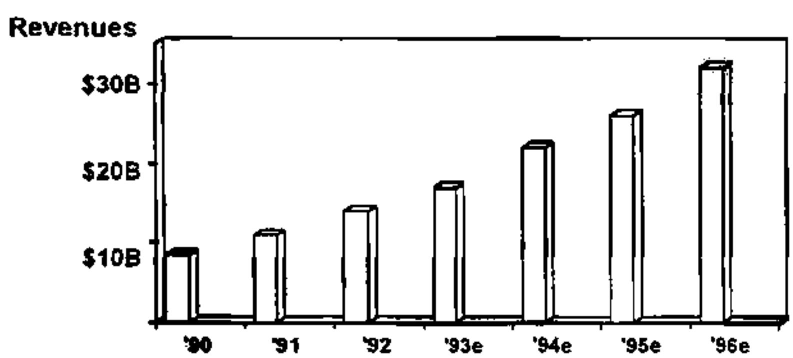
WILL THE TREND CONTINUE?



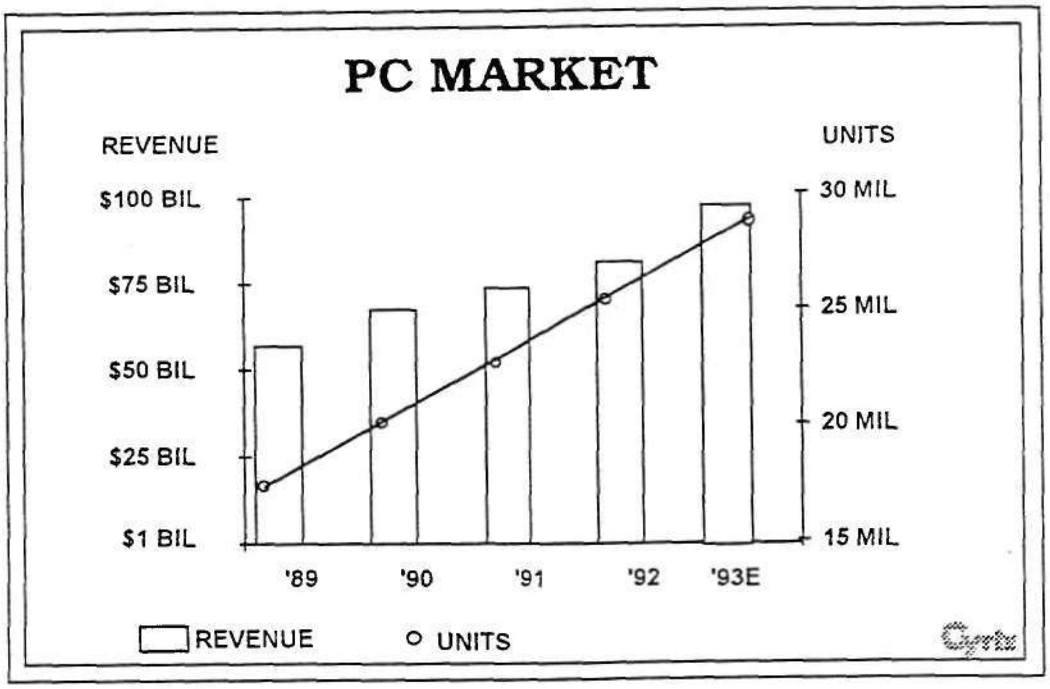
ESTABLISHED STANDARD

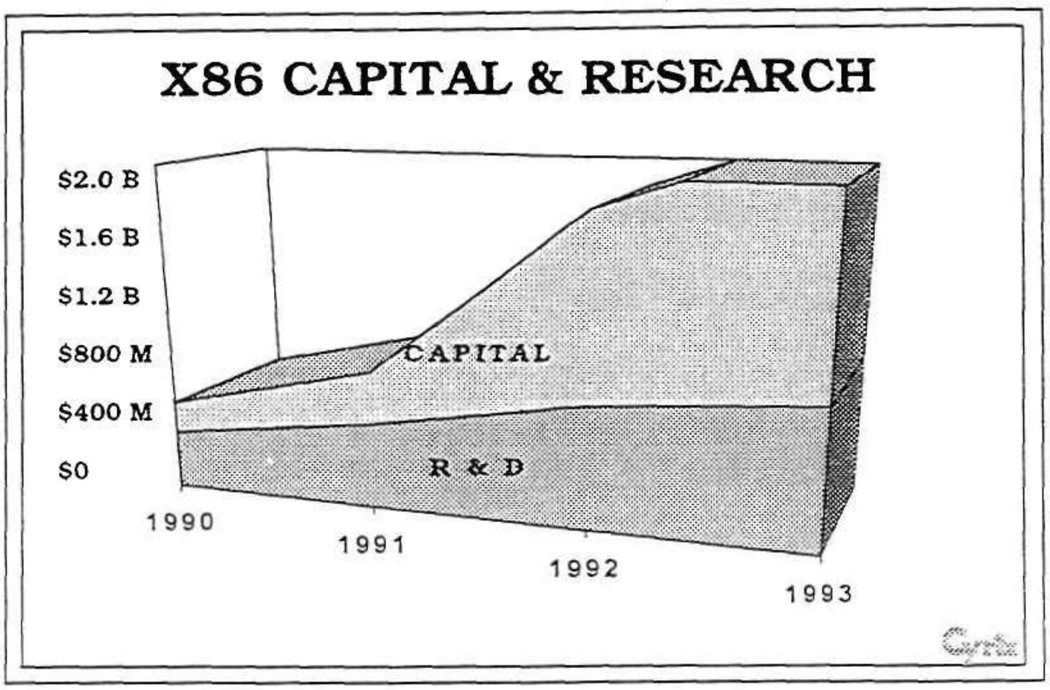
- HUGE SOFTWARE BASE
- ESTABLISHED HW/SW STANDARD
- 100M INSTALLED BASE

SOFTWARE IS KING!



- 50K x86 Software Applications
- $50B Aggregate Value

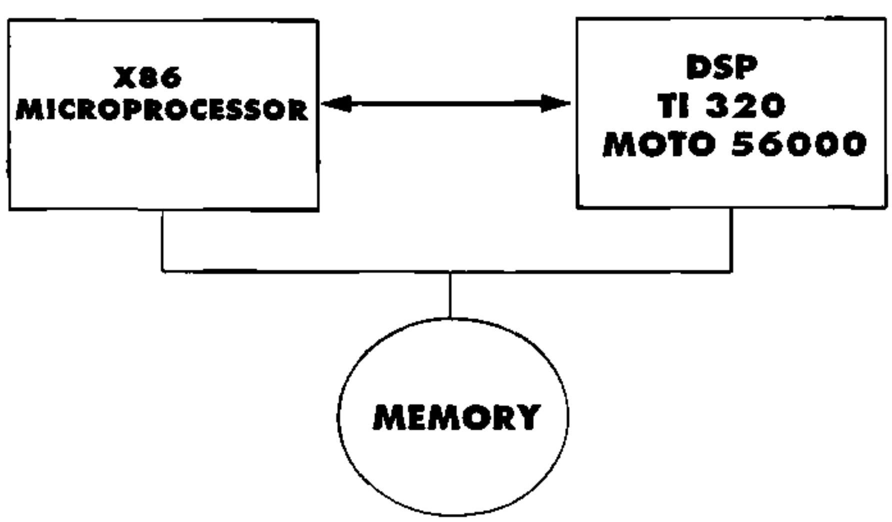

PC MARKET
REVENUE
UNITS
$100 BIL
$75 BIL
$50 BIL
$25 BIL
$1 BIL
30 MIL
25 MIL
20 MIL
15 MIL
'89
'90
'91
'92
'93E
REVENUE
UNITS
Cyrix


X86 CAPITAL & RESEARCH
$2.0 B
$1.6 B
$1.2 B
$800 M
$400 M
$0
CAPITAL
R & D
1990
1991
1992
1993
Cyrix

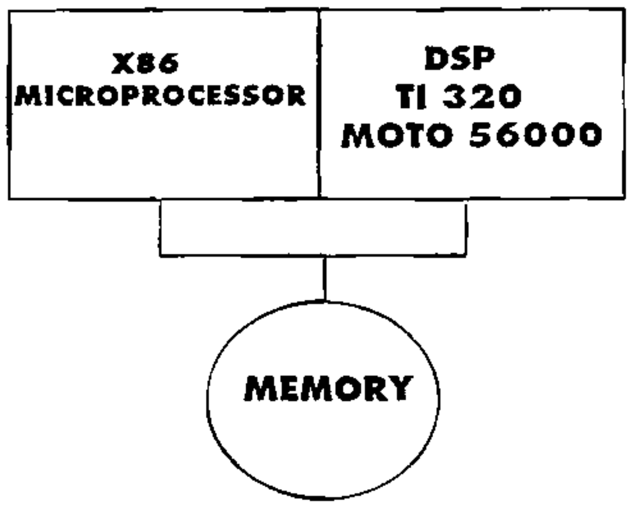
ADVANTAGES OF X86

- ESTABLISHED MARKET STANDARD
- INTEGRATION OPPORTUNITIES
- CUSTOMER REQUIREMENTS

PC MULTIMEDIA



MULTIMEDIA MICRO



128 POINT FFT REQUIREMENTS

PARAMETERS	486	DSP
REGISTERS	8	172
INSTRUCTION TIMES		
LOAD	1	1/2
STORE	1	1/2
ADD	1	1/2
SUBTRACT	1	1/2
MULTIPLY	26	1/2
JMP	3	1/2

$$\text{DFT } X_K = \sum_{N=0}^{N-1} X_N * W_N^{KN}$$

MULTIMEDIA X86

PARAMETER	x86
REGISTERS	172
INSTRUCTION TIMES	
LOAD	1/2
STORE	1/2
ADD	1/2
SUBTRACT	1/2
MULTIPLY	1/2
JMP	1/2

$$\text{DFT } X_K = \sum_{N=0}^{N-1} X_N * W_N^{KN}$$

Cyrix

WHY X86 MULTIMEDIA?

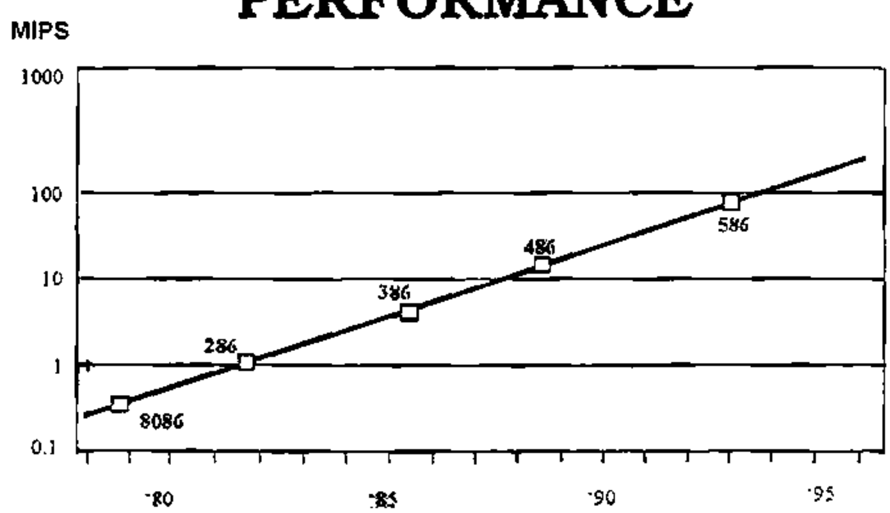
- ENGINEERING KNOW-HOW
  100K X86 ENGINEERS
- INFRASTRUCTURE ESTABLISHED
  COMPILERS
  ALGORITHMS
  DEBUGGERS
  DEVELOPMENT STATIONS
  OPERATING SYSTEMS
- LOW COST OF ENTRY

Cyrix

COMPATIBILITY CHALLENGE

- 100s OF MANUFACTURERS
- 1,000s OF PC MODELS
- 10,000s OF ADD-ON PERIPHERALS
- BILLIONS OF SOFTWARE CODE LINES

PERFORMANCE



ADVANTAGES OF X86

- ESTABLISHED MARKET STANDARD
- INTEGRATION OPPORTUNITY
- CUSTOMER REQUIREMENTS

END USER REQUIREMENTS

- BINARY COMPATIBILITY
- HIGHER PERFORMANCE
- VALUE PROPOSITION

VALUE PROPOSITION

- ADDITIONAL FEATURES
- ADDITIONAL FUNCTIONALITY
- ATTRACTIVE PRICING
- EXISTING SOFTWARE COMPATIBILITY

X86 ARCHITECTURE
HERE TODAY, HERE TOMORROW

- ADHERES TO ESTABLISHED HW/SW STANDARD
- OFFERS OPPORTUNITY FOR INTEGRATION
- MEETS CUSTOMER REQUIREMENTS

FOCUS SESSION: NEW PROCESSOR ARCHITECTURES

Rakesh Sood
Director of Marketing, Personal Communication Systems
AT&T Microelectronics

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FOCUS SESSION: NEW PROCESSOR ARCHITECTURES

Rakesh Sood
Director of Marketing,
Personal Communication Systems
AT&T Microelectronics

Mr. Sood is Director of Marketing, Personal Communication Systems for AT&T Microelectronics, and is responsible for worldwide marketing of AT&T's new Hobbit processor as well as other communication, display, storage, and I/O component technologies. Before joining AT&T, he served as Group Marketing Manager at Chips and Technologies for communications, I/O, storage and RISC technologies. His career also includes previous positions with Intel, Hewlett-Packard, and Ultra Network Technologies. Mr. Sood received an MBA from The Wharton School; an MSEE from State University of New York, Stoneybrook; and a BSEE from the Indian Institute of Technology, New Delhi.

Dataquest Europe Limited
EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE
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AT&T Microelectronics Personal Communication Systems

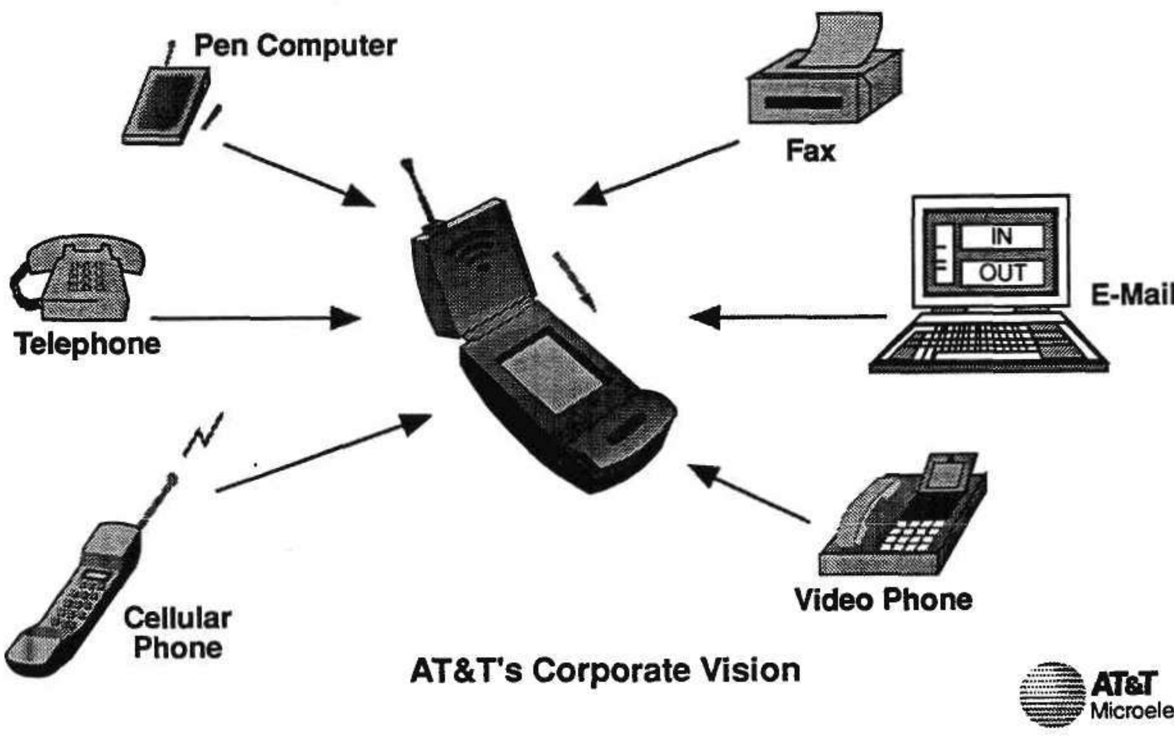
The 92K *Hobbit*™ Family . . .

. . . And The Personal Communicator Revolution

Rakesh Sood
Director of Marketing
May 27, 1993

AT&T Microelectronics

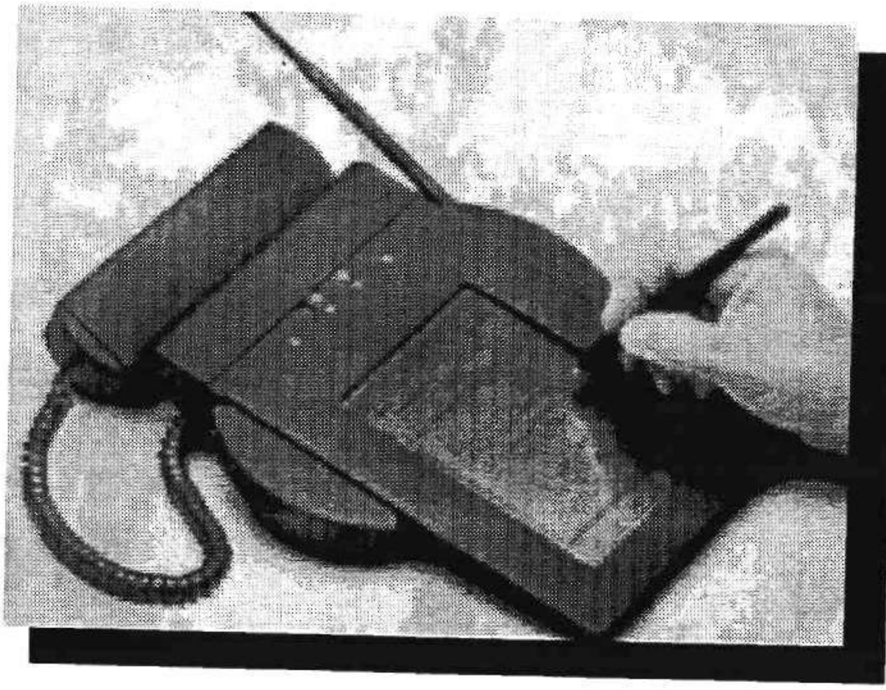
Personal Communicators Allow Mobile Access to Voice, Data and Video



AT&T's Corporate Vision

AT&T Microelectronics

Personal Communicators Are Real



- Cellular phone
- Fax
- Modem
- Electronic mail with voice annotation
- Ink capture
- Speaker phone
- Voice mail

AT&T Microelectronics

Personal Communicators Are Different

Category	Application	Users	Compliance
Notebooks	Desktop Extension	PC Users	PC
Tablets	Custom Field Apps.	Mobile Workers	Corporate Database
Communicators	Personal Messaging – Voice, e-mail, fax	Business Professionals (Today)	Messaging
Telephones	Voice Communications	Business & Consumer	Telecom Standards

AT&T

What Communications Users Want Next

Computing as easy to use as the telephone...

User Needs	*Product Requirements*
Ease of Use	**Flexibility, speed, easy-to-see display, common user interface**
Mobility	**Light weight, small size, work-week operation**
Communications	**Wired and wireless Real time and deferred Integrated voice, e-mail, FAX**

AT&T Microelectronics

Processor Architecture Requirements

- **High performance**
- **Low power**
- **High Density**
- **Comm-oriented**
- **Low Cost**

AT&T Microelectronics

How the Hobbit™ *Microprocessor Delivers*

- High performance
  - C optimized architecture - register free
  - Pipelined architecture
- Low power
  - Stoppable clock
  - Low I/O traffic

AT&T Microelectronics

How the Hobbit™ *Microprocessor Delivers*

- High density
  - CRISP architecture
  - High code density
- Comm-oriented
  - Low bus traffic
  - Fast interrupt response
- Low Cost
  - Small die size
  - JEDEC 132-pin PQFP

AT&T Microelectronics

Operating System Requirements

- New category requires, permits fresh start
- Object-oriented, multi-tasking
- Communications, messaging framework
- Consistent user interface across applications
  - Mobile user is target

Example: PenPoint* from GO meets these key requirements

* PenPoint is a trademark of GO Corporation.

AT&T Microelectronics

Applications Software and Services

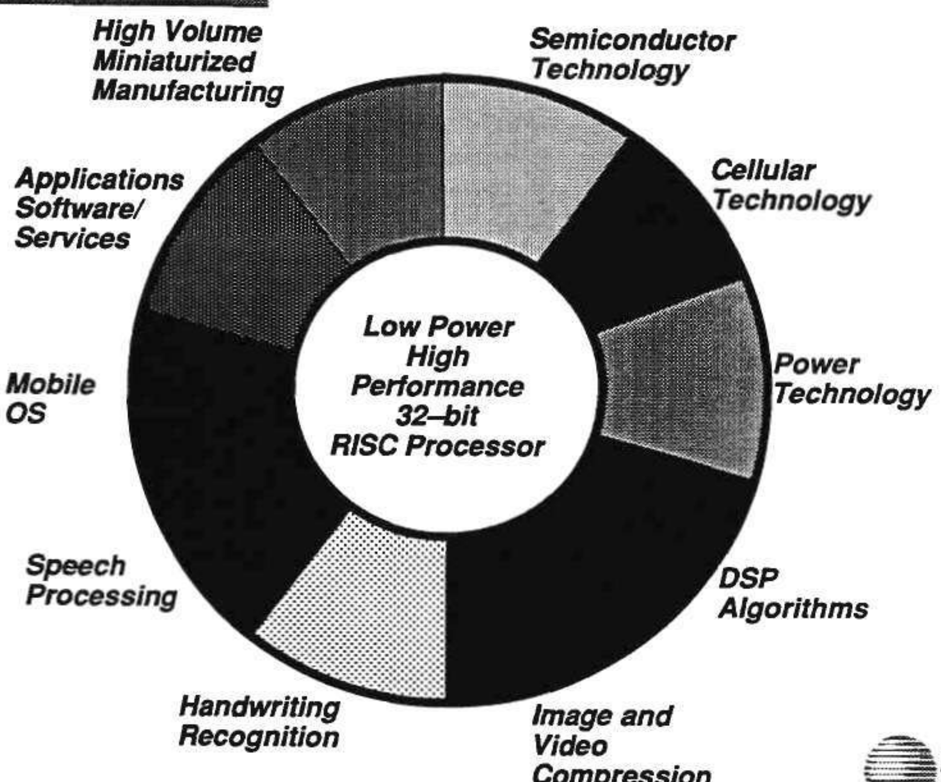
- Applications based on integrated messaging
  - Voice, data and FAX
  - Real-time and store-and-forward
- Innovative integration of calendaring, note-taking and scheduling applications
- Communication gateways
  - Links to desktops
  - Links to network services
- Consumer and business information services

AT&T Microelectronics

Personal Communications Environment

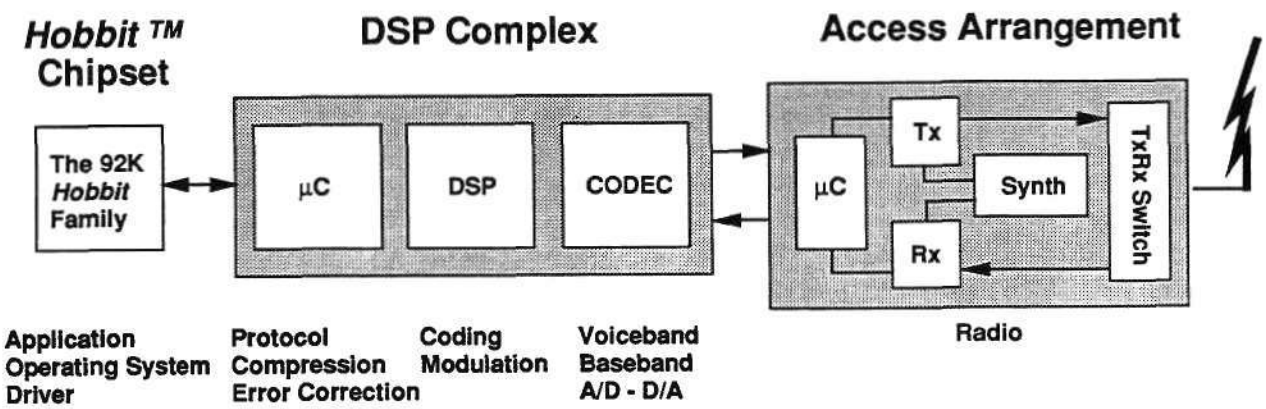
Info. Services	Stock Quotes, OAG, Weather, ...
Net. Services	E-Mail, Fax, Voice Mail
Infrastructure	Landline, GSM, IS-54, JDC, DCS1800, DECT, Mobitex
Communicators	Multiple Sources, Multiple Devices
O.S.	Pen/Communication-centric
Hardware	Hobbit, DSP, RF

Key Technologies for Personal Communicators



AT&T Microelectronics

Telecommunication in Personal Communicators



AT&T Microelectronics

FOCUS SESSION: NEW PROCESSOR ARCHITECTURES

Ray Gleason
Marketing Director
GEC Plessey Semiconductors

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FOCUS SESSION: NEW PROCESSOR ARCHITECTURES

Ray Gleason
Marketing Director
GEC Plessey Semiconductors

Mr. Gleason was appointed Marketing Director of GEC Plessey Semiconductors upon its formation. He had held the same position in Plessey Semiconductors Limited since 1988. He joined the company from ITT Semiconductors and was appointed Bipolar Product Manager. He then took the post of Worldwide Marketing Manager with overall marketing responsibility for the company's products and services. Mr. Gleason has a B.Sc. in Electronics from Queen's University, Belfast.

