Military IC Procurement

Focus Conference

November 10, 1986
Sheraton Harbor Island Hotel
San Diego, California

Dataquest

a company of The Dun & Bradstreet Corporation

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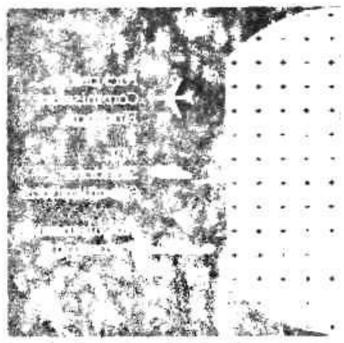


[illegible] Coope
...ger for Weapons Engineering
L... Guidance and [illegible] Systems

[illegible] Williams
Manager [illegible] HAN/Space [illegible]
Texas Instruments Incorporated

2:45 p.m.
Break

3:15 p.m.
[illegible] Session on Military Packaging — Impact of Packaging Changes on Military Procurement

Panelists:

Dave Francis (Panel Leader)
DaPaques Associate
DaPaques Incorporated

[illegible] E. Wescott
Technical Director and Deputy Chief of Staff
Product Assurance and Acquisition Logistics
Air Force Systems Command

...vin Gaughan
Military Program Manager
...ocel International Corporation

E. Edward Johnston
Director of Product Technology
Dense Pac Microsystems Inc

Vincent SanLatore
Vice President
Jade Corporation

Martin Greenwald
Manager, Applications Engineering
International [illegible]

[illegible] p.m.
Reception (cocktails and hors d'oeuvres)

Military IC Procurement Focus Conference

November 10, 1986
Sheraton Harbor Island Hotel
San Diego, California

SEMINAR PROGRAM

8:00 a.m.
Registration, Continental Breakfast

8:45 a.m.
Welcome and Conference Introduction

Stan Bruederle
Vice President and Director
Semiconductor User Information Service
Dataquest Incorporated

9:00 a.m.
Mil-Standard Semiconductor Outlook, 1986–1987

Gene Miles
Dataquest Associate
Dataquest Incorporated

9:45 a.m.
Procurement of Military Microelectronics

Carl Salanitro
Materiel Manager of Corporate Procurement Agreements
Hughes Aircraft Company

10:30 a.m.
Break

11:00 a.m.
Packard Commission Findings and Recommendations

Jim Martin
Editor
Defense Science and Electronics
Rush Franklin Publishing, Inc.

11:45 a.m.
Lunch

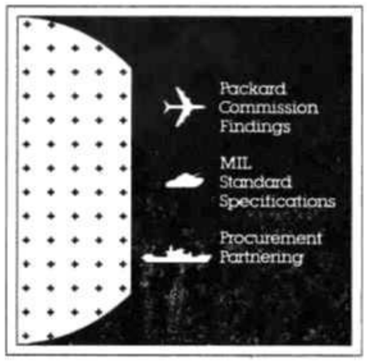
12:45 p.m.
Panel Session on Mil-Standard Specification 883, Military Drawings, and JAN: Where are They Going?

Panelists:

Ron Marfil (Panel Leader)
Director, Military/Aerospace Marketing
National Semiconductor Corporation

Steve Davis
Manager of Strategic Programs for Military Operation
Intel Corporation

Arney Stensrud
Director, Strategic Marketing and Government Relations
Military Products Sector
Motorola Incorporated



Dr. Mark Cooper
Manager, Components Engineering
Litton Guidance and Control Systems

Ron Williams
Manager of JAN/Space Products
Texas Instruments Incorporated

2:45 p.m.
Break

3:15 p.m.
Panel Session on Military Packaging—Impact of Packaging Changes on Military Procurement

Panelists:

David Francis (Panel Leader)
Dataquest Associate
Dataquest Incorporated

Edmond J. Westcott
Technical Director and Deputy Chief of Staff
Product Assurance and Acquisition Logistics
Air Force Systems Command

Kevin Gaughan
Military Program Manager
Kyocera International Corporation

B. Edward Johnston
Director of Product Technology
Dense-Pac Microsystems Inc.

Vincent Spadafora
Vice President
Jade Corporation

Martin Greenfield
Manager, Applications Engineering
Interamics, Incorporated

5:15 p.m.
Reception (cocktails and hors d'oeuvres)

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MILITARY IC TRENDS SEMINAR CONFERENCE
November 10, 1986
San Diego, California

List of Attendees

AT&T Bell Laboratories	Robert Braun, Supervisor
AT&T Technologies, Inc.	Karen Raymond, Department Chief, Market Planning Mgmt
Airforce Systems Command	Edmund Westcott, Technical Director/Deputy Chief of Staff
Atomic Energy of Canada, Ltd.	Phil Campbell, Manager, Commercial Operations
Bipolar Integrated Technology, Inc.	Brian Sheets, Director, Military Program Development
California Devices, Inc.	Nicholas Ortenzi, Director, Quality Assurance/Reliability
Data Incorporated	Steven d'Adolf, Technical Director
Dataquest Incorporated	Stan Bruederle, Vice President & Director, SUIS Steve Cooper, Industrial Marketing Manager David Francis, Dataquest Associate Gene Miles, Dataquest Associate David Norman, Research Associate Victoria Ruddy, Conference Assistant Lynn Stern, Conference Coordinator Anthea Stratigos, Product Manager, SAM
Delco Electronics Corporation	Marty Herrera, Senior Buyer Stephen Schreiter, Buyer
Dense-Pac Microsystems, Inc.	B. Edward Johnston, Director of Product Technology
Fairchild Semiconductor Corporation	Greg Sheppard, Business Analyst
Fujitsu Microelectronics, Inc.	Jim Kane, Marketing Manager Tom Vogt, Manager, Assembly Operations
GE Intersil, Inc.	Jerry Kiachian, Vice President, Manufacturing
Hamilton/Avnet	Daniel Colman, Senior Vice President, Military
Harris Semiconductor/Custom IC Div.	Bob Quinn, Vice President, Marketing/Sales

Hughes Aircraft Company	Carroll Perkins, Marketing Manager Carl Salanitro, Manager, Materiel
Indy Electronics, Inc.	John Minott, Director/Military Sales Scott Voss, Sr. Vice President/Sales and Marketing
Instruments, Inc.	Robert Bourcier, Business Manager Michael Fry, Chief Engineer
Integrated Device Technology, Inc.	Kenneth McKinney, Manager, Assembly Operations
Intel Corporation	Steve Davis, Strategic Program Manager
Interamics, Inc.	Martin Greenfield, Manager, Applications Engineering
Intersil, Inc.	Paul Sullivan, Director, Hi-Rel Product Line
Kierulff Electronics	Scott Meyers, Director of Corporate Military Marketing
Kyocera International, Inc.	Kevin Gaughan, Sales Manager
LSI Logic Corporation	Norm Chanoski, Vice President, Military Operations George Wells, President & Chief Operating Officer
Lansdale Semiconductor	Robert Grandestaff, General Manager
Lear Siegler, Inc.	Pamela Boogard Robert Jarman, Director of Procurement
Linear Technology Corporation	Clive Davies, Vice President, Quality Assurance Mike Munger, Military Marketing Manager
Litton Guidance & Control Systems	Mark Cooper, Manager, Components Engineering
Litton Systems Canada, Ltd.	Lloyd Austin, Procurement Liaison Engineer
Logic Devices, Inc.	Jesse Huffman, Vice President, Marketing & Sales
McDonnell Douglas Microelectronics	John Hayn, Manager of Applications Engineering
Motorola, Inc.	Bill Altonen, Business Operations Manager, MICARL Arney Stensrud, Manager, Military Marketing

NMB Semiconductor Company	Gary Ater, Vice President
National Semiconductor Corporation	Ronald Marfil, Director of Marketing Military/Aerospace Group
Omni Technology	Ronald Floyd, Vice President Thomas Swanson, President
Part Technology, Inc.	Leon Hamiter, Vice President
Plessey Semiconductor	Dan Wolfe, Southwest Regional Manager
Precision Monolithics Inc.	Tom Cate, Director, Strategic Marketing
RCA Corporation	James Saultz, Manager, Program Management Louis Schmeezer, Purchasing Engineer Edward Schmitt, Manager, Market Development, Gvt. & H.RI
Rockwell International Corporation	Stu Bardach, Programming Manager
Rome Air Development Center	Joe Brauer, Chief, Microelectronic Reliability Division
Rush Franklin Publishing, Inc.	Jim Martin, Editor
SGS Semiconductor Corporation	Gerry Pellegrini, Director, Military Operations
Shinko Electric America, Inc.	William Cruickshank, Executive Vice President
Signetics Corporation	Lou Johnson, Military Division Marketing Manager
Smith Industries, Ltd.	Larry Wagner, Manager of Operations
Sperry Corporation	Dominic Aquino, Buyer
Sundstrand Data Control	Al Emery, Senior Buyer
Texas Instruments, Inc.	Ron Williams, Manager of JAN/Space Products
The Jade Corporation	Vincent Spadafora, Vice President
Vitelic Corporation	Vijay Marathe, Manufacturing Engineering Manager Sam McCarthy, Military Product Line Manager

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MILITARY IC TRENDS SEMINAR CONFERENCE
November 10, 1986
San Diego, California

List of Attendees

Bill Altonen	Motorola, Inc.
Dominic Aquino	Sperry Corporation
Gary Ater	NMB Semiconductor Company
Lloyd Austin	Litton Systems Canada, Ltd.
Stu Bardach	Rockwell International Corporation
Pamela Boogard	Lear Siegler, Inc.
Robert Bourcier	Instruments, Inc.
Joe Brauer	Rome Air Development Center
Robert Braun	AT&T Bell Laboratories
Stan Bruederle	Dataquest Incorporated
Phil Campbell	Atomic Energy of Canada, Ltd.
Tom Cate	Precision Monolithics Inc.
Norm Chanoski	LSI Logic Corporation
Daniel Colman	Hamilton/Avnet
Mark Cooper	Litton Guidance & Control Systems
Steve Cooper	Dataquest Incorporated
William Cruickshank	Shinko Electric America, Inc.
Clive Davies	Linear Technology Corporation
Steve Davis	Intel Corporation
Al Emery	Sundstrand Data Control
Ronald Floyd	Omni Technology
David Francis	Dataquest Incorporated
Michael Fry	Instruments, Inc.

Kevin Gaughan	Kyocera International, Inc.
Robert Grandestaff	Lansdale Semiconductor
Martin Greenfield	Interamics, Inc.
Leon Hamiter	Part Technology, Inc.
John Hayn	McDonnell Douglas Microelectronics
Marty Herrera	Delco Electronics Corporation
Jesse Huffman	Logic Devices, Inc.
Robert Jarman	Lear Siegler, Inc.
Lou Johnson	Signetics Corporation
B. Edward Johnston	Dense-Pac Microsystems, Inc.
Jim Kane	Fujitsu Microelectronics, Inc.
Jerry Kiachian	GE Intersil, Inc.
Vijay Marathe	Vitelic Corporation
Ronald Marfil	National Semiconductor Corporation
Jim Martin	Rush Franklin Publishing, Inc.
Sam McCarthy	Vitelic Corporation
Kenneth McKinney	Integrated Device Technology, Inc.
Scott Meyers	Kierulff Electronics
Gene Miles	Dataquest Incorporated
John Minott	Indy Electronics, Inc.
Mike Munger	Linear Technology Corporation
David Norman	Dataquest Incorporated
Nicholas Ortenzi	California Devices, Inc.
Gerry Pellegrini	SGS Semiconductor Corporation
Carroll Perkins	Hughes Aircraft Company

Bob Quinn	Harris Semiconductor/Custom IC Div.
Karen Raymond	AT&T Technologies, Inc.
Victoria Ruddy	Dataquest Incorporated
Carl Salanitro	Hughes Aircraft Company
James Saultz	RCA Corporation
Louis Schmeezer	RCA Corporation
Edward Schmitt	RCA Corporation
Stephen Schreiter	Delco Electronics Corporation
John Seto	Vitelic Corporation
Brian Sheets	Bipolar Integrated Technology, Inc.
Greg Sheppard	Fairchild Semiconductor Corporation
Vincent Spadafora	The Jade Corporation
Arney Stensrud	Motorola, Inc.
Lynn Stern	Dataquest Incorporated
Anthea Stratigos	Dataquest Incorporated
Paul Sullivan	Intersil, Inc.
Thomas Swanson	Omni Technology
Tom Vogt	Fujitsu Microelectronics, Inc.
Scott Voss	Indy Electronics, Inc.
Larry Wagner	Smith Industries, Ltd.
George Wells	LSI Logic Corporation
Edmund Westcott	Airforce Systems Command
Ron Williams	Texas Instruments, Inc.
Dan Wolfe	Plessey Semiconductors
Steven d'Adolf	Data Incorporated

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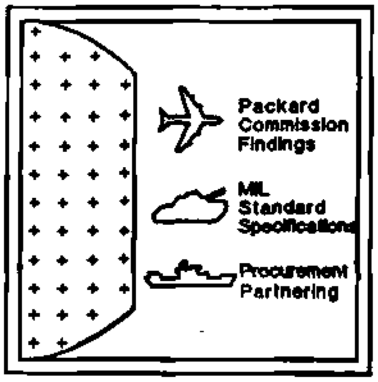
MIL-STANDARD SEMICONDUCTOR OUTLOOK, 1986-1987

Gene Miles
President, Aztek Associates
Consultant, Dataquest
Incorporated

Mr. Miles is President of Aztek Associates, a technology consulting company based in Florida. Prior to founding Aztek Associates, Mr. Miles was Vice President of Marketing for the Bipolar Memory Division of Harris Semiconductor. In 1981, Mr. Miles founded Dataquest's Semiconductor User Information Service, and in recent months, he has compiled an analysis of the gallium arsenide industry for Dataquest. He has 27 years of engineering and management experience in semiconductor applications, hardware and software development, and marketing at semiconductor and systems companies, including Fairchild, Honeywell, and IBM. Mr. Miles received a Bachelor's degree in Electrical Engineering from the University of South Carolina and an M.B.A. degree from Pepperdine University.

Dataquest Incorporated
MILITARY IC PROCUREMENT
November 10, 1986
San Diego, California



Military IC
Procurement

MILITARY SEMICONDUCTOR OUTLOOK, 1986-1987

GENE MILES

Consultant
Dataquest Incorporated

MILITARY SEMICONDUCTOR OUTLOOK

- Government programs
- Budgeting
- Semiconductor trends
- QPL suppliers and products
- 1985-1986 consumption
- 1987 forecast

ESTIMATED DEFENSE RDT&E

	FY'85 ($B)	FY'86 ($B)	% Change	FY'87 ($B)	% Change
Technology Base	$ 3.1	$ 3.4	10.5%	$ 3.6	3.9%
Advanced Technology Development	2.8	4.2	54.0%	6.6	55.3%
Strategic Programs	8.2	8.1	(1.4%)	9.4	17.1%
Tactical Programs	9.1	10.9	20.3%	12.8	16.2%
Intelligence & Communications	3.9	4.7	19.0%	5.1	8.5%
Defense-wide Mission Support	3.8	4.1	8.1%	4.6	10.7%
Total RDT&E	$30.9	$35.4	14.9%	$42.1	18.2%

Source: Department of Defense

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PROGRAMS EXEMPTED FROM CUTBACKS IN FY'86

Strategic Defense Initiative	$2,760 million
Mobile Subscriber Equipment	$ 335 million
A-6F Upgrade	$ 239 million
F-14 Upgrade	$ 348 million
EA-6B R&D	$ 78 million
Navstar Satellite	$ 197 million

Source: Electronic News

PROGRAMS EXEMPTED FROM CUTBACKS IN FY'86 (Continued)

DSCS-3 Communications Satellite	$142 million
Nuclear Detection Satellite	$ 44 million
T-45 Trainer	$116 million
AV-8B R&D	$ 65 million
T-56 Engine R&D	$ 45 million
VH-60 Presidential Aircraft	$103 million

Source: Electronic News

C³I BUDGET SUMMARY

	FY'86 ($B)	FY'87 ($B)	% Change
Defense Agencies RDT&E	$ 2.3	$ 2.7	19.6%
Army Procurement	2.3	3.1	35.6%
Army RDT&E	0.7	0.6	(8.5%)
Navy Procurement	1.1	1.5	29.0%
Navy RDT&E	2.1	2.4	12.4%
Air Force Procurement	3.0	4.2	41.2%
Air Force RDT&E	2.8	2.9	3.4%
Total:	$14.3	$17.4	21.7%

Source: Department of Defense

HASC ACTION ON FY'87 C^3I BUDGET

- Cut $1 billion in EW programs
- Cancelled Army's SHORAD and Aquila RPV programs
- Cancelled Navy's ASPJ and airborne EW; cut E-6A TACAMO
- Cut Air Force JSTARS to $0, Navstar to half
- Set SDI to $3 billion

However, much funding expected to be restored in HASC/SASC conference

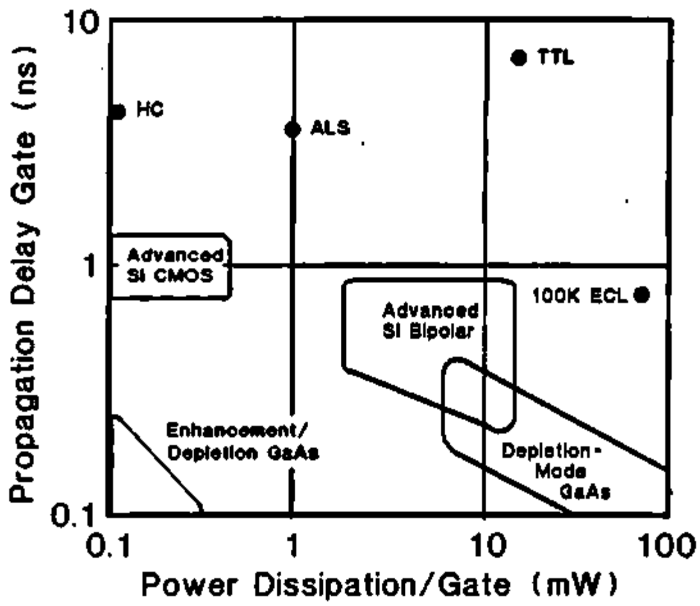
Source: Trade Press

TECHNOLOGY TRENDS

Driven by major program requirements

- SDI, smart–skin aircraft, compact radar
- Demand for performance
- VHSIC insertion
- DSP, AI, RISC architectures
- Photonics where practical

IC TECHNOLOGY COMPARISON

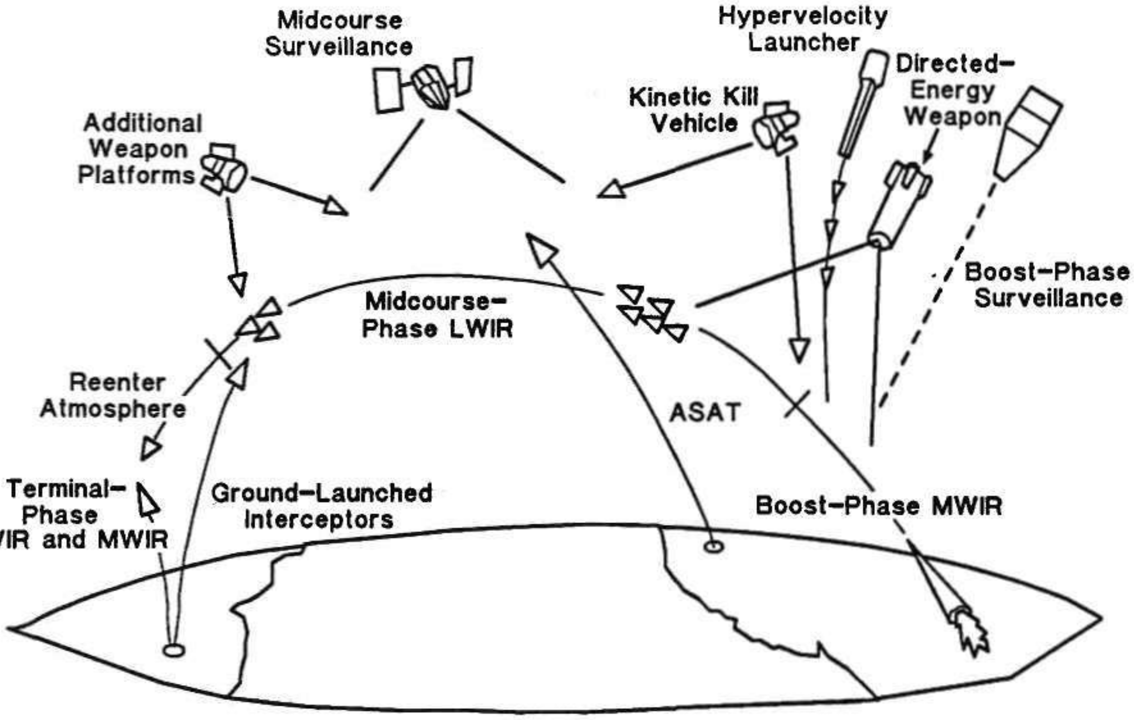


Source: Vitesse Electronics Corp.

