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1994 SYMPOSIUM ON VLSI TECHNOLOGY

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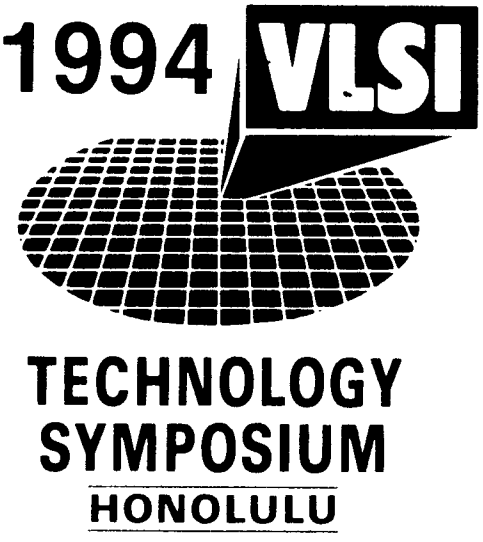

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1994 Symposium on VLSI Technology

Digest of Technical Papers

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FOREWORD

Welcome to the 1994 Symposium on VLSI Technology

On this 14th meeting of the Symposium, we are returning to the Hilton Hawaiian Village Hotel where the Symposia was held in 1990. This year sets yet another record for participation in this Symposium. Two hundred and eight papers were submitted and seventy-six of these were selected for presentation. The program committees chaired by Richard Chapman and Eiji Takeda are to be congratulated for a job well done.

The Symposium begins with a Plenary Session which includes two invited papers. Carl S. Ledbetter, Jr. of AT&T Bell Consumer Products will discuss the technology/market needs for an intelligent two-way global telecommunications network in his presentation "Consumers on a Chip." Susumu Kohyama of Toshiba will discuss the convergence of different technologies as industry emphasis changes from commodity to more application specific custom products in his presentation "Semiconductor Crisis and Challenges Toward the Year 2000."

To provide a forum for informal interaction between researchers from many different countries, five evening rump sessions are scheduled for discussion of key issues in modern VLSI. Tony Alvarez and Seiichiro Kawamura have done an excellent job in organizing these rump sessions.

Preceding the Symposium on June 6, a one-day Workshop on VLSI Technology will be held. This workshop will focus on technology issues that could limit practical scaling of VLSI into the deep submicron regime. Thanks are due to Rafael Reif and Masahiro Kashiwagi for organizing the Workshop.

We greatly appreciate the work of Ching-Te Chuang and Seiichiro Kawamura who were in charge of publications, Richard Jaeger and Masakazu Kakumu - treasurers, Bill Siu and Tadashi Nishimura - secretaries, and especially to Wayne White and Kiyoshi Yoneda for local arrangements.

There are a number of technology issues that are becoming more evident as we scale towards 0.1μm devices in an environment of world wide participation. We sincerely hope that your own work will benefit from interaction with your colleagues from around the world and that you will have an enjoyable and rewarding time in Honolulu, Hawaii.

James T. Clemens
Symposium Chairman

Hiroyoshi Komiya
Symposium Co-Chairman

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1994 VLSI Technology Workshop Program
Limits of Device Scaling: Uniformity/Fluctuation Issues

Monday, June 6, 8:45 a.m.

Organizer: Rafael Reif, Massachusetts Institute of Technology
Co-Organizer: Masahiro Kashiwagi, Toshiba Corporation

SCHEDULE

TIME	TOPIC	SPEAKER
8:45	**The Effect of Randomly Distributed Dopant Atoms on MOSFET Performance**	A. Toriumi, Toshiba
10:15	**Break**	
10:30	**Atomic Scale Microroughness of Chemically Cleaned Si Surfaces and Tunneling Current through Ultra-thin Gate Oxides**	M. Hirose, Hiroshima University
12:00	**Lunch**	
1:15	**Limits of Optical Lithography**	L. Van den hove, IMEC
2:45	**Break**	
3:00	**Plasma Etching Issues for Future VLSI Devices**	J. McVittie, Stanford University
4:30	**Conclusion**	

Session 1: Welcome and Plenary Session [Tapa I/II]

Chairpersons:	Richard Chapman	Texas Instruments
	Eiji Takeda	Hitachi

Session 2: Low Power and 0.1μm CMOS Fluctuations [Tapa I/II]

Chairpersons:	Y. Taur	IBM
	M. Kakumu	Toshiba

Session 3A: Deep Sub-Micron MOSFETs [Tapa II]

Chairpersons:	K. Chiu	Hewlett-Packard
	T. Kobayashi	NTT

Session 3B: Process Technology [Tapa I]

Chairpersons:	E. Castel	National Semiconductor
	R. Tsai	TSMC

Session 4A: SOI Technology [Tapa II]

Chairpersons:	J. Woo	University of California, Los Angeles
	S. Kawamura	Fujitsu

Session 4B: VLSI Reliability [Tapa I]

Chairpersons:	B. Siu	Intel
	K. Hoh	University of Tokyo

Session 5A: Non-Volatile Memory I [Tapa II]

Chairpersons:	J. Yeargain	Motorola
	T. Ohmi	Tohoku University

Session 5B: Interconnect Technology I [Tapa I]

Chairpersons:	R. Havemann	Texas Instruments
	R. Tsai	TSMC

Session 6A: Non-Volatile Memory II [Tapa II]

Chairpersons:	N. Masnari	North Carolina State University
	C.G. Hwang	Samsung Electronics

Session 6B: Interconnect Technology II [Tapa I]

Chairpersons:	W. Lynch	Semiconductor Research Corporation
	K. Yoneda	Sanyo Electric

Session 7A: Novel Devices [Tapa II]