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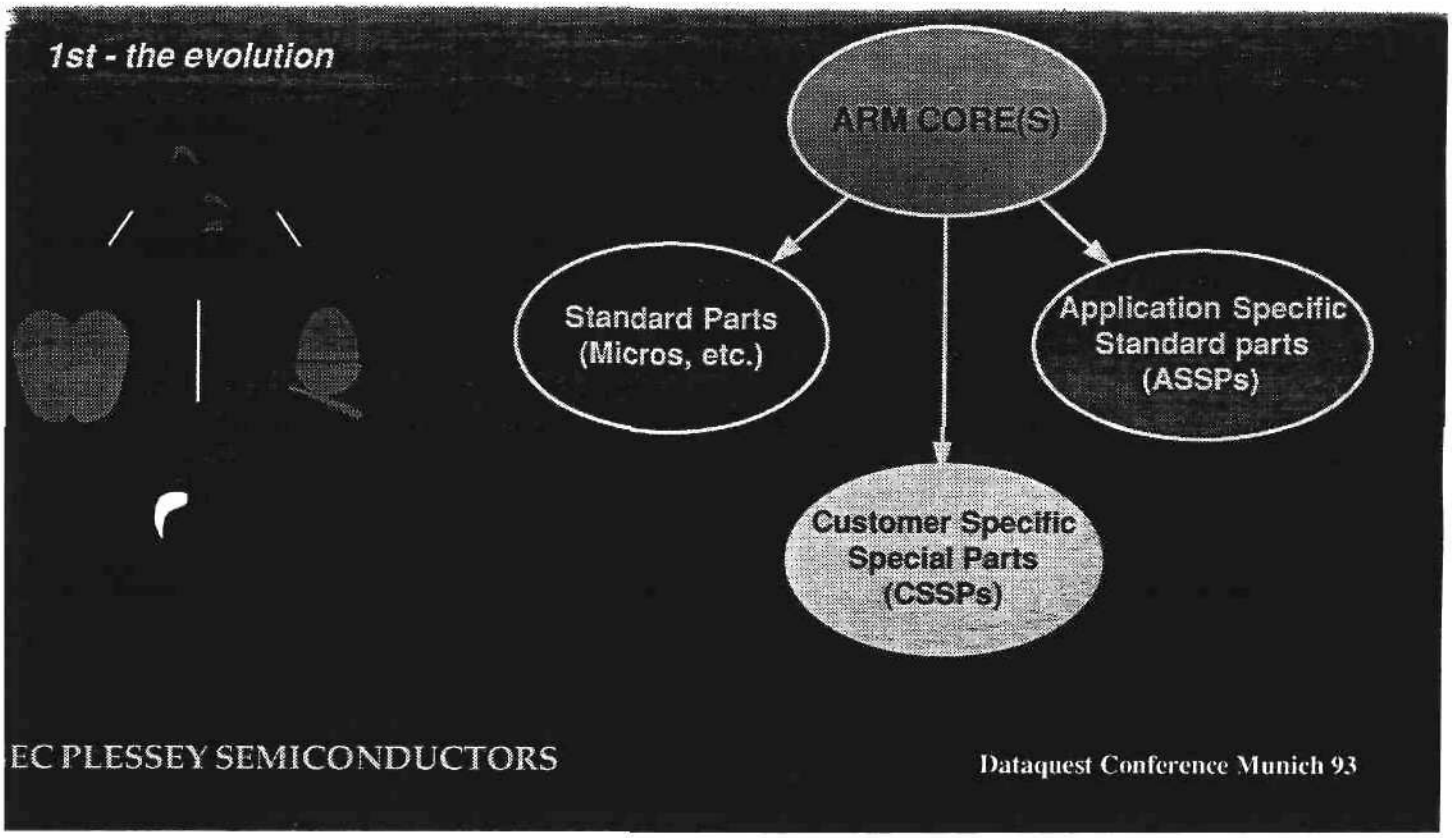
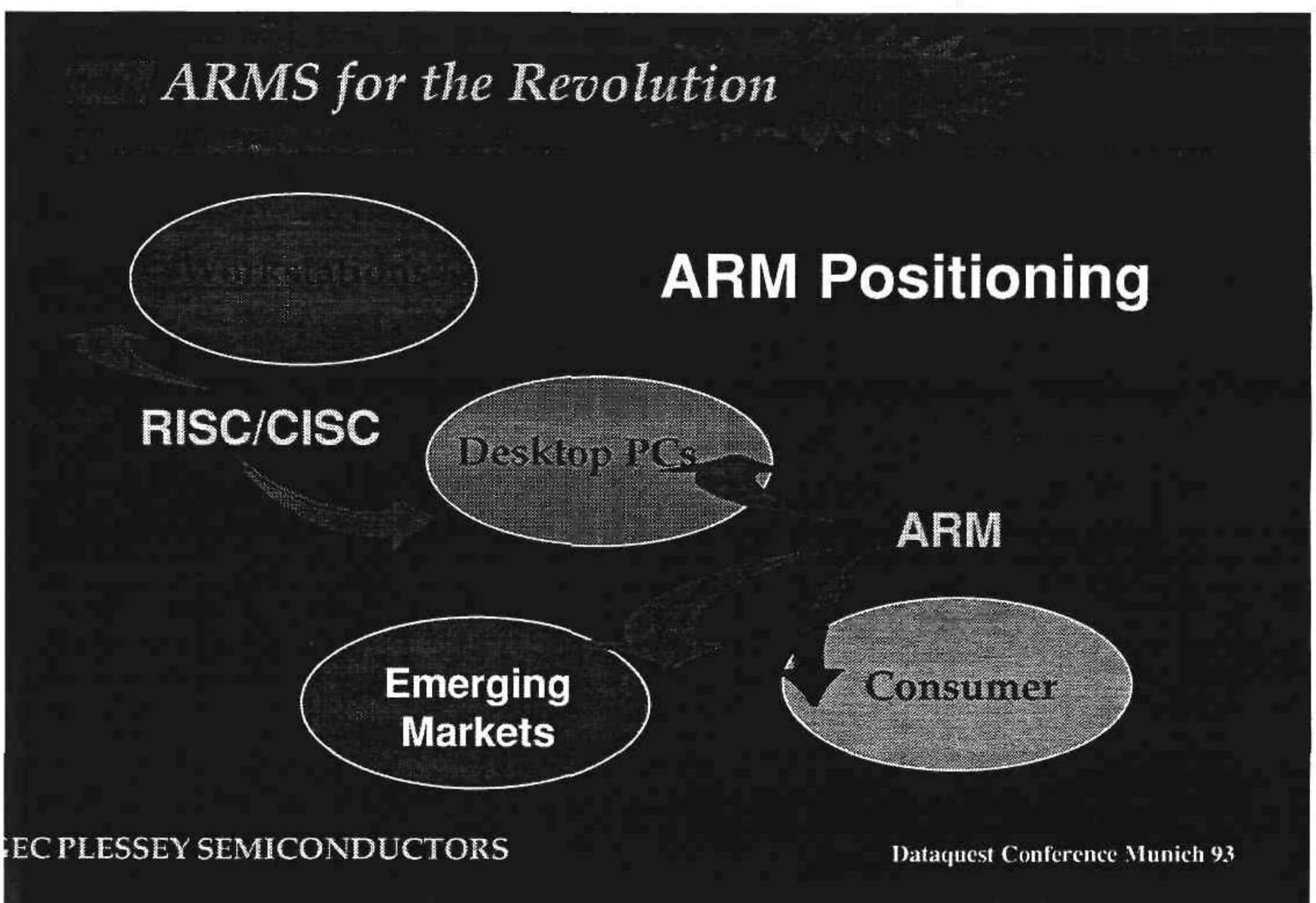
ARMS for the Revolution

Ray Gleason
Marketing Director
GEC Plessey Semiconductors

ARMS for the Revolution

The
Portable
handheld
&
Wireless
Revolution


1st - the evolution
ARM CORE(S)
Standard Parts
(Micros, etc.)
Application Specific
Standard parts
(ASSPs)
Customer Specific
Special Parts
(CSSPs)
EC PLESSEY SEMICONDUCTORS
Dataquest Conference Munich 93


ARMS for the Revolution
ARM Positioning
RISC/CISC
Desktop PCs
ARM
Emerging
Markets
Consumer
EC PLESSEY SEMICONDUCTORS
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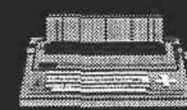
ARMS for the Revolution

ARM Products

- 32- bit RISC Microprocessors and support chips
- Available either as a chip or as an ASIC core
- Highest performance-per-Watt of any RISC processor
- Very small chip size
- Proven products with proven software
- Multi sourced product



GEC PLESSEY SEMICONDUCTORS

Dataquest Conference Munich

ARMS for the Revolution

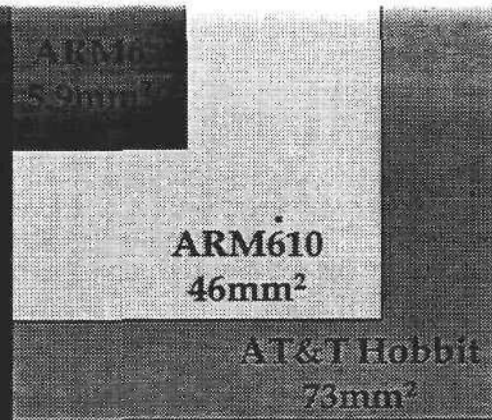
ARM ENABLES NEW MARKETS

- PDA
- Multimedia
- Consumer
- Entertainment / Cable
- Global Positioning
- Virtual Reality
- Security/ Encryption
- Videotelephony

- High Performance
- Power Efficient
- Low Cost
- Upward Integration Path
- Quick Time to market
- Proven Software tools
- Differentiation

ARM

Comparison of die sizes



Source: Microprocessor Forum 92(normalised to 0.8 micron)

ARMS for the Revolution

Low Power consumption means

- Low cost plastic packaging
- Lower system costs
- Higher reliability
- Improved end product

The ARM is

- Available in 100/144 PQFP packages
- A Fully static design
- A Reliable proven technology
- Only 1.5mA/MHz
- Ideal for battery applications

ARMS for the Revolution

High performance low cost design

- Write buffering
- on-chip CACHE option
- Excellent code density
- 3 stage pipelining

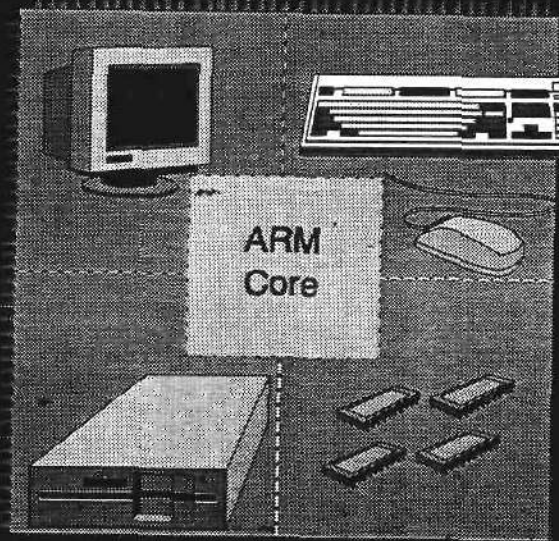
ARMS for the Revolution

Interactive real time response

- Fast interrupt response
- All instructions are conditional
- MMU designed for A.I applications
- Able to add real time I/O for ASSP's

The first RISC Computer on a chip

The ARM250

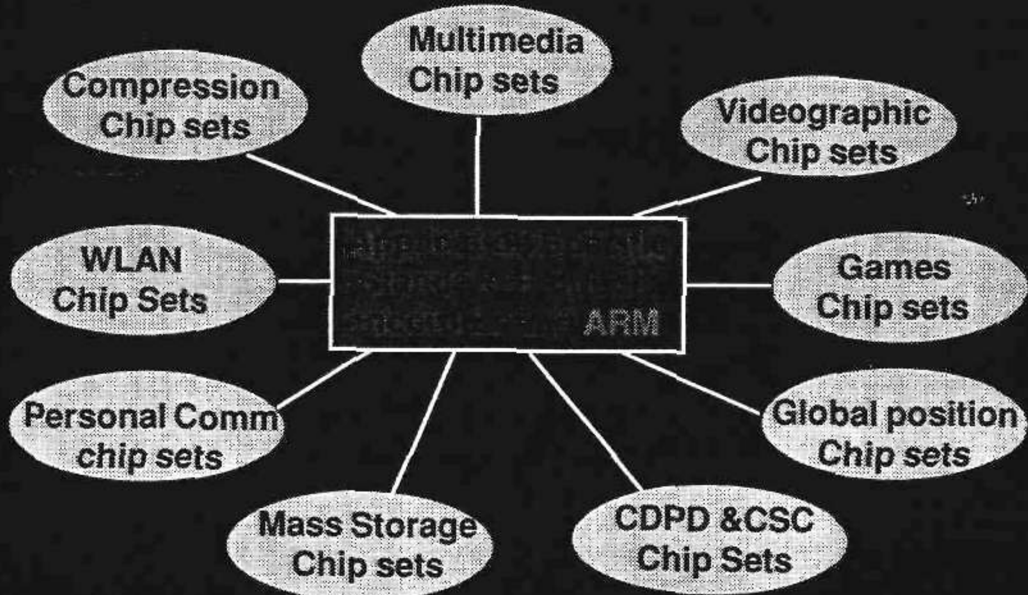


GEC PLESSEY SEMICONDUCTORS

Dataquest Conference Munich 93

ARMS for the Revolution

ARM an enabling core -- ASSPs play major Role



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ARMS for the Revolution

GPS Leading the Way in the Emerging RISC markets

Applications expertise

Standard devices

Low Voltage operation

Silicon integration capability

Mixed signal

Enhanced Core

Cache Technology

3LM

GPS

0.7-0.5 Micron

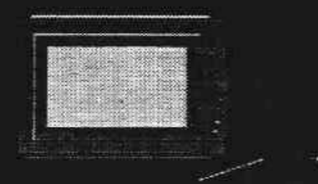
ARM6 ARM7 ARM8

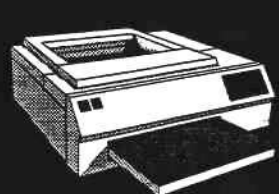
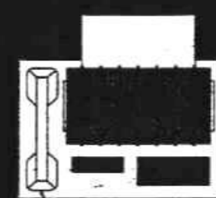
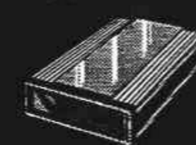
ARMS for the Revolution

Market Targets

Target Markets for ARM

- Advanced Consumer electronics: Multimedia, games etc.
- Portable products: PDAs, phones, GPS receivers
- X- terminals
- Disk drives
- Datacomms : e.g Networks, WLAN, CDPD, CSC, Token ring, FAX
- Automotive: safety, suspension, entertainment

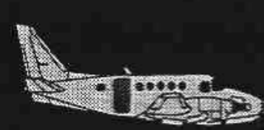


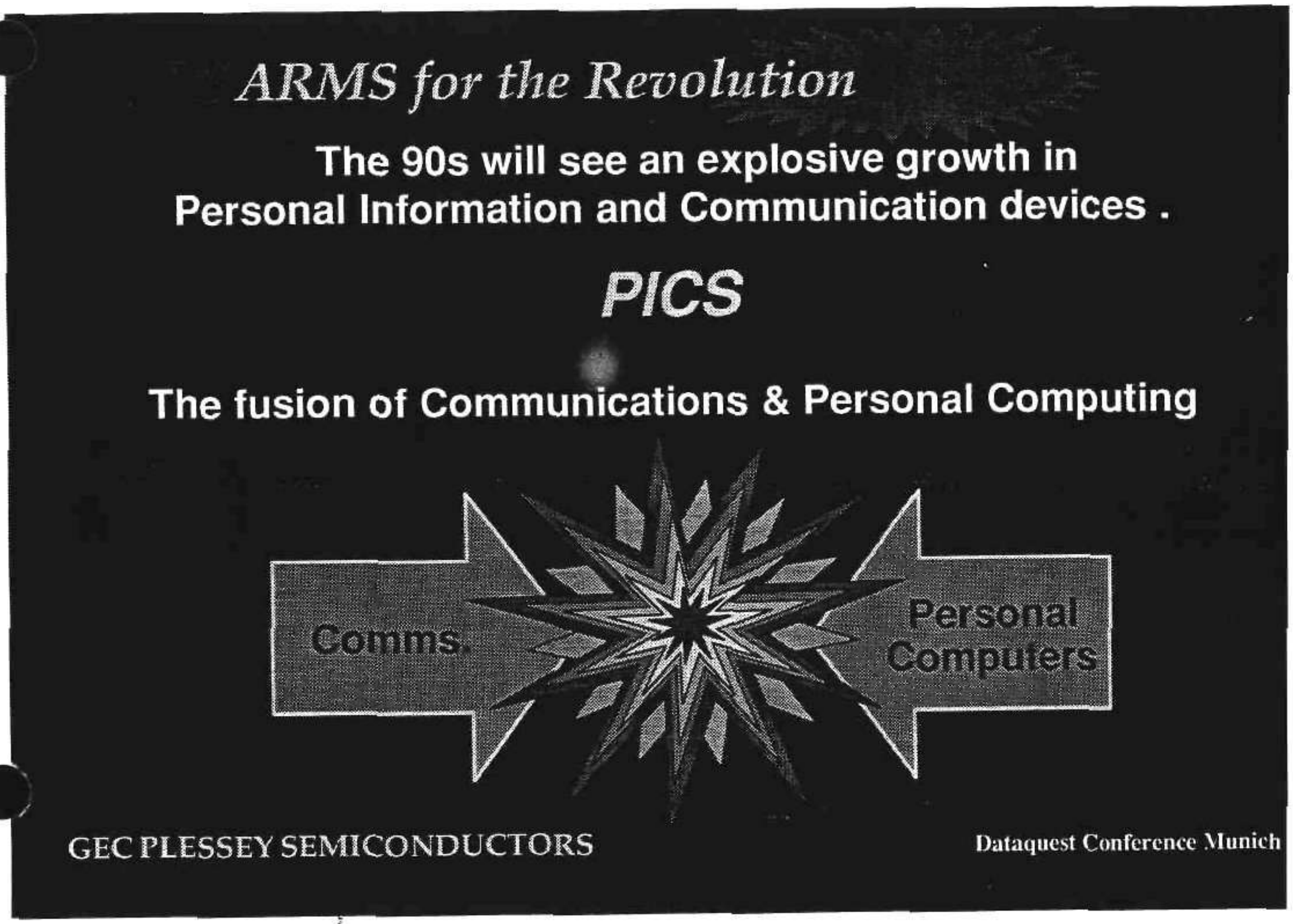




ARMS for the Revolution

APPLE
SHARP
3DO
ACORN
MATSUSHITA

ARM POWERED



ARMS for the Revolution
The 90s will see an explosive growth in
Personal Information and Communication devices .
PICS
The fusion of Communications & Personal Computing
Comms.
Personal
Computers
GEC PLESSEY SEMICONDUCTORS
Dataquest Conference Munich


ARMS for the Revolution
To take part in the PICS market you need at least.....
ARM
Powered
Good partnerships
RF circuit design skills for Wireless transmission
Video compression and Graphics circuits
High performance low power 32 bit Micros
Application Specific System & software skills
Mixed signal design skills
Very high speed Bipolar technology
Multi - chip module technology
CMOS technology

ARMS for the Revolution

" The ARM Micro is the Z80 of the 90s "

FOCUS SESSION: NEW PROCESSOR ARCHITECTURES

Art Swift
Semiconductor Marketing and Sales Manager
Digital Equipment Corporation

Dataquest Europe Limited, a company of The Dun & Bradstreet Corporation
Roussel House, Broadwater Park, Denham, Uxbridge, Middx UB9 5HP / 0895 835050 / Tlx 266195 / Fax 0895 835260

FOCUS SESSION: NEW PROCESSOR ARCHITECTURES

Art Swift
Semiconductor Marketing and Sales Manager
Digital Equipment Corporation

Mr. Swift is Marketing and Sales Manager for Digital Equipment Corporation's Semiconductor Operations. In this role he has worldwide responsibility for marketing and sales of Digital's Alpha AXP 64-bit microprocessor family, as well as other high-performance, value-added components. Prior to joining Digital Mr. Swift was most recently Vice President of Marketing at B.I.T. Incorporated, and previously held marketing positions at Fairchild Semiconductor and Monolithic Memories, Incorporated. He has a B.Sc. degree in Electrical Engineering from Pennsylvania State University.

Dataquest Europe Limited
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May 26–28, 1993
Munich, Germany

Alpha AXP™ - Unlocking the Full Potential of Windows NT™

Art Swift
Semiconductor Marketing and Sales Manager
Digital Equipment Corporation
Hudson, Massachusetts

digital™

Agenda

- Windows NT - The Next Desktop Standard OS
  - Features, Market Sizing, End Users
- Alpha AXP Architecture - The Engine of Choice
  - Goals, Compatibility, Roadmap
- Market Infrastructure Required for Success
- Conclusion

Standard Operating System

Features	Benefits
Integrated networking	Enterprise comm
	Interoperability
Pre-emptive multitasking	High productivity
	Multiple tasks
Multi-processing support	High performance
32-bit address space	
Address space protection	Reliability
Fault tolerant features	
Security features	Data protection
	Confidentiality

Modern operating system and bridge from DOS & Windows environment

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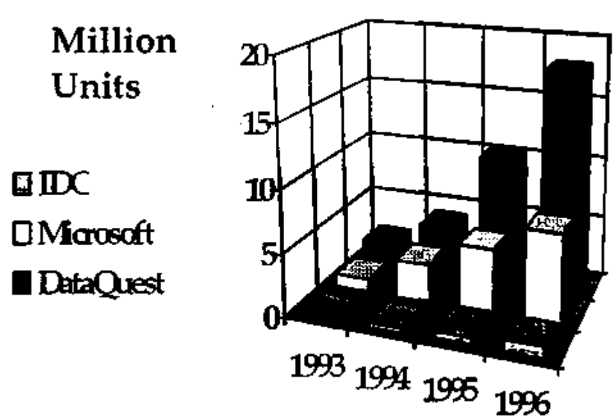
Projected Windows NT Market Size



Dataquest forecasts strong growth for Windows NT

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End Users Demanding Higher Performance

"The PC Elite" - running high end PC applications or have critical requirement for robustness, reliability and security

Desktop publishing	Integrated office automation
CASE	Financial analysis
Low end CAD	Document processing

"The Downsizer/Upsizer" - running business critical applications on minis and mainframes or moving from standalone PCs to PC LANs

Database	Payroll/Accounting
Inventory Control	Work Flow Applications
GroupWare	

"The RISC User" - running technical or compute/graphics intensive business applications on workstations

CAD/CAM	Financial Trading
Animation	Scientific imaging
Mechanical analysis	Molecular design

digital™

Alpha AXP Architecture Goals

- **Sustained Performance Leadership**
  - Superscalar
  - Superpipelined
- **Longevity / Scalability - 1000X**
  - Issue Rate
  - Multiprocessing
  - Clock Speed
  - Large Address Space
- **Universality**
  - Operating System Neutral

Alpha AXP 21064 vs. Pentium -
DOS Compatibility in Hardware Drives Complexity

	21064	Pentium
# Transistors	1.7 Million	3.1 Million
Die Size	1.9 cm2	2.6 cm2
Process Technology	.68 um	.8/.6 um
Frequency	200Mhz	66Mhz
Voltage	3.3V	5/3.3V
SPEC89	161	60
SPECint92	110	65
SPECfp92	163	57
Samples (Generally Available)	4/93	Q1/Q2 93

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DOS Compatibility Trade-offs

DOS compatibility drives X86/Pentium design

- hardware overhead to retain compatibility
- more complex chip designs, larger die-size
- longer design cycles, less frequent upgrades

Alpha AXP provides DOS compatibility more economically through emulation

- freedom to design for performance goals

Alpha required to unlock the full potential of Windows NT

digital™

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Alpha AXP 21064 vs. Pentium -

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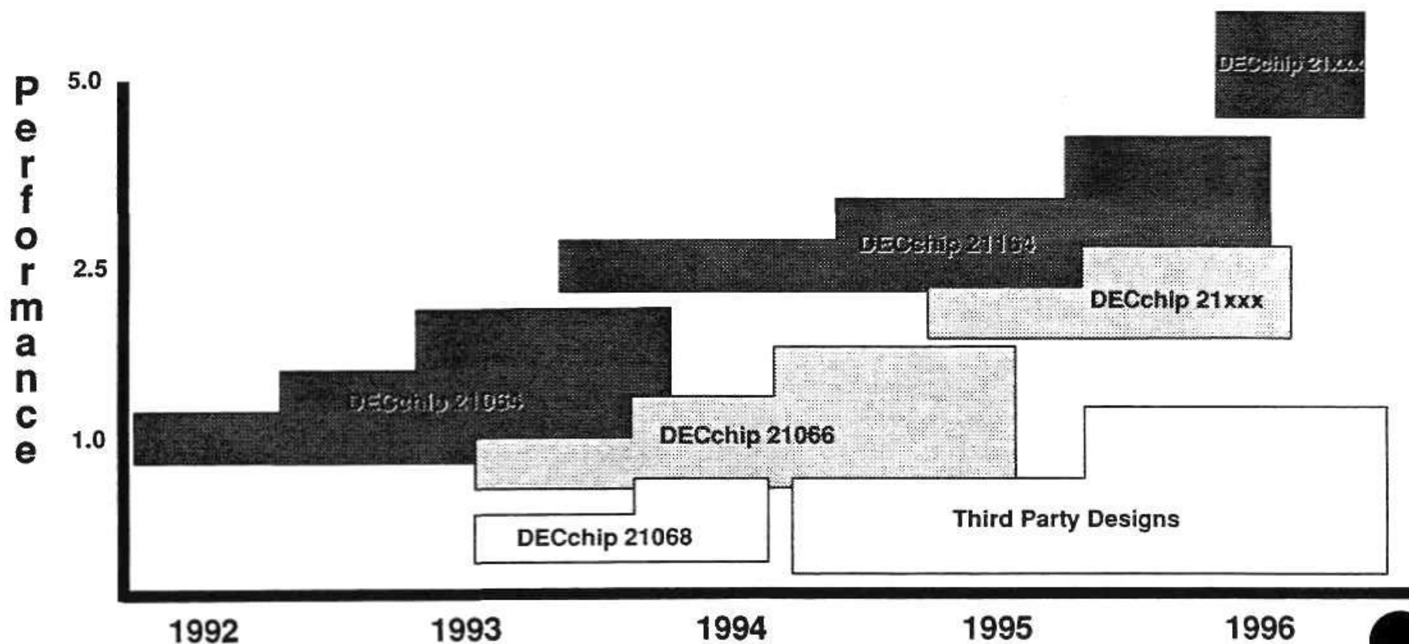
Sustained Performance Leadership



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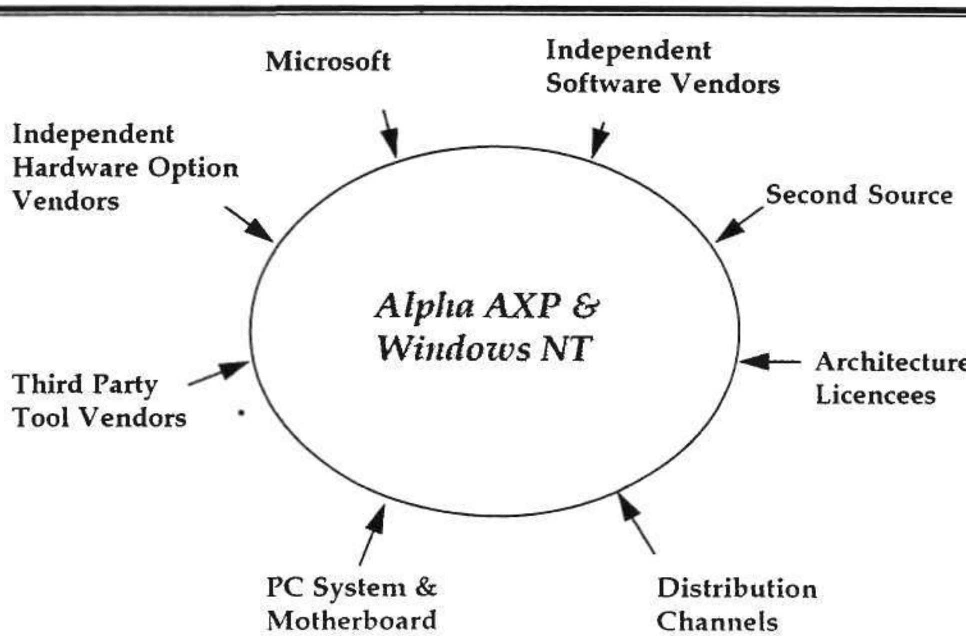
Alpha AXP Market Infrastructure - A Key Requirement for Success



Conclusion

Alpha AXP will be the OPEN platform of choice for unlocking the full potential of Windows NT

Sustained Leadership Performance

Multiple Sources of Innovation

Alpha AXP

Multiple Sources of Supply

Broad Application Base

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FOCUS SESSION: NEW PROCESSOR ARCHITECTURES

Les Crudele
Vice President and General Manager
RISC Microprocessor Division—Motorola

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Vice President and
General Manager
RISC Microprocessor
Division—Motorola

Mr. Crudele is Vice President and General Manager of the RISC Microprocessor Division at Motorola Inc. Prior to this he was Assistant General Manager of the high-end MPU division. Before this he was a founder member of Stella Computer Inc. where he was Vice President of technology, Vice President of hardware development and Corporate Vice President of research and development and Director of hardware. Earlier he worked for Motorola's MPU division then went on to Stromberg-Carlson. Mr. Crudele was initially employed by Motorola's Communications Division. Mr. Crudele received a B.S. in Electrical Engineering at Florida Atlantic University.