PROJECTED 1990 MILITARY SIGNAL PROCESSING REQUIREMENTS

Application	Processing Improvement	Volume x Power Reduction	Reliability Improvement
Signal Intelligence	100x	3x	>10x
Radar	50-100x	4-10x	2-10x
Weapons Targeting	100x	16x	10x
Image Processing	200-500x	-	-
Wideband Communications	50-70x	4x	100x
ASW-Global Search	4000x	-	-
Electronic Warfare	1000x	-	-

Source: Naval Research Laboratory



Source: Honeywell

M I/MIMIC
MONOLITHIC MICROWAVE AND MILLIMETER-WAVE INITIATIVE

- Similar to VHSIC; GaAs instead of Si
- Four-phase program
  - Feasibility studies
  - Development
  - Pilot production
  - CAD/CAE, packaging, test technology
- Technology insertion ATF, MILSTAR, etc.
- Budget request exceeds $130 million

M^3I/MIMIC
MONOLITHIC MICROWAVE AND MILLIMETER-WAVE INITIATIVE

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MIL-M-38510 QPL SUPPLIERS AND PRODUCTS

	Logic/Memories/ASICs				MOS	A/Ds,	Op Amps, Other
	TTL	ECL	CMOS	NMOS	µPs	D/As	Linear
AMD	X						
Analog Devices						X	
Fairchild	X					X	X
GE/RCA			X				
Harris			X				

(Continued)

MIL-M-38510 QPL SUPPLIERS AND PRODUCTS (Continued)

	Logic/Memories/ASICs				MOS	A/Ds,	Op Amps, Other
	TTL	ECL	CMOS	NMOS	μPs	D/As	Linear
Intel				X	X		
Linear Tech.							X
MMI	X						
Motorola		X	X				
NSC	X		X				X

(Continued)

MIL-M-38510 QPL SUPPLIERS AND PRODUCTS (Continued)

	Logic/Memories/ASICs						
	TTL	ECL	CMOS	NMOS	MOS µPs	A/Ds; D/As	Op Amps, Other Linear
PMI						X	X
Raytheon	X					X	X
Signetics	X						
TI	X		X				
Zilog					X		

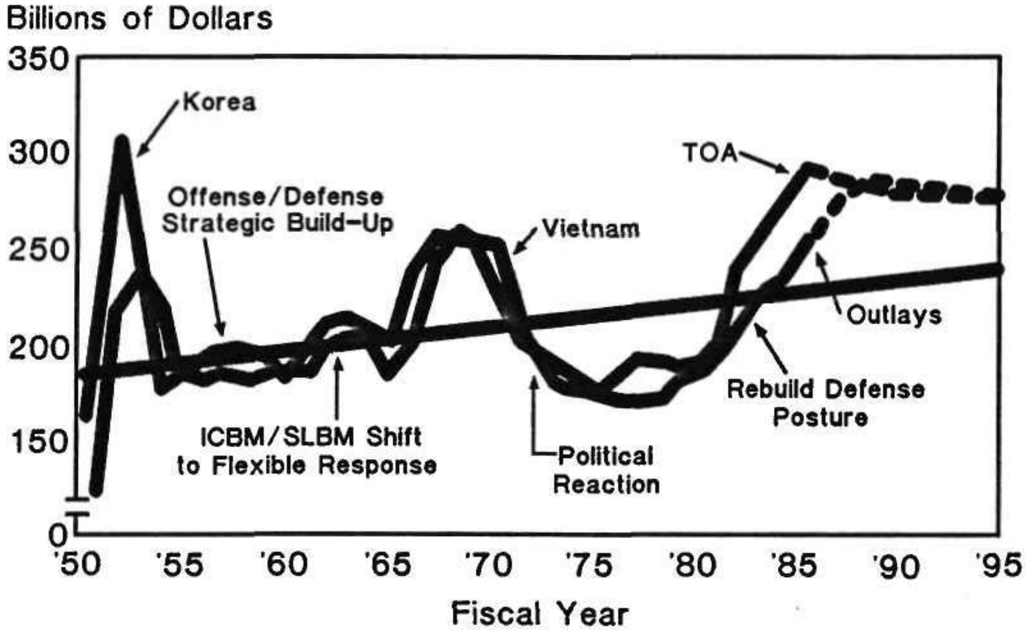
Source: Dataquest

IMPLICATIONS

- Major role for distribution
- Careful choice of alternate sources
- Continuing cost problems
- Use 883 parts where permissible

PRICE TRENDS

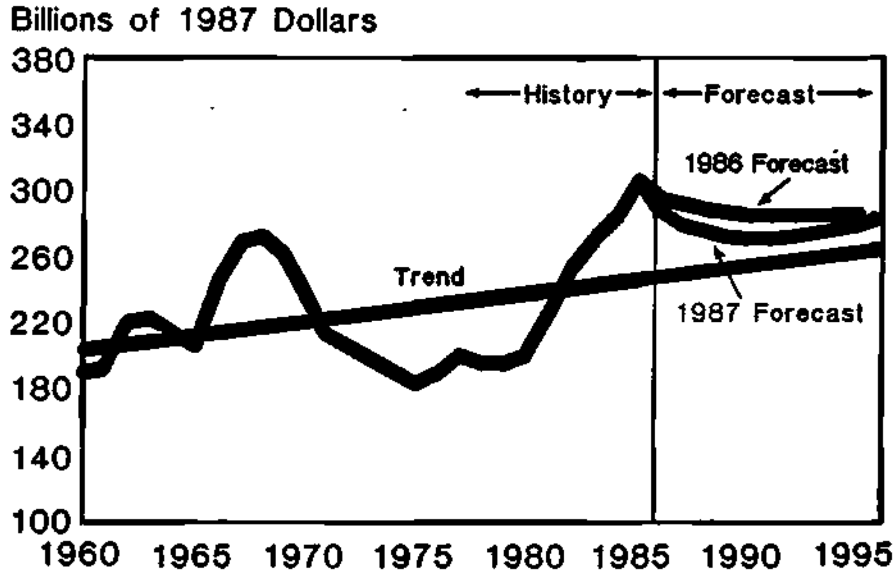
DEFENSE BUDGET TREND



Source: Microwave Journal

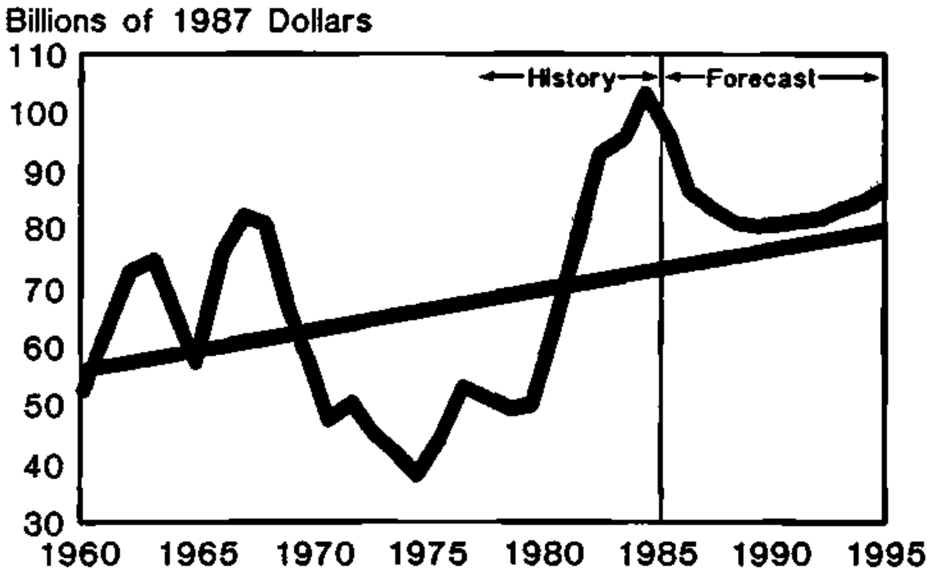
EIA DoD BUDGET AUTHORITY FORECASTS

1986 vs. 1987



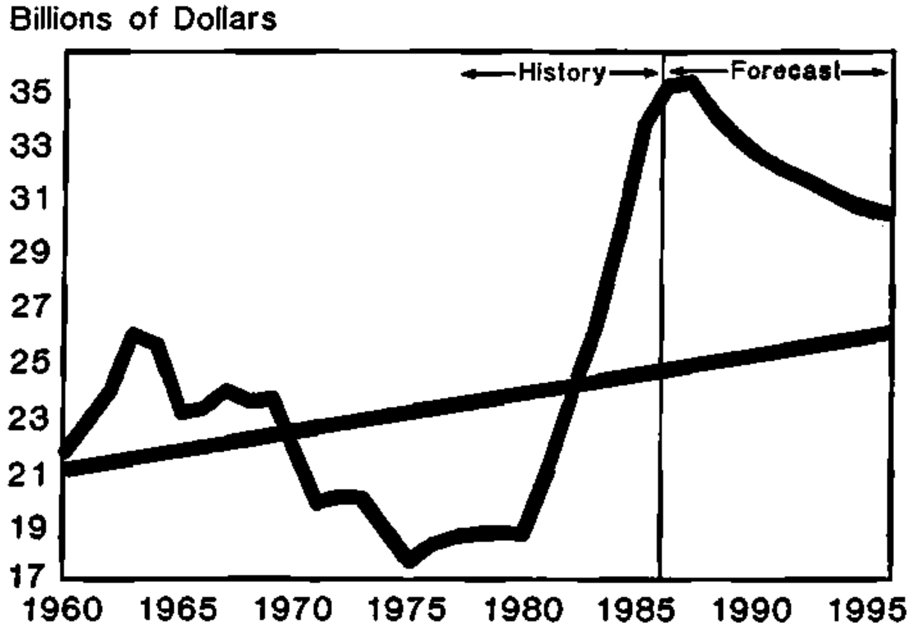
Source: EIA

DoD PROCUREMENT BUDGET AUTHORITY FORECASTS



Source: EIA

DoD RDT&E BUDGET AUTHORITY FORECASTS



Source: EIA

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ELECTRONIC CONTENT SUMMARY
TOTAL PROCUREMENT FORECAST
BY MAJOR PROGRAM

(In Constant FY 1987 Billions of Dollars)

Program	1985	1986	1987	1988	1989	1990
Aircraft	11.5	10.0	8.3	8.4	8.3	8.3
Missiles	4.9	6.0	6.1	5.9	5.7	5.6
Space	2.6	2.6	2.6	2.7	2.8	2.9
Ships	4.4	3.8	3.2	3.0	3.0	3.0
Ordnance & Weapons	1.3	1.2	1.1	1.1	1.1	1.1
Vehicles	1.1	0.9	0.9	0.9	0.9	0.9
Electronics & Communications	6.5	7.2	7.1	7.2	7.2	7.2
All Other	0.9	0.9	0.9	0.8	0.8	0.8
Total	33.3	32.6	30.2	30.0	29.6	29.7
Percent Change	-	(2.2)	(7.3)	(0.7)	(1.2)	0.3

Note: Columns may not total due to rounding.

Source: EIA

ELECTRONIC CONTENT SUMMARY TOTAL PROCUREMENT FORECAST BY MAJOR PROGRAM (Continued)

(In Constant FY 1987 Billions of Dollars)

Program	1991	1992	1993	1994	1995	1996
Aircraft	8.4	8.5	8.8	9.0	9.2	9.5
Missiles	5.6	5.5	5.5	5.5	5.5	5.4
Space	3.2	3.4	3.7	4.0	4.4	4.8
Ships	3.0	3.0	3.1	3.1	3.1	3.1
Ordnance & Weapons	1.1	1.2	1.2	1.2	1.3	1.3
Vehicles	0.9	1.0	1.0	1.0	1.0	1.0
Electronics & Communications	7.2	7.3	7.6	7.9	8.1	8.4
All Other	0.8	0.8	0.8	0.8	0.9	0.9
Total	30.2	30.8	31.7	32.7	33.5	34.3
Percent Change	1.5	2.0	2.9	3.1	2.5	2.6

Note: Columns may not total due to rounding.

Source: EIA

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ELECTRONIC CONTENT SUMMARY TOTAL RDT&E FORECAST BY MAJOR PROGRAM

(In Constant FY 1987 Billions of Dollars)

Program	1985	1986	1987	1988	1989	1990
Aircraft	1.7	1.7	1.6	1.6	1.6	1.5
Missiles	5.1	5.4	5.4	5.0	4.7	4.6
Space	2.5	3.0	3.3	3.6	3.8	4.0
Ships	0.6	0.6	0.6	0.5	0.5	0.5
Ordnance & Weapons	0.2	0.3	0.3	0.3	0.3	0.3
Vehicles*	0.0	0.0	0.0	0.0	0.0	0.0
Electronics & Communications	5.5	5.7	5.6	5.4	5.2	5.2
All Other	0.4	0.4	0.4	0.4	0.4	0.4
Total	16.1	17.1	17.3	16.9	16.6	16.5
Percent Change	–	6.4	1.0	(2.2)	(1.8)	(0.7)

*Less than $.05 billion per year
Note: Columns may not total due to rounding.

Source: EIA

ELECTRONIC CONTENT SUMMARY TOTAL RDT&E FORECAST BY MAJOR PROGRAM (Continued)

(In Constant FY 1987 Billions of Dollars)

Program	1991	1992	1993	1994	1995	1996
Aircraft	1.5	1.5	1.4	1.4	1.4	1.5
Missiles	4.5	4.4	4.1	3.9	3.8	3.8
Space	4.2	4.2	4.2	4.4	4.5	4.5
Ships	0.5	0.4	0.4	0.4	0.4	0.4
Ordnance & Weapons	0.3	0.2	0.2	0.2	0.2	0.2
Vehicles*	0.0	0.0	0.0	0.0	0.0	0.0
Electronics & Communications	5.3	5.3	5.3	5.3	5.5	5.4
All Other	0.4	0.4	0.4	0.4	0.4	0.4
Total	16.5	16.4	16.0	16.0	16.3	16.2
Percent Change	0.0	(0.6)	(2.7)	0.2	1.9	(0.4)

*Less than $.05 billion per year
Note: Columns may not total due to rounding.

Source: EIA

NORTH AMERICA
SEMICONDUCTOR CONSUMPTION FORECAST

(Millions of Dollars)

	1985	1986	1987	1991	86-91 CAGR (%)
Total Semiconductor	9,607	10,219	11,445	18,329	12.4
Total Integrated Circuit	7,710	8,214	9,414	15,735	13.9
Bipolar Digital	2,006	2,143	2,302	3,442	9.9
MOS	4,247	4,436	5,377	9,700	16.9
Linear	1,457	1,634	1,735	2,593	9.7
Total Discrete	1,528	1,599	1,612	2,008	4.7
Total Optoelectronic	369	406	419	586	7.6

Source: Dataquest

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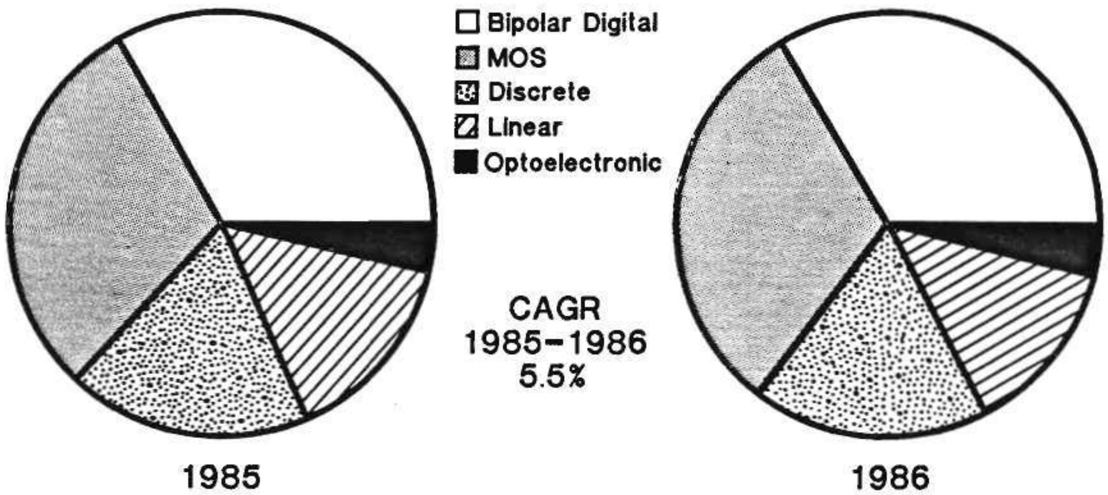
MILITARY SEMICONDUCTOR CONSUMPTION FORECAST



Source: Dataquest

MILITARY SEMICONDUCTOR CONSUMPTION FORECAST

(Millions of Dollars)

	1985	1986	1987	% Chg. 86-87
Total Semiconductor	1,486	1,567	1,803	15.1
Total Integrated Circuit	1,160	1,225	1,394	13.8
Bipolar Digital	498	529	571	7.9
MOS	442	487	578	18.7
Linear	220	209	245	17.2
Total Discrete	278	284	330	16.2
Total Optoelectronic	51	58	79	36.2

Source: Dataquest

SUMMARY

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PROCUREMENT OF MILITARY MICROELECTRONICS

Carl Salanitro
Materiel Manager of Corporate Procurement
Hughes Aircraft Company

Mr. Salanitro is currently Manager, Corporate Materiel, for Hughes Aircraft Company. He is responsible for overseeing procurement activities of approximately $500 million annually through the implementation of the Corporate Purchase Agreement. He joined Hughes in September 1969 and has held various positions in manufacturing and materiel. Mr. Salanitro's previous positions include Manager of Materiel at Hughes Microelectronic Circuits Division, where he managed purchasing, shipping, and receiving functions in support of hybrid microcircuit and semiconductor product lines, and Project Manager at Hughes Aircraft Radar Systems Group, where he was responsible for the preparation of cost estimates and proposals, organizing facilities and manpower, and allocating budgets. Mr. Salanitro has a Bachelor of Arts degree in Business from the University of California in Los Angeles.