Chairpersons:	S. Banerjee	University of Texas
	E. Suzuki	Electrotechnical Laboratory

Session 7B: Lithography [Tapa I]

Chairpersons:	G. Declerck	IMEC
	N. Nomura	Matsushita Electric

Session 8A: SRAM Technologies [Tapa II]

Chairpersons:	M. Bohr	Intel
	J. Kudo	Sharp

Session 8B: Dielectrics [Tapa I]

Chairpersons:	K. Saraswat	Stanford University
	K. Taniguchi	Osaka University

Rump Sessions [Honolulu I, II, III and Iolani I, IV]

Organizers:	T. Alvarez	Cypress Semiconductor
	S. Kawamura	Fujitsu

Session 9A: Silicides for Deep Sub-Micron Technology [Tapa II]

Chairpersons:	F. Neppl	Siemens
	J. Ida	Oki Electric

Session 9B: Modeling of Silicon Devices [Tapa III]

Chairpersons:	R. Liu	AT&T Bell Laboratories
	E. Sheckler	Hitachi

Session 10A: Novel DRAM Structures [Tapa II]

Chairpersons:	J. Abernathy	IBM
	M. Inuishi	Mitsubishi Electric

Session 10B: Hot Carriers [Tapa III]

Chairpersons:	B. Zetterlund	Digital Equipment Corporation
	M. Kakumu	Toshiba

Session 11: Advanced DRAM Capacitors [Tapa I]

Chairpersons:	T. Alvarez	Cypress Semiconductor
	T. Kunio	NEC

Session 12: Advanced Bipolar/BiCMOS Technologies [Tapa I]

Chairpersons:	R. Reif	Massachusetts Institute of Technology
	A. Kayanuma	Sony

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CONSUMERS ON A CHIP

by
Carl S. Ledbetter, Jr.
President, AT&T Consumer Products
Parsippany, New Jersey

The telecommunications technology now exists to provide customers with intelligent instruments that offer them readier access to an increasingly intelligent global network, and greater control over the services it provides. The question is whether this technology can be converted into products that meet customer needs and expectations.

The hardware and software are now available to supply real-time, two-way voice, data and messaging services anytime the customer needs them, from any location, using wired or wireless networks. Moreover, the communications instrument at the customer's disposal -- whether corded or cordless, cellular or video -- will contain intelligence that allows the customer to summon services tailored to that customer's individual needs.

The Driving Force

The device driving this evolution in communications technology will be the integrated circuit, the computer-on-a-chip. Computers now help to make almost every aspect of our lives easier, more productive and more enjoyable. Thomas Watson, the founder of IBM, once stated that he saw a world market for about five computers. With today's microelectronics technology, computers are virtually everywhere. Someone once said, with more truth than humor: "If it costs more than $20, and you can't eat it or wear it, it's probably a computer."

The computer-on-a-chip will be essential to the next generation of telecommunications products. Tomorrow's communicator will be a plastic braincase housing a sophisticated integrated circuit -- a one-module engine that defines any "phone". This chip will have downloadable and upgradable features, and can be customized by channel, by region or by account.

The microchip will be the entree, not only to the network, but to the world of global communications. Technically, the marvels of this new communications age are at the customer's disposal today. But first, we must be sure that what we offer is what the customer wants. Social conventions and user interface will ultimately determine that, not technology.

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The Critical Role of User Interface

Many of the electronic products offered today suffer from too much technology and too little ease-of-use. Unless a consumer product is simple to understand and easy to operate, it is doomed in the marketplace. The telephone dial is a model example of technological evolution wedded to practical design. From the simple handcrank set, to network switching and the rotary dial, to electronic switching and the touch-tone set, the telephone has been a user-friendly instrument. The touch-tone telephone, for example, is the product of careful design and years of satisfied use. Anyone dialing a touch-tone phone, anywhere in the world, could do it in the dark because the placement of its buttons is convenient, logical and consistent. Yet that simple interface gives even the most unsophisticated user instant access to the largest, most complex computer in the world -- the telephone network.

Today, a person can set up a call without dialing at all, using the medium of voice recognition technology. Handwriting recognition makes it possible to hand write a message on a personal communicatior and send it over the network. However, these technologies share a common limitation -- the customer. Voice recognition is effective only if the customer speaks clearly, and even the best handwriting recognition system has an accuracy rate of about 70 percent, or three errors in every ten words sent.

Does the problem rest with the customer? The solution does not. Educating the customer through more written instructions is not the answer. Experience shows that the operating manual that comes with a product is not the first place a customer looks for help. It is the last place. Operating manuals tend to read more like textbooks than helpful customer aids. Many owners do not know how to program their VCRs and cannot be bothered to look it up in an operating manual. What is needed are not more and better instructions, but easier-to-use products that contain their own operating instructions.

Accommodating Social Conventions

Social conventions are equally daunting. When AT&T introduced the Picturephone thirty years ago -- without benefit of VLSI technology -- it proved to be too cumbersome, too limited in its applications, and too expensive for most customers. In addition, customers balked at the prospect of always being on camera. Today's version, the videophone -- featuring microelectronics technology -- is smaller, more convenient and more economical. But the original social contraint persists: customers still balk at being on camera all the time.

In another example, AT&T advertises that with its newest product, you can send a fax from the beach. Great! But the real question is, "Who would want to get a fax at the beach?" User interface and social conventions thus remain powerful considerations.

Conclusion

The role of the telecommunications industry, then, is not to sell what it invents, but to invent what will sell. To do that, we must understand what customers need and will be comfortable with, and then design an affordable product that meets their criteria. That includes devices with built-in, easy-to-execute instructions. In short, progress in telecommunications will rely heavily on the microelectronics industry to produce the kind of technology and circuits that will truly make our products useful, pleasurable and affordable.

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