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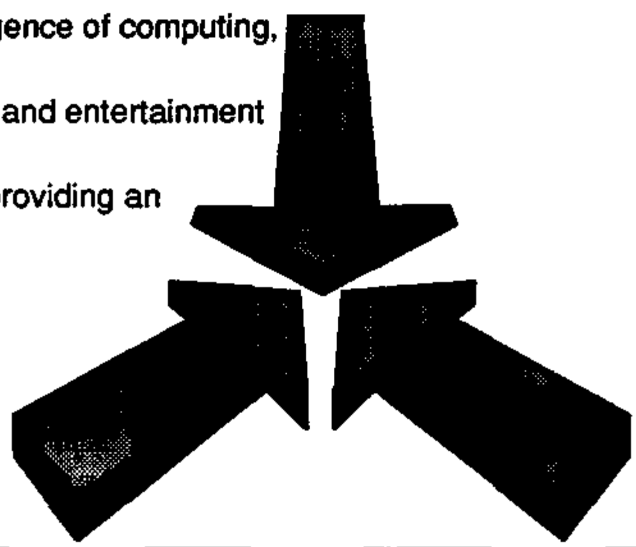
RISC

PowerPC™

MOTOROLA

RISC Motorola Microprocessor Vision

Drive the convergence of computing, communications, and entertainment technologies by providing an industry-standard microprocessor architecture



MOTOROLA

RISC Future Technology Differentiators

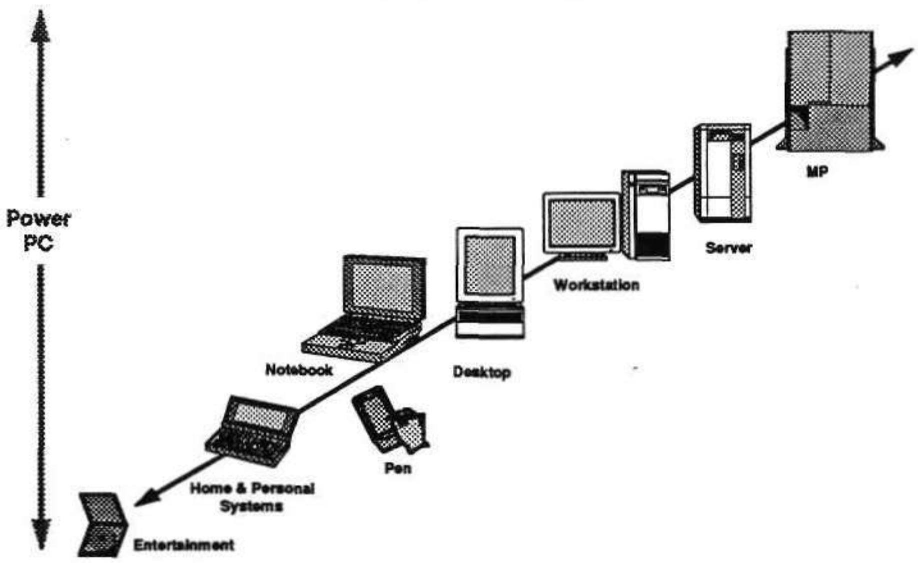
Enabling Technologies

- Integrated processor technology
  - CPU + Cache + Memory + I/O + System glue = One Chip
- Power management
  - Low power consumption at max speed plus,
  - On Chip Power Management System
- Handwriting recognition
  - A new I/O paradigm
- Digital Signal Processing
  - Speech recognition
  - Compression, Encryption
  - V.32bis, V.Fast, CELP/VSELP
- Untethered Communications
  - Cellular (reach out and touch...)
  - Wireless (short range, roving workers)
  - Pager
- ATM (Asynchronous Transfer Mode)

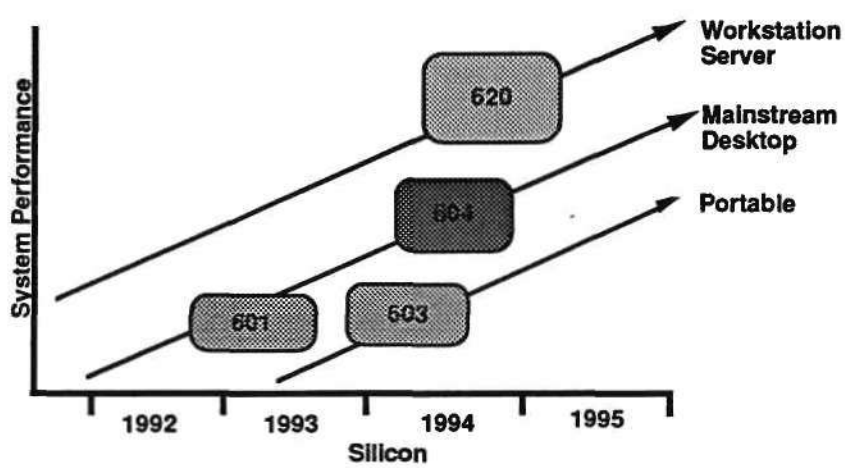
RISC Motorola Corporation Technologies

- Wireless Data Communication 
- Cellular Phones
- Low Power Technology Development 
- Manufacturing Technology & Capacity 
- Multi-Media 

Wide Range of PowerPC Applications



PowerPC Roadmap



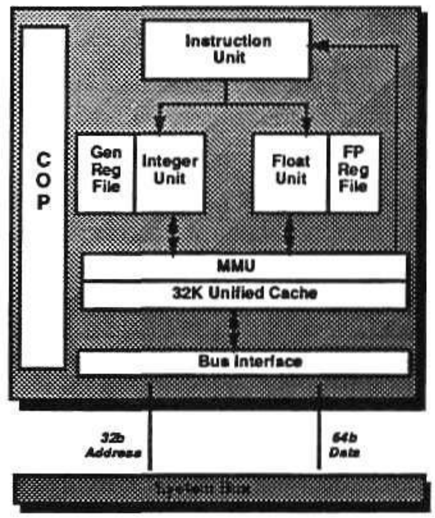
MPC601 Overview

Target Markets:
- Early PowerPC adopters
- High volume desktop computers

Features:
- Superscalar (3 IPC)
- Branch Folding
- 32K unified byte cache
- Demand paged memory management unit
- 64-bit data bus
- Multiprocessing support
- 32-bit PowerPC implementation
- Pipelined single/double precision float unit

Performance:
- 67 SPEC89 @ 66MHz (50 ISPEC, 81 FPSPEC)

Technology:
- 0.65μm CMOS
- CQFP package



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Worldwide Applications

Endorsed by the Leading Systems Companies in the World

Apple - Personal Computers & Desktop/Multimedia Workstations

IBM - Desktop Workstations, Servers, MPP Systems & Personal Systems

Bull - SMP Servers & European Desktop Workstations

Thomson - VME Realtime Systems & Defense Systems

Ford - PowerPC for Embedded Control

Harris - Realtime systems for simulators and NASA

Tadpole - Portable workstation and single board computers

Sunsoft - Supplier of Solaris operating systems

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RISC PowerPC Momentum Builds

October 1991	Apple, IBM, and Motorola announce formation of alliance including details on PowerPC architecture and PowerOpen Environment
January 1992	Bull announces adoption of PowerPC and licensing multiprocessing technology
April 1992	Thomson-CSF subsidiary, CETIA, announces agreement with IBM to develop product line based on PowerPC
May 1992	Motorola, IBM, and Apple dedicate Somerset design center
October 1992	Motorola, IBM, and Apple unveil PowerPC 601—first silicon
November 1992	Harris announces agreement with IBM to adopt PowerPC into future real-time workstations

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RISC PowerPC Momentum Builds (cont.)

December 1992	Tadpole announces agreement with IBM to develop PowerPC notebooks
January 1993	Thomson CETIA announces PowerPC VME systems and Lynx real-time software
March 1993	Apple, Bull Harris, IBM, Motorola, Tadpole Technology, and Thomson-CSF announce PowerOpen Association
April 1993	SunSoft announces plans to support Solaris on PowerPC
April 1993	Motorola announces PowerPC 601 general sampling
May 1993	Motorola and IBM announce PowerPC 601 tools catalog and several vendors announce support tools

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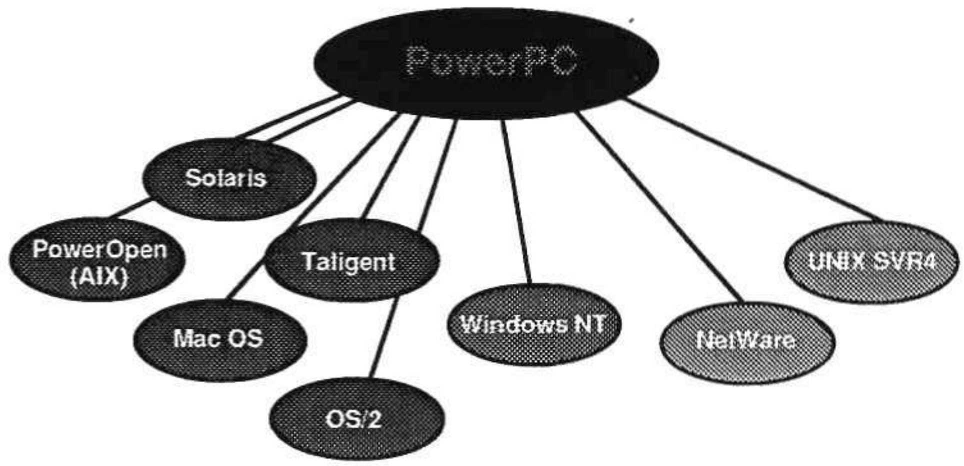
Comprehensive OS Support



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Converging Technologies

Scalable architecture
Compatible applications
Price-performance

Portable
Low-power
Miniaturization
Pen-based

Communications
Networking
Cellular
Wireless

MOTOROLA

DAY

3

EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

Takao Nakano
Senior Executive and General Manager
Mitsubishi Electric Corporation

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EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

Takao Nakano
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Dr. Nakano is Senior Executive and General Manager of Mitsubishi Electric Corporation (MELCO). He is responsible for managing the development and production of MCU and ASICs. Dr. Nakano joined MELCO in 1964 and has been Project Manager and Deputy General Manager. He has contributed to the circuit design of VLSI memories from 64 Kb to 16 Mb. Dr. Nakano graduated from Osaka University, Japan and holds a Ph.D in Electronic Engineering.

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MITSUBISHI ELECTRIC

European Semiconductor Industry Conference
26-28 May 1993
Munich Park Hilton, Munich, Germany

Semiconductor Strategies and Directions for Growth

Takao Nakano
Mitsubishi Electric Corporation

Contents

1. Introduction
2. Market Trends
3. Technology Trends
4. Strategies and Directions for Growth

MITSUBISHI ELECTRIC

1. INTRODUCTION

MITSUBISHI ELECTRIC

INDUSTRIAL TRANSFORMATION AND THE SEMICONDUCTOR INDUSTRY

I. CONVERSION OF THE INDUSTRIAL STRUCTURE (THE MITI COUNCIL ON INDUSTRIAL STRUCTURE)

1. "UNIFICATION"-THE CONCEPT BEHIND CURRENT POLICY DEVELOPMEMT
2. DIRECTION → FORM

ECONOMIES OF SCALE PRODUCTION → LIMITED VARIETY, HIGH VOLUME PRODUCTION

↓ ↓

ECONOMIES OF WIDE SCOPE PRODUCTION → WIDE VARIETY, LOW VOLUME PRODUCTION

II. SEMICONDUCTOR INDUSTRY

FROM THE DEVICE ERA,"HOW TO MAKE"(up to 1985) TO THE SYSTEM ERA,"WHAT? AND WHEN TO MAKE IT?"(1986 on ward)

↓

BUSINESS COMPATIBILITY

1. ADJUSTMENT OF MANAGEMENT STRATEGIES, MARKET STRATEGIES, TECHNOLOGICAL STRATEGIES
2. THE CRITICAL IMPORTANCE OF TIMING, SPEED & NETWORKING

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VLSI DEVELOPMENT IN THE 1990S

Increasing Difficulty of "How-to"

Increasing Importance of "What"

Increasing Development Costs & Intensified Competition

Device Business; Expanding Scale & Increasing Profits

Efficient Development Via Cooperations.

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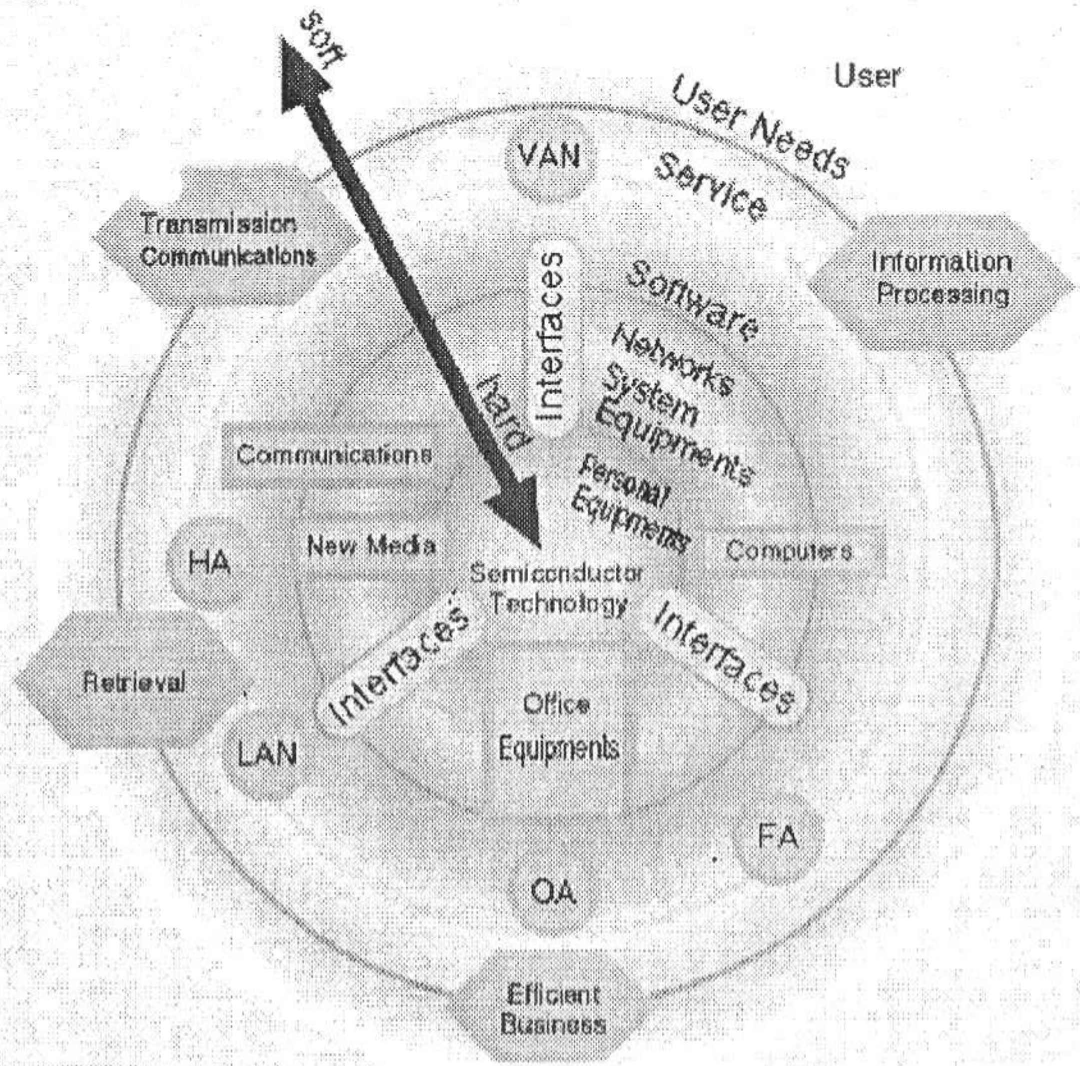
HIERARCHICAL STRUCTURE OF THE INFORMATION INDUSTRY



2. MARKET TRENDS

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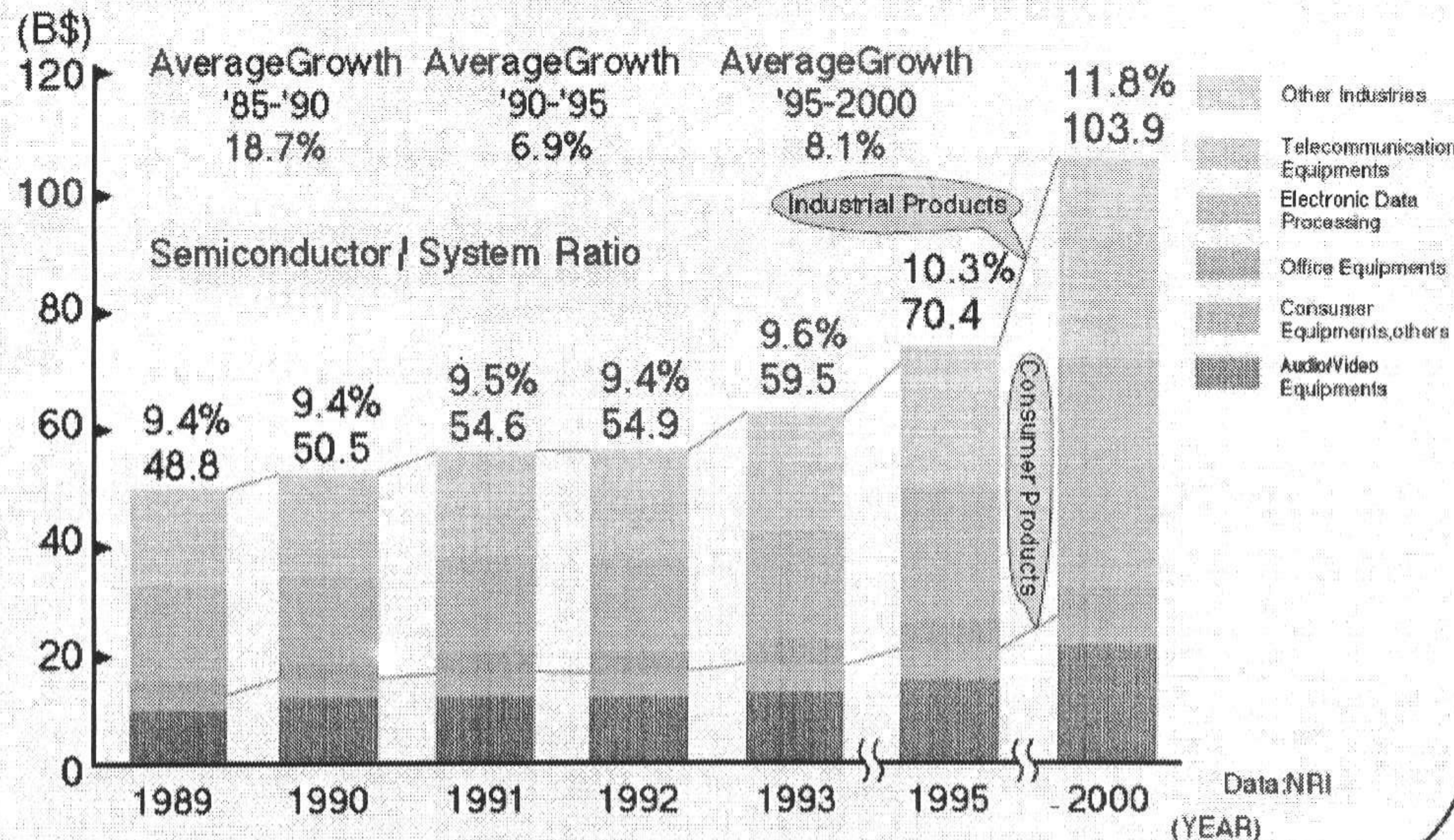
SEMICONDUCTOR USAGE BY TYPE OF PRODUCTS (WORLDWIDE)



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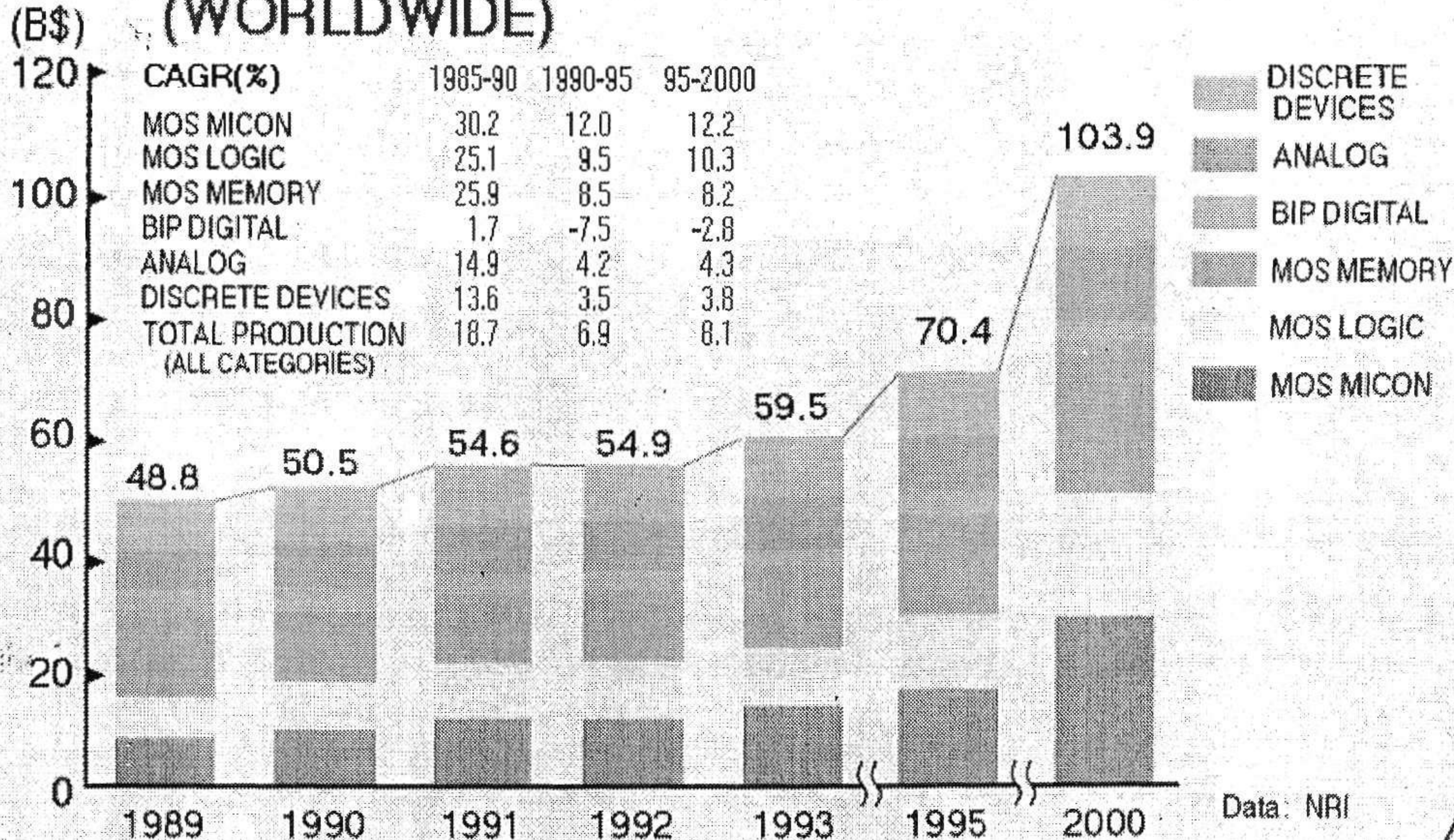
SEMICONDUCTOR DEMAND BY SECTOR (WORLDWIDE)

CAGR(%)	1985-90	1990-95	95-2000
MOS MICON	30.2	12.0	12.2
MOS LOGIC	25.1	9.5	10.3
MOS MEMORY	25.9	8.5	8.2
BIP DIGITAL	1.7	-7.5	-2.8
ANALOG	14.9	4.2	4.3
DISCRETE DEVICES	13.6	3.5	3.8
TOTAL PRODUCTION (ALL CATEGORIES)	18.7	6.9	8.1