Dataquest Incorporated
MILITARY IC PROCUREMENT
November 10, 1986
San Diego, California

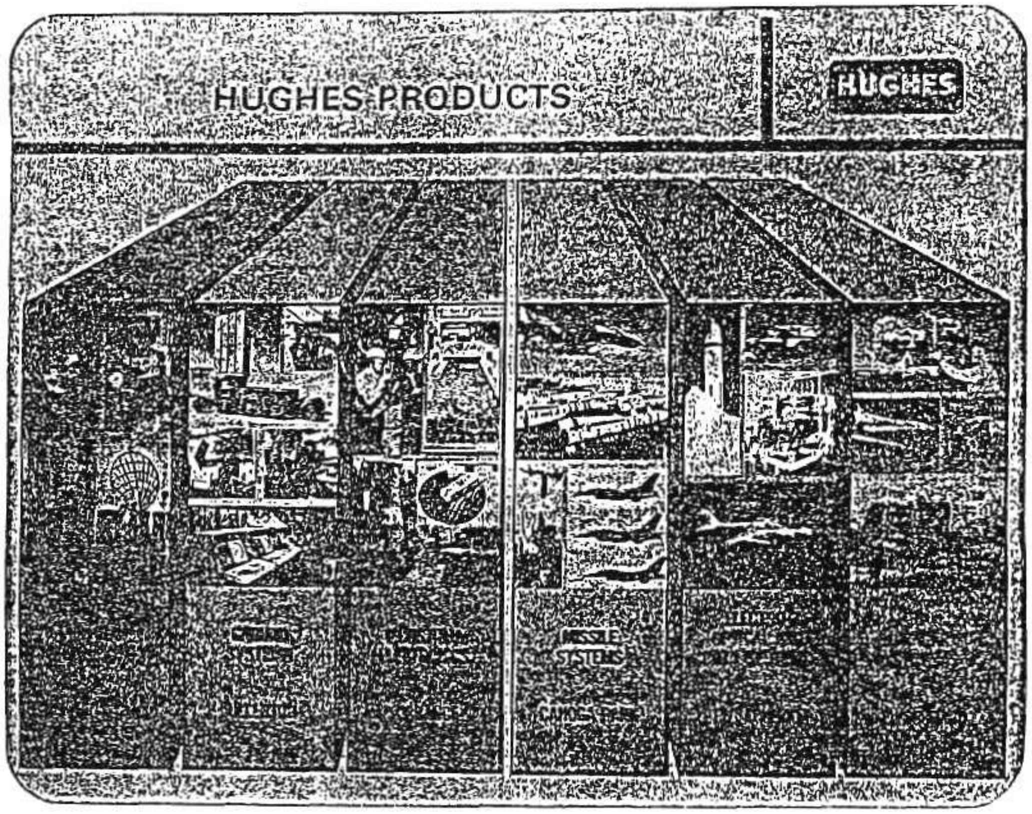
PROCUREMENT OF MILITARY MICROELECTRONICS

HUGHES
AIRCRAFT COMPANY

AGENDA

HUGHES

- HUGHES PRODUCTS
- MARKETPLACE RELATIVE TO HUGHES
- MILITARY DEMANDS
- IMPROVEMENTS INTERNALLY AND EXTERNALLY
- ETHICS



GEMINI

COMPARATIVE COMPLEXITY FACTORS

HUGHES

MEASUREMENT	RSG UNIT	CONSOLE	COMPUTER
POUNDS PER CUBIC FOOT	55	12	46
QUALITY REQUIREMENTS	MILITARY	"COMMERCIAL"	"COMMERCIAL"
PACKAGED CIRCUITS PER SQUARE INCH (CIRCUIT BOARD FACE)	2.33	1.04	0.75
BOARD COMPLEXITY	12 AND 14 LAYER MLBs (TWO PER MODULE)	TWO-SIDED PCBs	TWO-SIDED PCBs
TEST EQUIPMENT	AUTOMATED	AUTOMATED AND MANUAL	MANUAL
PRODUCTION TEST	AMBIENT, BURN-IN, TEMPERATURE CYCLING AND VIBRATION	AMBIENT	AMBIENT, BURN IN OF MODULES

COMPANY "CLOUT"

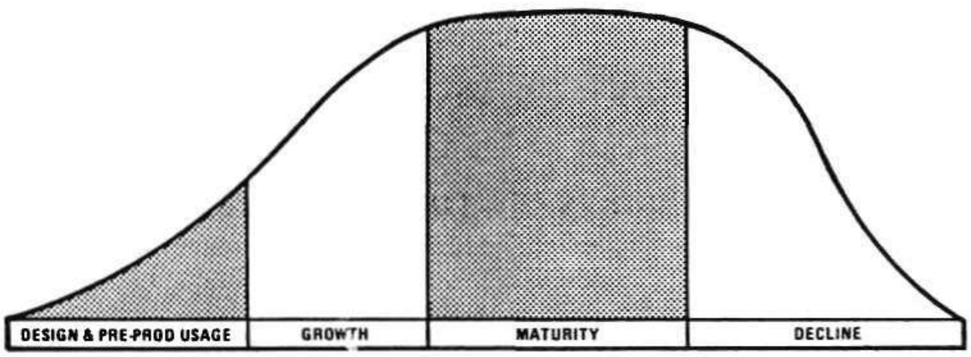
HUGHES

LIMITED:

- HIGH PRODUCT DIVERSITY
- DECENTRALIZED (FRAGMENTED REQUIREMENTS)
- SELDOM DOMINANT IN SUPPLIER'S MARKET

MICROELECTRONICS LIFE CYCLE

HUGHES



MILITARY SPECIFICATION PRIORITY

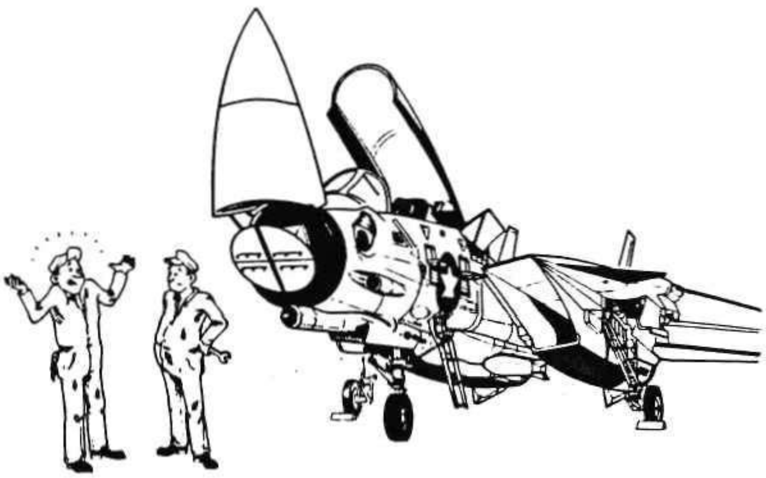
HUGHES

GOVERNMENT PUSH:

- MIL/JAN QPL MIL-S-1562
- JAN NON-QPL
- DESC SELECTED ITEM DRAWING MIL-S-883
- SOURCE CONTROL DRAWINGS - MIL-S-883

NON-PROCURABLE PART PROBLEMS

HUGHES



"THEY SAID THAT THE PART IS NON-PROCURABLE"

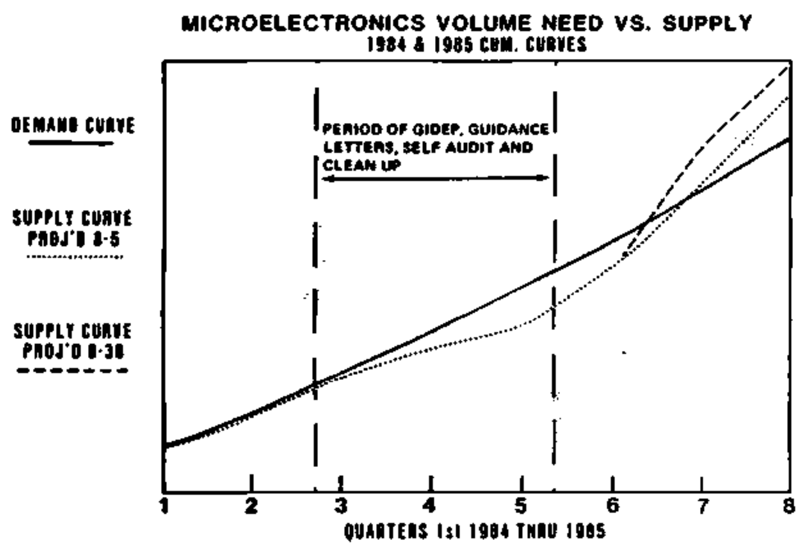
TURMOIL IMPACTS MARKETPLACE

HUGHES

- EARNINGS TO LOSSES
- PRODUCT LINES DROPPED
- COMPANY CLOSED
- PERSONNEL TURNOVER
- GIDEP ALERTS
- FAR EAST INFLUENCE
- ETC., ETC.

GIDEP IMPACT

HUGHES



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CONGRESS AND DOD

HUGHES

OBSESSIVE

COMPULSIVE

- THE (INSERT ADJECTIVE) PURSUIT OF COMPETITION

RELENTLESS

BLIND

STRATEGY CHOICES

HUGHES

COMPETITION	DUAL/MULTI SOURCES YEAR-TO-YEAR BUYS
PREFERRED VENDORS	FEWER SUPPLIERS LONG TERM RELATIONS

WHAT COMPETITION CAN DO

HUGHES

- INCENTIVIZES LOW PRICE BID
- INVITES ALTERNATIVE APPROACHES
- ENSURES VERSUS RISK
- SAFEGUARDS VERSUS FAVORITISM

WHAT COMPETITION BRINGS

HUGHES

- TIME CONSUMING BID PROCESS
- RFP EXPENSE (INSIDE AND OUT)
- OFTEN SINGLE SOURCE AFTER SELECTION

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COMPETITION
DOWN-SIDE RISKS

HUGHES

- "MINI AUCTION BY EXPEDITOR"
- MORE AND MORE DROP-OUTS
- REDUCED QUALITY
- HIGHER OVERALL COST

WHAT "PARTNERSHIP" BRINGS

HUGHES

- MUTUAL TRUST
- MINIMUM BUY/SELL EXPENSE
- NEED FOR STRONG MANAGEMENT
- NEED FOR "SHOULD-COST" SKILL

WHAT "PARTNERSHIP" CAN DO

HUGHES

- GIVES EARLY MUTUAL HELP
- ENCOURAGES SUPPLIER INVESTMENT
- PROMOTES TEAMWORK

DEMING: "YOU'RE LUCKY TO FIND ONE (GOOD SUPPLIER)".

PARTNERSHIP
DOWN-SIDE RISKS

HUGHES

- COMPLACENCY
- FEWER AND FEWER CHOICES
- SUPPLIER CHANGES COURSE
- HIGHER COST

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WHAT ABOUT TEAMWORK?

HUGHES

- COMMON GOOD
- MUTUAL TRUST
- COMMITMENT TO SHARED GOALS

IMPROVED INTERNAL OPERATION

HUGHES

- PARTS TECHNICAL MANAGEMENT
- STRATEGIC PLANNING
- STANDARIZATION
- TOTAL QUALITY SYSTEM

IMPROVEMENT PLAN WITH SUPPLIER BASE

HUGHES

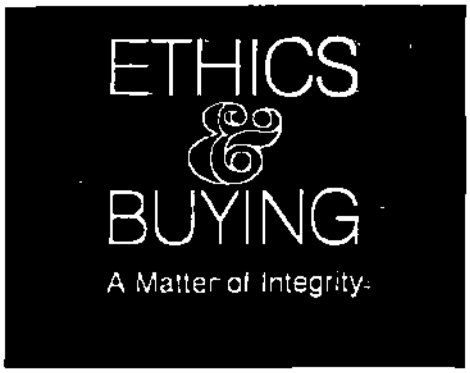
- LONG TERM AGREEMENTS
  - PROCUREMENT
  - TEAMING
- FORECASTING
- QUARTERLY MEETING

TQS SUPPLIER WORKSHOPS

HUGHES

ETHICS

HUGHES



IN SUMMARY

HUGHES

- HUGHES PRODUCTS
- MARKETPLACE RELATIVE TO HUGHES
- MILITARY DEMANDS
- IMPROVEMENTS INTERNALLY AND EXTERNALLY
- ETHICS

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PACKARD COMMISSION FINDINGS AND RECOMMENDATIONS

Jim Martin
Editor
Defense Science and Electronics
Rush Franklin Publishing, Inc.

Mr. Martin is the Editor of Defense Science and Electronics magazine. He has also authored numerous articles and reports on microcircuit technology and its impact on military systems. Mr. Martin has 15 years of experience in the industry, the last two of which have been with Defense Science and Electronics.

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MILITARY IC PROCUREMENT
November 10, 1986
San Diego, California

UNDERSTANDING THE PACKARD COMMISSION RECOMMENDATIONS

Jim Martin
Defense Science & Electronics

1. What were the Packard Commission's objectives?

2. What portions of the problem were addressed? ignored?

3. What are DoD's actual needs.

4. What are the recommendations of other organizations?
   - o The Navy.
   - o The Air Force.
   - o The Semiconductor Industry Association
   - o The National Science Board.
   - o ???

5. Purchase price vs cost of ownership: should that be the real question?

6. ASICs and the commercial/military question.

7. Some relevant technological trends.
   - o VHDL.
   - o VHSIC.
   - o Superchips & System Scale Integration.
   - o ???

8. What does "off the shelf" really mean?

9. Dealing with the Packard Commission Recommendations.

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MIL-STANDARD SPECIFICATION 883, MILITARY DRAWINGS, AND JAN: WHERE ARE THEY GOING?

Ronald Marfil
Director, Military/Aerospace Marketing
National Semiconductor Corporation

Mr. Marfil is the Director of Military/Aerospace Marketing at National Semiconductor Corporation. Previously, he was Military/Aerospace Marketing Manager for Advanced Micro Devices, Inc. Mr. Marfil has 19 years of experience in the industry, the last two of which have been with National Semiconductor Corporation.

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November 10, 1986
San Diego, California

MIL / AERO

THE SEMICONDUCTOR INDUSTRY ASSOCIATION

IS OPPOSED TO THE ELIMINATION

OF THE ORDER OF PRECEDENCE IN MIL-STD-454

National Semiconductor

MIL / AERO

WHY?

- JAN IS THE CORNERSTONE OF THE MIL SPEC SYSTEM. COMPLIANCE TO JAN FLOWS DOWN TO ALL GRADES OF PRODUCT.
- JAN B WOULD <u>CEASE TO EXIST</u> IN IT'S PRESENT FORM
- S LEVEL WOULD <u>CEASE TO EXIST</u> IN IT'S PRESENT FORM

National Semiconductor

WHY? CONT'D

- JAN ELIMINATION COULD RESULT IN A PROLIFERATION OF SCD'S.
- ANY DOMESTIC CAPACITY TO PRODUCE MILITARY GRADE SEMICONDUCTORS WOULD CEASE TO EXIST
- OUR DATA AND CUSTOMER INPUT INDICATE SUPERIOR QUALITY AND RELIABILITY RESULTS WITH JAN PRODUCT.

MIL / AERO

OFFSHORE JAN

- OFFSHORE JAN FACILITIES MUST HAVE D.E.S.C. CERTIFICATION.
- THE SAME RULES MUST APPLY AND BE APPLIED
- IS THE EXPERTISE IN PLACE? COMMITMENT? KNOWLEDGE?

National Semiconductor

LET'S NOT THROW OUT THE BABY

WITH THE BATH WATER!

FIX THE SYSTEM!

MIL / AERO

SUGGESTIONS

- GENERIC FAMILY QUALIFICATION VS. INDIVIDUAL DEVICE QUALIFICATION

  IF IT IS GOOD ENOUGH FOR GATE ARRAYS IT'S GOOD ENOUGH FOR GATES.

- ELIMINATION OF TESTS NO LONGER USEFUL

  WE ADD BUT DON'T SUBTRACT

- MAKE IT A DOLLARS AND SENSE ISSUE

  SCD'S USERS SHOULD BE CHARGED.

National Semiconductor

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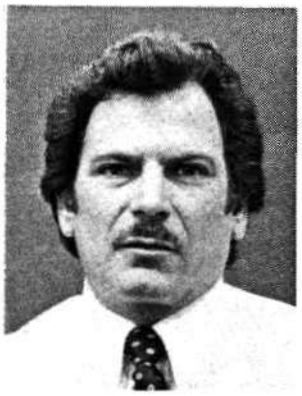
MIL-STANDARD SPECIFICATION 883, MILITARY DRAWINGS, AND JAN: WHERE ARE THEY GOING?



Steve Davis
Strategic Program Manager
Intel Corporation

Mr. Davis is the Strategic Program Manager for Intel Military Operations in Chandler, Arizona. Since joining Intel four years ago, Mr. Davis has held variouls positions in military marketing. Previously, he was a Divisional Distribution Marketing Manager at Fairchild Semiconductor. From 1966 to 1979, Mr. Davis held technical and marketing positions in the semiconductor and aerospace fields.

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November 10, 1986
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intel

NATIONAL CERTIFICATION/SURVEILLANCE

SYSTEM FOR MILITARY SEMICONDUCTORS

STEVE DAVIS
STRATEGIC PROGRAM MANAGER
INTEL MILITARY OPERATIONS
(602) 961-2806

CMD MILITARY OPERATION

intel

NATIONAL ELECTRONIC COMPONENTS QUALITY
CERTIFICATION SYSTEM

<u>WORLD WIDE</u>

INTERNATIONAL ELECTROSTANDARDS COMMISSION (IECQ)

<u>UNITED STATES</u>

ELECTRONIC COMPONENTS CERTIFICATION BOARD

<u>EXECUTION</u>

UNDERWRITERS LABORATORY (UL)

CMD MILITARY OPERATION

intel

QUALITY ASSURANCE SYSTEM

INDUSTRY ASSOCIATIONS

TECHNICAL COMMITTEE

DOCUMENTATION: STANDARDS/DEFINITIONS

FACILITY AND CAPABILITY APPROVAL

1. MANUFACTURER'S CERTIFICATE OF CONFORMANCE
2. AUDITS/SURVEILLANCE (THIRD PARTY)
3. MANUFACTURER'S INTERNAL AUDITS
4. MANUFACTURING REPORTING
5. USER FEED BACK

CMD MILITARY OPERATION

intel

SIA
GOVERNMENT PROCUREMENT COMMITTEE

THE SIA CONTINUES TO SUPPORT DESC AS THE CERTIFYING/QUALIFICATION ACTIVITY FOR ALL JAN PRODUCT LINES.

SIA SUPPORTS THE CONCEPT OF A SINGLE NATIONAL CERTIFICATION SYSTEM FOR SURVEILLANCE OF MILITARY SEMICONDUCTOR SUPPLIERS TO ASSURE COMPLIANCE TO DOD REQUIREMENTS <u>PROVIDED THAT</u>:

CMD MILITARY OPERATION

intel

SIA
GOVERNMENT PROCUREMENT COMMITTEE

NATIONAL CERTIFICATION SYSTEM

1. THE SYSTEM FULLY MEETS THE REQUIREMENT FOR CONTROL OF SUPPLIERS IMPOSED ON THE EQUIPMENT MANUFACTURERS BY THE DoD.

2. THE DoD SUPPORTS THE SYSTEM AND RECOGNIZES IT AS A REPLACEMENT FOR THE MANY INDIVIDUAL EQUIPMENT MANUFACTURERS AUDITS CURRENTLY BEING CONDUCTED AND THAT DoD CERTIFIES THIS SYSTEM MEETS THE SURVEILLANCE REQUIREMENTS THEY IMPOSE ON THE OEMs.

3. THE DoD MANDATES EQUIPMENT MANUFACTURERS TO UTILIZE THE SYSTEM IN PLACE OF THEIR CURRENT SURVEILLANCE SYSTEM.

CMD MILITARY OPERATION

intel

BENEFITS

COST SAVINGS FOR DOD/OEMS/SUPPLIERS

CONSISTENCY - IN METHODOLOGY

UNIFORMITY IN QUALITY

CMD MILITARY OPERATION

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MIL-STANDARD SPECIFICATION 883, MILITARY DRAWINGS, AND JAN: WHERE ARE THEY GOING?

Arney C. Stensrud
Director of Strategic Marketing
and Government Relations
Motorola, Inc.

Mr. Stensrud is Director of Strategic Marketing and Government Relations for the Military Products Operation at Motorola, Inc. He has been with Motorola for 11 years, serving as an Operations Manager and Director of Marketing for the Government Electronics Group and in his current position. Mr. Stensrud has 29 years of experience in the military weapon systems business, working in engineering, design, development, and systems integration for airborne and shipborne weapon systems. Previously, he was Director of Marketing for Kaiser Aerospace, Director of Advance Development for Ball Brothers Research, and Engineering and Operations Manager at Sylvania Electonic Systems. Mr. Stensrud received a B.S. degree in Electrical Engineering from South Dakota State College and an M.S.E.E. degree from Northeastern University. He also completed an M.B.A. degree at Northeastern University.

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MILITARY IC PROCUREMENT
November 10, 1986
San Diego, California

DATAQUEST MILITARY IC PROCUREMENT CONFERENCE

10 NOVEMBER 1986
SAN DIEGO, CALIFORNIA

SEMICONDUCTOR PLASTIC PACKAGE SPECIFICATIONS FOR USE IN MILITARY ENVIRONMENTS

PRESENTED BY:
ARNEY C. STENSRUD
DIRECTOR OF STRATEGIC MARKETING
MILITARY PRODUCTS OPERATION
MOTOROLA, INC.

THE DEFENSE SCIENCE BOARD SUMMER STUDY RECOMMENDED THE ACCELERATED USE OF 'RUGGEDIZED' INDUSTRIAL DEVICES IN MILITARY SYSTEMS.

THE DSB ALSO RECOMMENDED THAT AN ACTION ITEM WAS NEEDED TO IMPLEMENT THE RECOMMENDATION.

ACTION ITEM

It is recommended that the Automotive Industry specifications for rugged industrial plastic semiconductors be adopted by DoD since they provide the capability to produce plastic encapsulated integrated circuits that will operate in a -40 C to +125 C environment with high quality and high reliability.

SIA POSITION ON USE OF COMMERCIAL IC PRODUCTS IN MILITARY ENVIRONMENTS

CAUTION SHOULD BE USED REGARDING MILITARY APPLICATIONS

- THE MILITARY ENVIRONMENT SYSTEM APPLICATION LIST PRESENTED BY THE DEFENSE SCIENCE BOARD IS TOO BROAD
- SYSTEM APPLICATIONS SHOULD BE LIMITED UNTIL A DATA BASE CONFIRMS RELIABILITY OF MOLDED DEVICES
- MOLDED PACKAGES ARE NOT HERMETIC. SOME FORM OF EXTERNAL PACKAGING MUST BE DEVISED TO PROTECT MOLDED PACKAGE

THE DEFENSE ELECTRONIC SUPPLY CENTER SHOULD BE THE QUALIFYING AGENCY

- A STRONG CENTRAL ORGANIZATION IS NEEDED TO REPERESENT THE MILITARY COMMUNITY
- REQUIRE EACH VENDOR TO HAVE A DESC CERTIFIED PROCESS LINE
- REQUIRE EACH VENDOR TO HAVE A DESC CERTIFIED INTERNAL QUALIFYING ACTIVITY

A TECHNICAL PANEL OF INDUSTRY/GOVERNMENT MEMBERS WRITE THE INDUSTRIAL PLASTIC SPEC

- WRITE THE MILITARY VERSION OF THE AUTOMOTIVE INDUSTRIAL PLASTIC SPECIFICATION
- EDUCATE THE MILITARY USERS ON THE SPECIAL CHARACTERISTICS OF MOLDED PACKAGES

DATAQUEST MILITARY IC PROCUREMENT CONFERENCE — MOTOROLA INC.

ESTABLISH CENTRAL CONTROL OF THE PLASTIC SPECIFICATIONS

- ELECTRICAL AND PACKAGE SPECIFICATIONS MUST BE CENTRALLY CONTROLLED FOR CONFIGURATION CONTROL
- DESC SHOULD ESTABLISH A NEW MILITARY DRAWING SYSTEM TO ASSURE STANDARDIZATION

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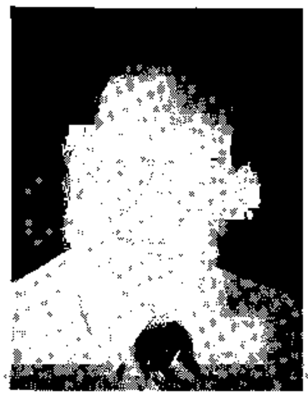
MIL-STANDARD SPECIFICATION 883, MILITARY DRAWINGS, AND JAN: WHERE ARE THEY GOING?



Mark S. Cooper
Manager, Components Engineering
Litton Guidance and Control Systems

Dr. Cooper is Manager of Components Engineering at Litton Guidance and Control Systems. Since joining Litton, he has held management and staff positions in integrated circuit specification, integrated circuit test, and radiation characterization of components. Previously, he performed radiation characterization and testing and radiation systems analysis work for GTE Sylvania and the Aerospace Corporation. Dr. Cooper received a B.S. degree in Electrical Engineering from the City University of New York, an M.S.E.E. degree from the Massachusetts Institute of Technology, and a Ph.D. degree in Physics from the University of California at Berkeley.

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MILITARY IC PROCUREMENT
November 10, 1986
San Diego, California

LITTON VIEW OF

MICROELECTRONICS PROCUREMENT

LITTON IS THE PREDOMINANT SUPPLIER OF INERTIAL NAVIGATION SYSTEMS TO THE MILITARY. LITTON SYSTEMS ARE MAINLY USED IN TACTICAL ENVIRONMENTS, SUCH AS FIGHTER AIRCRAFT, SOME MISSILE SYSTEMS (INCLUDING CRUISE MISSILE), SHIPS NAVIGATION, AND LAND NAVIGATORS FOR TANKS AND JEEPS.

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LITTON PROCUREMENT PREFERENCES

MICROCIRCUITS

- JAN M38510
- MIL DRAWING
- LITTON SELECTED ITEM DRAWING

SEMICONDUCTORS

- JANTX
- JANTXV
- LITTON SELECTED ITEM DRAWING

GENERAL

- BUY DIRECT (NOT DISTRIBUTION)
- HEAVY SUPPLIER CONTACT ESSENTIAL TO SOLVE PROBLEMS

LITTON PREFERS M38510 AND JANTX GRADE PRODUCT. QUALITY LEVEL OF THESE PRODUCTS IS SUPERIOR - LOWER REJECTS IN ELECTRICAL TEST AND FEWER MAJOR PRODUCTION LINE QUALITY/RELIABILITY PROBLEMS. JANTXV LEVEL PRODUCT IS USUALLY NOT REQUIRED IN OUR SYSTEMS. LITTON DOES REQUIRE SOME SELECTED ITEMS FOR CIRCUIT PECULIAR APPLICATIONS (CHEAPER THAN SELECT IN TEST, OR MIX AND MATCH MAJOR ASSETS).

LITTON PREFERS TO BUY DIRECT SO THAT PROBLEMS (IF THEY OCCUR) CAN BE WORKED DIRECTLY WITH SUPPLIERS. ALSO, PROLIFERATION OF DATE CODES MAY BE MINIMIZED.

LITTON VIEW OF MIL DRAWINGS

- LITTON FULLY SUPPORTS MIL DRAWING SYSTEM
- FIRST LOT PROCUREMENT TO UNRELEASED SPEC IS A PROBLEM
- MIL DRAWINGS WEAK IN DETAILED ELECTRICAL TEST DOCUMENTATION (M38510 SLASH SHEETS PREFERABLE)
- WOULD BE BETTER IF SUPPLIER WROTE DRAWINGS
- A FEW SELECTED ITEMS WILL STILL BE NECESSARY
- ALTERED ITEM DRAWINGS REQUIRED FOR PROM/PAL PATTERNS, ASIC PERSONALIZATION

MIL DRAWING SYSTEM IS BEING IMPLEMENTED NOW, SO THAT LARGE MAJORITY OF NEW LITTON IC PROCUREMENT WILL USE MIL DRAWINGS. M38510 PARTS ARE BETTER IN DOCUMENTATION OF TEST METHODS - ESSENTIAL FOR CORRELATION AND AIDS CIRCUIT DESIGNER IN CORRECTLY APPLYING THE PART.

LITTON WOULD PREFER A SYSTEM WHERE SYSTEM DESIGNERS WOULD IDENTIFY PARTS NEEDS AND THE PART SUPPLIER WOULD HAVE THE MAJOR ROLE IN DRAFTING THE MIL DRAWINGS. MILITARY HAS ELECTED TO MAKE THE OEM (CONTRACTOR) THE PRIME AGENT FOR DRAFTING THE MIL DRAWING.

POTENTIAL CHANGES TO MILITARY REQUIREMENTS

DRIVING FUNCTION

- MILITARY CUSTOMERS APPLYING MUCH HIGHER RELIABILITY CRITERIA AT ALL PHASES OF SYSTEM BUILD
- MILITARY REQUIRING ENVIRONMENTAL STRESS SCREENING OF PARTS, CARDS, SYSTEMS

POSSIBLE ADDITION TO MIL-STD DEVICE SCREENING

- PIND TEST OPTION
- LARGER NUMBER OF TEMP CYCLES (100-200 CYCLES)
- REQUIRE 100% ELECTRICAL TEST (NO SAMPLING)

MAJOR REMAINING QUALITY ISSUES

- SUPPLIERS SHOULD COMPLETELY DOCUMENT ELECTRICAL TEST CONDITIONS
- ELECTRICAL TEST CORRELATION EFFORTS MUST SUBSTANTIALLY INCREASE
- SOLDERABILITY CHRONIC PROBLEM
- HERMETICITY TEST SHOULD BE DONE JUST BEFORE OR AFTER FINAL ELECTRICAL TEST
- LITTON PRODUCTION LINE REQUIRES DEFECT LEVEL LESS THAN 200 PPM
- FUTURE AIR FORCE CONTRACTS MANDATE LESS THAN 100 PPM DEFECT LEVEL AT PART LEVEL

THE MILITARY IS JUSTIFYING MOST NEW ELECTRONICS EQUIPMENT TO CONGRESS ON REDUCED MAINTENANCE DUE TO ENHANCED RELIABILITY. VERY STRINGENT AND EXTENSIVE SYSTEM LEVEL BURN-IN, TEMPERATURE CYCLING, AND RANDOM VIBRATION CONTRACTUALLY MANDATED TESTING HAS NOW BEEN IMPOSED ALSO AT LOWER LEVEL. ENVIRONMENTAL STRESS SCREENING, INCLUDING PARTS OF THE THREE STRESSES MENTIONED ABOVE, ARE NOW BEING CONTRACTUALLY REQUIRED ON THE CARD ASSEMBLIES AND PIECE PARTS. THE INDICATED CHANGES WOULD REPRESENT THE LOGICAL PROGRESSION OF THESE REQUIREMENTS FROM THE OEM TO THE PART SUPPLIER.

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LITTON SEES THE CHIEF QUALITY ISSUES AS NEW REQUIREMENTS FOR VERY LOW DEFECTS IN ELECTRICAL CHARACTERISTICS AND PACKAGING (INCLUDING HERMETICITY) AND THE UNSOLVED SOLDERABILITY PROBLEM. AT PRESENT, LITTON CAN ACHIEVE ACCEPTABLE QUALITY PRODUCT IN OUR FACTORY PRODUCTION LINE ONLY WITH EXTENSIVE RECEIVING INSPECTION TESTING INCLUDING 100% ELECTRICAL TEST OF MICROELECTRONICS. A SUBSTANTIAL CORRELATION EFFORT IS NEEDED IN ADDITION TO THE SPECIFICATION STANDARDIZATION OF MIL-STD-883 REVISION C AND MIL DRAWINGS.

Litton GUIDANCE & CONTROL SYSTEMS

SUPPLIER QUALITY VERIFICATION

MICROELECTRONICS

TEST OR INSPECTION / COMMODITY	ELECTRICAL		POSTCAP VISUAL	BOND PULL DIE SHEAR	SOLDER-ABILITY (LOT SAMPLE)	MARKING (LOT SAMPLE)	HERMETICITY (100%)	PIND TEST (100%)
	TEMPERATURE EXTREMES (100%)	AMBIENT (100%)						
DIGITAL INTEGRATED CIRCUITS	X		LOT SAMPLE EACH D/C		X	X	X	[1]
LINEAR INTEGRATED CIRCUITS	X	X	LOT SAMPLE EACH D/C		X	X	X	[1]
TRANSISTORS AND DIODES	SAMPLE	X			X	X	X [2]	[1]
HYBRIDS	X	LINEAR ONLY	SAMPLE EACH LOT	SAMPLE EACH LOT	X	X	X	[1]
SUPER HYBRIDS	X [3]	X [3]	100% PRECAP	SAMPLE EACH LOT [3]	X	X	X	X

[1] SELECTIVE DEVICES BASED ON VENDOR AND HISTORY
[2] AXIAL LEAD DIODES EXEMPTED
[3] SOURCE INSPECTION

THIS CHART IS A SYNOPSIS OF LITTON RECEIVING INSPECTION TESTING POLICY FOR MICROELECTRONICS. NOTE THAT ICs ARE 100% TESTED AT THE -55°C AND +125°C FOR FULL ELECTRICAL CHARACTERISTICS (DC, FUNCTIONAL AND AC).

RECEIVING INSPECTION TEST DATA

		FY 1985			FY 1986 (11 months)		
MAJOR ITEMS	UNIT	INSP/TEST	REJECTED	% REJ	INSP/TEST	REJECTED	% REJ
HYBRIDS							
ELECTRICAL	PARTS	100,800	2,860	2.8	75,700	1,056	1.4
HERMETICITY	PARTS	102,500	943	0.9	97,900	509	0.5
PIND	PARTS	8,500	30	0.4	10,650	71	0.7
SOLDERABILITY	LOTS	1,020	27	2.6	915	20	2.2
PRE-CAP INSPECTION	PARTS	32,800	1,433	4.4	51,000	1,153	2.3
POST CAP	LOTS	680	10	1.5	550	3	0.5
I.C.'S							
ELECTRICAL	PARTS	802,000	11,350	1.4	1,397,800	11,425	0.8
HERMETICITY	PARTS	294,600	240	0.08	521,100	314	0.06
PIND	PARTS	45,860	320	0.7	21,302	24	0.1
SOLDERABILITY	LOTS	590	22	3.7	2,783	350	12.6
POST CAP INSPECTION	LOTS	2,574	15	0.6	2,744	19	0.7
SEMICONDUCTORS							
ELECTRICAL	PARTS	754,200	5,040	0.67	1,272,150	6,617	0.5
HERMETICITY	PARTS	594,000	492	0.08	498,600	1,115	0.2
SOLDERABILITY	LOTS	3,246	100	3.1	2,783	370	13.3

NOTE ON THIS CHART THAT ELECTRICAL TEST REJECT RATE IS IMPROVING BUT REMAINS UNACCEPTABLE (DOES NOT ALLOW SAMPLE TEST). THIS DATA IS SIMILAR TO THAT OBSERVED AT MOST OEMs WITH SIMILAR TEST.

RECEIVING INSPECTION TEST DATA (CONT'D.)

COMPARISON OF QUALITY LEVEL AND REJECTS

M38510	0.3 - 0.5%	0.3%	(MOST RECENT - 6 MONTHS)
883	0.7 - 1.5%	1.0%	" " " "
SELECTED ITEMS	1.3 - 2.0%	1.4%	" " " "

COMPARISON OF ELECTRICAL REJECT RATE OF PARTS PROCURED TO M38510, MIL-STD-883 AND AS A SELECTED ITEM SHOWS THE SUPERIOR QUALITY OF M38510 AND THE ADVISABILITY OF USING A STANDARD PART (WHERE IT WILL WORK IN THE CIRCUIT).

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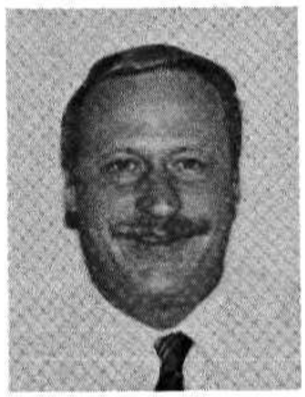
MIL-STANDARD SPECIFICATION 883, MILITARY DRAWINGS, AND JAN: WHERE ARE THEY GOING?



Ron Williams
Manager of JAN/Space Products
Texas Instruments

Mr. Williams is Manager of JAN/Space Products for the Military Products Division of Texas Instruments Semiconductor Group. Mr. Williams has been with the company for 18 years and has held his current position since January 1985. Previously, he served as the Washington Representative for the Semiconductor Group from 1983 to 1985 and as Managing Director of TI Spain from 1980 to 1983. Prior to that, he was Quality Manager for TI Houston and was in field sales for six years. Mr. Williams received a Bachelor of Science degree from Arizona State University and a Doctor of Jurisprudence from South Texas College of Law in Houston.

Dataquest Incorporated
MILITARY IC PROCUREMENT
November 10, 1986
San Diego, California

S I A

MILITARY SEMICONDUCTOR PROCUREMENT

TRENDS OF THE 80'S

MILITARY DRAWING SYSTEM

RONALD E. WILLIAMS

MANAGER, JAN/SPACE PRODUCTS
MILITARY PRODUCTS DIVISION
SEMICONDUCTOR GROUP
TEXAS INSTRUMENTS

SEMICONDUCTOR INDUSTRY ASSOCIATION

S I A

MILITARY SEMICONDUCTOR PROCUREMENT

TRENDS OF THE 80'S

THE SIA FULLY SUPPORTS THE MILITARY DRAWING SYSTEM TO PROMOTE STANDARDIZATION WITHIN THE SEMICONDUCTOR INDUSTRY AND OEM'S.

SEMICONDUCTOR INDUSTRY ASSOCIATION

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MILITARY SEMICONDUCTOR PROCUREMENT

TRENDS OF THE 80'S

MILITARY DRAWING SYSTEM ISSUES

- CYCLE TIME
- S.C. NEW PRODUCT RELEASE/ OEM NEW DESIGN-REDESIGN
- ORDER PLACEMENT
- CERTIFICATION REQUIREMENTS

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MILITARY SEMICONDUCTOR PROCUREMENT

TRENDS OF THE 80'S

MILITARY DRAWING SYSTEM CYCLE TIME

- OEM's require 30 days from time need is recognized
- Current DESC cycle time is 90 - 150 days
- Alternatives for quick cycle time - A "Crutch"
  - Interim drawing specifying manufacturers documentation
  - One page drawing listing manufacturers part number
  - OEM and program work out specifics
- Let's design a system that meets the 30 day requirement
  - DO IT RIGHT THE FIRST TIME
- During the design of "System 30" use alternative two
- When a JAN slash sheet is available, use it

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MILITARY SEMICONDUCTOR PROCUREMENT

TRENDS OF THE 80'S

MILITARY DRAWING SYSTEM
NEW PRODUCTS/NEW DESIGNS

- Current practice requires OEM to request Mil Drawing
- SC manufacturers should be required to release all new military products to a Mil Drawing
- New OEM designs and redesigns should be required to be released only with product which has a Mil Drawing or JAN slash sheet
- No new SCD's should be generated.
- "System 30" DESC can't do it all
  - OEM-Focus on conversion of existing SCD's to Mil Drawings
  - SC Suppliers-New military product release require Mil Drawings
  - DESC-OEM new design requirements

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MILITARY SEMICONDUCTOR PROCUREMENT

TRENDS OF THE 80'S

MILITARY DRAWING SYSTEM
ORDER PLACEMENT

- CURRENT PRACTICE:
  - OEM writes SCD which specifies MIL Drawing or JAN part number
  - OEM orders by SCD number
  - Supplier forced to treat as SCD and review print
- RESULT: Multiple SCD's from multiple customers for same generic part
- OEM's must place orders with suppliers using Military Drawing number or JAN part number

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MILITARY SEMICONDUCTOR PROCUREMENT

TRENDS OF THE 80'S

MILITARY DRAWING SYSTEM CERTIFICATION REQUIREMENTS

- All suppliers must have at least one JAN certified line
  - Assures proper understanding of discipline and requirements
  - One year to comply, extension by exception

- All suppliers must be compliant to MIL-STD-883C, Para. 1.2.1
  - Qualifying activity certified by DESC
  - One year to comply, extension by exception

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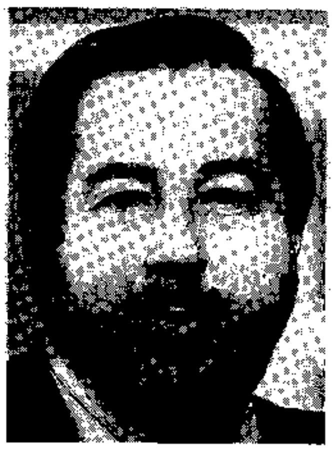
MILITARY PACKAGING--IMPACT OF PACKAGING CHANGES ON MILITARY PROCUREMENT



David H. Francis
President, Micro Process Technology
Consultant, Dataquest Incorporated

Mr. Francis is President and Founder of Micro Process Technology, a company that publishes technical newsletters on surface-mount and interconnection technology, and also serves as a consultant to Dataquest. Prior to forming his current company, Mr. Francis was Director of Engineering for the IC Packaging Group at Borns. Previously, he started and operated a hybrid company. He also spent 10 years at Motorola, where he was primarily involved in hybrid circuit and packaging technology. Mr. Francis received a B.S. degree in Electrical Engineering from Newark College of Engineering and an M.S. degree in Industrial Engineering from Arizona State University.