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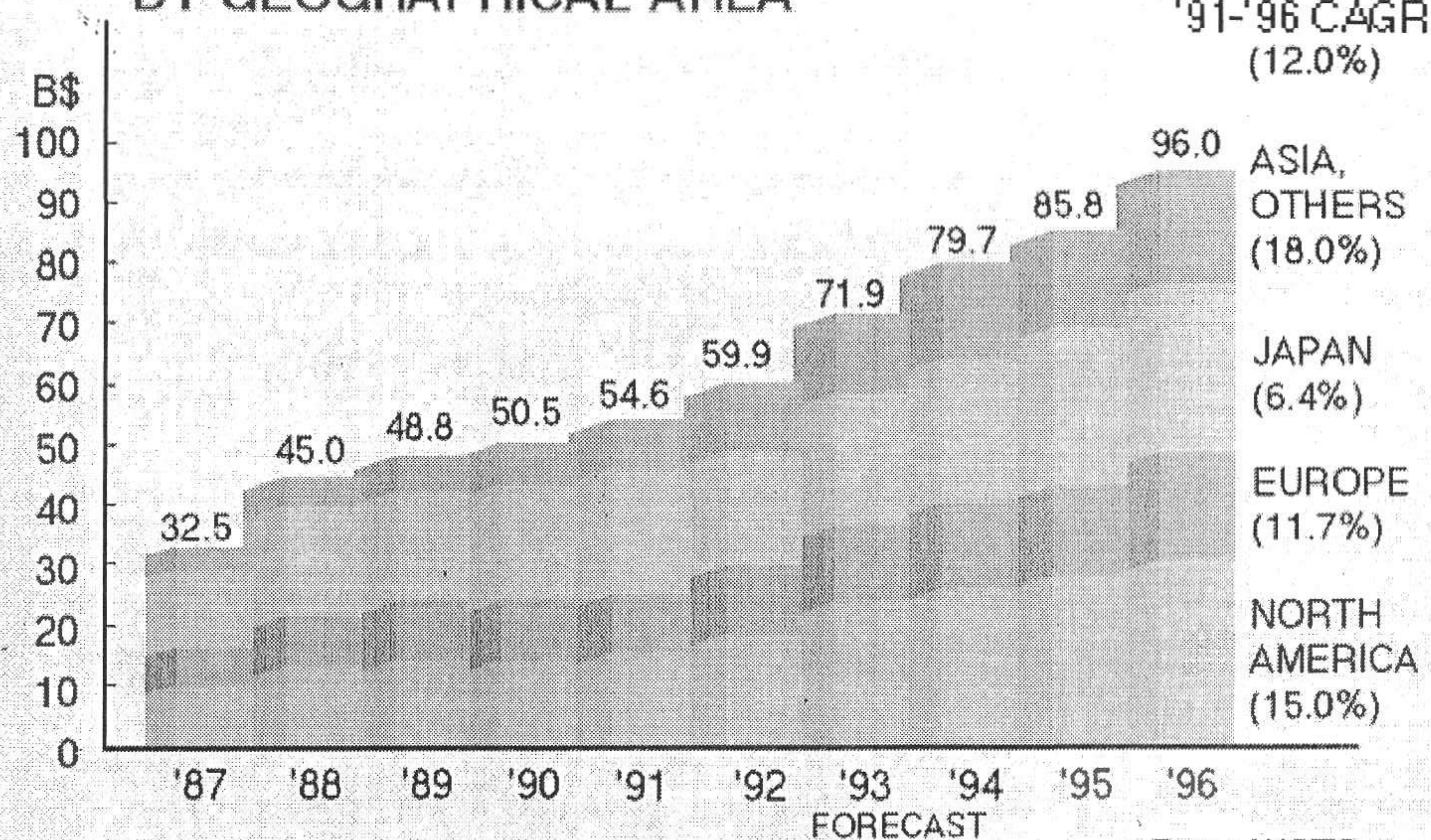
WORLD SEMICONDUCTOR MARKET BY GEOGRAPHICAL AREA



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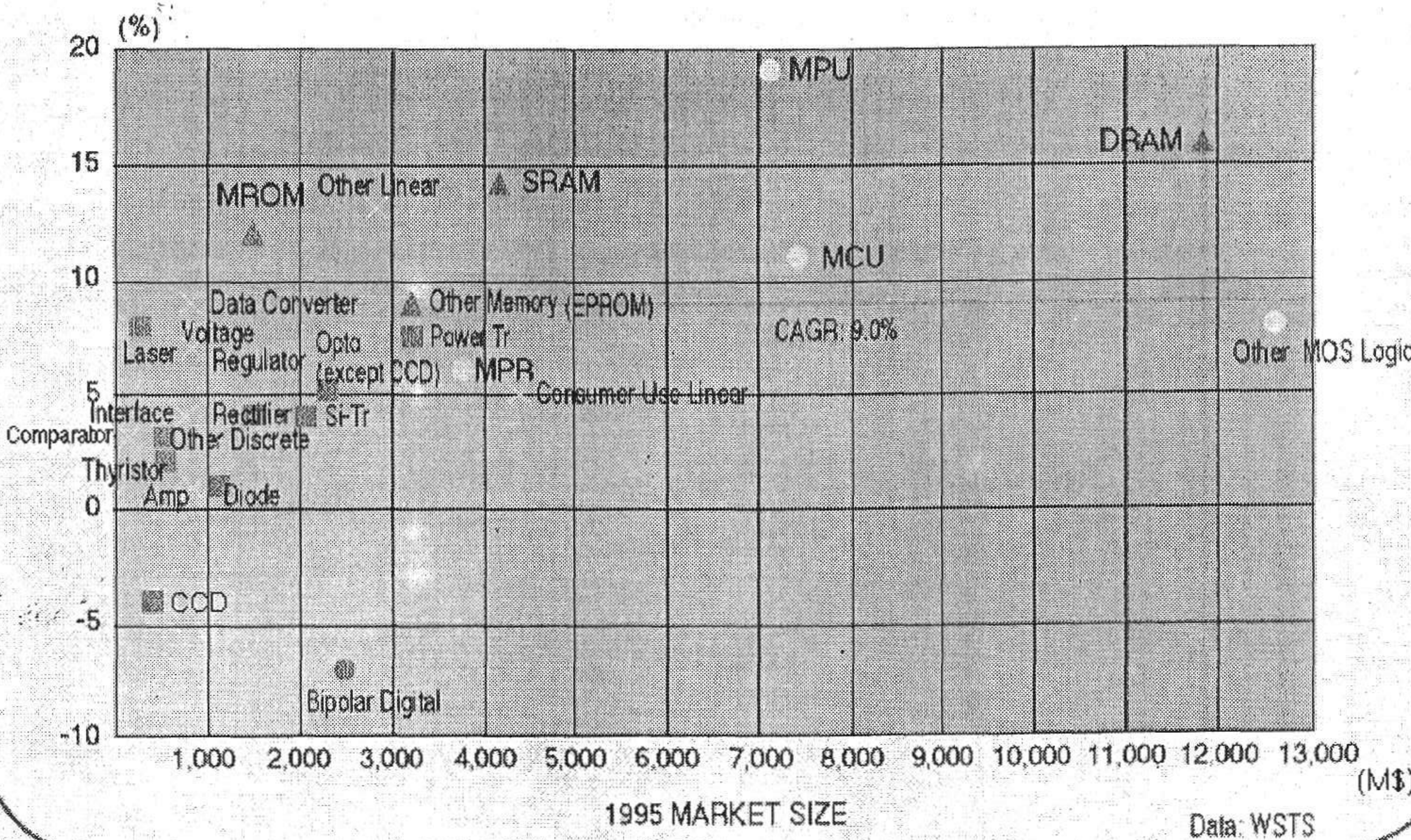
GROWTH SECTOR-OF FUTURE(Market size & Growth Rate)



3. TECHNOLOGY TRENDS

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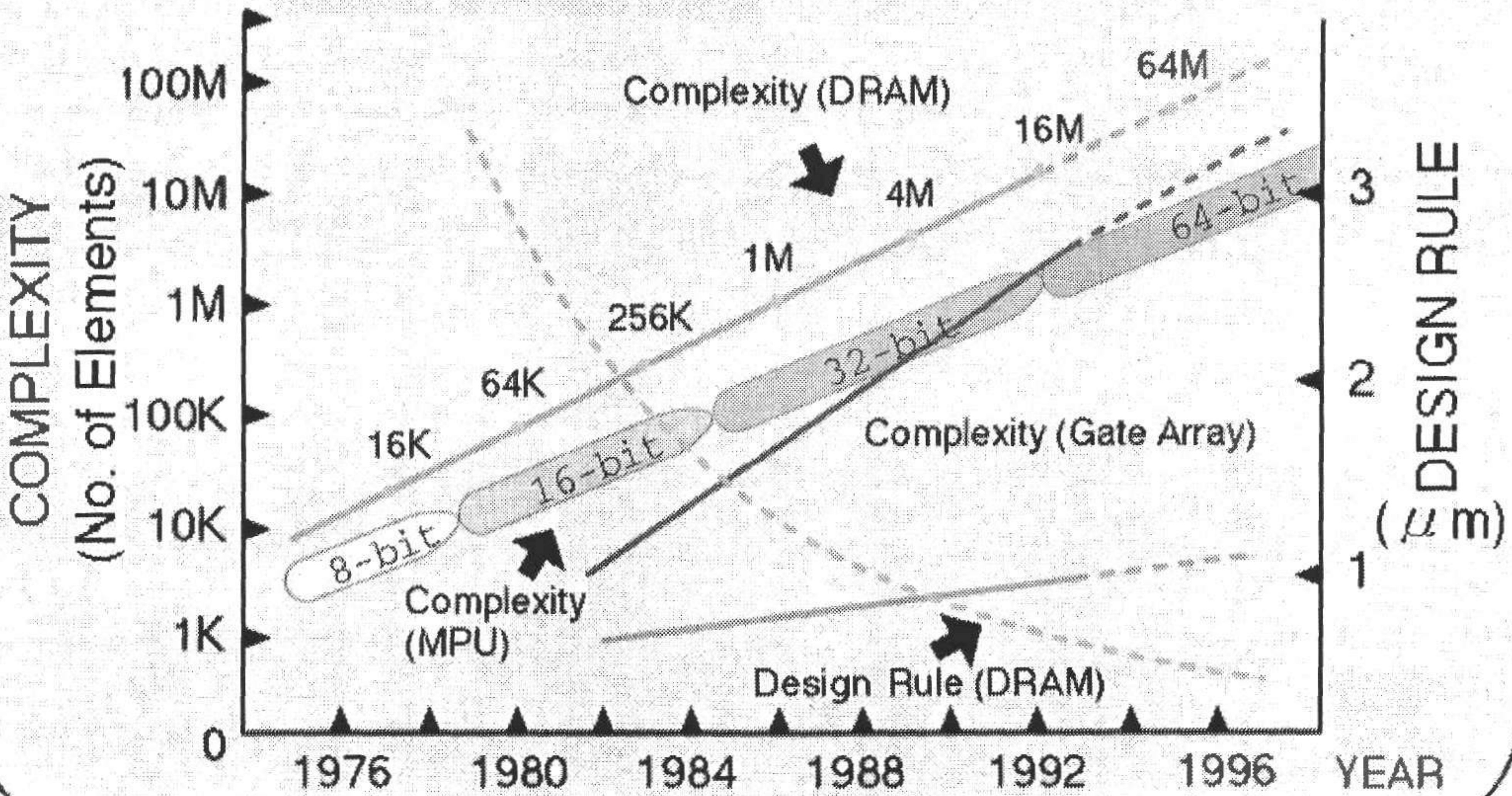
TRANSITIONS IN COMPLEXITY OF ADVANCED LSIs



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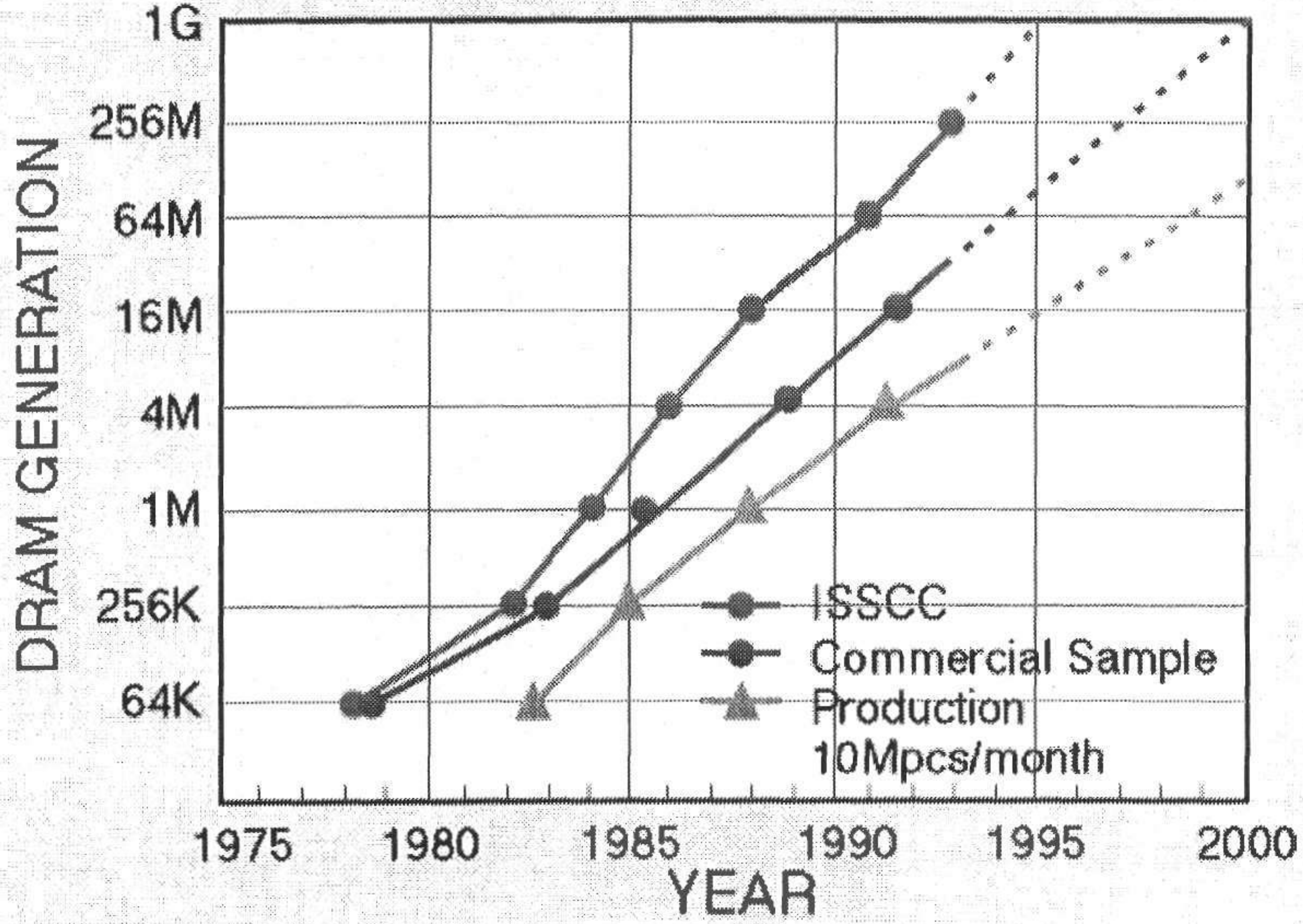
PROGRESS OF DRAM



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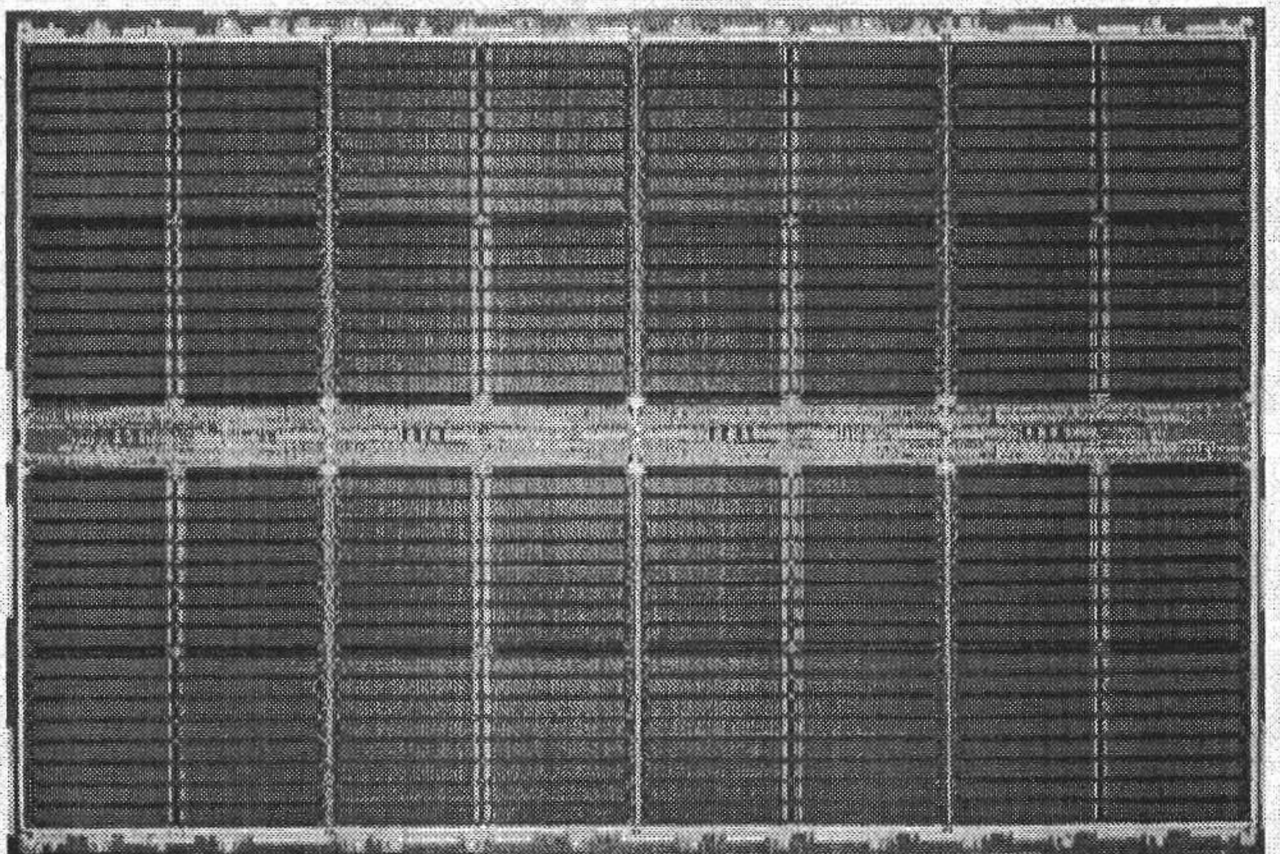
64M DRAM



- Process Technology: 0.35μm CMOS
- Supply Voltage: 3.3V
- Access Time 50/60/70ns
- Chip Size: 12.5mm × 18.7mm

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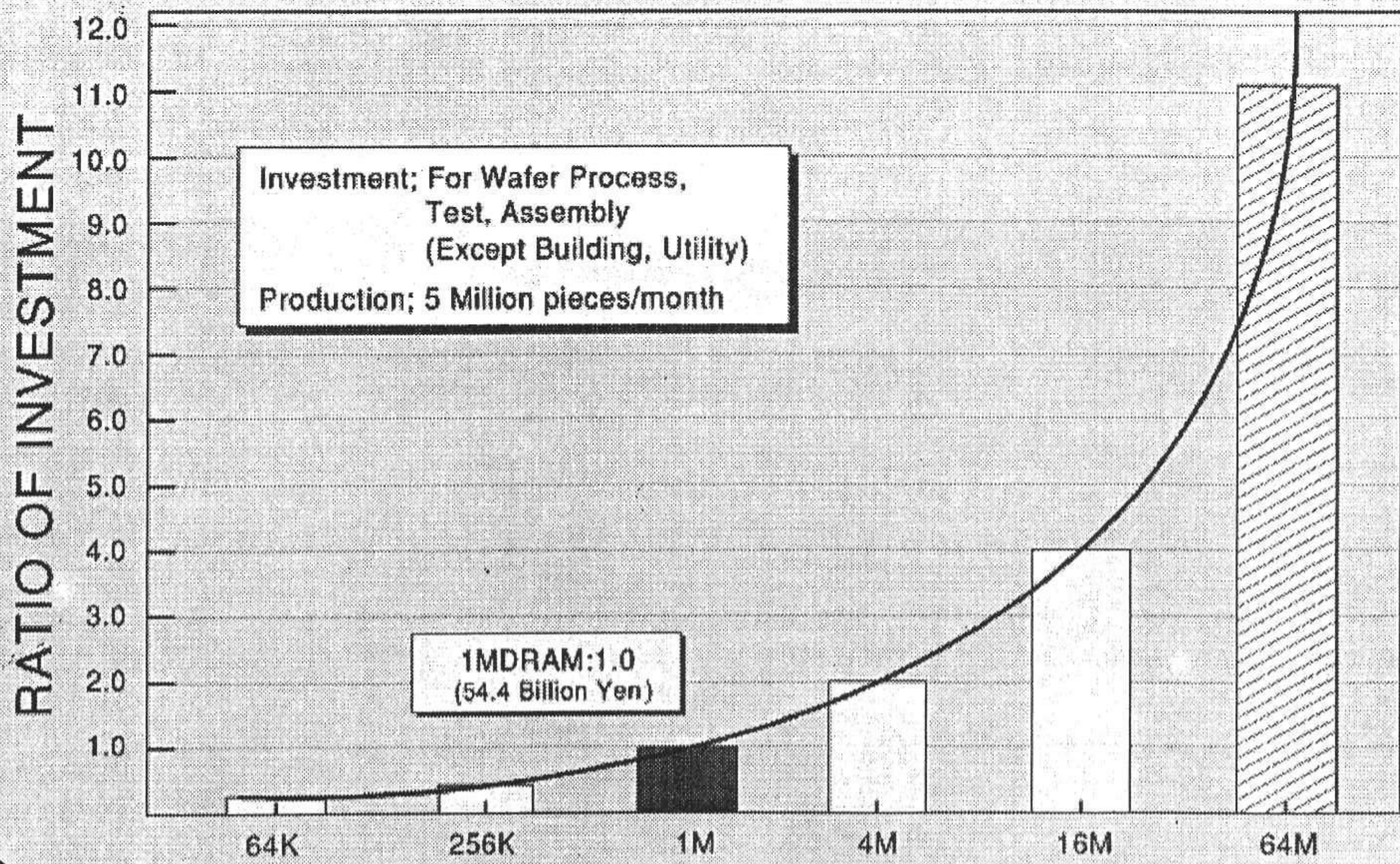
DRAM INVESTMENT TREND



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INVESTMENT SUMMARY

Assum: From 1991 to 2000 (3.3 generations)

R&D investment	: ×5
Investment for production equipments	: × 13
Total market	: × 2.3 (Dataquest)

At 1991

R&D Investment	: 9% of total sales
Investment for production equipments	: 13% of total sales

Results : At 2000

R&D investment	: 20% of total sales
Investment for production equipments	: 70% of total sales

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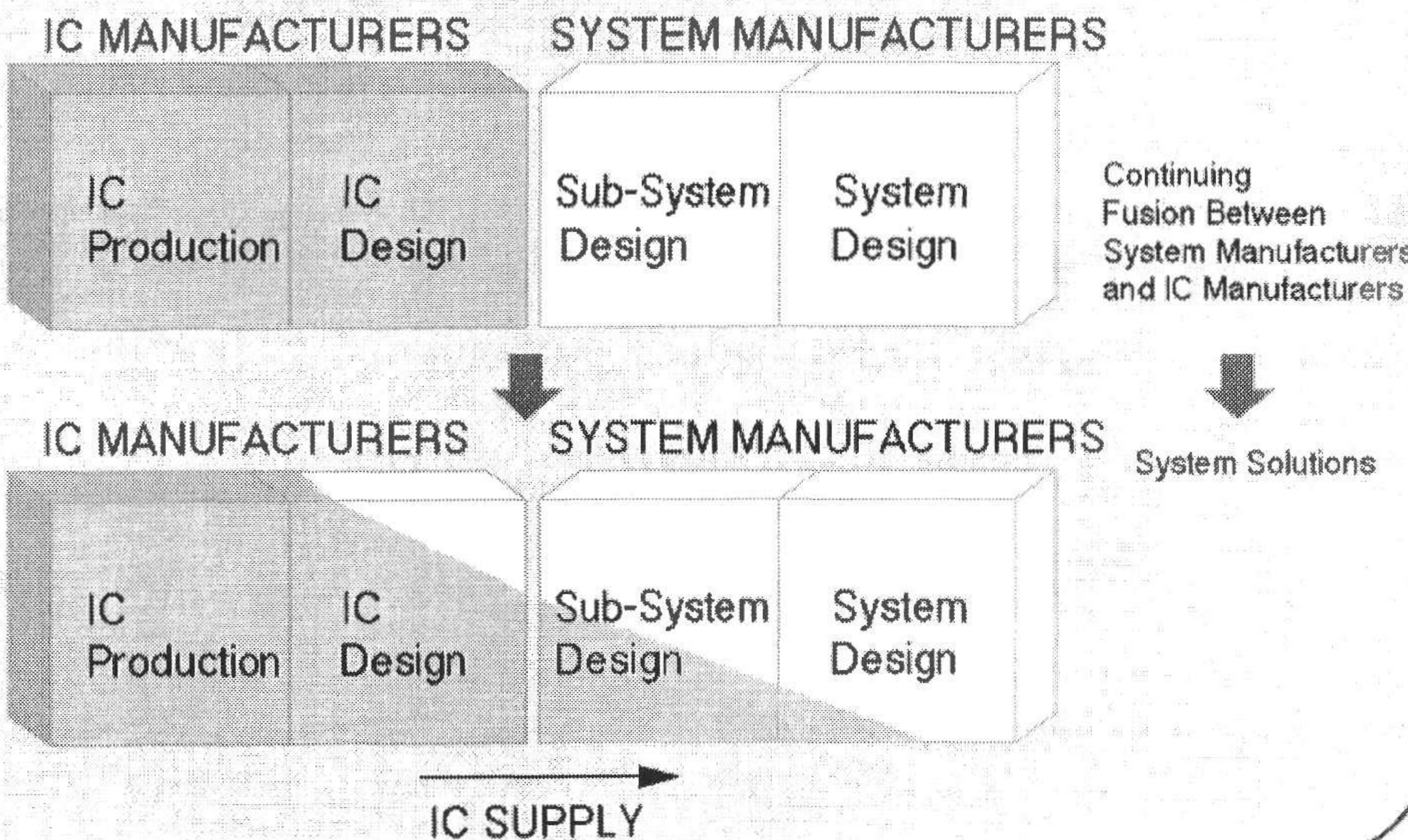
CORRESPONDING TO THE "SYSTEM ON CHIP" ERA



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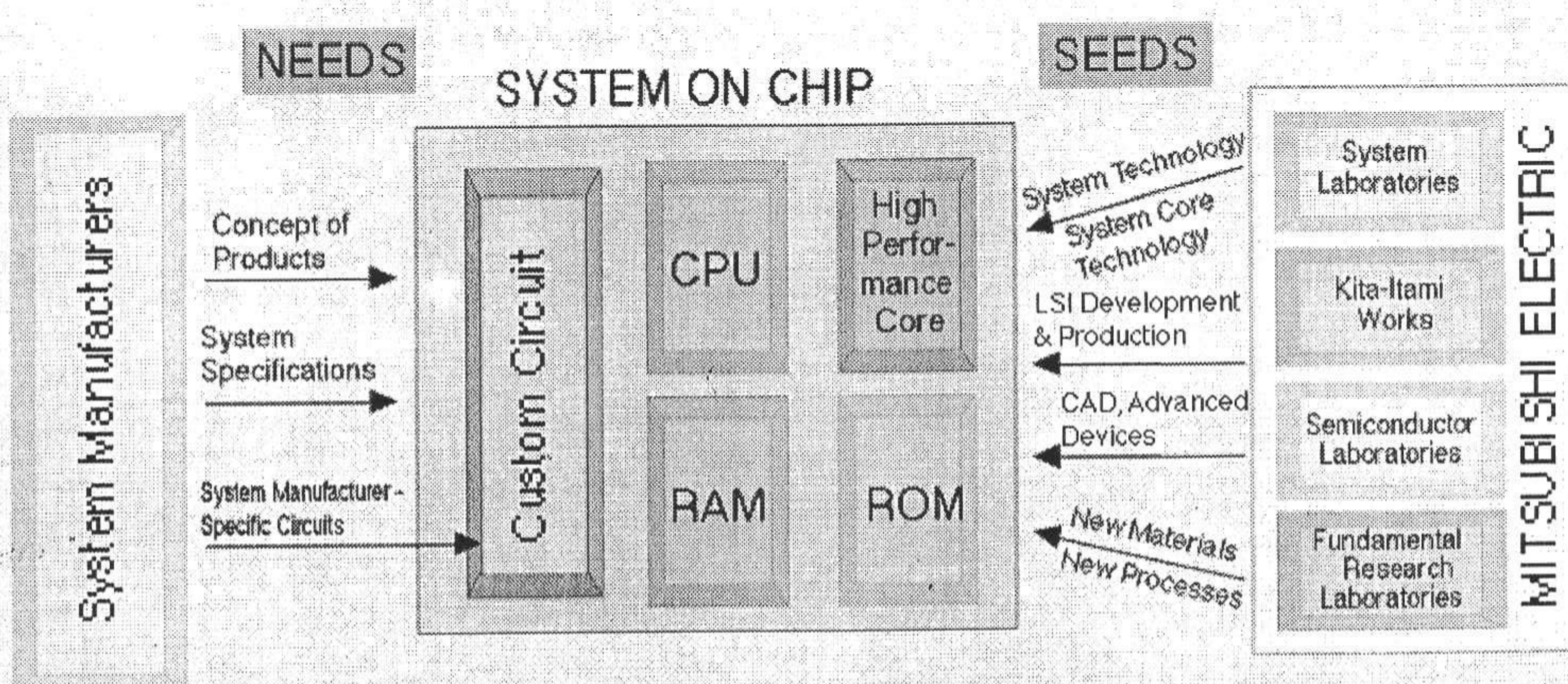
COLLABORATIVE DEVELOPMENT FOR THE SYSTEM-ON CHIP ERA