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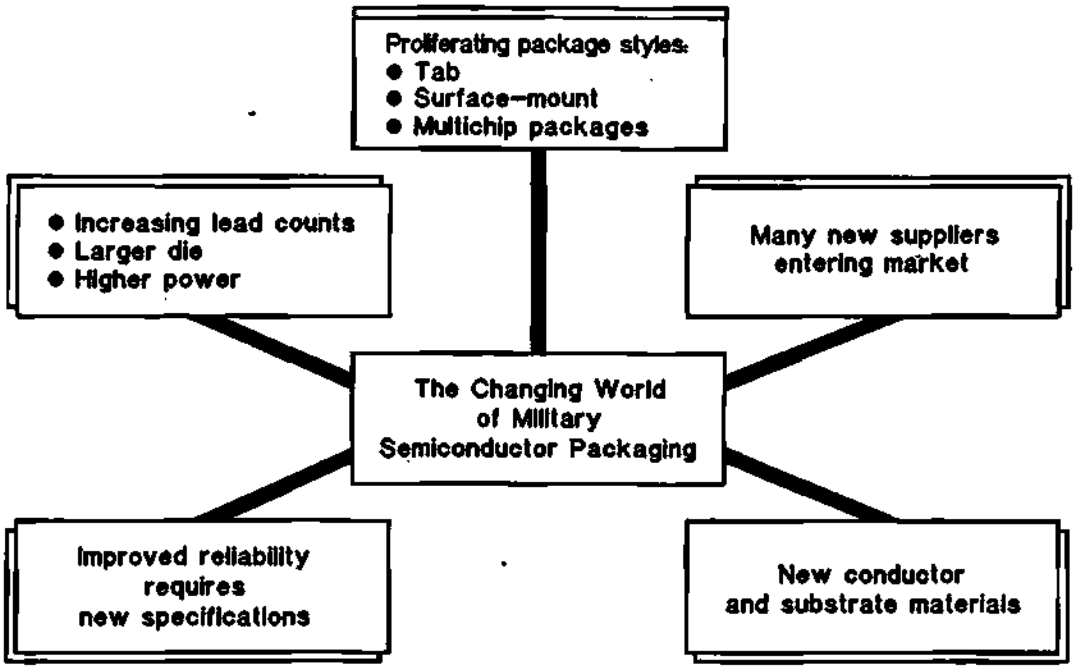

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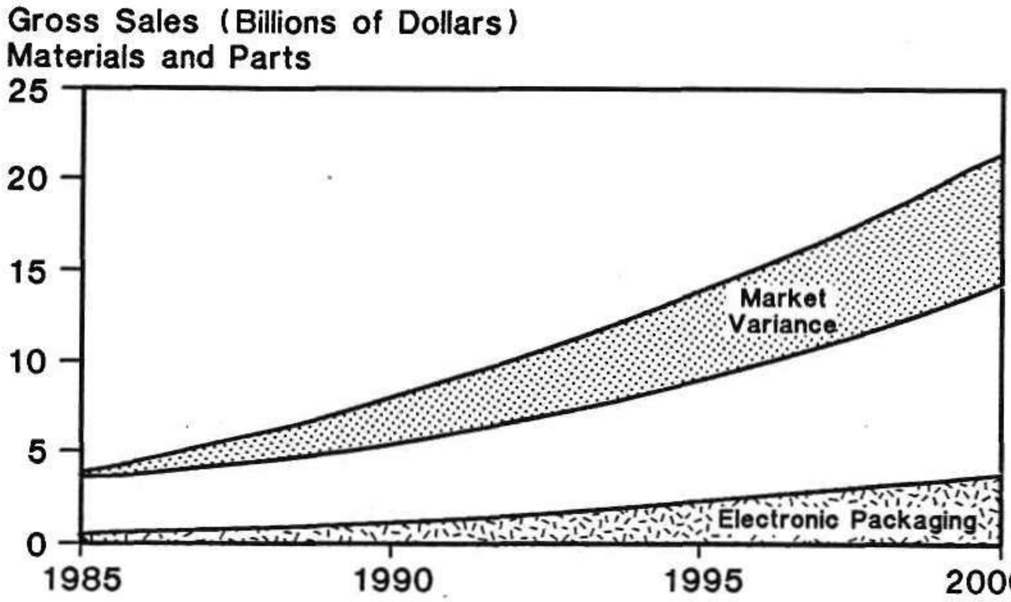
MARKET OUTLOOK FOR FINE CERAMICS

MITI Survey



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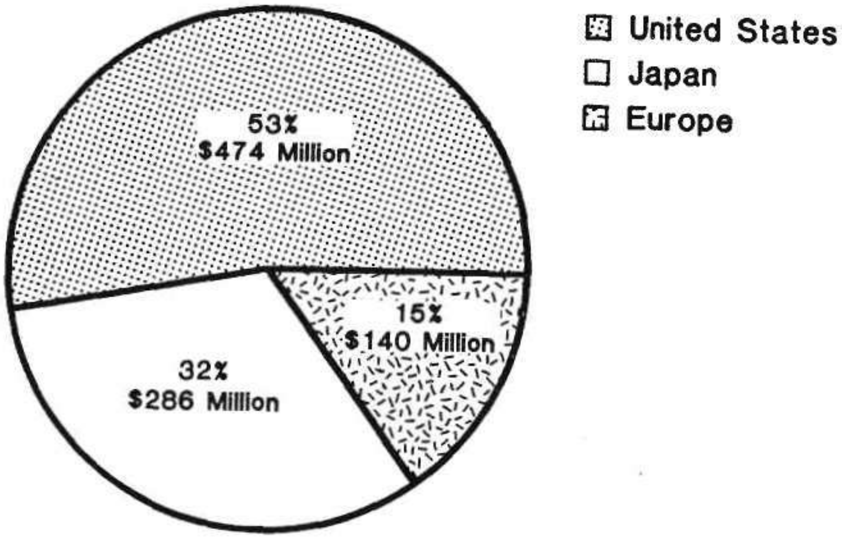
WORLDWIDE CERAMIC PACKAGE MARKET



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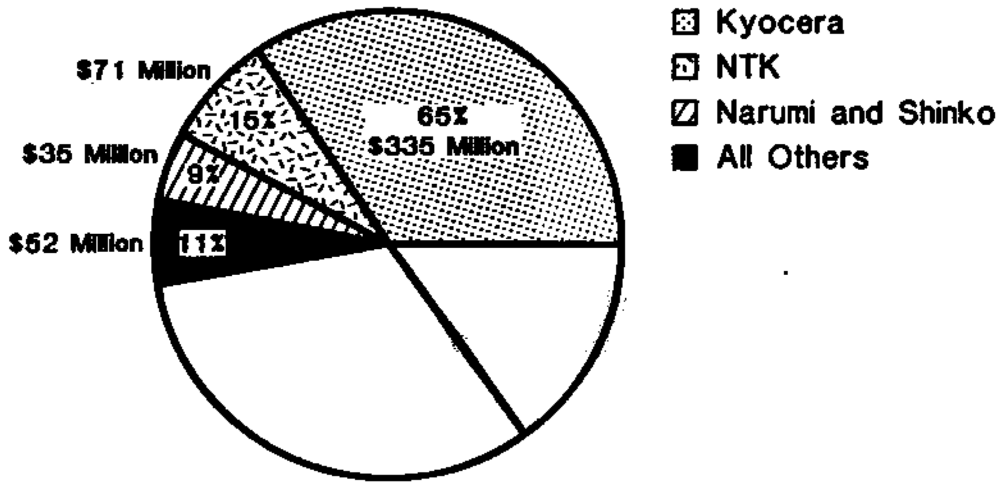
U.S. MARKET

$474 Million



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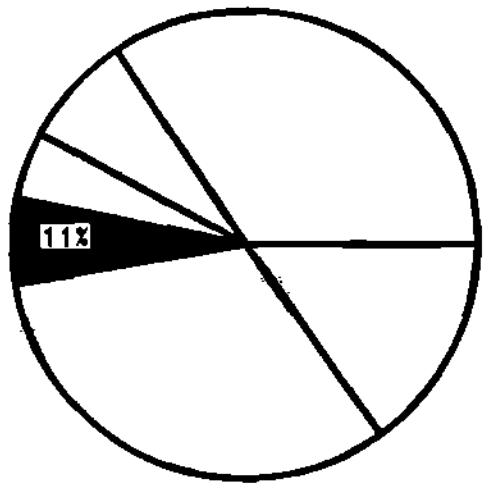
AVAILABLE U.S. MARKET

$52 Million



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PLAYERS

Hoechst AG
GE
Cabot
Interamics
Alcoa Interconnections
DuPont
General Ceramics
Microelectronic Packaging
Coors Porcelain
Metaramics
Ceramatec
Tektronix
Olin/Asashi
Degussa
Hitachi
Matsushita
Nippon Glass
AVX
Corning
Union Carbide
Universal

PLAYERS

Hoechst AG

Hoechst is a $15 billion German conglomerate and has spent at least $30 million to expand packaging capabilities. They are best known as Rosenthal Technik. This no longer has manufacturing in U.S. The market share is 2-3%.

GE

GE is a $28 billion U.S. conglomerate that has invested more than $100 million in acquiring and upgrading 3M (American Lava) operation. Market share is 2%.

Cabot

Cabot is a $1.5 billion company which acquired the ceramics package operation of Augat, Rhode Island Ceramics, and Spectrum Ceramics from Ferranti. Their investment is in excess of $10 million and they hold about a 2% market share.

Interamics

This company was purchased by Raychem for $11 million. We have a speaker from this company today. This company manufacturers cofired products.

Alcoa Interconnections, aka American Ceramic Technology

Alcoa is a $5.1 billion company which has previously made ceramic powders but is now moving into the packaging market. ACT was formed from a spin-off of Interamics and they are attempting to set up a fully automated manufacturing operation. The products will be conventional cofired multilayer.

Dupont

Dupont has purchased the packaging operation of Bourns. Their primary thrust will be pressed packages and low temperature fire tape.

General Ceramics

General Ceramics is a $23 million company which was previously comprised of Ceramic Systems and National Beryllia. Its products are both conventional cofired tape and BeO Products.

Microelectronic Packaging

This company was a spin off of the Coors packaging operation. It currently specializes CERDIP type packages but is looking at other types of packages.

Coors Porcelein

Coors is a $1.3 billion company that continues to make ceramic powders and parts but has sold off their packaging business. This business was primarily CERDIP. Coors may be taking another look at the cofired ceramic package business.

Metaramics

This company was purchased by W.R. Grace as their entry into the electronics marketplace. Metaramics specializes in packages for high frequency and power applications. Does not specifically compete in the cofired marketplace.

Ceramatec

This $2 million company is a recent entry into the cofired marketplace. This company has limited manufacturing capacity.

Tektronix

Tektronix has given a number of their divisions the right to go outside for business and their ceramics group is one such division. This group has a fairly broad range of capability but limited manufacturing capacity. Has both a cofired and a thick film capability.

Olin/Asashi

This $800,000 joint venture has recently been announced. It will start by manufacturing and marketing substrates for hybrid circuits but an entree into the ceramic packaging market is expected. Olin also owns part of Mesa Technology, a TAB company and Indy, a contract assembly house.

Degussa

A $4 billion German conglomerate. Their subsidiary was Demetron and this is now Degussa. They manufacture a line of pin grid packages (similar to IBM) and ceramics lids.

Other Japanese Companies

Hitachi - Building 200K LLCCs per month (using copper Metallization).
Matsushita - has a lie of 30 chip carries.
Nippon Glass (NGK) - 1986 goal is $12 million in LLCCs.

Other U.S. Companies Looking at the Market

AVX, CORNING, UNION CARBIDE, and UNIVERSAL (captive to IBM)

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MILITARY PACKAGING--IMPACT OF PACKAGING CHANGES ON MILITARY PROCUREMENT

Edmund J. Westcott
Technical Director, Deputy Chief of Staff
Product Assurance and Acquisition Logistics
HQ Air Force Systems Command

Mr. Westcott is a member of the DOD Senior Executive Service and is assigned to the Air Force Systems Command (AFSC). As the Technical Director, Deputy Chief of Staff for Product Assurance and Acquisition Logistics, he is responsible for establishing and implementing AFSC reliability, maintainability, productivity, quality and logistics support policy for research and development, and acquisition and fielding of Air Force Systems Command weapon systems. Prior to this assignment, Mr. Westcott was the Technical Director of the Reliability and Compatibility Division, Rome Air Development Center, at Griffiss Air Force Base in New York. Prior to joining the Federal government, he held executive management positions with RCA and E-Systems. Mr. Westcott has more than 30 years experience in the fields of reliability, maintainability, quality assurance, human factors, logistics supportability, and electromagnetic compatibility; has held reliability and quality assurance chairmanships in the EIA, AIA, IEEE, and ASQC; and has authored and presented numerous papers. Mr. Westcott holds both B.S. and M.S. degrees in Electrical Engineering.

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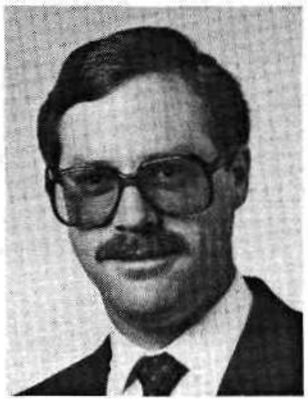

Kevin Gaughan
Sales Manager
Microelectronics Division
Kyocera International Corporation

Mr. Gaughan is a Sales Manager for the Microelectronics Division at Kyocera International, Inc., of San Diego, were he has been responsible for sales and marketing of hi-rel ceramic semiconductor packages for military and aerospace applications for the last four years. He joined Kyocera International in 1976 and spent the first four years supervising the production of ceramic IC packages. Mr. Gaughan received a B.A. degree in Psychology from the California School of Professional Psychology in San Diego.

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B. Edward Johnston
Director of Product Technology
Dense-Pac Microsystems Inc.

Mr. Johnston is the Director of Product Technology at Dense-Pac Microsystems, a manufacturer of high-reliability memory modules for the military and commercial markets. Previously, Mr. Johnston worked as an engineer and an engineering consultant, and has designed computer systems, hardware, and software for Hughes Aircraft, Rockwell International, RCA, Calcomp, and other companies. He has been involved in the specification, design, and testing of memory modules since 1981 and has designed modules using all types of memory technology on both co-fired and thick-film ceramic substrates. Mr. Johnston received a B.S.E.E. degree from the University of Florida.

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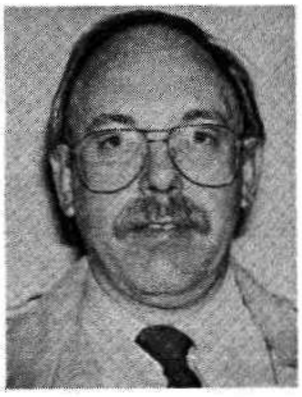

Vincent A. Spadafora
Vice President
The Jade Corporation

Mr. Spadafora is Vice President of Operations at The Jade Corporation, where he is responsible for contract assembly operations and ceramic package manufacturing. He joined Jade in 1972 and has been involved in many aspects of microelectronic packaging, including lead frame stamping, the design and building of automated assembly equipment such as T.A.B. (Tape Automated Bonding), die attach, and wire and flip chip bonding. He has been granted a patent for a method of making leaded ceramic chip carriers. Mr. Spadafora received B.S.M.E. and M.B.A. degrees from Temple University.

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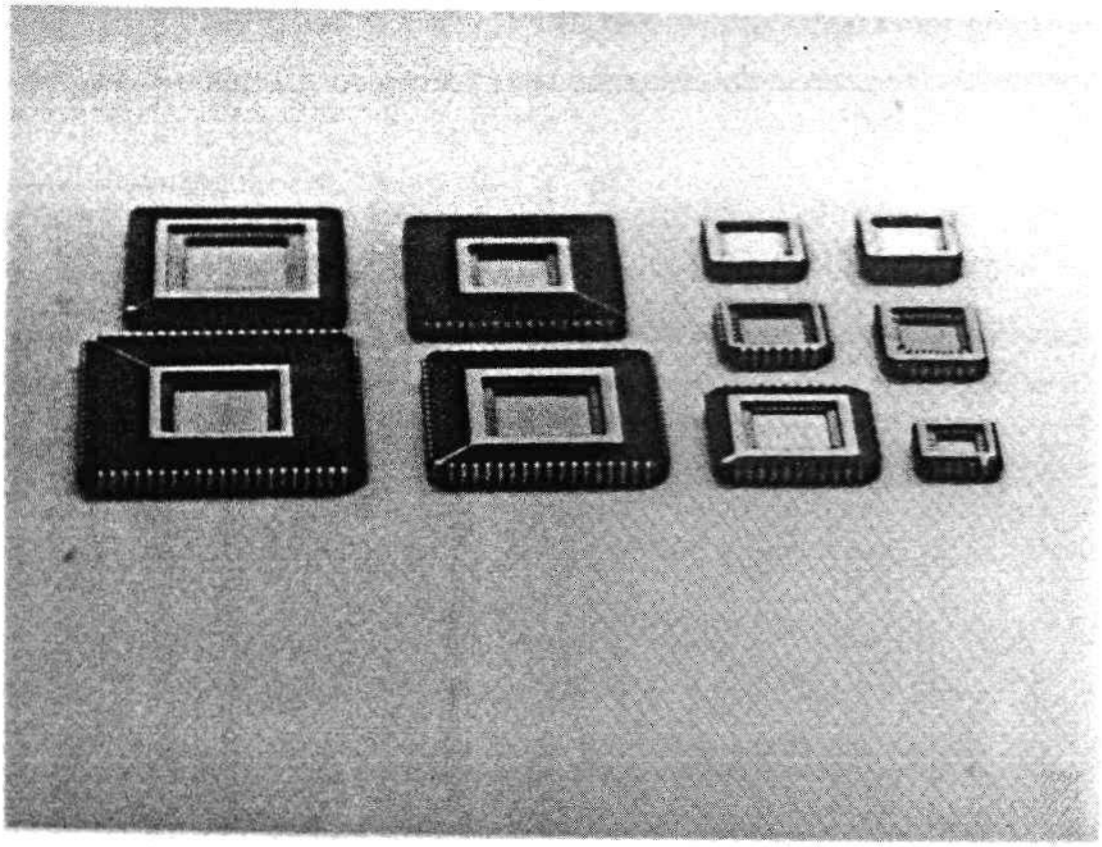