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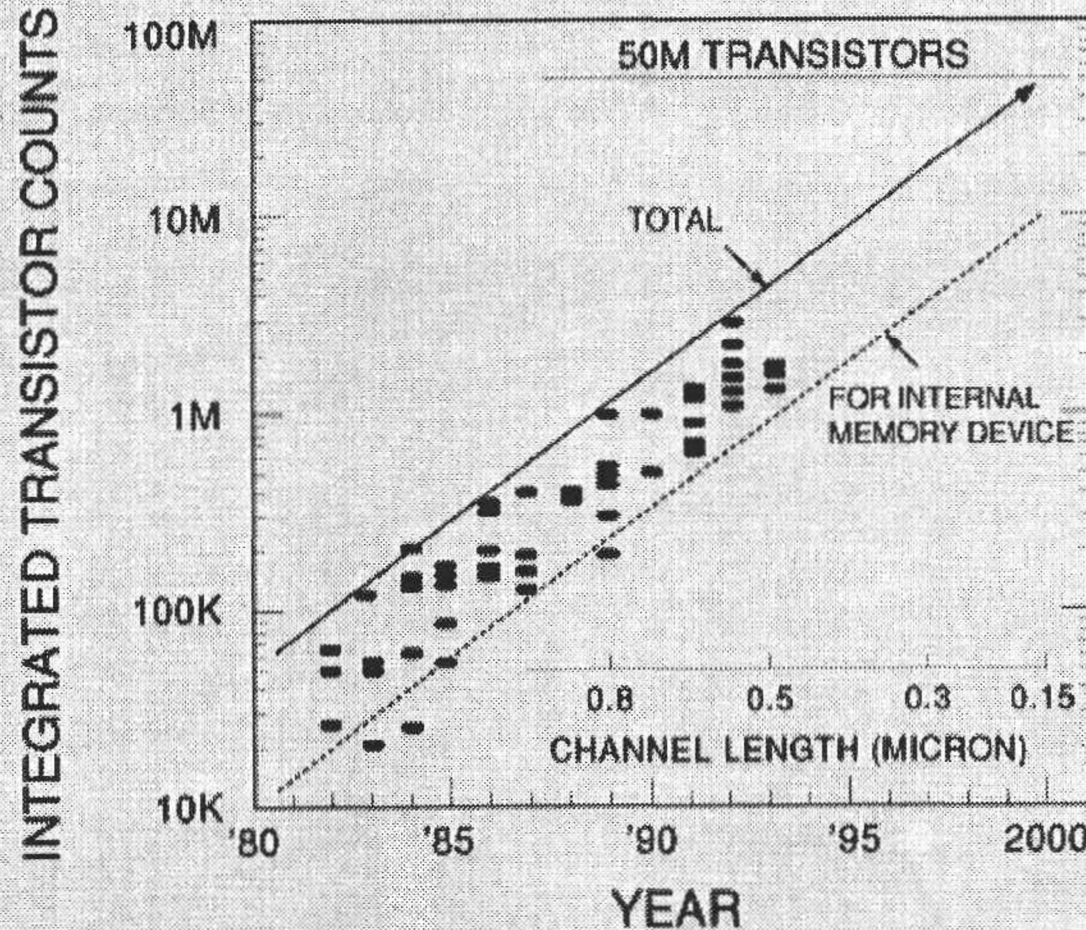
PROCESSOR LSIs REPORTED IN ISSCC



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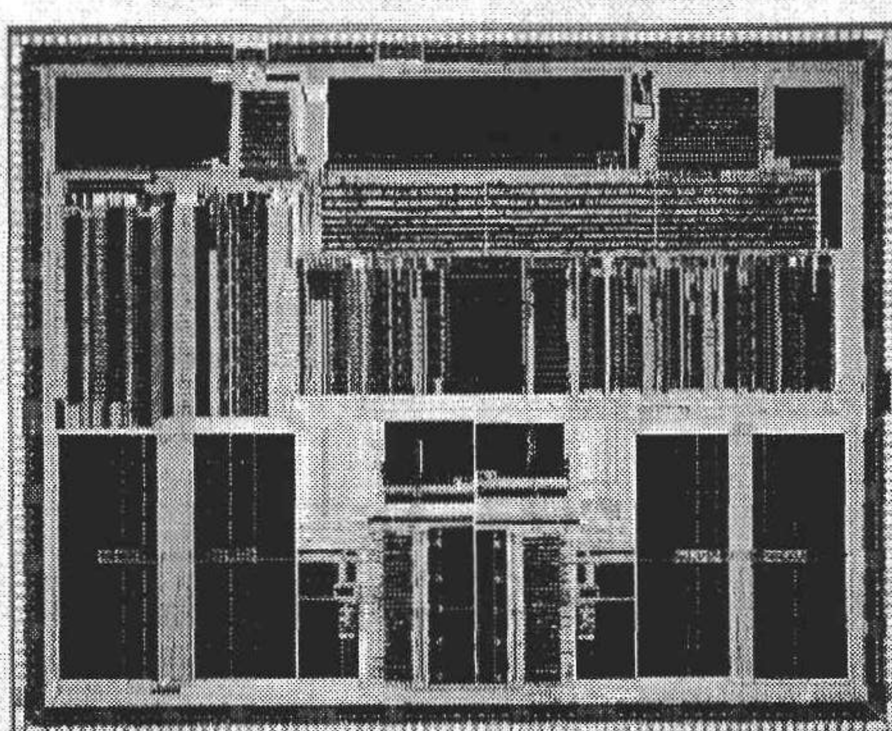
32BIT CISC PROCESSOR

for High-end Business computer



- 40MHz operating frequency (Peak 40MIPS)
- Dual 32bit integer and 64bit floating point units
- 8K+8K Byte I&D cache
- 1.72M transistors
- 16.3 × 12.7mm^2 die size
- 0.8micron double-metal double-polysilicon CMOS

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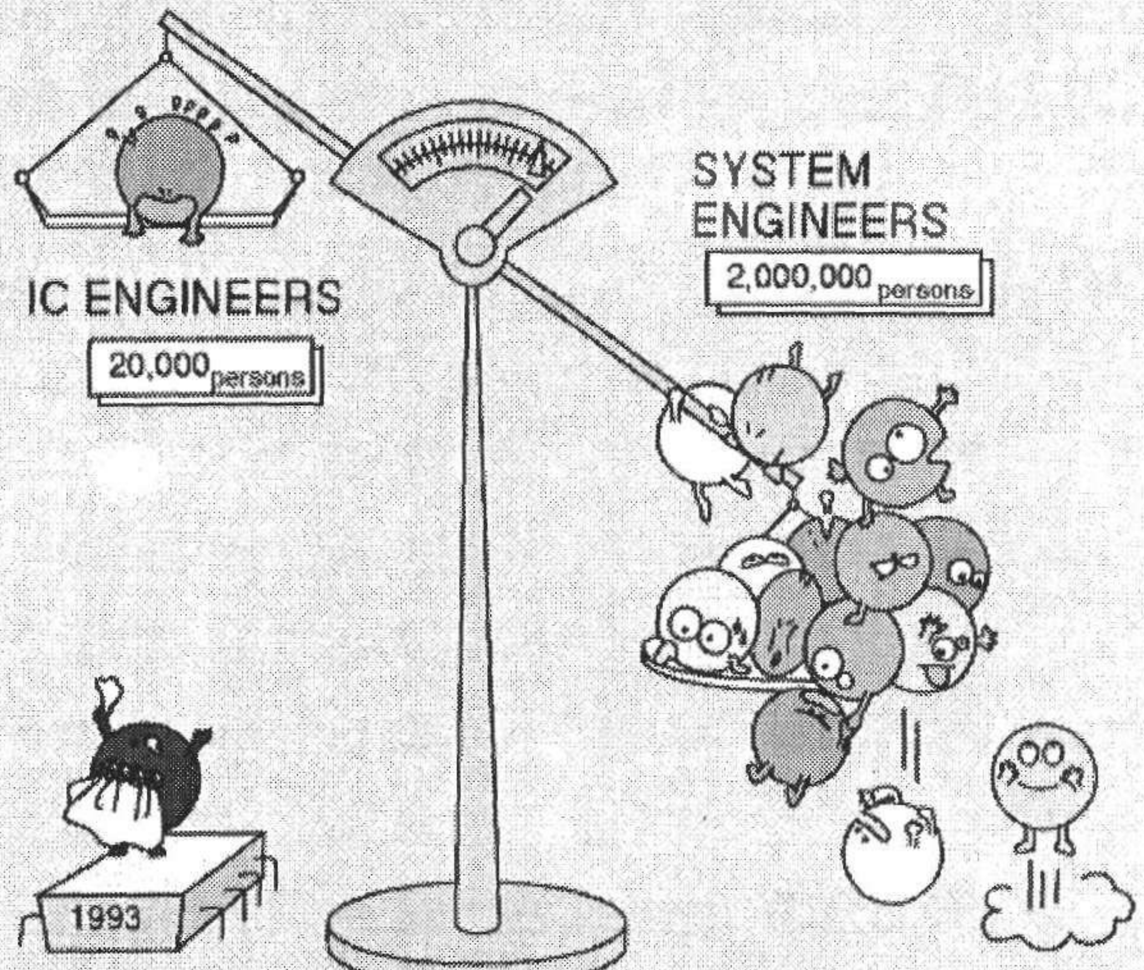
RATIO OF IC DESIGN ENGINEERS TO SYSTEM ENGINEERS



4. STRATEGIES AND DIRECTIONS FOR GROWTH

- MARKET CREATION
- COST REDUCTION
- ALLIANCE

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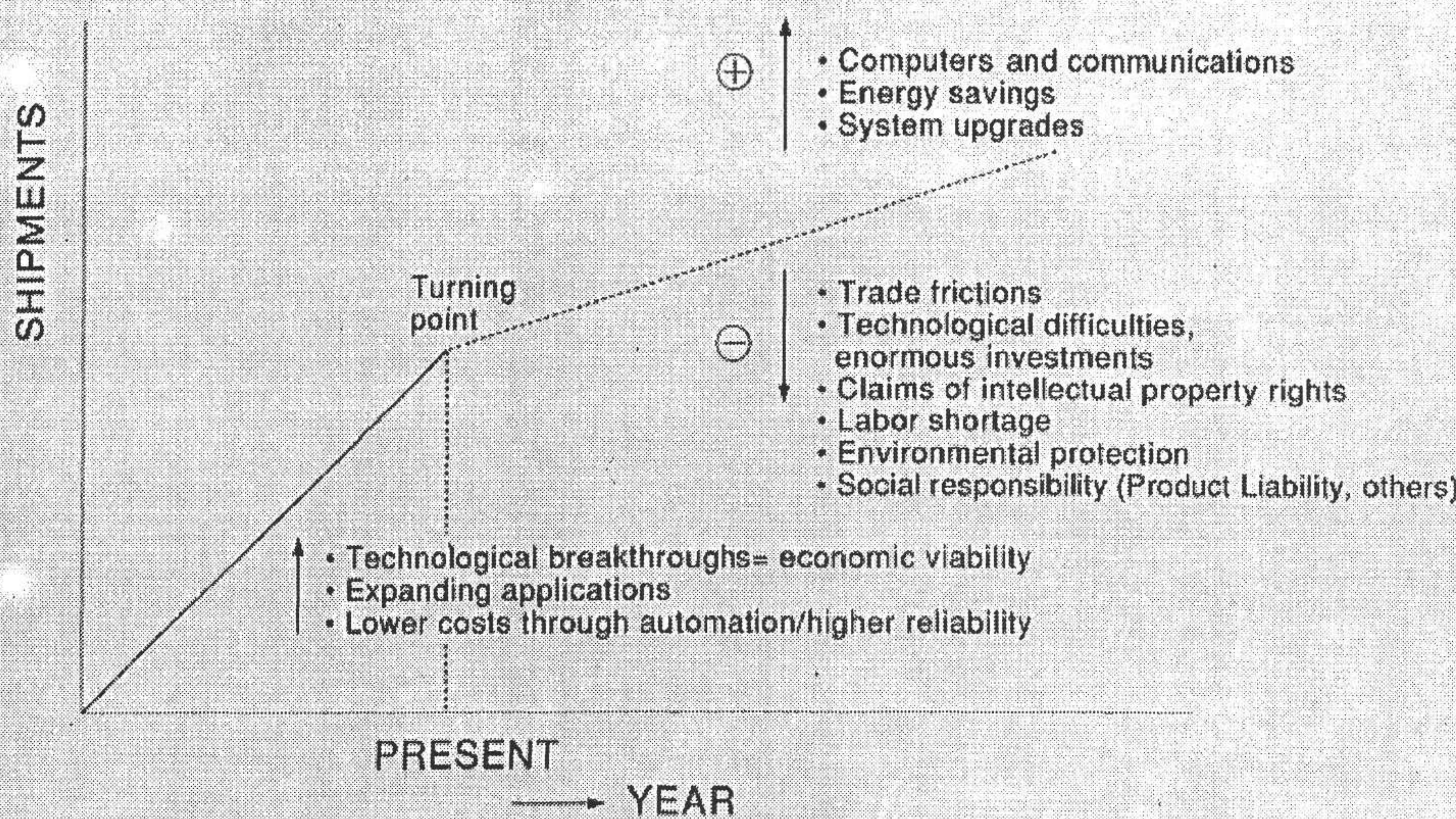
TURNING POINTS IN SEMICONDUCTOR GROWTH



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MARKET CREATION

- Cooperation with customers
- Optimized Silicon Solutions proposed by LSI vendors who cover from architectural design to process development
- Share profits by Value-Added LSI with more function, higher performance, higher integrity, lower cost and QTAT

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MARKET CREATION

Fields	Applications	Key Devices
Personal	PDA	Cold RISC Flash memory CODEC (Audio/Video) LSI
Home	Digital CATV HDTV Interactive TV	Cold RISC CODEC (Audio/Video) LSI Recognition Engine (Voice/Image)
Business	Multimedia PC/WS	CODEC (Audio/Video) LSI Recognition Engine (Voice/Image) Data communication LSI
Society	Network Medical	Hot RISC Optical devices Data/Telecommunication LSI

MITSUBISHI ELECTRIC

TO REDUCE DESIGN COST;

- Accumulation of application specific macro-core with high level description
- Complementary joint development of macro-core and standardization of internal bus
- More sophisticated CAD tools (Synthesis & verification)

MITSUBISHI ELECTRIC

TO REDUCE PRODUCTION COST;

- Simple device structure
  —Planar STC with high-ε
- Slim & standard process
  — Sophisticated simulation
- Yield improvement
  —Wafer diameter to 18"
- Cost effective equipments
  — High reliability
  — Standardization
  — Longer life
- Flexible fab. line

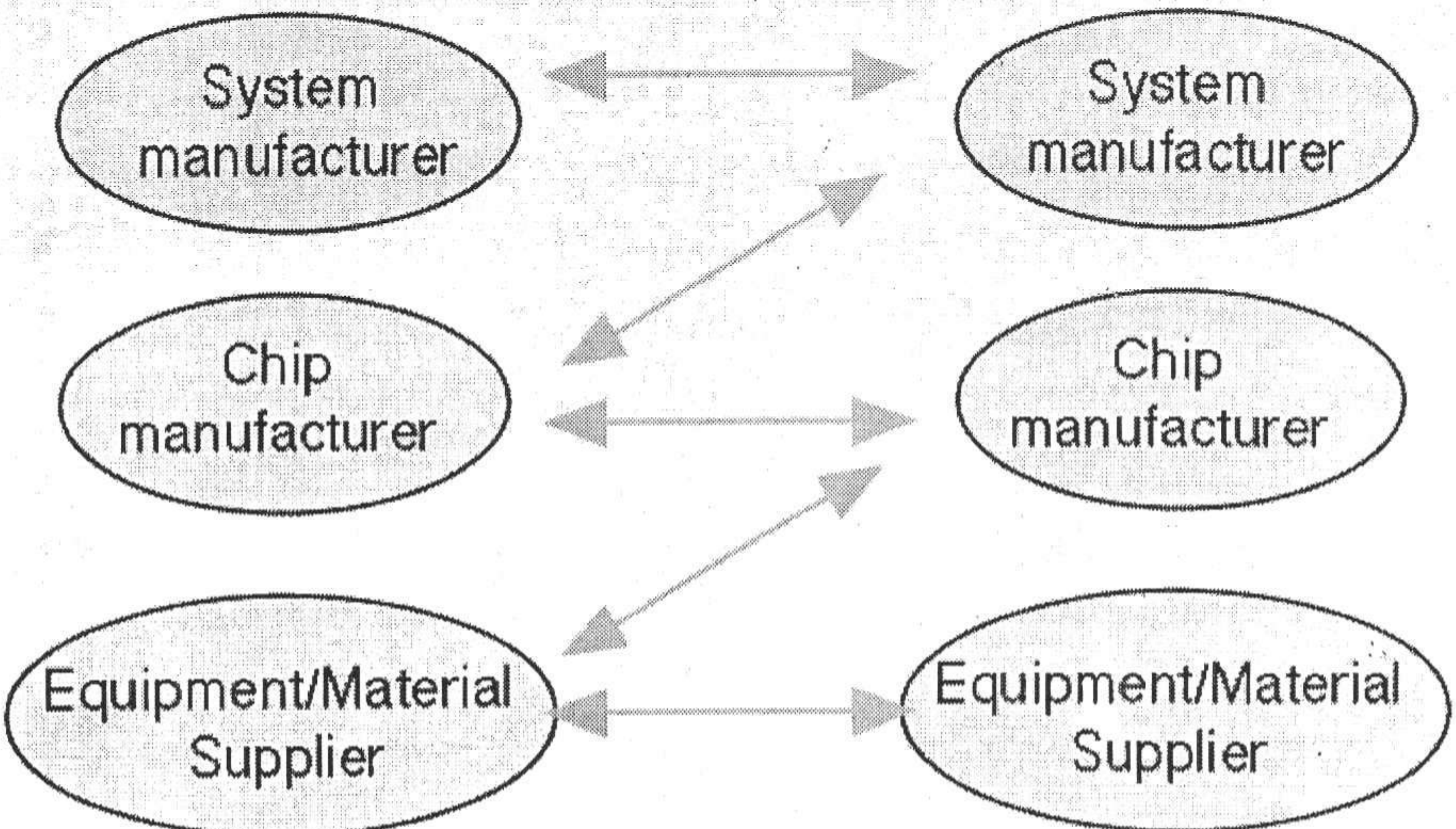
MITSUBISHI ELECTRIC

PURPOSES OF ALLIANCE

- Cost reduction & investment saving
  - Slim & standard equipments
  - Suppression of R&D investment
  - Joint development of macro-cores
  - Joint production
- Market creation

MITSUBISHI ELECTRIC

ALLIANCE STRUCTURE



MITSUBISHI ELECTRIC

Conclusions

- Total Amount Money of VLSI will reach
  ~100 B$ at 2000 year
  with Average Growth rate 8.1% / year
- VLSI technology will realize
  - 1G DRAM
  - 50M Tr system VLSI
- VLSI economics cells
  - Investment increase
  - Longer lead time period
- Challenge
  - Cost reduction by multiple cooperation
  - Market creation with value-added solution

EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

Bernie Vonderschmitt
President
Xilinx Inc.

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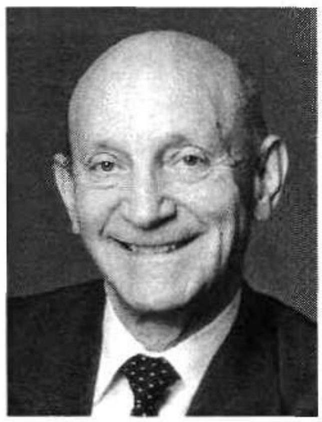
EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH



Bernie Vonderschmitt
President
Xilinx Inc.

Mr. Vonderschmitt is President and cofounder of Xilinx Inc. Included in Mr. Vonderschmitt's responsibilities is expanding Xilinx's international business. Prior to founding Xilinx, he was Vice President and General Manager of the microprocessor division of Zilog Inc. Before that, he was with RCA for more than 20 years, most recently as Vice President and General Manager of the solid state division. He gained a BSEE, MSEE and an MBA.

Dataquest Europe Limited
EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE
May 26–28, 1993
Munich, Germany

DATAQUEST

EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE

MUNICH, GERMANY

MAY 26 - 28, 1993

"STRATEGIES FOR PROFITABLE GROWTH"

XILINX

"STRATEGIES FOR PROFITABLE GROWTH"

OUTLINE

- Assumptions
- Basics for High Technology Suppliers (Semiconductors)
- Product, Manufacturing & Customer Preferences
- Financial Resources & Alliances
- Company Environment
- Correlation to Actual Performance

XILINX

"STRATEGIES FOR PROFITABLE GROWTH"

ASSUMPTIONS

- ❑ Relates to Semiconductor Products
- ❑ > 50% of Company Revenue/Profits Derive from Semiconductor Products
- ❑ Company is merchant Supplier of Semi-Products with Profit Motives

XILINX

"STRATEGIES FOR PROFITABLE GROWTH"

BASIC REQUIREMENTS

- ❑ A Product that Provides Unique Value to Customers
- ❑ A Market Demand with Assured Growth (Minimum 10X Economic Growth)
- ❑ A Manufacturing Process That is Demanding But established

XILINX

"STRATEGIES FOR PROFITABLE GROWTH"

BASIC REQUIREMENTS

Continued:

- **A Diversified Customer Base**
- **Continuing Innovation is Paramount**
- **Address Only One Previously Unsolved Problem at One Time**

XILINX

"STRATEGIES FOR PROFITABLE GROWTH"

PRODUCT CHARACTERISTICS

- **Unique Value to Customers**
- **Each Successive Product Generation Requires Innovation**
- **Intellectually Protectible**

XILINX

"STRATEGIES FOR PROFITABLE GROWTH"

PRODUCT CHARACTERISTICS

Continued:

- Manufacturing Technology Direction Enhances Product Value
- Applicable to Numerous Market Segments
- Product is Applicable in Worldwide Markets

XILINX™

"STRATEGIES FOR PROFITABLE GROWTH"

MANUFACTURING TECHNOLOGY

- Manufacturing Processes: Useful for Other Products
- Manufacturing Process Requirements: "Standard" with Evolutionary Improvements
- Rewards Total Cost Reduction From Reduced Feature Size

XILINX™

"STRATEGIES FOR PROFITABLE GROWTH"

CUSTOMERS

- Serve Diverse Equipment Markets
- Diverse Geographical Areas
- Many: 20% = 80%

XILINX™

"STRATEGIES FOR PROFITABLE GROWTH"

FINANCIAL ($) RESOURCE CATEGORIES

- Multi-Billion
- < 1 Billion
- < 100 Million
- < 25 Million

XILINX™

"STRATEGIES FOR PROFITABLE GROWTH"

COMPANY GOALS

- Profit is the Central Objective
- Return on Equity Excluding Cash ≥ 15%
- Continuing Investment
  - R&D (% of Revenue) to Sustain Revenue & Profit Growth
  - Marketing & Sales Expense
  - Fixed Assets

XILINX

"STRATEGIES FOR PROFITABLE GROWTH"

ALLIANCES

- Focus on Distinctive Competence
- Form Alliances Based on
  - Financial Resources
  - Competence
  - Make or Buy Advantages
  - Complementary Skills

XILINX

"STRATEGIES FOR PROFITABLE GROWTH"

COMPANY ENVIRONMENT

- Customer is QUEEN / KING
- Employee Recognition
- Key Employees (10-15%): Incentive Plan & Equity Participation
- All Other Employees: Profit Sharing Plan
- Key Member/s of Management: ZEALOT

XILINX

"STRATEGIES FOR PROFITABLE GROWTH"

"BENCH MARKING" COMPANY ENVIRONMENT

- Customer Survey Every Six Months
- Customer Comment About Employees Enthusiasm
- Minimum Need for Key Employee Recruitment
- Less Than 2% Involuntary Turnover Annually

XILINX

"STRATEGIES FOR PROFITABLE GROWTH"

HISTORICAL ANALYSIS OF SEMICONDUCTOR COMPANIES

ANALYSIS:

- **Profitability Over Extended Period**
- **Correlation to Previously Defined Parameters**
- **Culture Sensitivity (Europe, Japan, Us)**

XILINX™

"STRATEGIES FOR PROFITABLE GROWTH"

COMPANY PERFORMANCE & PERCEIVED VALUE

$ IN MILLIONS

	Years in Business	1983 - 1992 CUMULATIVE Revenue	1983 - 1992 CUMULATIVE Net Income	Net Income % of Revenue	YEAR END Dec.'92 Revenue	Market* Capitalization	RATIO MC / Rev.
LINEAR TECH.	12	557	80	14.4	132	830	6.3
INTEL	25	27,834	3,740	13.4	5,844	22,919	3.9
XILINX	9	460	58	12.5	163	708	4.3
DALLAS SEMI.	9	511	61	11.9	120	378	3.2
ALTERA	10	418	50	11.9	102	323	3.2
MAXIM	10	368	41	11.2	97	397	4.1
ATMEL	8	480	45	9.5	140	333	2.4
CIRRUS LOGIC	10	681	58	8.5	275	808	2.9
CYPRESS	10	1272	107	8.4	272	410	1.5

** Market Capitalization is based on January closing prices (Jan. 29, 1993).*

Note: U.S. companies included are limited to those deriving more than 50% of revenues from semiconductors.