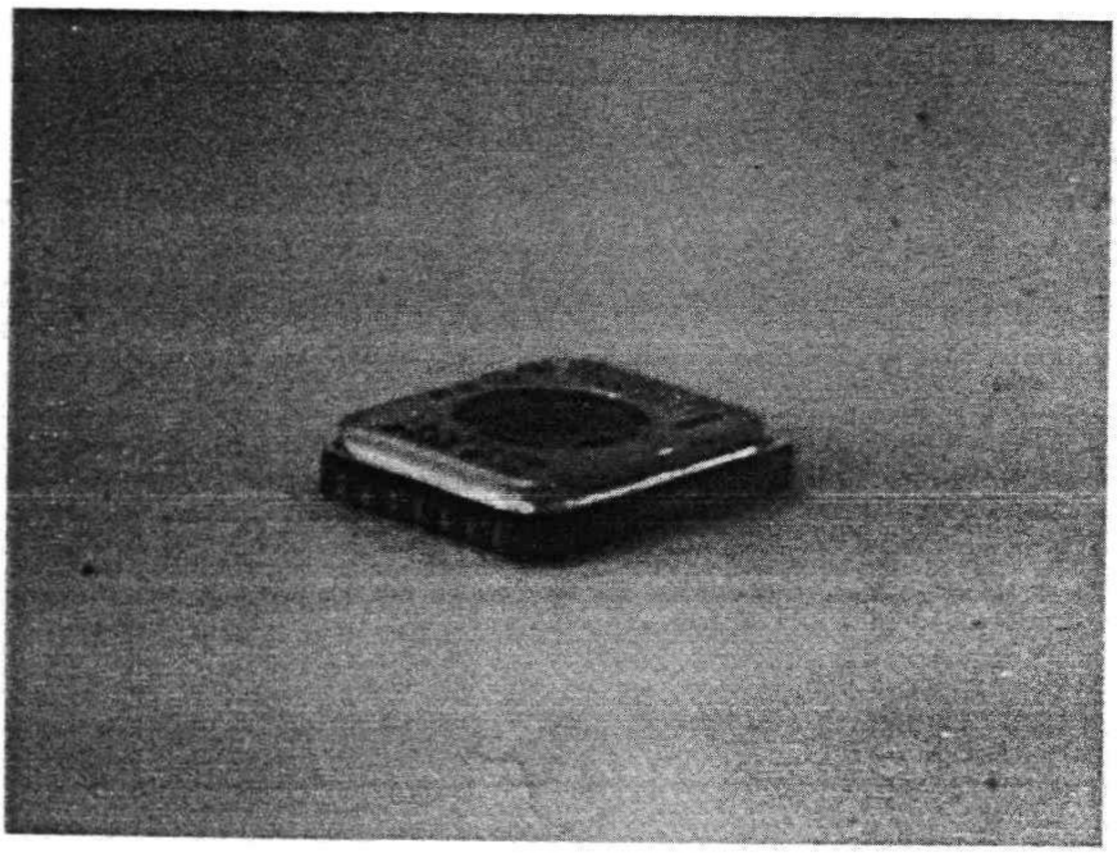

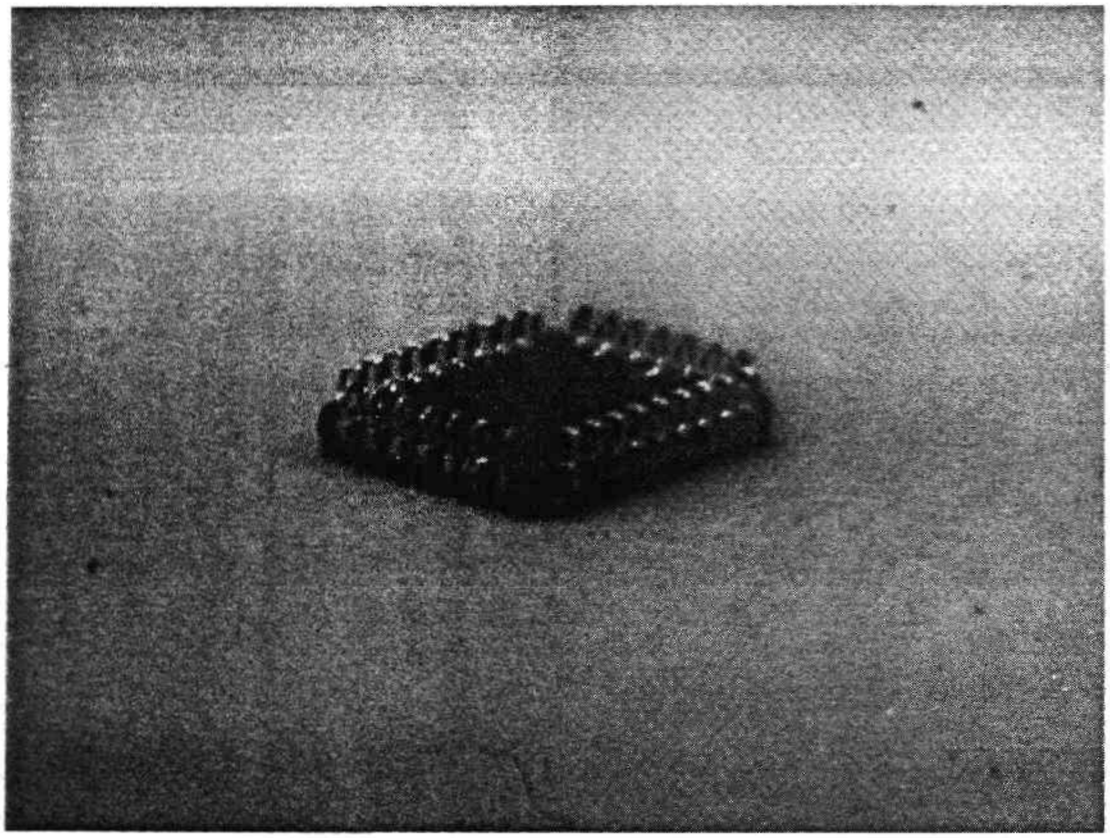

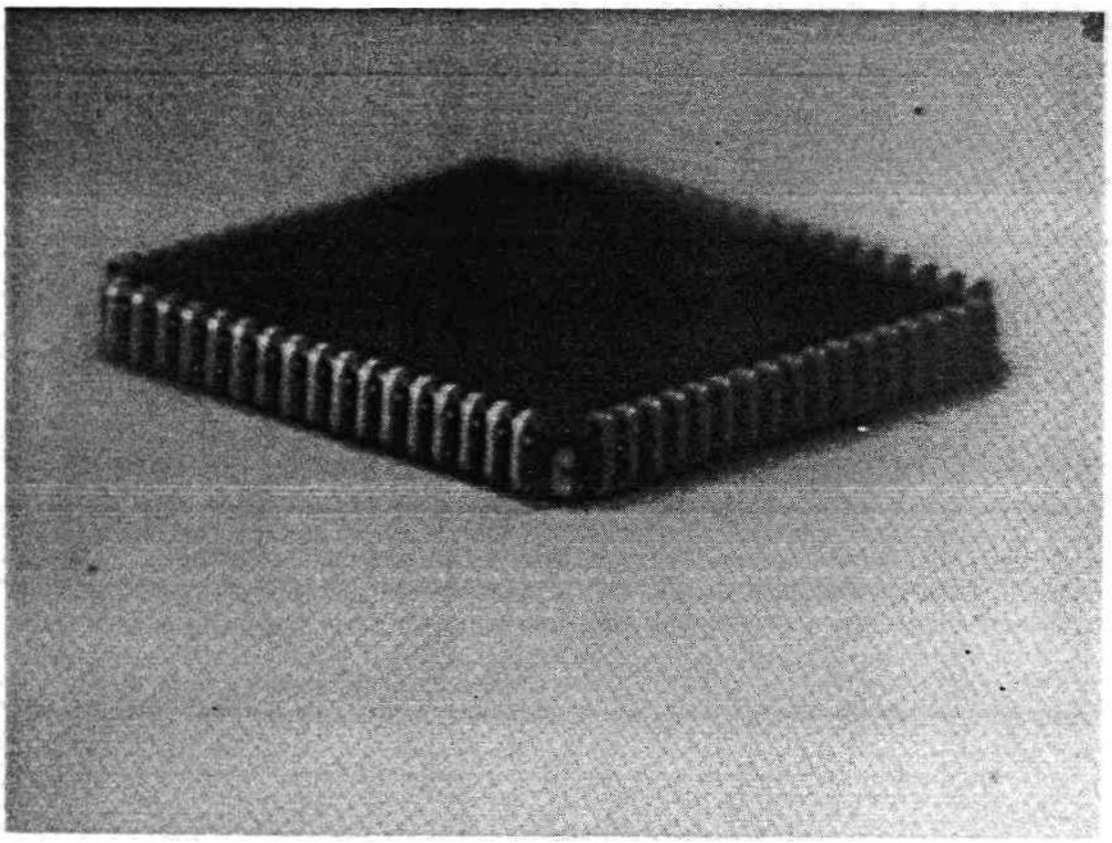

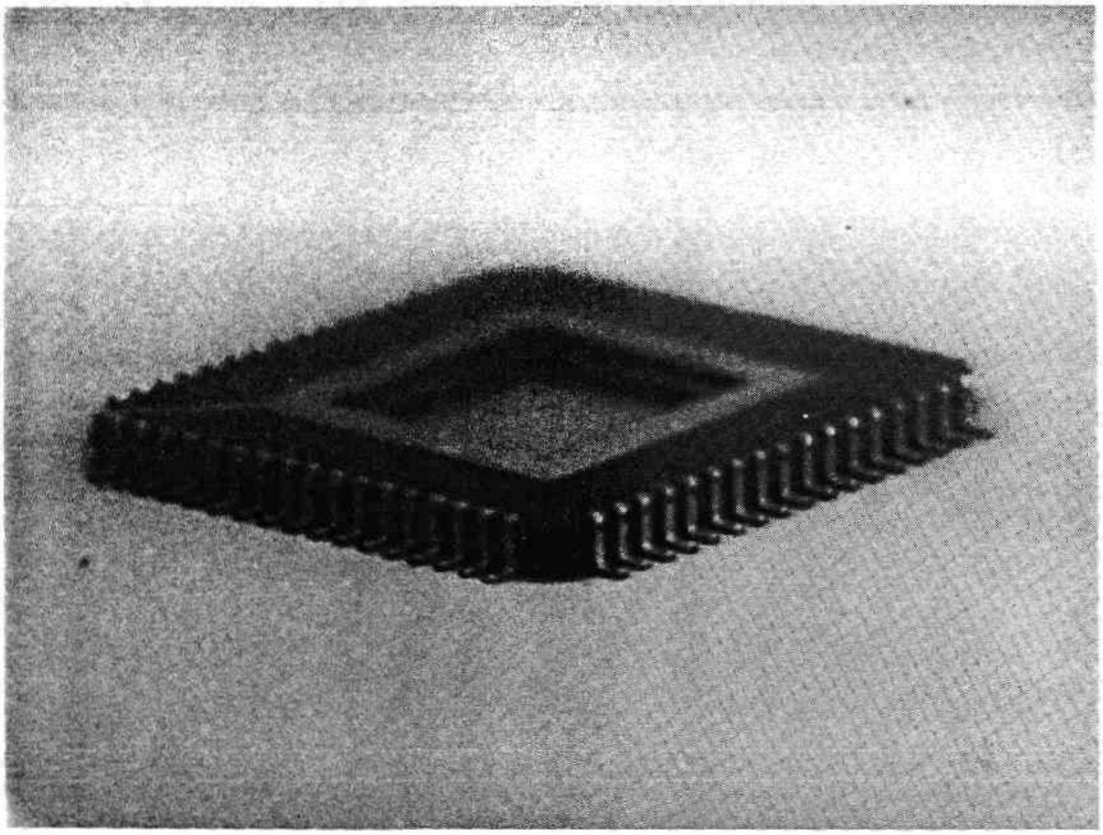

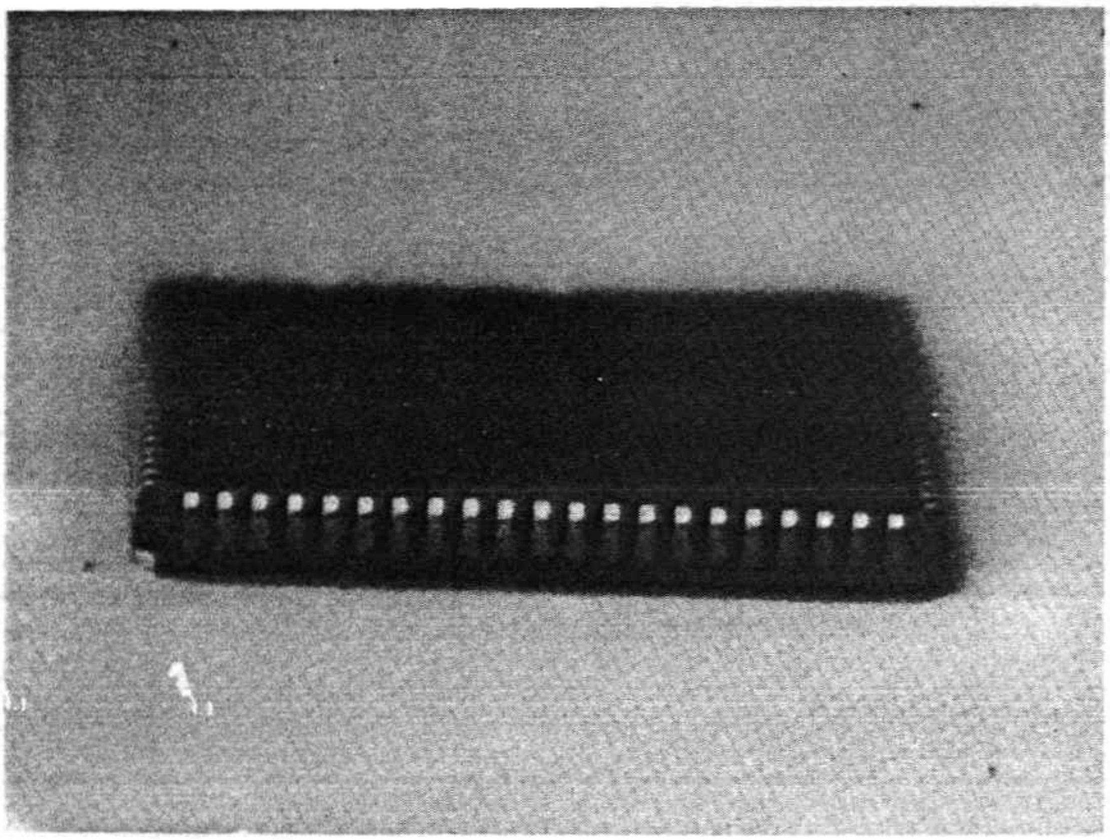

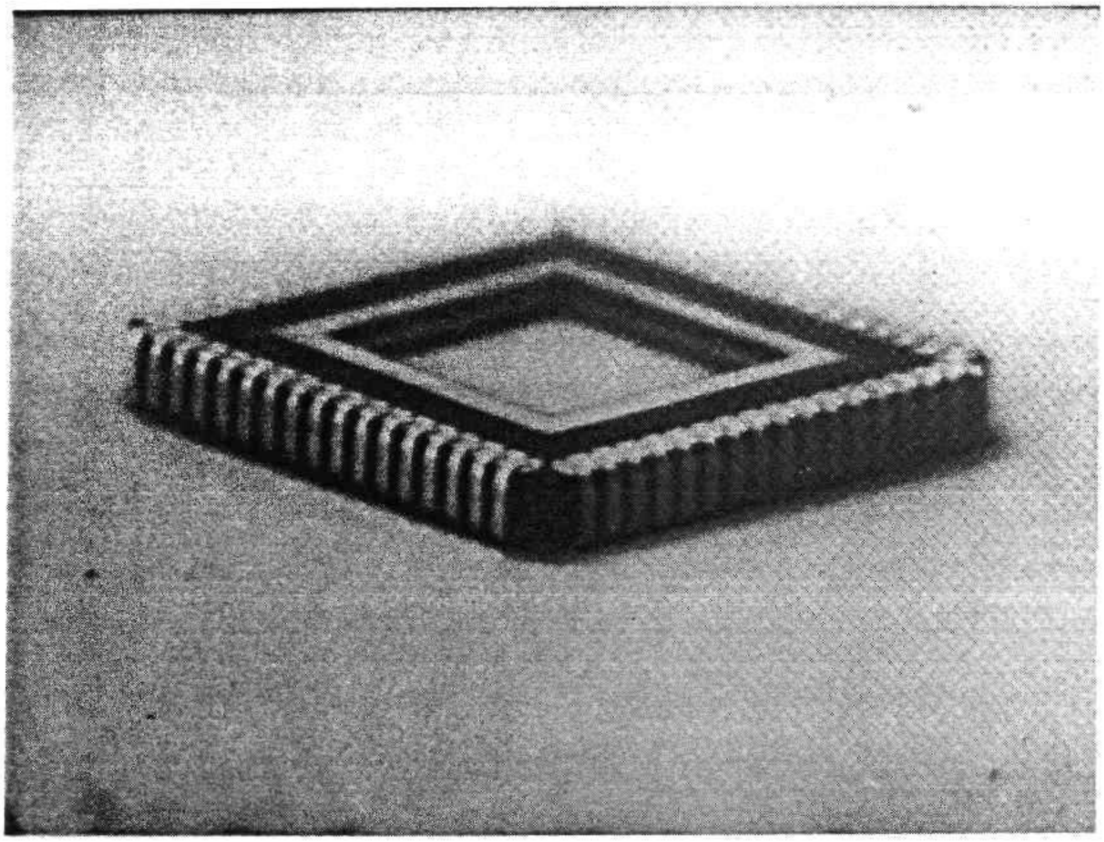

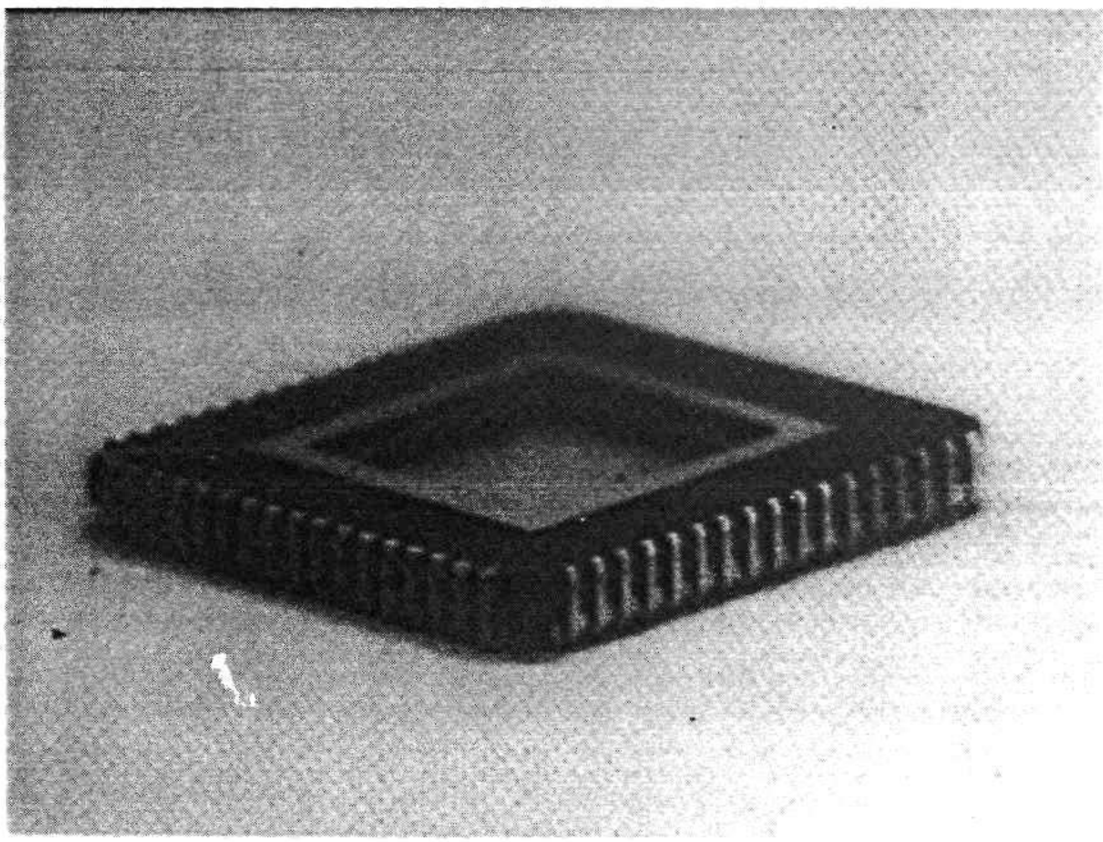

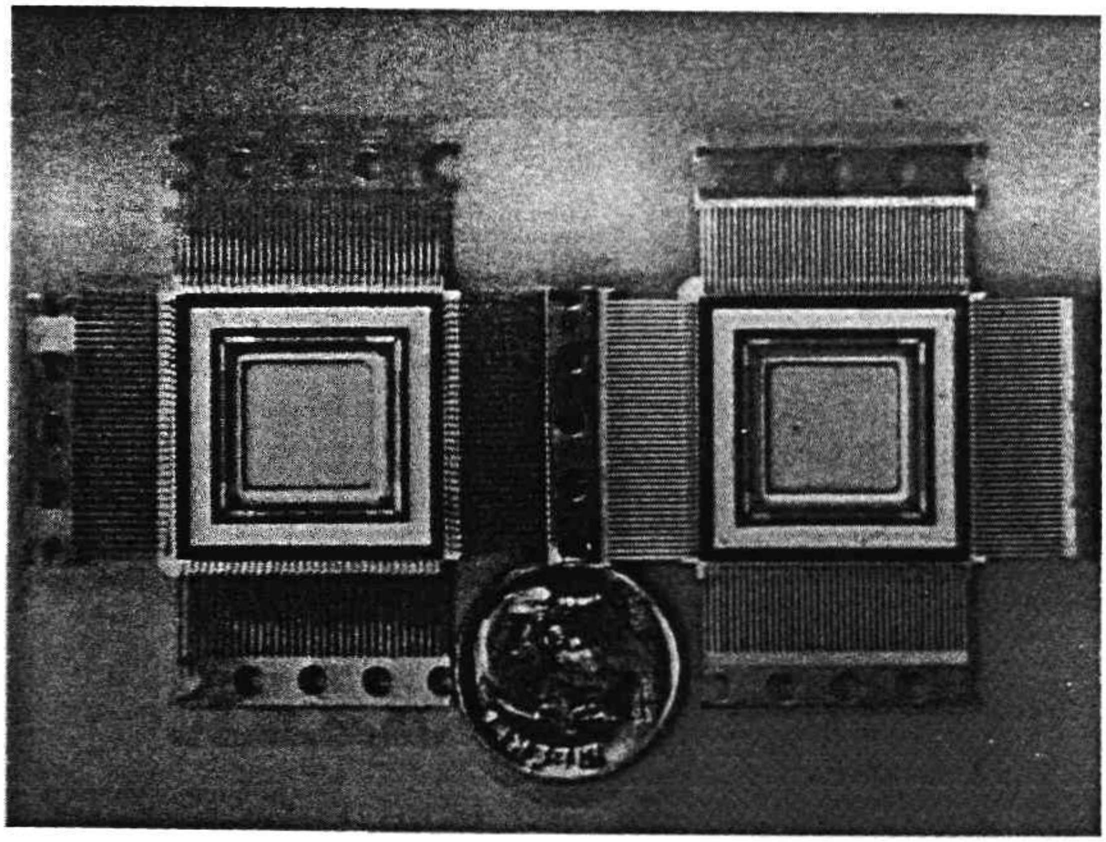

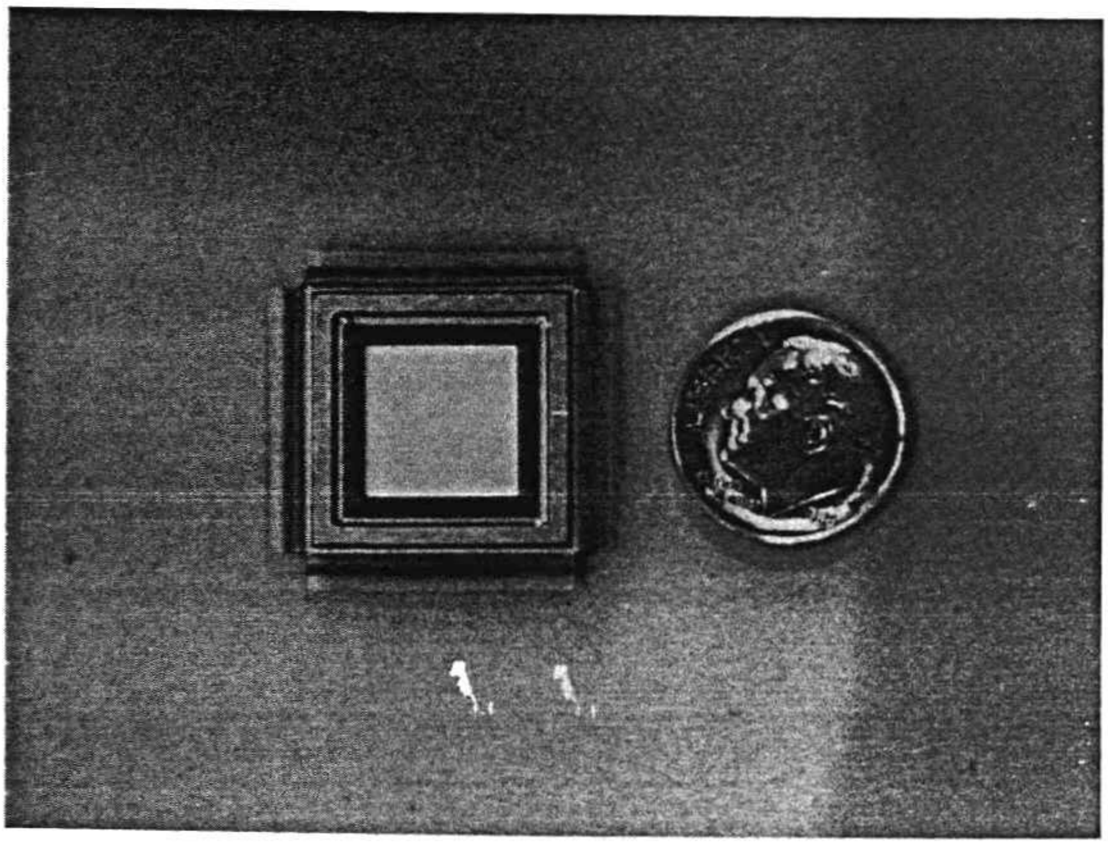

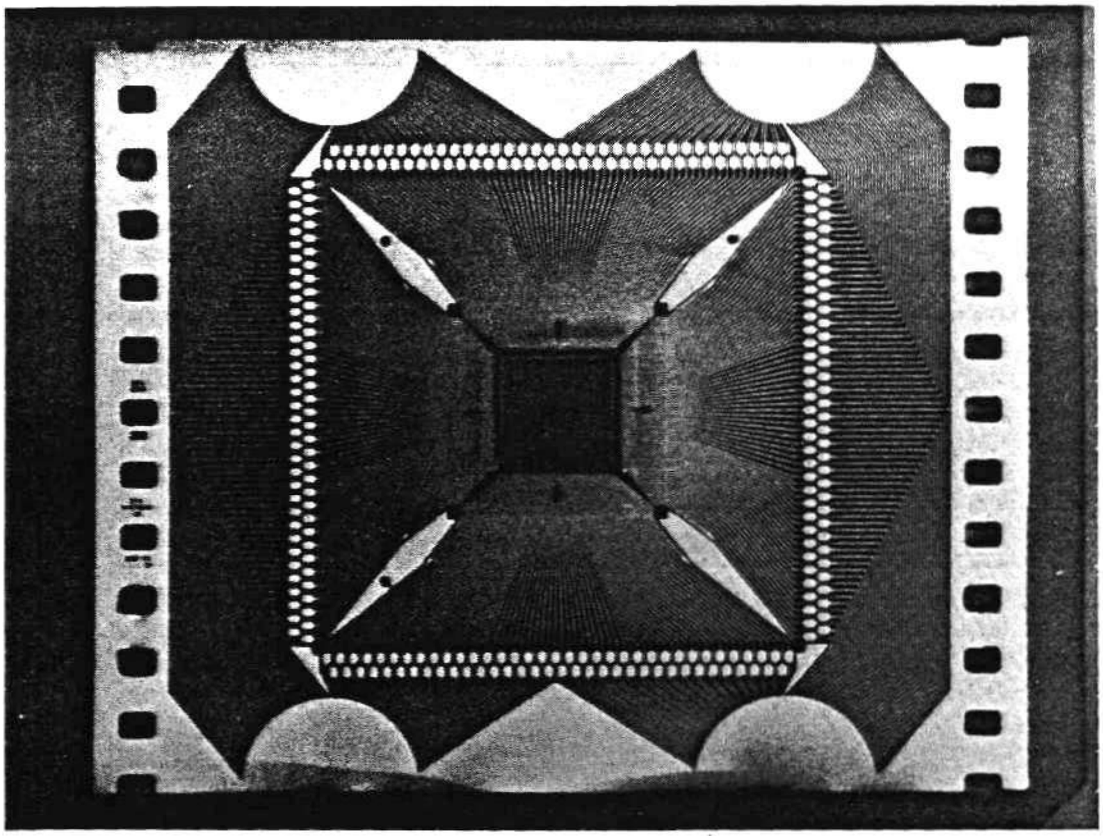

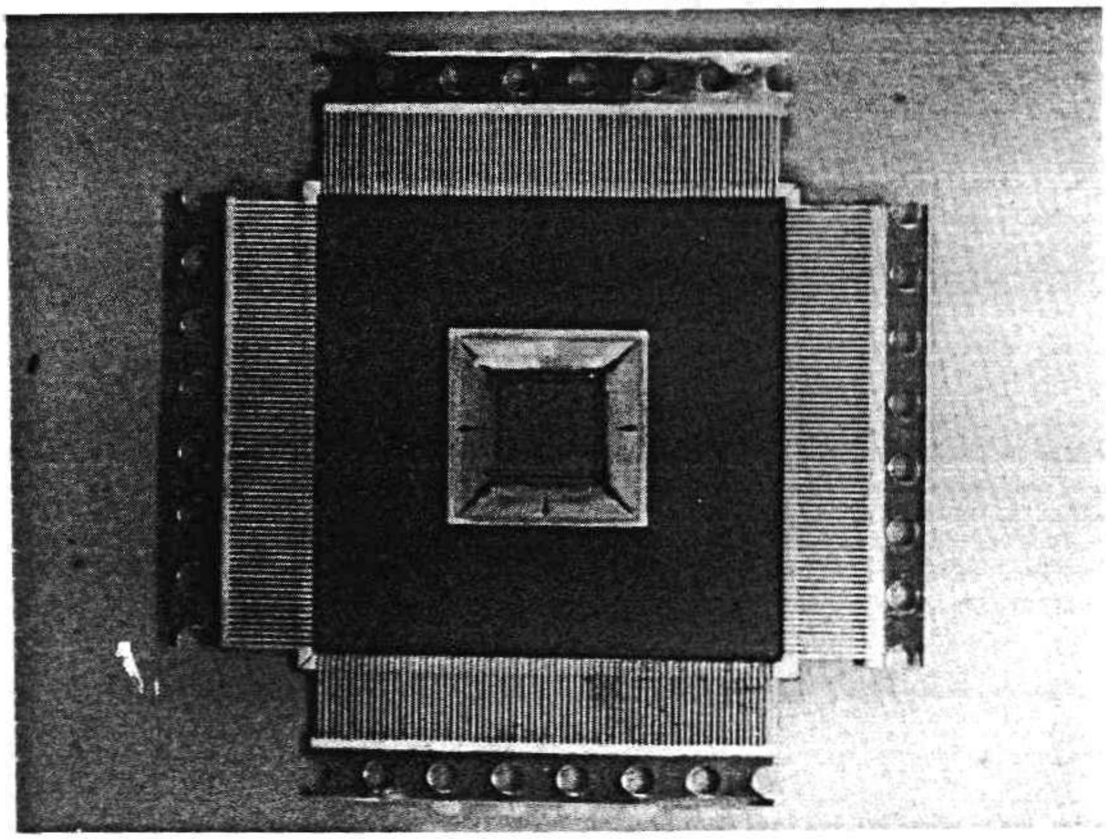

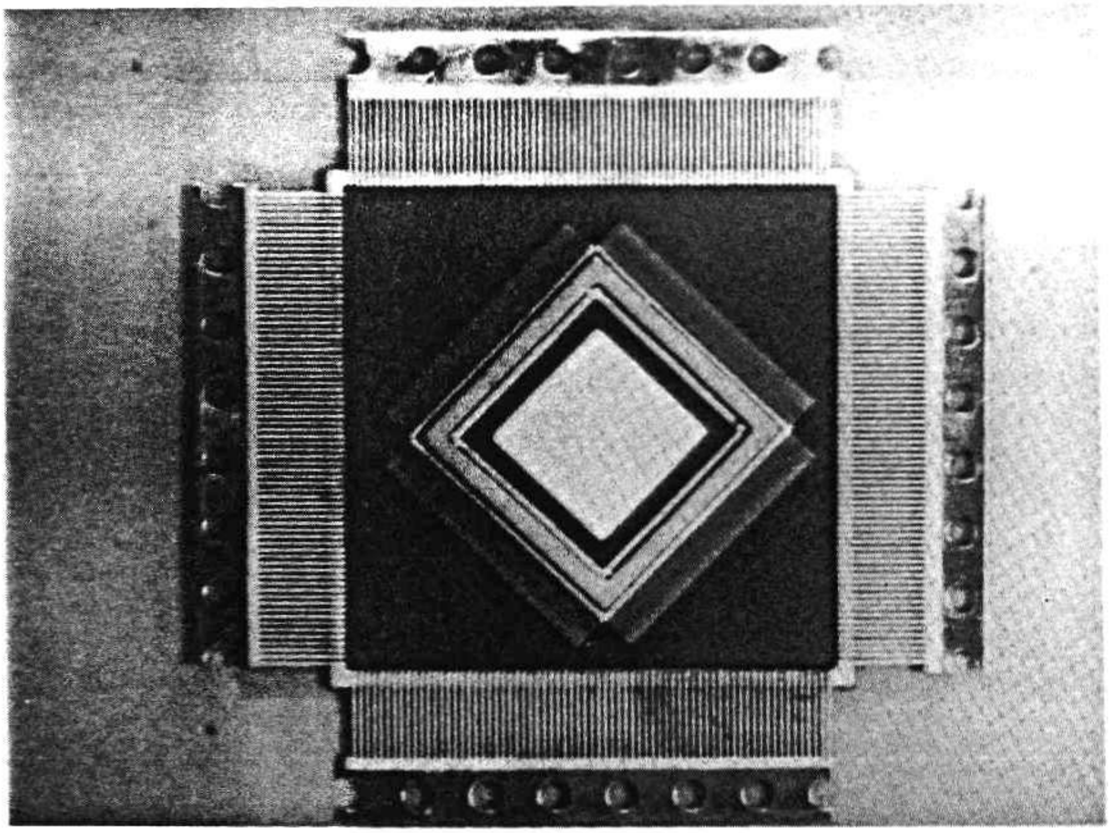

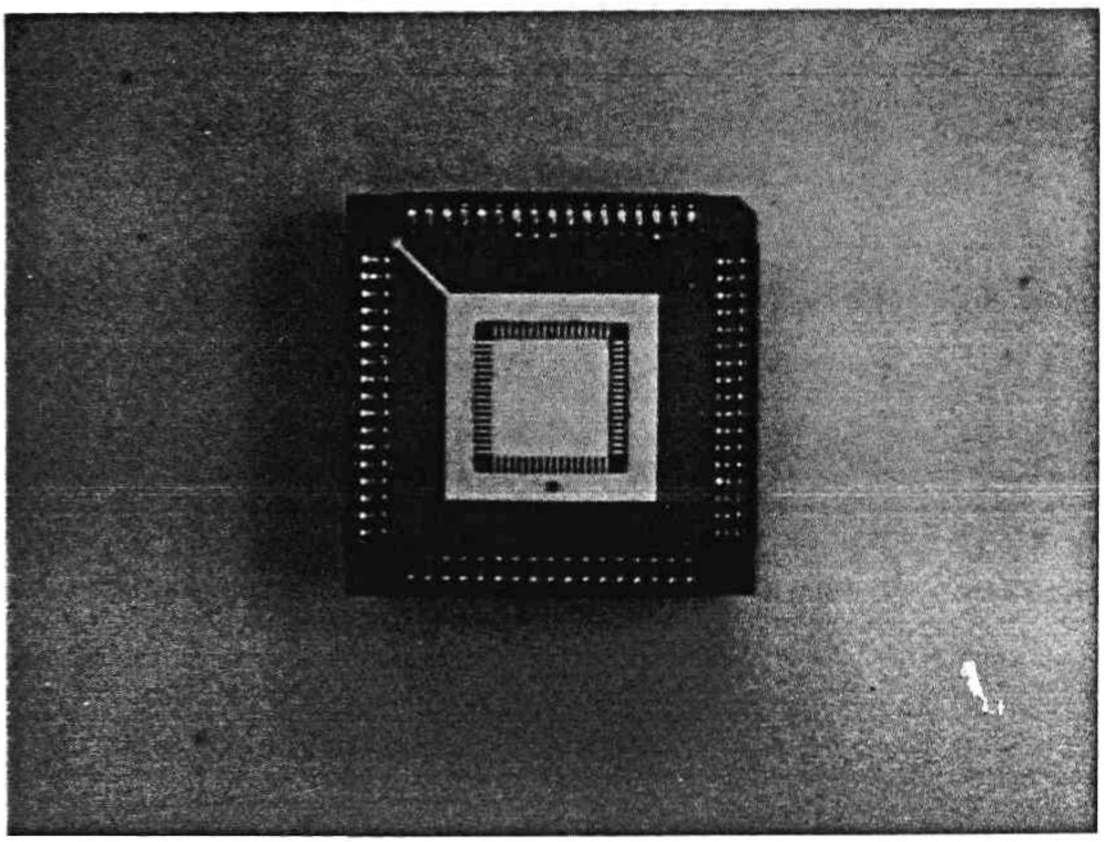

MILITARY PACKAGING--IMPACT OF PACKAGING CHANGES ON MILITARY PROCUREMENT

Martin Greenfield
Manager, Applications Engineering
Interamics

Mr. Greenfield is Manager of Applications Engineering at Interamics. Prior to joining Interamics, Mr. Greenfield was Manager of Customer Services at Ceramic Systems. Previously, he held various positions in engineering and management with Alloys Unlimited, Allen Bradley, and AVX Materials. He has worked in the microelectronics industry for more than 25 years, and has more than 21 years of experience with thick-film materials and processes. Mr. Greenfield hold a Bachelor's degree in Physics and a Master's degree in Business Administration. He has authored and presented numerous papers on thick-film materials and processes.

(Coauthor Martin Lutzen is an Applications Engineer at Interamics, where he is responsible for cost estimation and design of co-fired ceramic packages. He started with Interamics as the Supervisor of Quality Engineering and briefly worked in Research and Development before joining Applications Engineering. Mr. Lutzen received a Bachelor of Engineering degree with a minor in Business from the State University of New York at Stonybrook and is currently pursuing an M.B.A. degree at San Diego State University.)

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MILITARY IC PROCUREMENT
November 10, 1986
San Diego, California

CUSTOM CERAMIC PACKAGING - MILITARY PROCUREMENT TRENDS

By Martin Greenfield &
Martin Lutzen

The year 1986 has been characterized by growing complexity, size, operating frequency, and thermal requirements for military packaging. These trends are really extentions of those first observed in the late sixties and throughout the seventies. One new element is a growing awareness on the part of the government and systems houses of the need to develop domestic sources for these critical items. Many military programs now mandate procurement from U.S. owned and operated suppliers.

The global market for ceramic packages is expected to triple during the next five years. Although the magnitude of growth depends on a resurgence of the currently depressed semiconductor industry, the overall market growth for ceramics should be healthy. Along with growth comes change. The market share and volume shipped of simple packages like cerdips and side brazed packages is eroding while that of more complex packages is increasing.

Single chip packages with higher I/O count, finer pitch and more layers of circuitry are experiencing close to exponential growth rates. By 1991 these packages should account for a major portion of product shipped. Hybrid packages are really the dark horse of the co-fired ceramic packaging market.

Hybrid packages of the past have primarily been of metal can construction. Until recently, multilayer co-fire ceramic construction had only been utilized in a few isolated instances. Increasing package complexity, concern over the glass feedthrough reliability and cost have caused package engineers to look to another technology, namely co-fire. There are compelling reasons why this trend should not only continue but accelerate. Design engineers are beginning to recognize the cost effectiveness and higher reliability inherent in the co-fire approach. As more conversions occur resistance to "trying something new" will diminish.

Items of concern to custom military ceramic package users involve one or more of the following categories:

*Thermal Management
*High I/O Fine Pitch
*Large Co-fire Ceramic Boards and Modules
*High Speed
*Tab VS Conventional Wire Bonding
*Detector/Headers
*Domestic Mandate Procurement Requirements

THERMAL MANAGEMENT

Thermal management was not an overwhelming concern with earlier semiconductor technology (with some exceptions such as power transistors). SSI (small scale integration) and MSI (medium scale integration) were generally associated with both low circuit and power density. Even high density CMOS technology seldom results in more than 2 - 4 watts dissipation per chip. These thermal requirements could be met with conventional all-alumina packages.

SSI and MSI packages increasingly are being replaced by LSI (large scale integration), VLSI (very large scale integration), and VHSIC (very high speed integrated circuits), and ECL (emitter coupled logic) which address density and speed requirements. However, the resultant increase in power density has exceeded the dissipation ability of alumina.

Conventional alumina packages cannot adequately address the question of single chips dissipating in excess of 20 watts. Early experimental work with monolithic high thermal conductive ceramics (such as Beryllia) has not yielded reproducible results and has proven costly. The best approach today is a composite package that marries a thermally conductive base to an alumina structure which carries the I/O scheme. (See figure 1)

In choosing a suitable base material more than thermal conductivity must be considered. Many materials with a thermal conductivity ten or more times greater than alumina exist. However, TCE (Thermal Coefficient of Expansion) of the conductive base must match the alumina "windowframe" closely or the structure will lose hermeticity or crack when stressed. (See figure 2)

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An examination of TCE and thermal conductivity produced two candidate materials that are now commonly used in this configuration: 90% tungsten/10% copper and Beryllia. Using these heat dissipation materials, single and multichip (hybrid) packages and modules dissipating 20 watts and more are in current production.

HIGH I/O COUNT, FINE PITCH CHIP CARRIERS

The trend toward increased density has resulted in a significant increase in I/O numerical requirements over the past five years. Packages with more than 250 I/O's are not uncommon. Several inquiries for detector packages with more than 1500 I/O's have been received.

The increase in I/O numbers is coupled to a trend toward the smallest possible ceramic package. Obviously, the smaller packages require less board real estate and have the added advantage of shorter signal paths. However, the smaller the package, the less package real estate available for an I/O scheme.

Peripheral leaded and pin grid array packages represent more than 95% of single chip packages shipped, although leadless and pad grid arrays are of some interest. The vast majority of military requirements are for peripheral leaded packages.

Leaded Packages

Fifteen years ago, 0.100 and 0.050 inch lead pitch were common. Brazing Kovar or Alloy 42 leads to the metallized and plated ceramic package offered little in the way of challenge. Wide leads often masked marginal braze adhesion and as a result of the wide isolation gap, braze alloy bridging between leads was not a meaningful problem.

Today, 0.030 and .035 inch pitch is fairly common. 0.020 is fairly standard for VHSIC and at least two package designs with 0.015 inch pitch have been fabricated.