Source: Company Reports

XILINX™

"STRATEGIES FOR PROFITABLE GROWTH"

COMPANY PERFORMANCE & PERCEIVED VALUE

Continued:

$ IN MILLIONS

	Years in Business	1983 - 1992 CUMULATIVE Revenue	Net Income	Net Income % of Revenue	YEAR END Dec.'92 Revenue	Market* Capitalization	RATIO MC / Rev.
LATTICE	10	301	22.2	7.4	90	340	3.8
MICRON	15	2,466	169	6.8	526	874	1.7
ANALOG DEV.	28	4,038	196	4.9	587	792	1.3
AMD	24	10,132	419	4.1	1,514	1,835	1.2
CHIPS & TECH.	8	1,247	8	0.6	119	64	0.5
VLSI TECH.	12	2,144	-20	-0.9	429	222	0.5
SIERRA SEMI.	9	365	-4	-1.1	92	146	1.6
LSI LOGIC	12	3,612	-90	-2.5	618	495	0.8
NATIONAL SEMI.	34	17,138	-502	-2.9	1,947	1,351	0.7

** Market Capitalization is based on January closing prices (Jan. 29, 1993).*

Note: U.S. companies included are limited to those deriving more than 50% of revenues from semiconductors.

Source: Company Reports

XILINX™

"STRATEGIES FOR PROFITABLE GROWTH"

SUMMARY

Add Value, Propretary, Broadly Applicable

Complement Your Strengths & Weaknesses

Service, Support & Real Added Value

Customer Sensitivity, Working Environment

Correlation of Factors Covered With Various Companies' Performance

XILINX™

EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

Heinz Hagmeister
Chairman
JESSI

Dataquest Europe Limited, a company of The Dun & Bradstreet Corporation
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EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

Heinz Hagmeister
Chairman
JESSI

Mr. Hagmeister is Chairman of JESSI, and was, until recently, Chairman and Chief Executive Officer (CEO) of Philips semiconductor products division. He has also been CEO of Philips Integrated Circuits and Managing Director of Philips components business unit, discrete semiconductors. He joined Philips, Valvo RHW early in his career, working for the semiconductor application group. He went on to become involved in quality assurance and was appointed quality manager of the groups' laboratory for integrated circuits and discrete semiconductors. Mr. Hagmeister studied Electronics at the Technical Universities in Hannover and Aachen.

Dataquest Europe Limited
EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE
May 26–28, 1993
Munich, Germany

JESSI

"Technology for Applications"

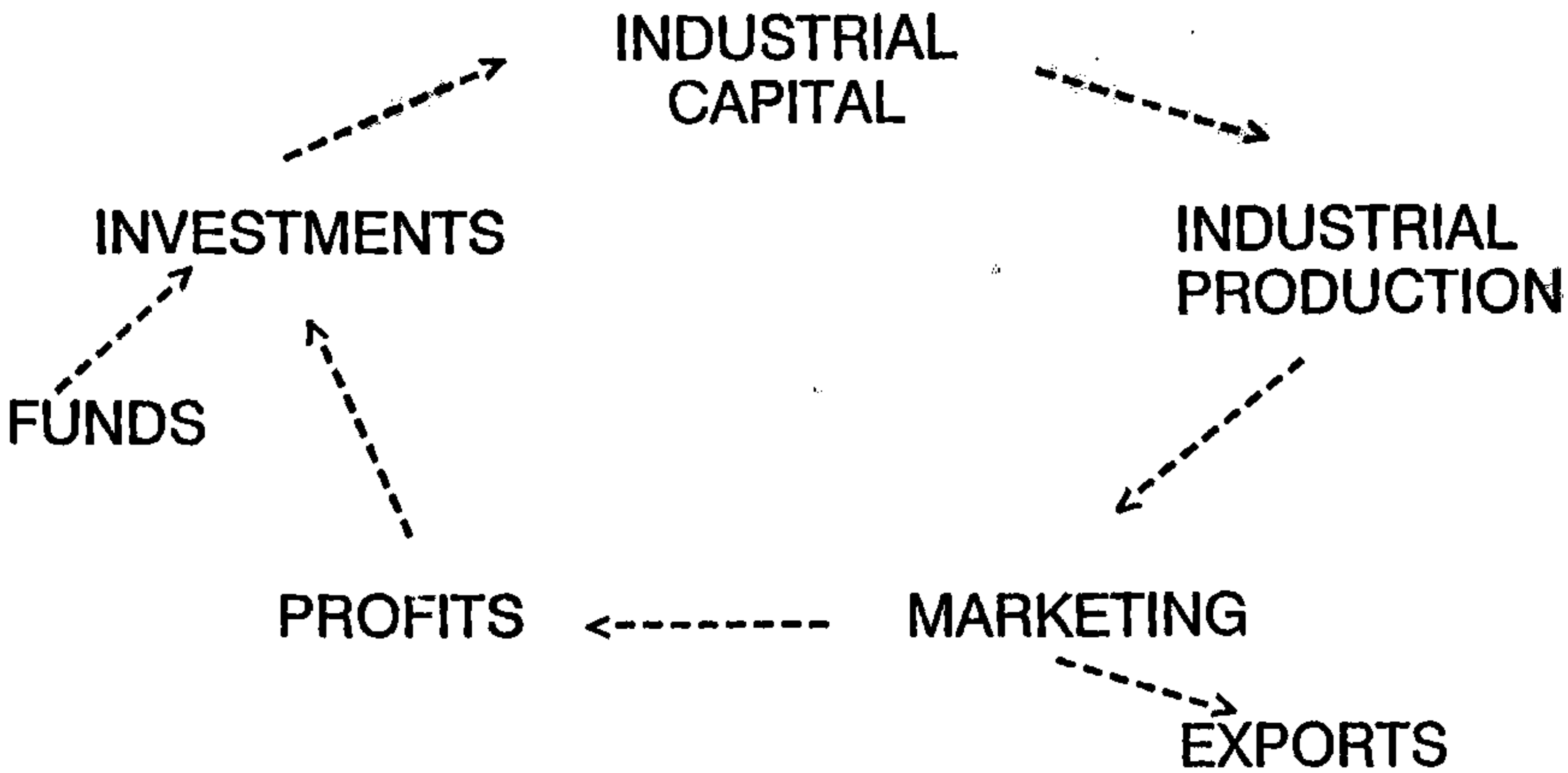
Heinz Hagmeister

Chairman JESSI

NSTABILITY

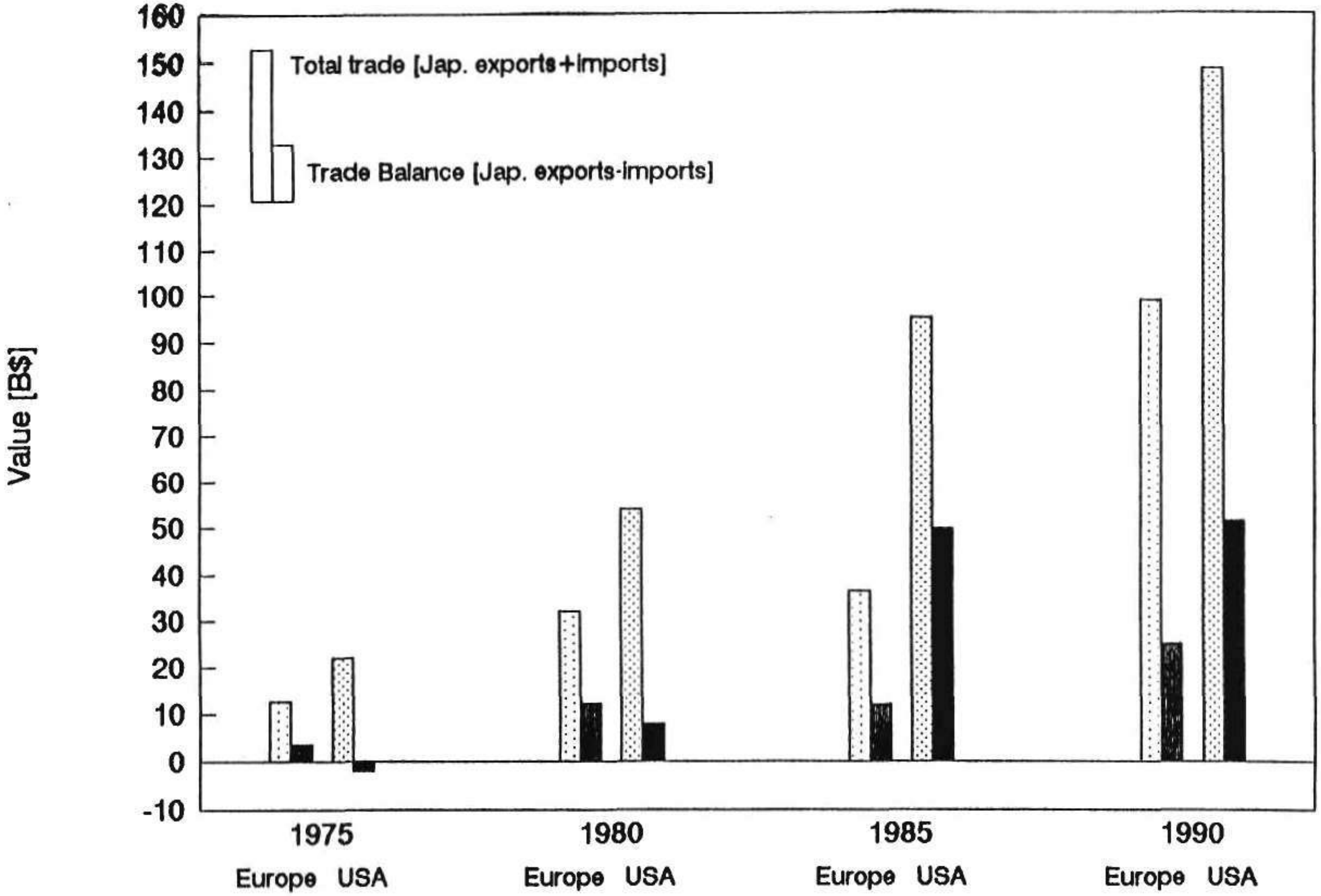
- the free trade system is unstable and leads to undesirable imbalances

POSITIVE FEEDBACK



Japanese Trade with Other Regions

[all industry sectors]

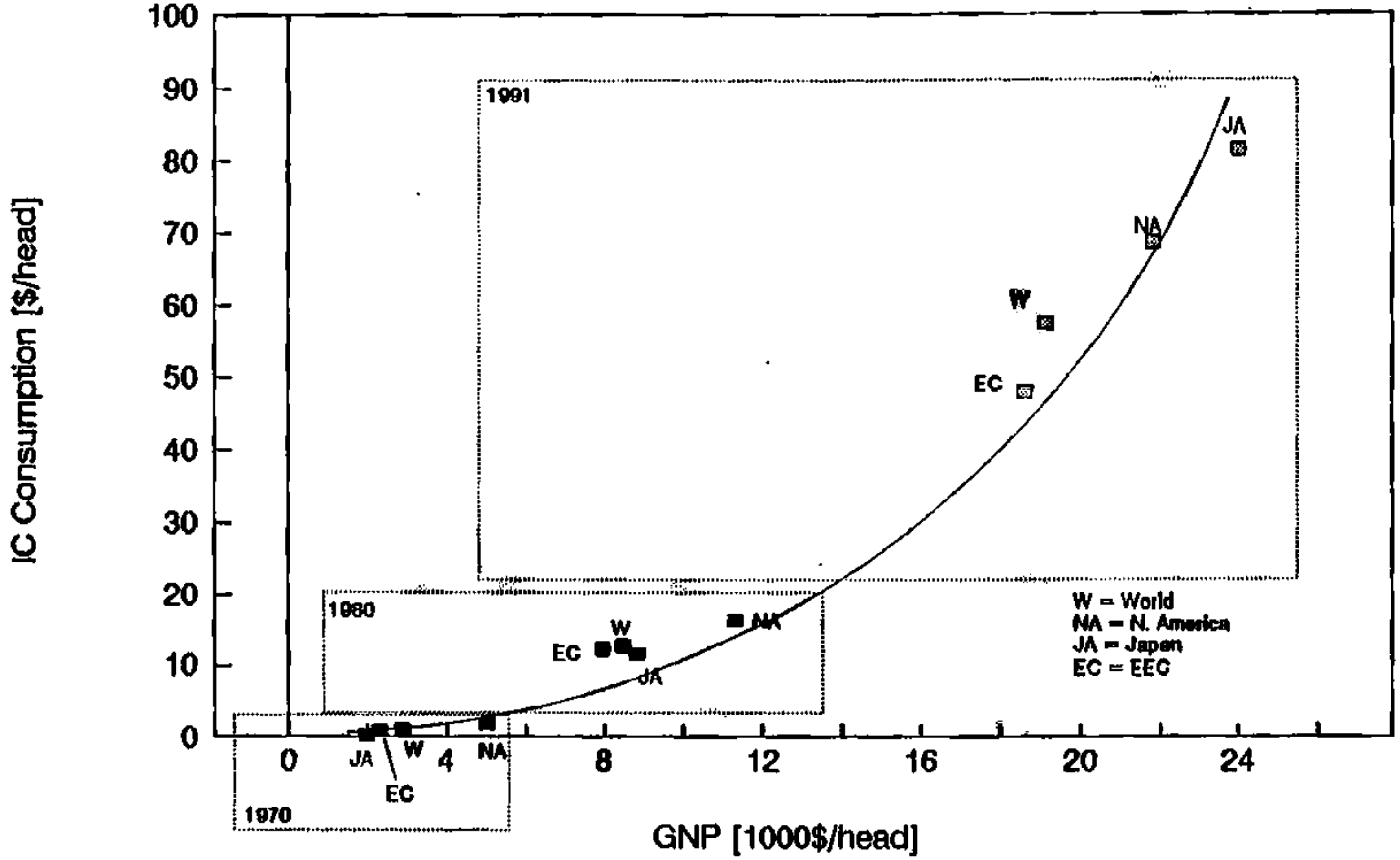


source: IMF

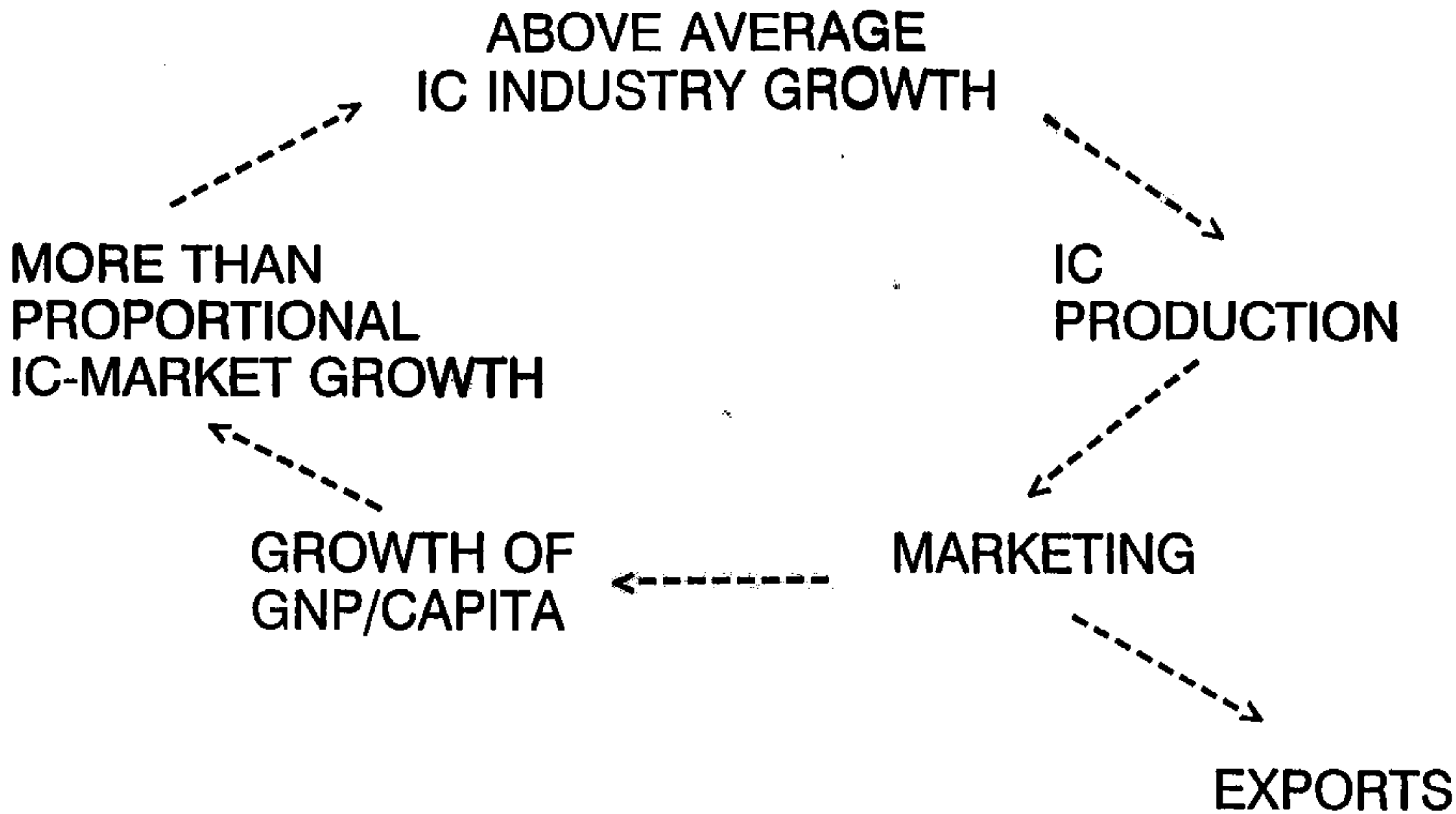
japtrad1.drw

IC Consumption related to GNP

[1970-1980-1991]



POSITIVE FEEDBACK IN MICROELECTRONICS



JAPAN: TRADE IN SEMICONDUCTORS

	TOTAL TRADE (M$)	EXPORT / IMPORT
1970	120	0.29
1975	320	0.77
1980	1700	1.78
1985	3760	3.50
1990	11900	3.08

Source: Japan Trade/Electronics Organisations

STABILIZING INITIATIVES HAVE NAMES

eferential procurement

(special) tariffs

fair market prices

JESSI

SEMATECH

DARP(A)

VHSIC

5G

MCC

investment support

ière electronique

ESPRIT

ALVEY

RACE

IMPEDIMENTS

SRC

VLSI

anti-dumping laws

tax incentives

MEGA

import quotas

oint European Submicron Silicon Program

JESSI

MOTIVES

- motives are different
(defense, technology base, dominance, prestige)

- initiatives should have structural effects

EFFECTS OF ACTIONS

- managed trade
- faster progress
- stabilization(?)

JESSI

- JESSI is an R&D program
- to safeguard Technology for Applications
- major issue: R&D productivity

INSTRUMENTS TO ENHANCE R&D PRODUCTIVITY

- coupling between science and technology with market needs
- collaboration

COLLABORATION

- in principle Europe has many natural obstacles for collaboration

- diversity is strength as well as weakness ("every region a University")

ͻBSTACLES

- FORMAL — result from legislation/rules
- PRACTICAL — differences in culture/language/script/physical distances
- NUISANCE — inconveniences, differences in standards

JESSI IN 1992

- 60 projects
- 15 clusters
- 150 partners
- 14 countries
- 2700 manyears

ΓECHNOLOGY FOR APPLICATIONS

JESSI a good balance between technology push and market pull

JESSI CLUSTERS

APPLICATIONS

- automotive
- broadband communication
- digital audio broadcast
- HDTV
- mobile radio

single projects:

- technology assessment
- CAD a.o. JESSI common framework
- SMI support

JESSI CLUSTERS

TECHNOLOGY

- CMOS competitive manufacturing
- CMOS logic

with BLR - packaging

with E&M - automation in clean environment
- lithography

JESSI CLUSTERS

EQUIPMENT & MATERIALS

- clean gases
- clean chemicals
- clustered etching & deposition
- testing
- silicon

JESSI CLUSTERS

BASIC AND LONGTERM RESEARCH

- 0.25 micron technology

JESSI's OBJECTIVE

Competitive Microelectronics capabilities

- IC and system design methodology
- technology
- manufacturing
- time to market
- quality
- costs
- user satisfaction

ꞁESSI STRENGTHS

- all parts of the microelectronics foodchain
- vertical and horizontal cooperation
- focal points and cluster structure
- management
- monitoring
- flexibility

JESSI RESULTS SUBPROGRAM E&M

- alliances between major EU process equipment manufacturers
- all EU suppliers participate in gases and chemicals projects
- cooperation with SEMATECH (mini-environment)
- evaluation platform for E&M established
- strong position with I-line and potential for DUV steppers

JESSI RESULTS SUBPROGRAM TECHNOLOGY

- 16 Mb EPROM engineering samples
- 0.7 micron CMOS VLSI logic technology
- 0.5 micron CMOS design rules fixed
- joint development by SGS Thomson/Philips
- common design of new waferfabs
- Jessi 0.5 micron CMOS to be exploited by all IC partners and available to all users

JESSI RESULTS SUBPROGRAM APPLICATIONS

- 15 JESSI companies are involved in JESSI designs
- commercialization of CAD tools
- definition of standard 0.5 micron teststructure
- SMI conference on EMC
- multi project wafer service

JESSI RESULTS SUBPROGRAM BLR

- science and industry define program in joint workshops

A GLOBAL INDUSTRY

EUROPE WISHES TO ACT ON EQUAL FOOTING

- fair share
- reciprocity
- compensation of differences

"RECIPROCITY IS THE ONLY WAY TO PREVENT THE WORLD ECONOMY FROM REGRESSING INTO EXTREME PROTECTIONISM"

DRUCKER IN "THE NEW REALITIES"

EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

Jean-Pierre Liebaut
President and Chief Executive Officer
Mietec Alcatel

Dataquest Europe Limited, a company of The Dun & Bradstreet Corporation
Roussel House, Broadwater Park, Denham, Uxbridge, Middx UB9 5HP / 0895 835050 / Tlx 266195 / Fax 0895 835260

EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

Jean-Pierre Liebaut
President and
Chief Executive Officer
Mietec Alcatel

Mr. Liebaut is President and Chief Executive Officer of Mietec Alcatel, which designs, manufactures and markets application-specific integrated circuits. Prior to this he was Marketing and Sales Director of Matra Harris Semi Conducteur, and prior to that he worked for Atomic Energy Board and then Texas Instruments. Mr. Liebaut was educated as an engineer at the Ecole Supérieure d'Electronique de Grenôble in France.

Dataquest Europe Limited
EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE
May 26–28, 1993
Munich, Germany

DATAQUEST: 1993 European Semiconductor Industry Conference

STRATEGIES AND DIRECTIONS FOR GROWTH

Jean Pierre Liebaut
Mietec Alcatel

ALCATEL

MIETEC
ALCATEL

In Short ...

- **Mietec:** The microelectronic arm of Alcatel, aiming primarly at serving the strategic requirements of the group.

- **Alcatel:** The N°1 Telecommunication equipment manufacturer based in Europe and operating worldwide.

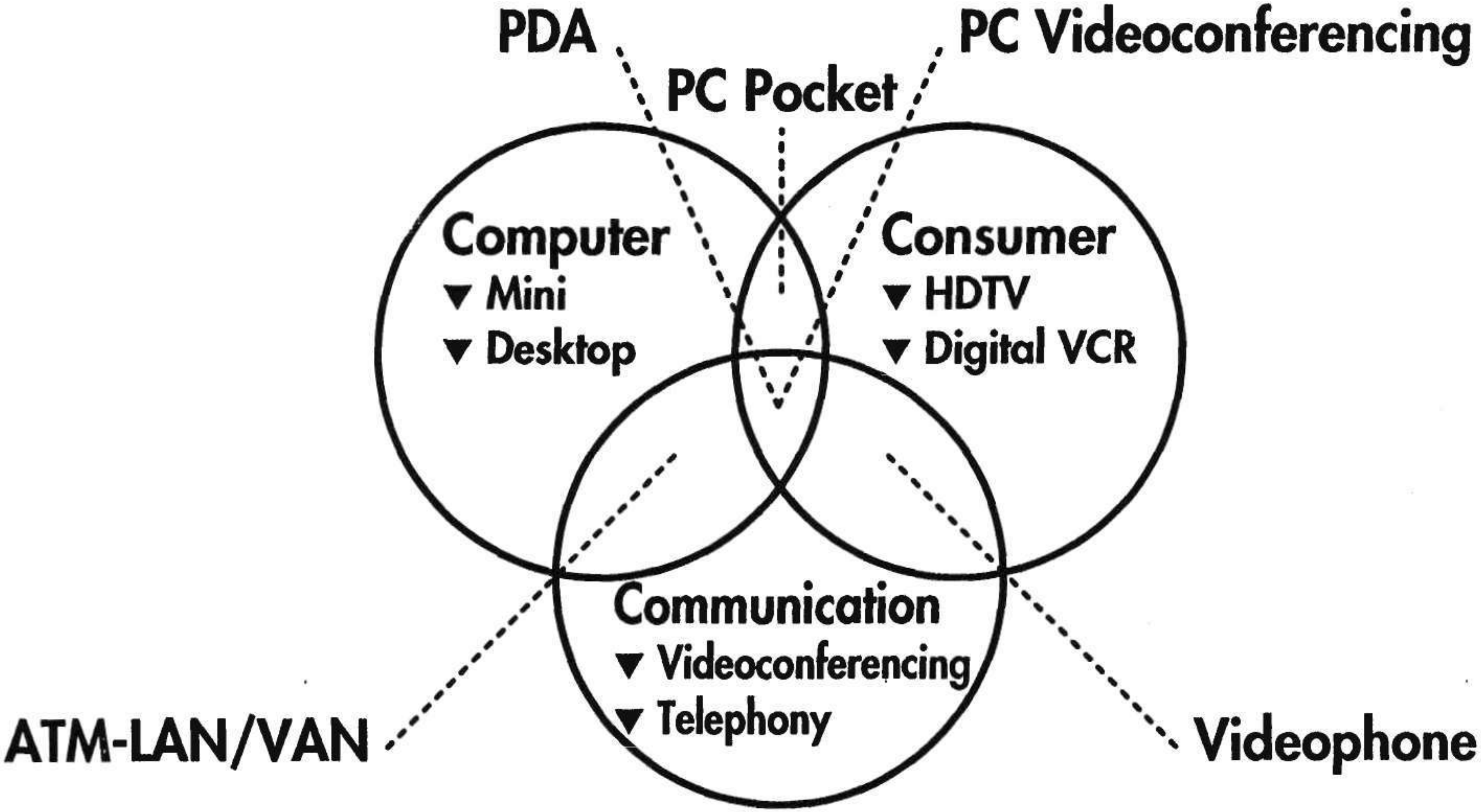
APPLICATION DRIVEN

A Move towards Systems

- 1960's: Transistor to ICs
- 1970's: Hardwired logic to microcomputer
- 1980's: Standard product to ASICs
- 1990's: ICs to "Systems-on-a-chip"

MIETEC
ALCATEL

Merging Markets



JPL/9305/05

MIETEC ALCATEL

Telecommunications

- Telephony
- Digital Cellular Radiotelephone: GSM
- DECT
- PABX

MIETEC
ALCATEL

THE (R)EVOLUTION IS DIGITAL

- Voice communications
- Local area networks / Wide area networks
- Video and audio processing