Fine pitch carriers present some difficulty both to the co-fire vendor and the end user. A high degree of process control is necessary to avoid braze alloy bridging between adjacent leads. Also, ceramic/leadframe adhesion becomes significant as the contact area between the lead and the ceramic decreases. From the systems house point of view, soldering peripheral leaded carriers to a mother board increases in difficulty as pitch becomes finer.

Leadless Packages

Military interest in high I/O count fine pitch carriers is high but there are concerns involving their use. Leaded packages typically require greater board real estate than their leadless counterpart. Moreover, lead length adds to overall length of the signal path. Both factors favor the use of leadless carriers. However, several major problems stand in the way of wide acceptance of this type of carrier.

An inspectable solder fillet is necessary in bonding the carrier to a mother board. The bond between the carrier bottom pads and the mother board is not readily visible. Fine pitch side metallization and/or castellations add to manufacturing difficulty and hence expense, but are necessary for inspectability.

Thermal mismatch between the leadless carrier and mother board is a critical concern. Thermal energy generated within an operating chip generally is conducted from the chip through the carrier to the motherboard. A thermal coefficient of expansion mismatch between the carrier and the mother board can result in solder joint failure, particularly with thermal and power cycling. The larger the carrier, the greater the potential for failure. Ceramic mother boards are a partial solution. Even though materials and TCE are identical, a thermal gradient between the package and board exists. This gradient can also result in joint failure. Prognosis is not encouraging. While limited data suggests there may be a solution there will be no easy answers.

Pin Grid Packages

Pin grid array packages are commonly used in the computer industry. Millions are manufactured every year. Military acceptance, however, is limited. PGA packages do not lend themselves to surface mount techniques. They do have the advantage of requiring less board real estate. Typical pin spacing is on .100 inch centers, although packages with pin spacing of .040 inch have been made.

Pad Grid Array Packages

Pad grid array packages (pads on the underside of the package, similar in design to pin grid arrays) are seldom used for military packaging. While compatible with surface mount requirements, solder joints are not inspectable. As with pin grid arrays, these packages are very economical of real estate. TCE matching problems are similar to those discussed for leadless carriers.

LARGE CO-FIRE CERAMIC BOARDS AND MODULES

Large co-fire boards were largely developed in response to military requirements. Boards 6.0" x 6.4" are now in production with still larger boards contemplated. These boards replace:

*Organic Printed Wiring boards which do not support the degree of complexity co-fire can, absorb moisture leading to outgassing problems, are not as dimensionally stable as ceramic, and the TCE does not match that of ceramic chip carriers.

*Copper/Invar/Copper Organic Printed Wiring Boards address the TCE problem at the expense of added weight. Otherwise, they suffer the same limitations as organic printed wiring boards.

*Low Temperature Co-fire, with the advantage of lower processing temperature (800 C to 1000 C in air) allows the use of high conductivity materials such as copper, gold, and silver. Low temperature co-fire boards tend to be much weaker and more brittle than their high temperature counterparts. Also, they have significantly lower thermal conductivity than is achieved with traditional co-fire.

*Thick Film Multilayer Boards offer many of the advantages (particularly TCE) of co-fire. However, thick film cannot support the cost benefits, increased reliability, and level of complexity co-fire can, but does offer certain other advantages:

- Thick film tooling costs are low. Generally, screens are all that is required.
- Turn around is fast. This is directly linked to the simple tooling required.
- Overall prototype costs are comparitively low. Again, this is linked to the simple tooling required.

Co-fire offers several clear advantages over thick film. Co-fire can support a much greater degree of complexity than thick film. Ten to fourteen layers are common and one design with 23 layers is in production. In contrast, six to eight thick film layers is a challenge.

Co-fire layer to layer spacing of .010 inches or more is typical and yields greater vertical isolation than can be accomplished with thick film. Thick film isolation is restricted to .002 inches per layer. Cross talk can be significantly lower for co-fire. Furthermore, pin holes in thick film dielectric can result in layer to layer electrical shorts. This is not an issue for co-fire.

Co-fire becomes more and more cost effective as board size, complexity, and quantity required increase. For a board 4" x 5", eight layers of circuitry, and a soldered on lead frame, a major military systems house identified an internal cost of $600 per board (2000 boards). Major reliability problems with the solder joints were experienced. However, they were able to purchase a comparable co-fire board with a brazed leadframe for less than $250. Joint reliability became a non-issue.

Co-fire does exhibit one technical shortcoming. As-fired co-fire boards are normally toleranced +/- 0.8% for feature location. This is not a problem if components are manually placed. Automatic pick and place equipment without either the ability to recognize individual pattern segments, or to proportion between fiducial markings is not compatible with large as-fired co-fired boards. One option to improve feature location is to utilize post-fire screening techniques. This approach can achieve tolerances similar to those of thick film but adds cost. Co-fire power and ground distribution boards are another approach under evaluation by several military systems houses. These boards contain power and ground planes with vias coming to the board surface in an array. The distribution boards are customized with copper thick film. Advantages are:

- *Reduced complexity required for thick film circuitry raising overall yield and lowering price.
- *Ability to maximize inherent thick film flexibility and minimize cost of design changes.
- *True position of thick film "footprints".

Another significant market trend is the conversion of thick film designs to co-fire. The prime drivers are reduced cost and maximizing performance and reliability.

HIGH SPEED PACKAGES

Twenty years ago, thick film hybrids capable of supporting a 10 Mhz signal were a rarity. Today, co-fire digital packages capable of supporting GaAs operation in the 2 - 3 GHz region are available. Some analog packages operating in the 8 - 10 GHz region have also been fabricated. Digital operation to 5+ GHz is anticipated and analog packages operating at 80 GHz are in the discussion stage. (See figure 3)

Many technical issues involved in package manufacture must be considered such as impedance matching, noise, etc. in order to achieve acceptable and consistant results for operation in the GHz range. However, design poses even greater problems.

Design involves matching physical material parameters and limitations with required electrical characteristics. Package design is an iterative process requiring many steps. An electromagnetic simulation program similar to the one developed by the Mayo Foundation is necessary. Each package design requires approximately three man months of effort. Even seemingly trivial changes such as cavity size or I/O configuration requires a complete redesign. Much of the funding for high speed GaAs package development originated via government contracts and is controlled by ITAR restrictions.

Package requirements for VHSIC and ECL are somewhat less exacting. However, clock rates from 50 MHz to 500 MHz still require careful design attention. ECL is of particular challenge in the sense that we are dealing both with high clock rates and thermal dissipation that can range to 20 watts per chip and beyond.

TAB VS. CONVENTIONAL WIRE BONDING

As numerical I/O requirements increase, conventional wire bond yield tends to decrease rapidly. TAB (Tape Automated Bonding) offers a potential solution to this problem. Routine usage of TAB in packages with more than 84 I/O's is not yet a common reality for technical reasons not related to the ceramic package. However, TAB does place several serious constraints on package design and tolerancing.

Conventional wire bonding requires a single lead to be bonded, point to point, from chip to package. This is repeated until every pad-out on the chip is electrically connected to its corresponding package wire bond finger.

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Because bonding is achieved one-at-a-time, leads can be bonded at more than one height. This is fortuitous in that it allows packages to be designed with multiple wire bond tiers. Two to three tiers are not uncommon in high I/O count packages. Multiple tiers allow the designer to maximize the width of each wire bond finger. This not only provides a large target for the wire bonder, it allows bonding without concern for as-fired tolerancing. Multiple tier bonding provides additional signal isolation by virtue of greater line to line spacing as well as layer/layer separation of signal traces.

TAB bonding leads are pre-configured to match pad-outs and bonding fingers. Bonding is achieved in a single operation with connections made either simultaneously or sequencially. Largely because the leads are pre-configured, TAB will not accomodate multiple bonding tiers. A single tier in a high I/O count package requires fine wire bond fingers with small isolation. Consider a package with a 0.500 inch cavity and 400 I/O's. Total available single bond tier length will be about 4 x 0.500 inch, or 2.000 inches. Available real estate for each bond finger (including isolation) is 2.000 inches/400 I/O's or 0.005 inches per finger.. Typically, this would mean a .003 inch finger with .002 inch isolation. A .003 inch target is difficult to hit at best, even assuming zero tolerance for location. As-fired ceramic tolerancing is not adequate. Sorting and/or post-fire techniques are mandated for high I/O TAB packages. This is both necessary and expensive. Close signal line spacing on a single ceramic layer will yield significantly higher crosstalk than the multiple tier case.

Early indications are that TAB will require a much flatter package than those needed for conventional bonding. Degree of flatness and associated costs have yet to be determined.

Co-fire ceramic packages for high I/O count TAB have been fabricated. Optimism is still high for eventual adoption of TAB in high I/O configurations. The user should expect the TAB package to be more expensive than its conventional counterpart.

DETECTORS/HEADERS

Co-fire detector/headers for night vision, infrared detection, satellite mapping, and space telescopes have been a significant but low volume military requirement for several years. These headers are usually circular, have 20 - 150 I/O pins and a brazed metal structure for attachment to a dewar (for operation at 77 k). However, header/detectors have been made in a variety of shapes, sizes, and complexity. The most complex header in current production has 23 ceramic tape layers, .005 inch diameter vias, .005 inch conductive lines, and .005 inch isolation.

The Strategic Defense Initiative has engendered a great deal of interest in this packaging concept. Size and complexity as well as quantity is expected to increase significantly. Inquiries for detectors as large as 6" in diameter with up to 1900 pins have been received.

Detector headers for heat seeking missiles are generally of glass feed-through construction and are of moderate complexity. Sizes range to perhaps 1+ inches in diameter. Co-fire reliability exceeds glass feed-through by a meaningful margin. Conversion from glass feed-through technology is expected to account for a significant volume increase in cryogenic infrared header/detectors. Co-fire offers reliability at liquid nitrogen temperatures not available with other technologies.

DOMESTIC MANDATE PROCUREMENT REQUIREMENTS

There is a growing awareness on the part of both government and military systems houses regarding dependence on offshore sources for critical ceramic packaging. Many military programs utilize ceramic packages manufactured either in whole or in part overseas. Some programs are virtually 100% dependent on these packages.

The National Security Agency has been at the forefront of domestic mandate sourcing. The mandate requires that a minimum of 50% of each design be procurred from a U.S. owned domestic source. Other agencies have expressed a strong desire to procure domestic packaging without an actual mandate in place. Still other programs are covered by ITAR regulations prohibiting disclosure to foreign nationals. Despite mandates in place for more than two years, implementation has been slow. Traditional offshore sources have experienced a learning curve of as much as fifteen years with tooling in place for that same period of time. Packages have been manufactured in quantity for a variety of programs. Most domestic vendors do not have the benefit of in-place tooling, learning curve, or volume production. As a result, initial domestic pricing has been significantly higher. Success of the mandate programs is largely dependent on available funding and patience on the part of the military as domestic sources experience the necessary learning curve.

In summary, military procurement trends for ceramic packaging are fairly well defined and reflect advances in semiconductor technology, a need for lessening of dependence on offshore sources, and requirements of new military programs. Prognosis is for a strengthening of both the trends and domestic packaging vendors.

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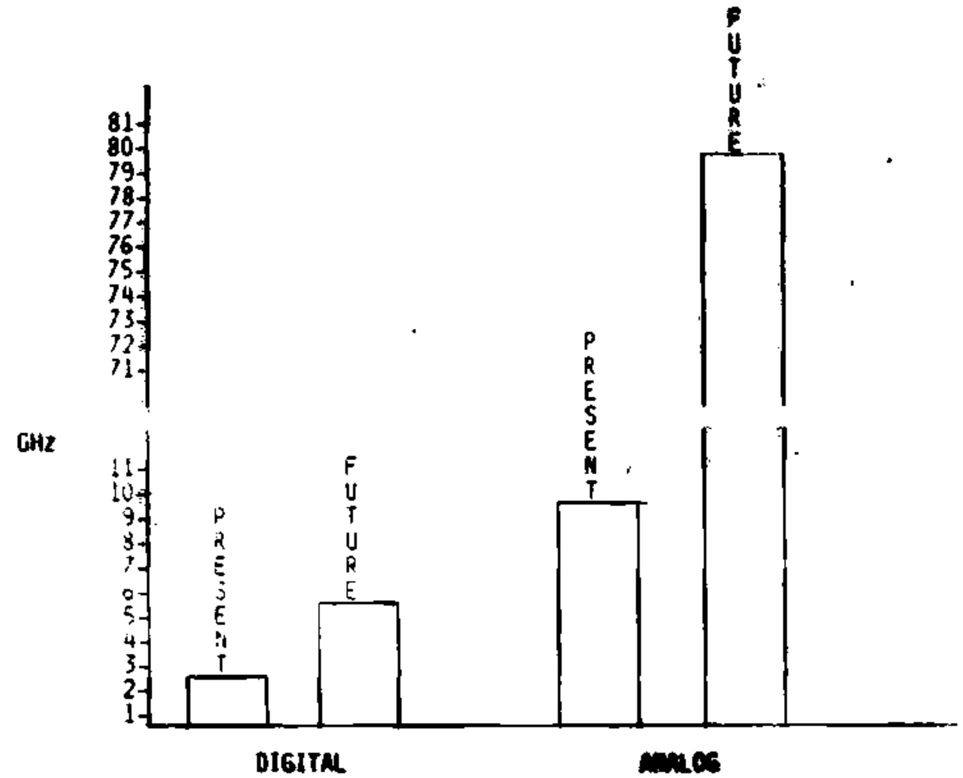

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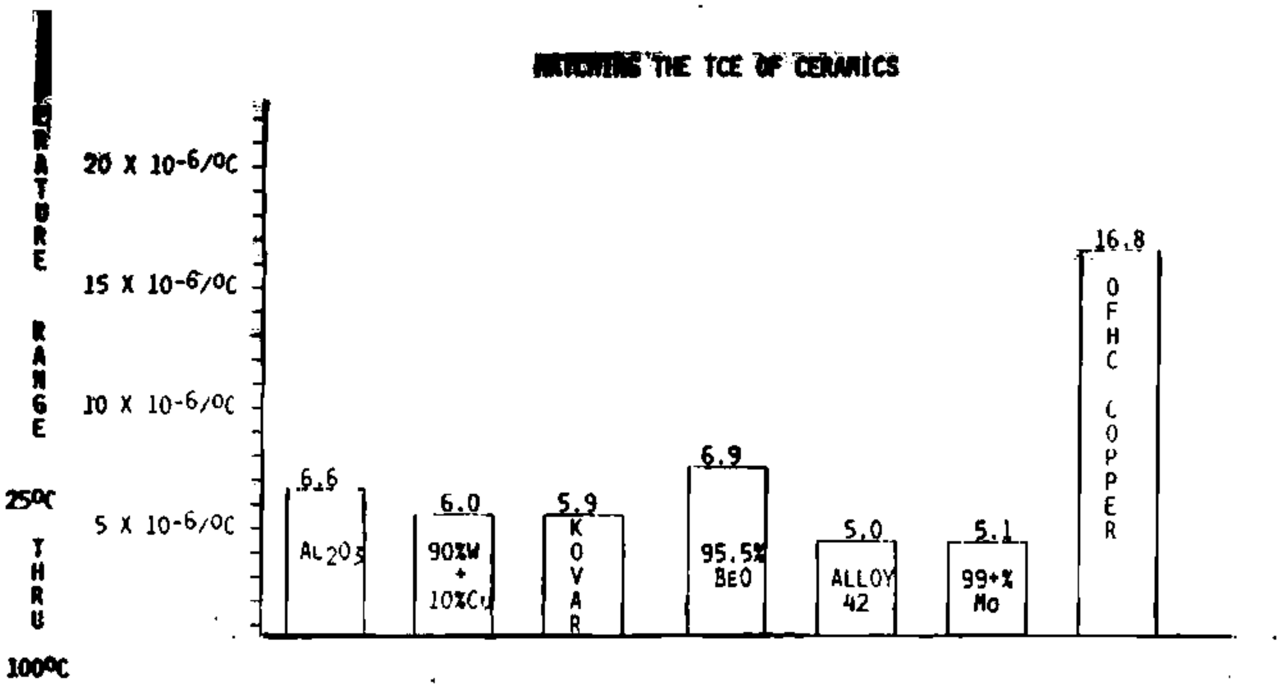

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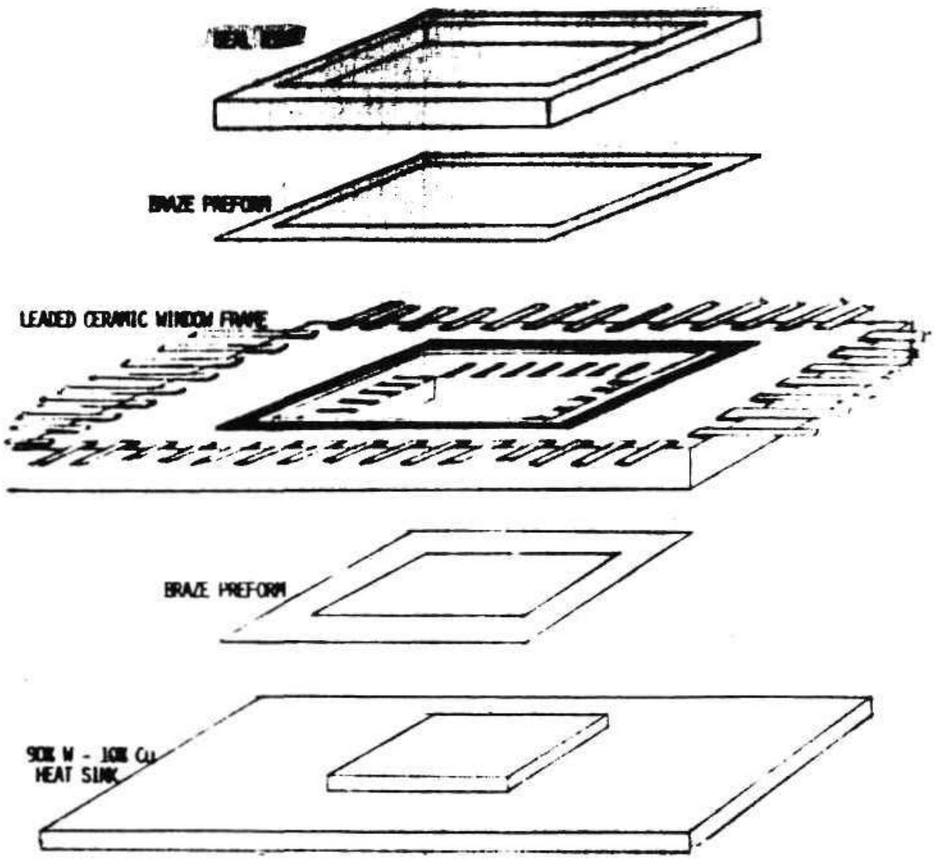

BRAZE PREFORM
LEADED CERAMIC WINDOW FRAME
BRAZE PREFORM
90% W - 10% Cu
HEAT SINK

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Evaluation Questionnaire

San Diego, California
November 10, 1986

Thank you for attending Dataquest's Military IC Focus Conference. Please assist us in planning our next conference by completing and returning this questionnaire?

1. How would you rate the conference on a scale of 1 to 10 (where 10 is the highest in terms of your approval)?

   Content ________ Delivery ________ Format ________ Location ________

   Comments ____

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

   Location ______ Meals ______ Meeting Rooms ______

3. How would you rate the following sessions (1 to 10)?

   Mil-Std Outlook ______

   Mil-Std Procurement ______

   Packard Commission ______

   Panels:

   Mil-Std Specifications ______
   - Ron Marfil ______
   - Steve Davis ______
   - Arney Stensrud ______
   - Mark Cooper ______
   - Ron Williams ______

   Packaging ______
   - David Francis ______
   - Edmond J. Westcott ______
   - Kevin Gaughan ______
   - B. Edward Johnston ______
   - Vincent Spadafora ______
   - Martin Greenfield ______

4. What were your objectives in attending this conference?

   ____

   ____

5. To what extent did the conference meet your objectives? (1 = completely; 5 = did not meet objectives)

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

6. What other topics would be of interest to you in future Military IC Procurement Focus conferences?

   ____

   ____

7. Would you prefer a conference that is ☐ longer ☐ shorter, or ☐ of same length?

(over)

8. Would you attend a Military IC Procurement Focus Conference in 1987? ☐ Yes ☐ No

9. Are there others in your company who would be interested in attending this type of conference or who should receive information about Dataquest's Semiconductor User Information Service?

☐ Conference information ☐ SUIS information

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