SEMICONDUCTORS
ARE
THE DRIVING FORCE

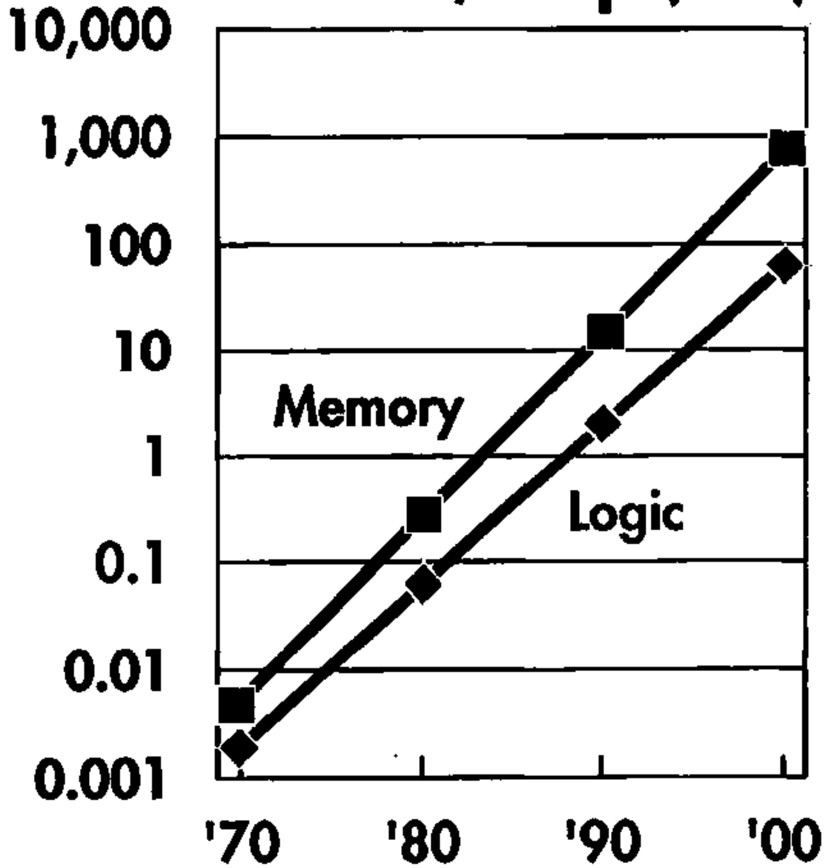
Enabling Technologies

- Aggressive CMOS technology roadmap
- Mixed signal technology
- DSP core
- Software capability
- Packaging issues

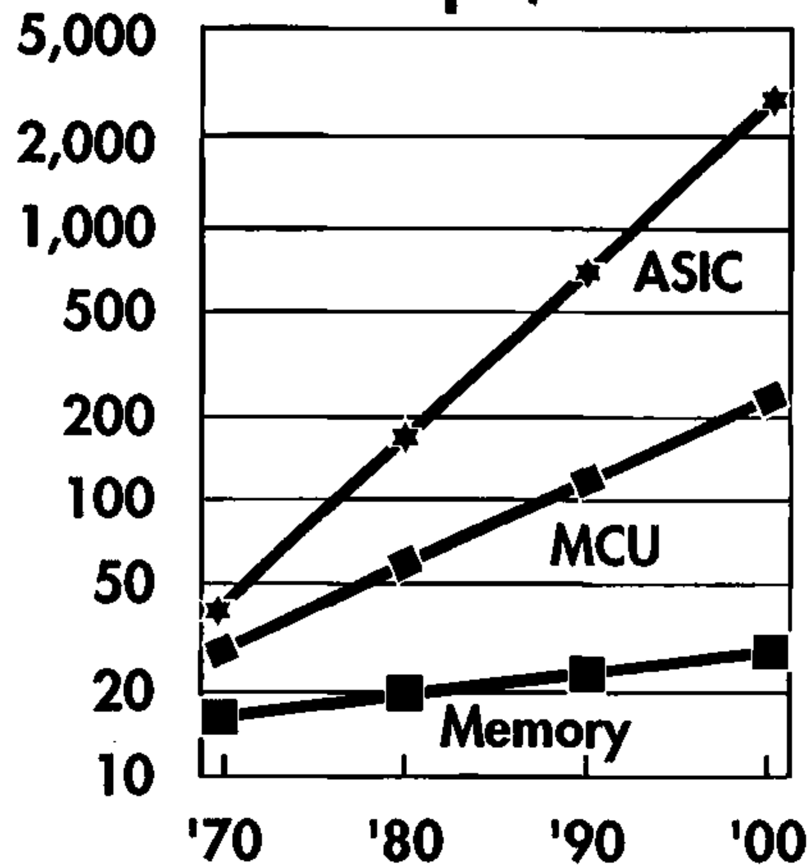
MIETEC
ALCATEL

IC Complexity Trends

Devices/Chip (MU)



Chip I/Os



Source ICE

MIETEC
ALCATEL

European Perspective

- Manufacturing in Europe ?
- The European environment
  - Esprit ...
  - Jessi

MIETEC
ALCATEL

Social Implications

- Contribution to GDP growth
  1980's: Employment 70% Productivity 30%
  1990's: Employment 40% Productivity 60%

- At the end of
  80's: A few percent home workers
  90's: More than one third home workers

- Implications: - Unemployment
  - Education and training
  - Role of the enterprise

JPK/9308/12

MIETEC
ALCATEL

Conclusions

- Semiconductors are the driving force behind changes
- ICs are increasingly becoming the system
- Relationship between supplier and customer needs to be close
- Returns flowing to product IPR owners
- In selected areas, European companies can be successful

EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

Hans-Dieter Mackowiak
Executive Director Sales
Siemens AG, Semiconductor Group

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EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

Hans-Dieter Mackowiak
Executive Director Sales
Siemens AG, Semiconductor Group

Mr. Mackowiak is Executive Director of Sales for Siemens AG, Semiconductor Group. He is responsible for the worldwide sales operations of Siemens Semiconductor Group located in Munich, Germany. Prior to Siemens Mr. Mackowiak worked for Mitsubishi Electric as a General Manager for Semiconductors and before that at Toshiba Europe. He gained his Dipl.-Ing. degree in Information Technology at the University of Dortmund, Germany.

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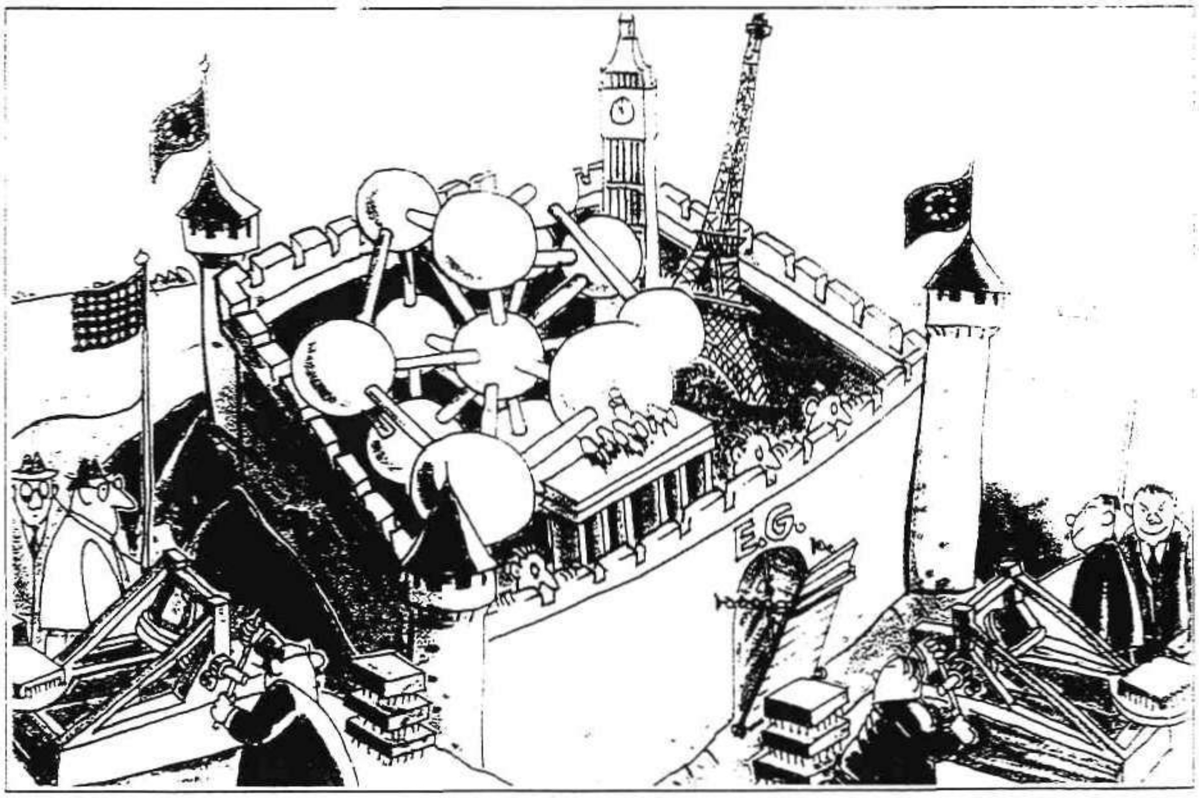
SIEMENS

Global PartnerChip

Strategies and Directions for Growth

Hans-Dieter Mackowiak, Siemens AG

SIEMENS



SIEMENS

SIEMENS

IBM	(+2%)	68 bn $
GE	(+3%)	63 bn $
Hitachi	(-3%)	60 bn $
Matsushita	(+4%)	58 bn $
Siemens	(+8%)	51 bn $
AT & T	(+1%)	47 bn $
Toshiba	(0%)	37 bn $
Philips	(0%)	32 bn $
Alcatel	(+10%)	32 bn $
Sony	(+6%)	31 bn $

Key figures '92

Sales	51 bn $	(+8%)
Orders	55 bn $	(+4%)
Employees	413,000	(+3%)
Investment	5.5 bn $	(+53%)
R& D	5.4 bn $	(+6%)
Income	1.3 bn $	(+9%)

Major activities

Communication
Computer
Automotive
Semiconductors ...

1$ = 1.55 DM
Base: 1992

Siemens – A Major Player

SIEMENS

Siemens ...

...invested 3 bn $ during the last 8 years in Submicron CMOS Technology,

...against an accumulated CMOS turnover of 2 bn $ during the same period,

...received only 130 mill. $ in government support however,

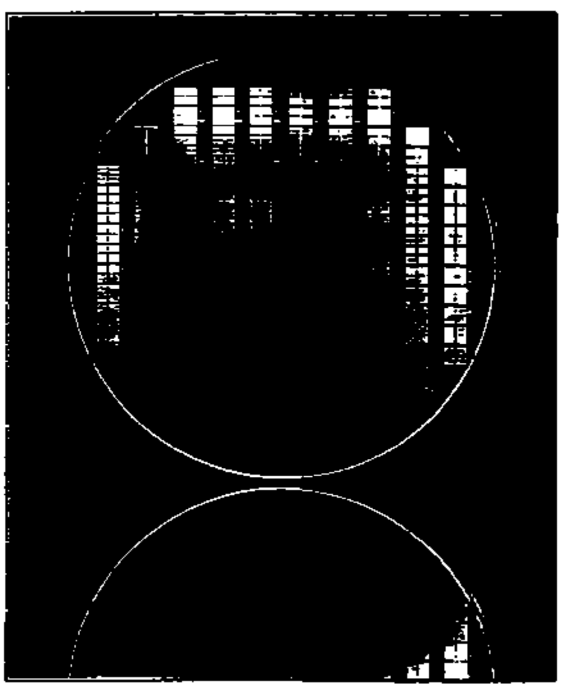
...needed cooperation on 1 bn $ 0.25 μm technology with IBM and Toshiba,

...operates backend fabs in Singapore, Malacca and Penang,

...has to globalize and maximize volume to cover technology costs.

Submicron – A Costly Adventure

SIEMENS



- CMOS 0.35 μm structure size
- 16 M x 4-bit, 8 M x 8-bit, 4 M x 16-bit organization
- 50/60/70 ns access time
- Fast page mode
- Trench capacitor
- Approx. 193 mm^2 chip area
- Approx. 135 million components

64M DRAM

SIEMENS

- In all four regions of the world, IC consumption at the end-user level is in good correspondence to the share of the population, which means an almost similar final IC consumption per capita in each region.
- Only the US and ROW have a fairly balanced IC supply and demand structure in their electronics food chain.
- Japan's and Europe's shares in world IC production are heavily out of proportion to their shares in IC consumption.

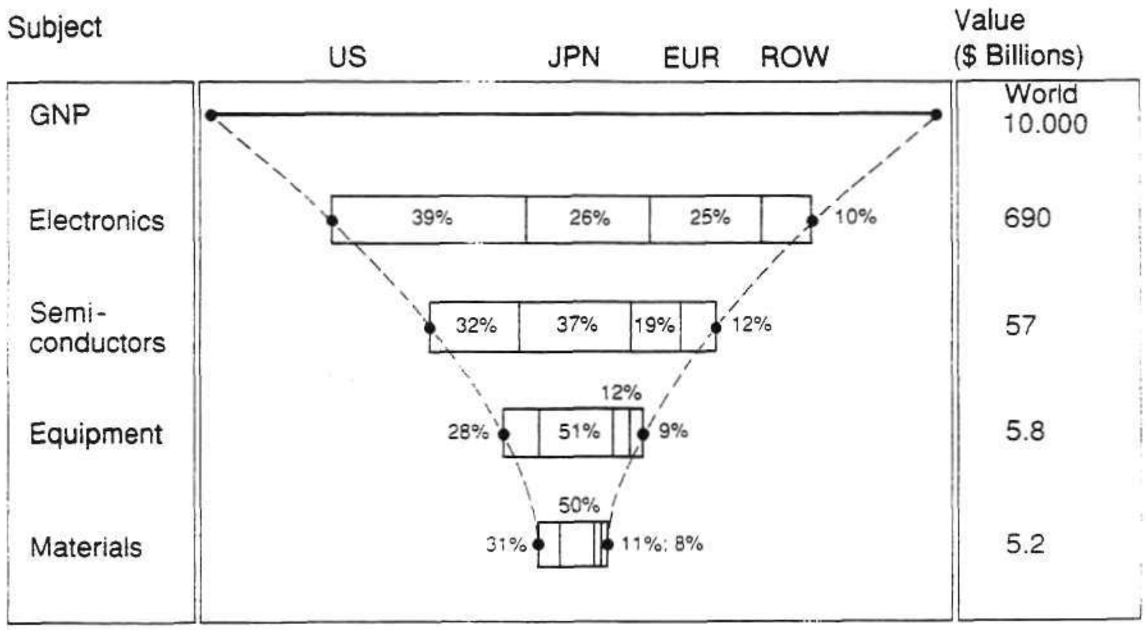
% per region

	U.S.A.	Europe	Japan	ROW
Population	33	41	16	9
IC Consumption (end-user level)	39	33	18	10
Equipment Production	39	26	26	11
IC Consumption (OEM-level)	35	17	37	11
IC Production (diffusion level)	35	10	49	6

World IC Consumption and Production

SIEMENS

- Japan clearly dominates the vital links of the electronic chain.
- To make strategic moves, an economic entity needs to be in control of "its electronic chain"

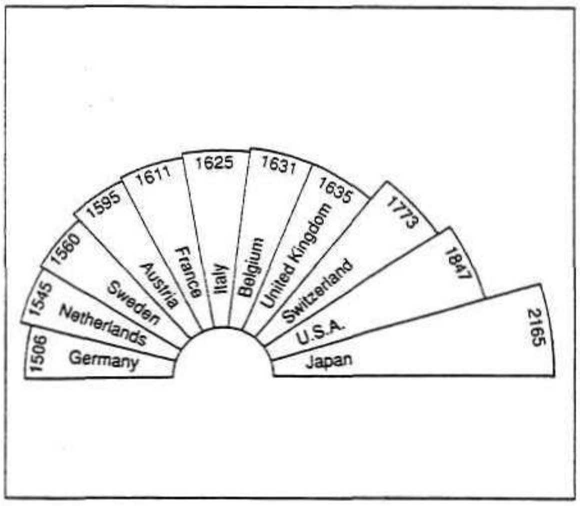


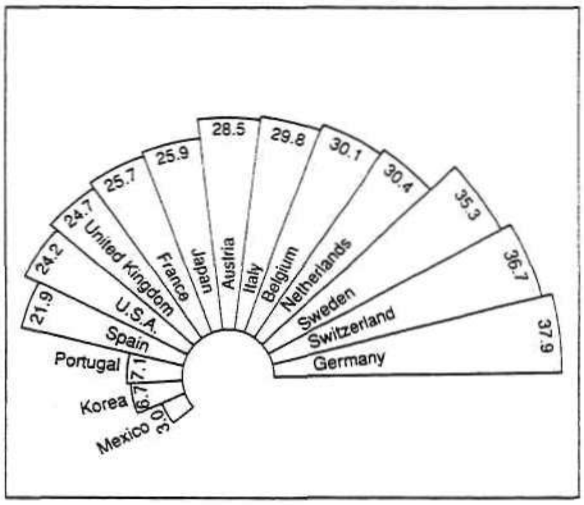
The Electronic Chain (by Regions)

SIEMENS

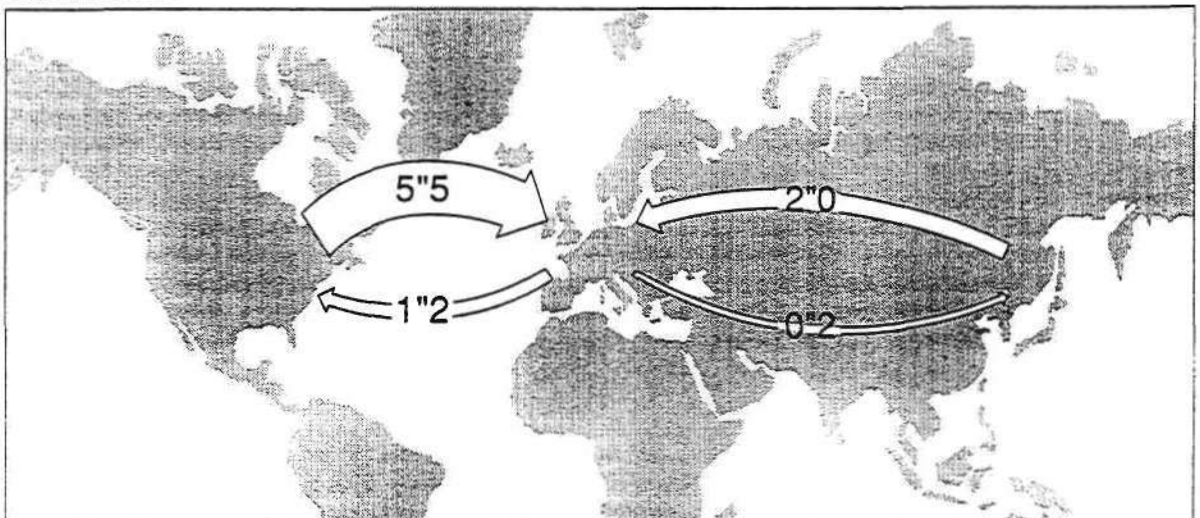
▶ Germany **pays highest salary per hour**... 46% higher than Japan

▶ **Germany** has **lowest yearly working time**... Japan works 44% more per year





SIEMENS

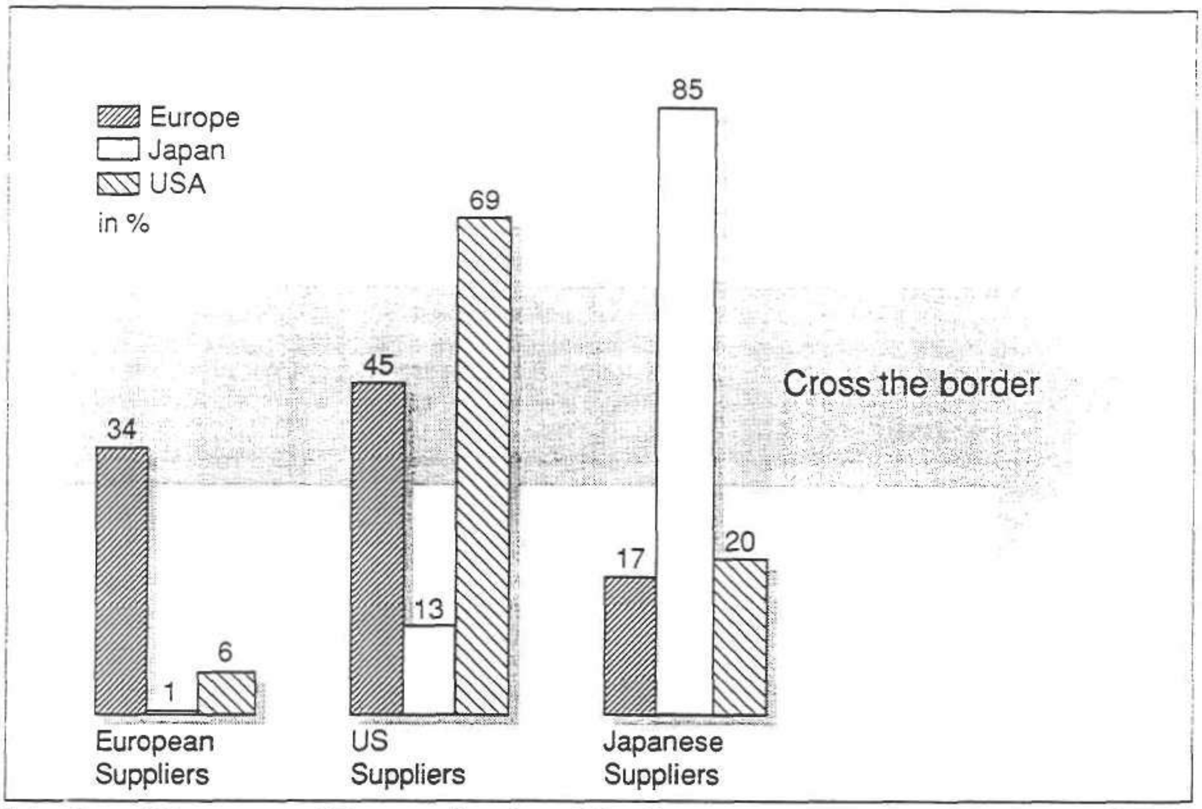


❑ Europe is the largest importer of semiconductors (7.5 bn $) within the triade.

❑ European suppliers cover 36 % of domestic demand.

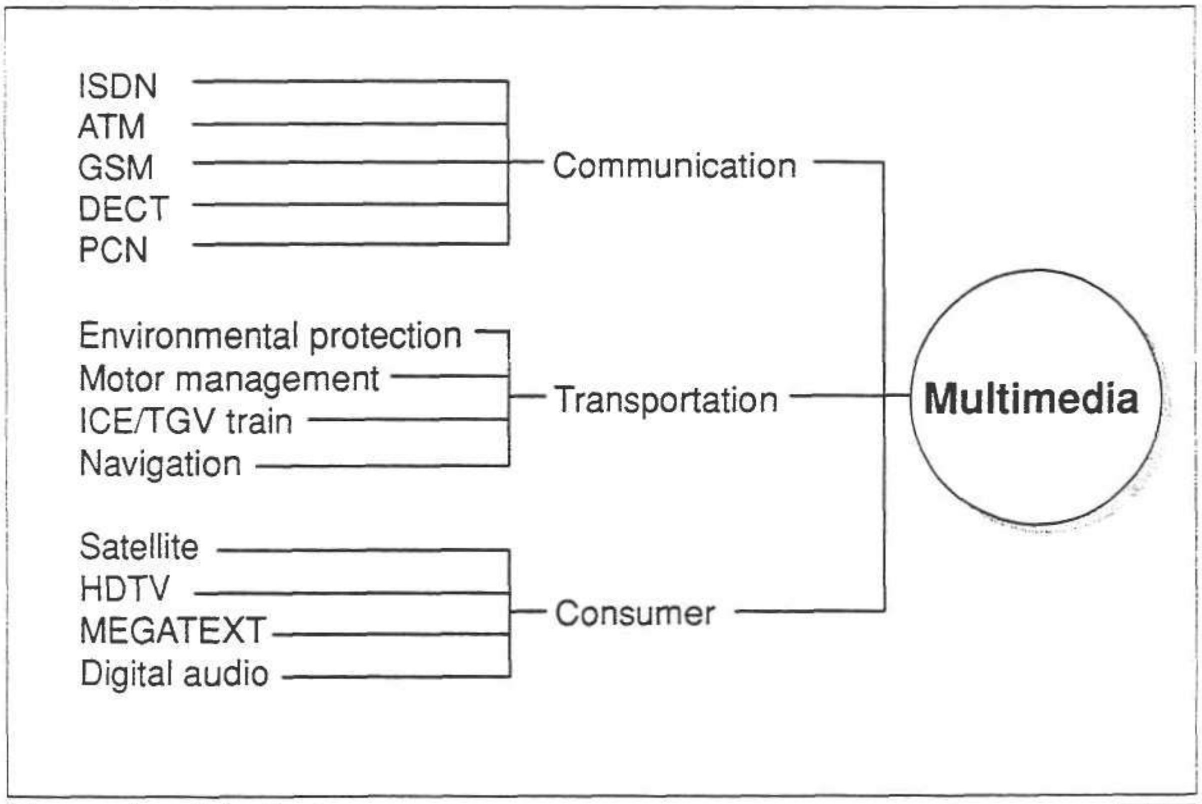
The EC – A Fortress with wideopen Doors

SIEMENS



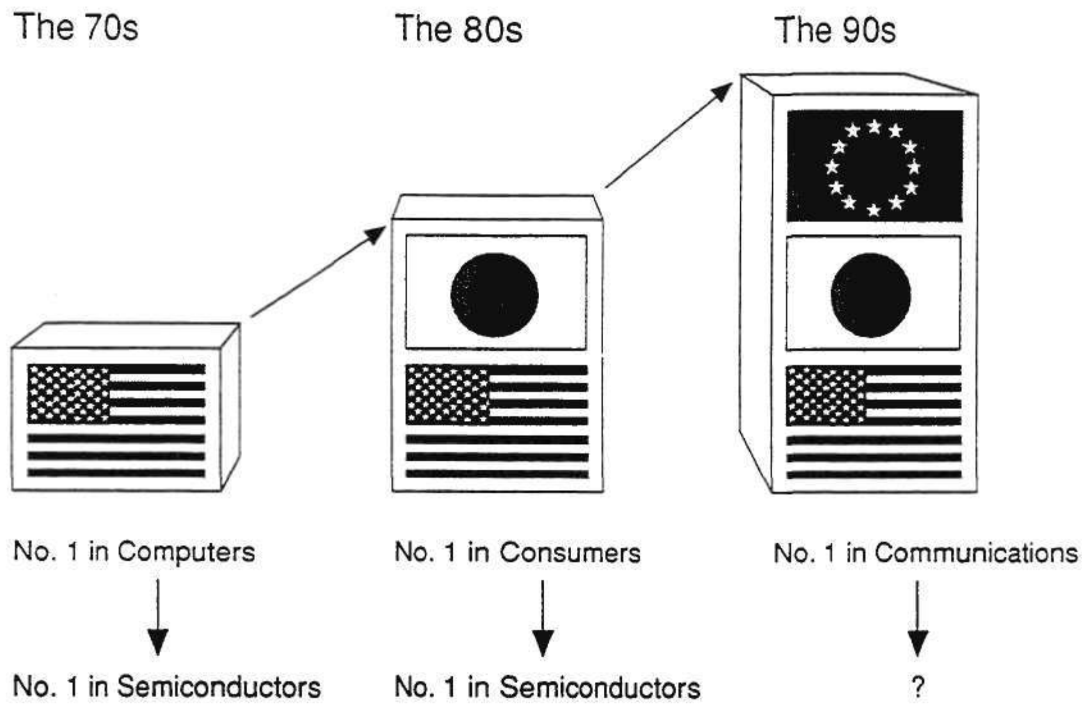
Market Shares – Export is the Challenge

SIEMENS



Emerging Markets

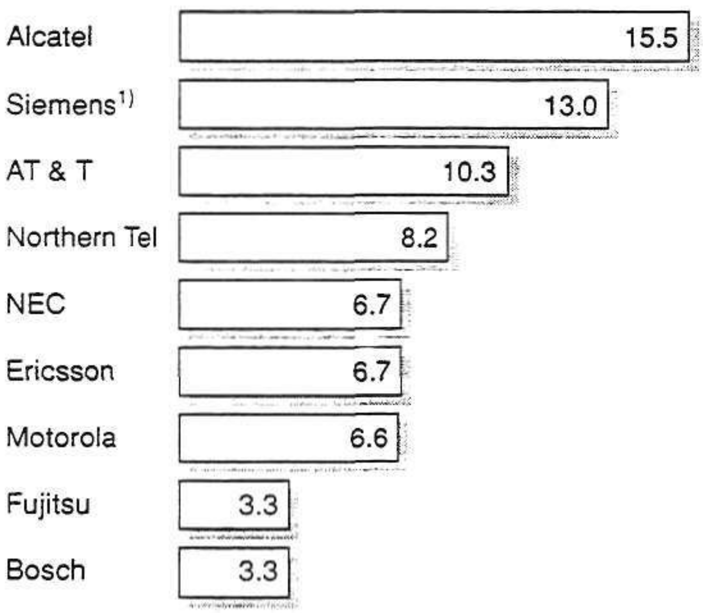
SIEMENS



Dominance – Driven by Homebase

SIEMENS

Leading Telecom Producer



- ❑ EC manufacturer keep 50% of world market share
- ❑ Europe sets world standards (GSM, DECT, PCN, etc.)
- ❑ 850 mill. European population[2] guarantees growth
- ❑ Highest semiconductor consumption in communications segment (31%)
- ❑ Liberalized PTTs stimulate consumption
- ❑ Leading PTTs favor ISDN

1) Incl. GPT/ROLM
2) Incl. Eastern Europe

Basis '91 in bn $

Communications – Develop your Strength

SIEMENS

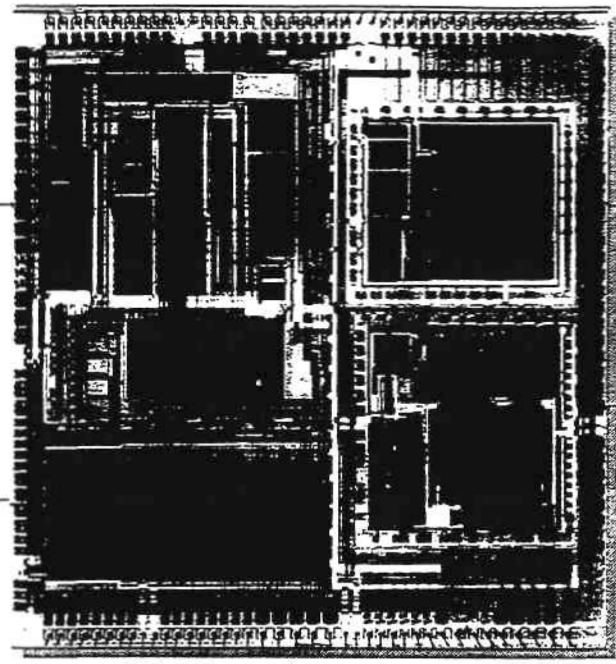
Gold (GSM One-Chip-Logic Device) for GSM and PCN applications

Core:
16 -bit micro-controller

Design:
mixed, optimized and semicustom methodology

Interface logic

Design:
standard cells



Core:
programmable equalizer digital signal processor

Design:
optimized

Core:
channel codec

Design:
mixed, optimized and semicustom methodology

0.7 μ, c. 570 000 transistors

VLSI Hi Tech Communication ICs

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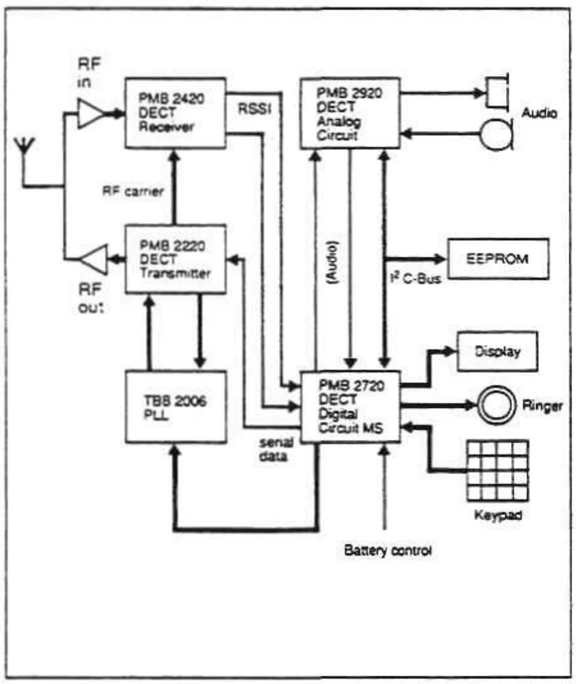
Cordless handheld



- Complete DECT-System of 5 ICs (2 Base band ICs, 3 RF ICs)
- Base band-controller features:
  - 8-Bit μC with 48K ROM / 3K RAM
  - Burst-mode control unit
  - ADPCM coding

  700K Transistors; 0,8 μm CMOS
- RF -ICs in 1.5 μm High speed bipolar
- T-MQFP-Packages; P-DSSO Packages

DECT – Chipset

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Worldwide car manufacturing

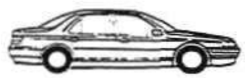
1. Europe 42 %
2. Japan 28 %
3. USA 17 %

Total: 33 mill. cars

Semicon content by car

1980  10 $/car

1985  35 $/car

1990  210 $/car

- ❑ No. 1 in automotive electronics (Bosch, Marelli, Siemens)
- ❑ Europe sets standards in…
  - … Motor management
  - … Drive
  - … Traffic control
  - … Navigation
  - … Environment protection
- ❑ Japanese car manufacturers move to Europe
- ❑ Ambitious Paneuropean high-speed train projects

Transportation – Europe in Pole Position

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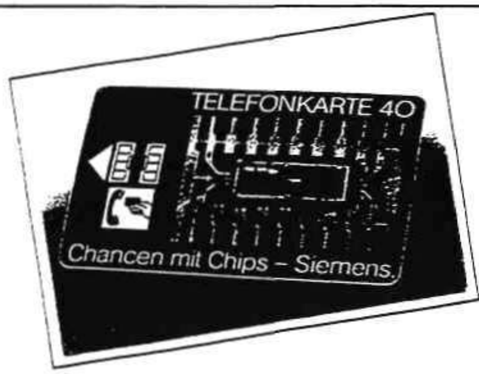


Present

- ❑ Market '92 exeeds 100 mill. $
- ❑ Europe consumes/produces > 90%
- ❑ Applications are emerging in
  - – Telephone debit card
  - – Health insurance card
  - – Banking cards

Future

5.000.000.000 people are waiting for…

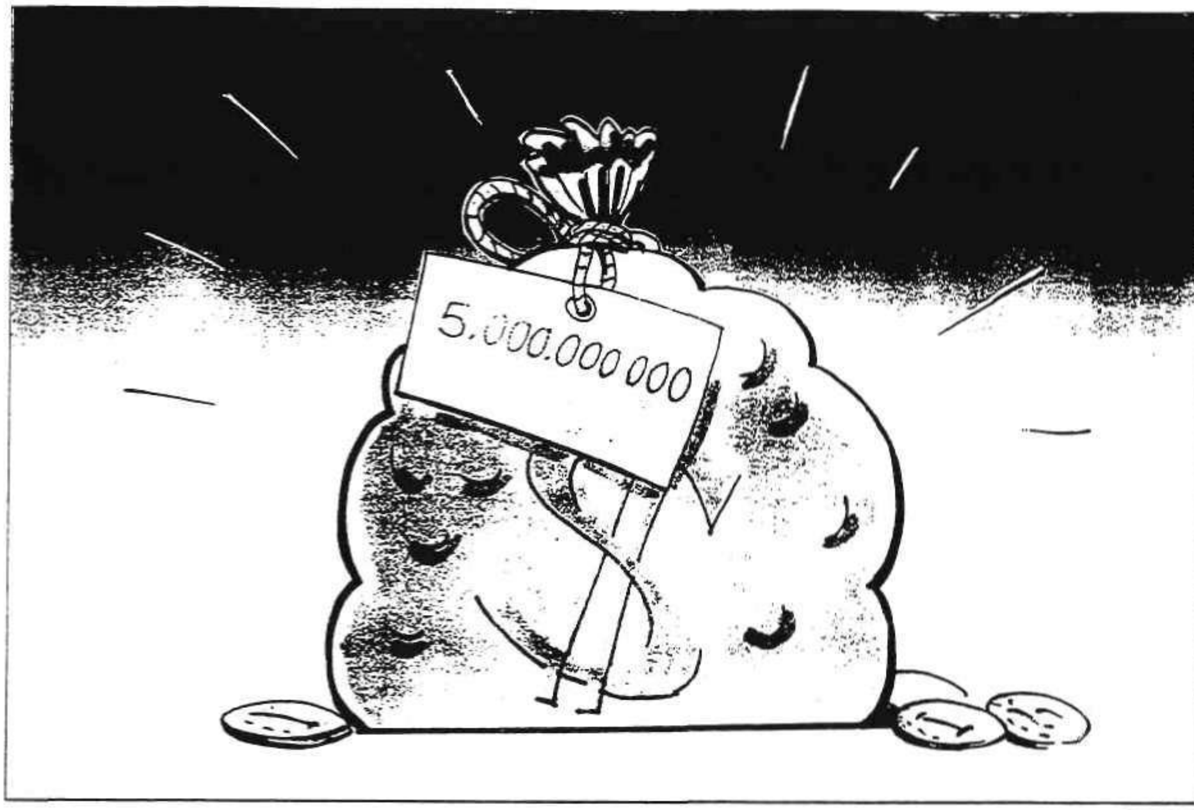
- – Telephon debit cards
- – Health care cards
- – Insurance cards
- – Credit cards
- – Identification cards
- – Passport cards
- – Electronic keys
- – Small coin cards
- – Ticket cards

⋮

Creating a market of…

CHIPCARDS – What a Potential

SIEMENS



SIEMENS

EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

Pasquale Pistorio
President and Chief Executive Officer
SGS-Thomson

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EXECUTIVE ISSUES: STRATEGIES AND DIRECTIONS FOR GROWTH

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Mr. Pistorio is President and Chief Executive Officer of SGS-Thomson Microelectronics. Previously he was General Manager of the International Semiconductor Division of Motorola, responsible for all design, manufacturing and marketing activities for all regions outside the United States. Before this he was Director of World Marketing, responsible for all marketing and sales activities worldwide. At the same time he was elected Vice President of Motorola Corporation. He has also been Motorola's Marketing Manager for Europe. Mr. Pistorio gained a masters degree in Electrical Engineering from the Polytechnic of Turin, Italy.

Dataquest Europe Limited
EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE
May 26–28, 1993
Munich, Germany

STRATEGIES AND DIRECTIONS FOR GROWTH

presented by

PASQUALE PISTORIO

President and C.E.O.
SGS-THOMSON Microelectronics Group

at the

Dataquest European Semiconductor Industry Conference

Munich, May 26-28, 1993

Ladies and gentlemen,

I would like to begin by thanking Dataquest on behalf of us all for giving us again the opportunity to meet together and exchange our views on the future of the electronics industry.

Over the past two days some of our industry's most prominent and well respected figures have presented their views on different strategies and directions for growth.

From a product point of view, I have little to add. I share the views of the majority of observers of our industry that predict the future boom of personal communicators, personal assistants and all forms of "électronique nomade" (nomadic electronics), as the French say with a lovely, newly coined expression. I, myself, find the trend towards the powerful combinations of computing, telecommunications and consumer electronics both exciting but at the same time frightening. As a manager of a semiconductor company I am excited by the prospects they offer. As a man who does not have youth's quick facility with these electronic marvels I confess I am a little scared.

However I do not want to address myself to the particular opportunities offered by these new products but rather to what I see as the future management challenges of our industry in general and how we should prepare ourselves for it.

To begin with, when all things are considered, I don't believe in discontinuities in the overall progress of our industry, but rather in evolution, not revolution.

Naturally there are some evolutionary trends that are accelerating, others that are slowing down. Some that will have a lasting impact on the future, others that will just fade away.

What I would like to do today is to cast some light on what I see as the important trends for the future, having first had a brief look at the past.

And here let me just state that I don't have a magic recipe, in fact many of my management beliefs are just industry common sense and you will find are similar, at least in part, to those of many experts within our industry. My magic ingredients, if you like are: spot the trends early, set your strategies accordingly, and make them work.

So what are the trends that I see?

Well in actual fact I can see six that I believe will be important to follow during the last part of this decade, or , if you prefer it, century.

1) There will be an increased accentuation of the industry's restructuring.

2) Packaging, testing and miniaturization will become as important as silicon itself

3) There will be an increase in the speed with which we need to react.

4) There will be some major changes in the geography of our industry.

5) There will be an increasing importance of social factors.

6) There will, in all probability, be some technological breakthrough which will condition the future of the industry.

Further on I will be expanding on these six points but first of all let's take a quick look at what major trends we have seen in the last 10 years.

At the beginning of the mid eighties, long before the merger of SGS and THOMSON, we could see three major factors we believed would condition the industry for the remaining part of the eighties and the early part of the nineties. I have spoken often about these but for the sake of completeness I would like to just mention them again.

First of all we -- the microelectronics industry -- found ourselves with technologies in production that were capable of integrating huge numbers of circuits and producing real systems in silicon. To take advantage of this enormous potential we needed to bring together our silicon know-how and the architectural know how of the systems manufacturers. In SGS-THOMSON we responded to this situation by forming strategic alliances which pushed us towards market driven innovation instead of the introverted technological innovation which had characterized our industry in the past.

Secondly, the concept of internationalization -- which was always with the semiconductor industry since its beginning -- was changing towards the idea of globalization in a regionalized world. I mean that each macroeconomic system privileged those companies that were able to establish an integrated presence in their territory, including marketing, manufacturing, product design and, sometimes, even technological research. My company was quite early in understanding this trend.

Finally as the industry became increasingly competitive and eager for defect free products and services, there was a strong drive towards higher productivity coupled with much higher attention for service and quality. The industry rediscovered TQM, which the Japanese had already institutionalized. Today, it is an evident sine qua non condition for success.

In synthesis, I would say that the past ten years have been characterized by three major trends:

1) Market driven innovation, through strategic alliances

2) Globalization, via integrated presence in the major macroeconomic systems

3) Obsession for quality and productivity through TQM.

Many companies including SGS-THOMSON spotted those trends and acted accordingly. And I must say that it worked well for us.

The results speak for themselves.

Let's start by taking a quick look at SGS and Thomson Semiconducteurs, the two companies that formed the base for what is today SGS-THOMSON. Back in the second quarter of 1987, that is to say the quarter preceding the merger, the situation was far from rosy.

Combined sales for the two companies were running at M$220 per quarter.

The combined losses for the same quarter were up to M$52.2.

And the combined debts had reached M$630

On top of that, the manufacturing base of the two companies were excessive and widely dispersed with 22 factories worldwide. What's more a large number of these facilities were concentrated in Europe where, as you know, costs are high and flexibility low.

These negatives were made even worse by the fact that the overall productivity of the company was very low, at just k$44 per head calculated on a yearly base.

This depressing situation was compounded by the fact that apart from manufacturing, our presence outside of Europe was, to say the least, only modest.

The one true bright spot in the picture was the excellent technological base, complementary to both companies, which in part helped compensate for the disadvantages inherent within the overall structure.

As I said, not a rosy picture, but by the end of 1992 we had turned the situation round and built up a company able to compete on the toughest markets in the world.

Sales have practically doubled to the point where last year, not an exceptional year in anyone's books, had reached $1.6 billion. What's more, we have gained two places in the world rankings and in terms of relative size closed on the leader, passing from just one quarter to one third of the market leader's size.

We have turned an annual loss running at a rate of something over $200 million into a gross operating profit of $127 million with a net profit of $3 million. And I can predict even now that our 1993 results will be much much better: our net profit for the first quarter of 1993 was $24.4 million.

Our improvement in productivity has been pretty good, doubling to over $100 thousand as a runrate, with an average increase of 15% per year.

So I think you will agree we have here a much more promising picture today than five years ago and a solid base for us to approach the next phase for our push to top ten status.

How successful we are in getting there I suppose will depend firstly on how well we can identify the way the market is moving and secondly on how well we implement strategies to meet the trend.

So let's now look at what I believe is going to happen in the future, and I want to state that although as a manager of a European based company I am focussing on Europe what I have to say applies equally to anywhere in the world. And I will take point by point the six trends I identified in my introduction

1) Increased accentuation of the industry's restructuring

The industry will continue its trend towards polarization and by the end of this decade we will have at most a dozen big broad range semiconductor manufacturers at one end -- each with more than 5% of the world market -- and a mass of many small specialists at the other end -- each with less than 0.5% of the world market.

The big suppliers will be the only ones with the dimensions of scale to withstand the increasing costs of R&D and capital investment. They will be very well established and we will not see any major new entries because of the prohibitive entry costs. They will also be part of a vertical organization or if they are not, they will create a virtual vertical organization through strategic alliances with major users within the industry. This will be necessary not just to give access to resources, but also to ensure continuing access to systems architecture and know-how.

Moreover, even the big guys will actively search cooperation with other semiconductor manufacturers, not only to share resources, but also for better time to market and to minimize the risk of wrong choices.

The smaller companies, which will tend towards being fabless, if they are not part of a vertical organization, will gravitate towards the large technological mass of the major companies and will orbit around them as satellites, taking their technological direction from the big suppliers. Their major contribution will be in specific applications, specific architectures or specific technological niches.

They will also have to be very close to the major user companies in order to have access to advanced systems know-how and to be guided in navigating through their own niche.

In this picture, the field between the first group and the second will be practically empty. Companies like SGS-THOMSON who currently occupy the middle ground will no longer be there. By that I don't mean they will have disappeared: just that they will have moved up or down.

Essentially, what I am saying is that the companies that are already big will remain so, unless of course they make a mega mistake. Small companies will of course remain small and will have to concentrate on allying themselves with the right partners. The others will have to force the issue and move either up or down. And I give no prizes for guessing in which direction SGS-THOMSON is going!

2) Testing, packaging and miniaturization will become as important as silicon itself

The whole history of microelectronics has seen a continuous race towards cheaper, smaller, cooler, faster products.

In the past, however, the accent has been put more on the idea of cheaper and faster devices than on anything else. I believe that already today the other two parameters -- smaller and cooler -- have gained a much higher importance than in the past and they will be as important as the other two in the future.

This originates from the increasing success of portable equipment that have opened totally new markets. But portable equipment, by definition, needs not only to absorb little energy, but must also be smaller, lighter and more rugged.

The immediate consequence of this is that we should pay much more attention than before to packaging and miniaturization in general, which, in turn, will require increasingly higher efforts in perfecting testing techniques for components which will become very difficult to handle.

3) Increase in the speed with which we need to react

Our industry is the most dynamic in the world with changes happening so quickly that companies have to be able to react in real time -- and the speed of change is accelerating. We have to learn how to be faster in adopting new technologies. We have to learn how to be faster in introducing new products and producing them in high volumes. We have to learn how to be faster in reacting to changes in market conditions.

This ability to be faster is probably the most important change we will have to make in the coming years and it will mean some significant changes in the way we organize our companies.

Essentially we will have to create organizations that are more agile. For the niche companies this will not be such a great problem since they are smaller and by definition focussed on a particular market or technology.

For the big companies, on the other hand, we have to overcome what has been the traditional problem of any big organization, its large inertial mass.

We have to create organizations which are

a) agile

and, at the same time,

b) able to take advantage of dimensions of scale.

The combination is difficult to achieve since normally the two aspects are mutually exclusive.

I see companies becoming much more fractionalized, with many tens of divisions, each of which is an autonomous profit center and each one with very wide decision making power.

These divisions will be synergistically grouped around areas of commonality like markets, technologies, etc., and will have access within the group to their own advanced pilot lines, which they will use to bring new products to volume maturity in the shortest possible time before they are transferred to the company's shared manufacturing resource.

The technologies and processes the divisions and groups use will come from another shared resource, that is the company's technological VLSI platform.

It is this combination of relatively small autonomous units with access to massive central resources like manufacturing and R&D which will give us both agility and critical mass.

To some extent, this model is similar to the one Tom Peters calls a networked organization.

Obviously if we are to react fast, we will also have to keep lines of command as short as possible. This means we must drastically change current hierarchical structures.

I believe that organizations of the dimension of mine, cannot afford to have more than 5 levels, and I include the Chief Executive Officer as one of those levels. So between the top and bottom of the company there should only be three levels.

This hierarchy is essential if we are to develop and control a large but agile organization and my own personal goal is to have it in place in SGS-THOMSON by the end of 1995. By the way, even though today, in the worst case, we are down to seven levels, the trimming of the last two will be the most difficult.

4) Some major changes in the geography of our industry

The first thing to underline here is that America still is, and will remain, the major force with Japan remaining very close but in a number 2 position. And I must say that I take some pleasure out of raising this point since it is exactly as I predicted at other similar Dataquest meetings even when America was in its worst condition and many experts were predicting that Japan would become the overpowering force.

We will continue to see the formidable rise of Asia/Pacific with the added dimension of a China which is becoming increasingly strong - it is already the fifth most developed country in the world in terms of GNP and a potentially significant force in our industry.

As a result the competition will become even more intense. This intensification in the rate of competitivity, coming from the emergence of new forces, will impose new conditions on all companies throughout the world.

For example, it will reinforce the need for organizations to become flat and lean and to adopt TQM's operational behavior.

There are also opportunities however. For example, as the decision to go into Singapore with both assembly and front-end has proved extremely successful for SGS-THOMSON in the booming Asia/Pacific market, so too will companies, who are ready, be able to hitch a ride on "space-ship China" as it blasts off towards the next century.

And to conclude this point, let me mention the ex Soviet Union, although it is not yet clear what role those countries will play. In my opinion, just the sheer size of the countries with their patrimony of physical resources coupled with the immense intellectual potential of well educated youths are very good reasons to force on us an attention to their evolution,in order not to miss important opportunities.

5) Increasing importance of social factors

I believe that there are factors which will compel all corporations to have an increasingly visible social conscience.

Within the organization itself this will be seen through an increased emphasis on people and the contribution they can make to the organization as a whole.

This is already being seen to a large extent through the employee empowerment aspects of TQM and will find new avenues of expression as flat organizations become more predominant.

Externally companies are going to have to become better "citizens" especially with regard to the environment and this will be forced by three main considerations:

a) A moral obligation

Business ethics have evolved historically towards a broader span of obligations. In the early days of the industrial revolution obligations were seen as being solely towards the owners/shareholders of the company. Later, under pressure, came a sense of obligation to customers, and then, again under pressure, towards employees. Recently we have seen an increase in a company's obligation towards its business partners with mutual trust and respect becoming an important part of ongoing business relationships.

Today, industry is again under external pressure to extend its obligations to the community at large, acting as a responsible member of society and respecting the rights of everyone to a safe environment. This has lead to an increase in focus, by the more forward thinking companies, on ecological aspects.

b) Economic importance

I'm convinced that it is wise to voluntarily invest in environmental protection now because we will increasingly be forced by legislation to clean up our act. Once again I believe that those companies who accept this trend and act first will have a significant strategic advantage over those companies who wait.

I also believe that the financial efforts will to a large extent be repaid if we are capable of designing and implementing processes that are pollution free and which also eliminate waste of valuable material resource. To paraphrase that well known statement "Quality is Free" I believe that "Ecology is Free".

c) Human resources

Today's younger generation, despite all the faults that our generation may wish to ascribe to them, are thank goodness much more ecologically sensitive and proactive.

They will exercise this sensitivity not only in their purchasing decisions but also in their choice of employment and employer. Therefore it is only by championing the causes of ecology that companies within our sector, or any other, can hope to attract the best young people on which our success ultimately depends.

<u>6) Some technological breakthrough will condition the future of the industry</u>

Although at the beginning of my presentation today I said that I did not believe in discontinuity, when you talk about technologies, processes or products, experience tells us that we are to some extent conditioned by breakthroughs which can change the whole face of our industry.

The change from germanium to silicon was a discontinuous change in our industry. The invention of the integrated circuit itself revolutionized an industry that was based on discrete transistors and diodes. The invention of the microprocessor was another discontinuity that had a profound impact. Similarly, the semicustom approach and compiling design techniques.

And I am sure that other breakthroughs are even today maturing in some R&D laboratory ready to take the industry by storm.

We have to be ready to spot the emergence of these breakthroughs and react quickly to them.

The best chance we have of spotting breakthroughs is to maintain wide and open links with the places working at the leading edge of processes, technologies and product concepts. That is to say universities, national research institutes and industry initiatives like JESSI.

And when we spot what we believe could be a breakthrough, we have to be ready to invest in it, even if that means backing losers. The important thing is to react quickly, especially as the market speeds up because if you wait too long the window of opportunity will already be closed.

We in SGS-THOMSON for example believe that fuzzy logic could well be a breakthrough and we have already invested a substantial amount in this area. However the breakthrough could just as easily come through systolic microprocessors, and I know there is a lot of activity in this area or even bio-electronics, although I don't think that will happen within this decade.

What is almost certain though is that within the next decade we will see the emergence of at least one new breakthrough product, technology or architecture that will significantly impact of our industry. I can't honestly say that I know what it will be and, believe me, even if I did I don't think I would kill my strategic advantage by prematurely announcing it to the world.

So, in conclusion, let me sum up my views.

In the recent past, three major trends have characterized the world scenario of our industry. Some companies identified these trends before others and, by reacting to them quickly, gained significant strategic advantages.

For the future I foresee six important trends effecting the progress of our industry in the last part of this decade, which I just described. Like in the past, but more so in today's fast moving markets, the companies that are first to successfully adapt to these trends will be the ones that come out on top.

Finally let me add that most of what I have said today was the core of a meeting held this week for the senior staff in SGS-THOMSON. We closed ourselves away for two days and concentrated on the theme "Vision 2000"

Today I know where we will be at the start of the next century but since I believe actions speak louder than words, I look forward to meeting with you again in 7 years time to describe how we successfully reached our next goal.

Thank you.