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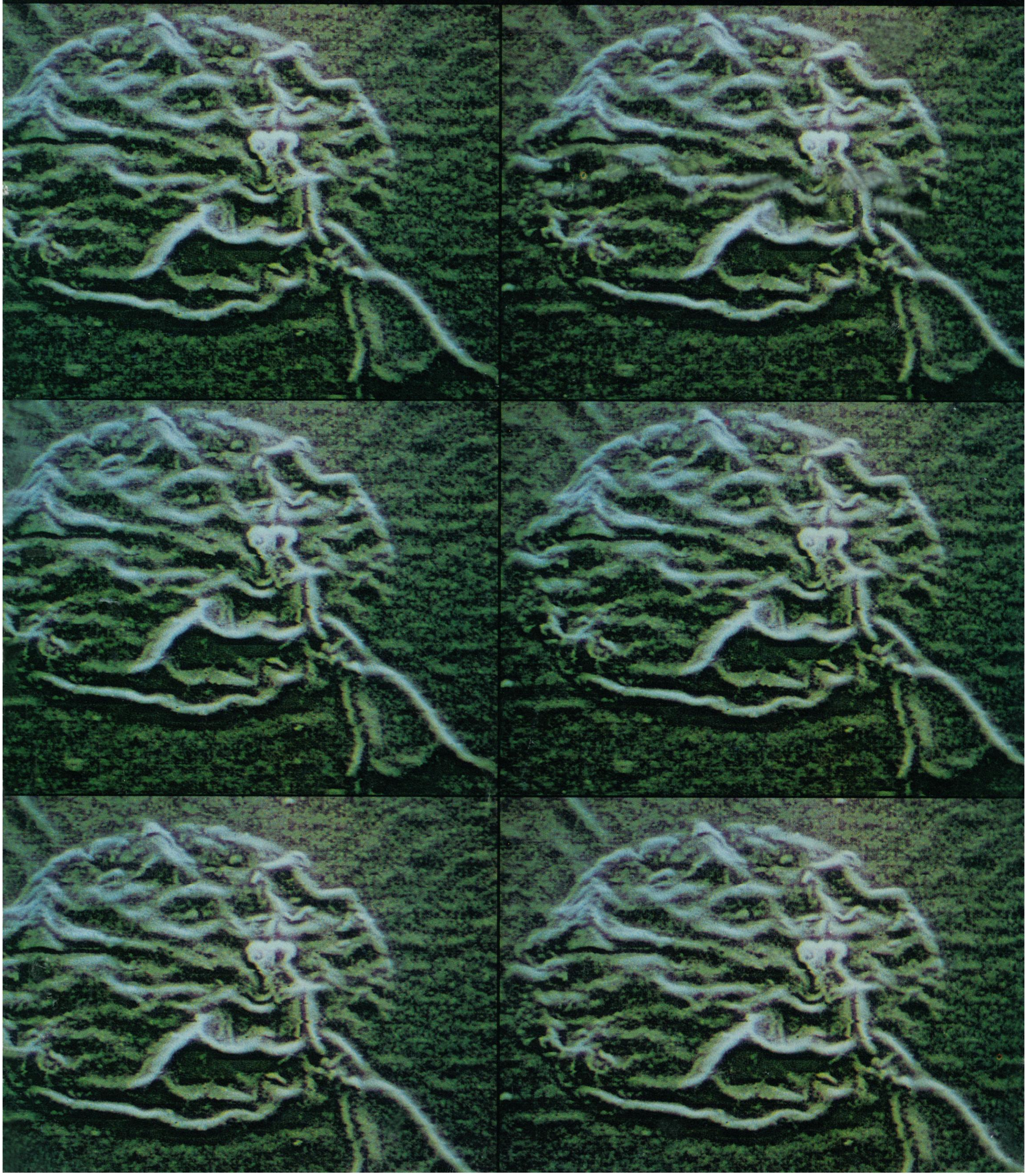
SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



The Case of the Tax-Perplexed Professor

It is the eve of April 15th. As midnight strikes, Professor Gregg G. Burnett is poring over a pile of papers. "Taxes, taxes, taxes," he groans. "Why do I have to pay all this money in taxes? How does everyone else manage? And still put a little extra aside for retirement?" Gregg sighs. "It's all a mystery to me."

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*Effective March 1, 1984 through February 28, 1985 for funds credited January 1, 1982 or later. This interest rate is not guaranteed after February 28, 1985. A 1.5% expense charge is deducted from SRA premiums. If you would like to know more about SRAs, simply mail the coupon below or write TIAA-CREF, 730 Third Avenue, New York, NY 10017.

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COVER

Microscopic image of a fully hydrated and live human platelet obtained by x-rays. A freshly prepared platelet suspension was exposed to a flash x-ray source of high intensity which produced a bas-relief impression on a photon-sensitive resist. The latter was examined by scanning electron microscopy. The live platelet was in a state of activation. Intracellular organelles are seen here contracted in one core of photon-dense material from which pseudopods originate. See page 63. [Photo digitizing by A. Appel and A. Stein, IBM, Yorktown Heights, New York 10598; image produced with Maxwell Laboratories Low Energy X-ray Illumination Source, San Diego, California 92123]

Masterslice and the Engineering Design System

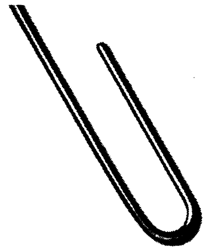
IBM

To: Abby
From: Roger
Subject: IBM Technology

I've been reviewing some of our past and present technological achievements, and it occurred to me that the scientific, engineering, and academic communities might like to know more about them. Will you select a topic from the following list? Thanks.

- Vacuum tube digital multiplier
- IBM 603/604 calculators
- Selective Sequence Electronic Calculator (SSEC)
- Tape drive vacuum column
- Naval Ordnance Research Calculator (NORC)
- Input/output channel
- IBM 608 transistor calculator
- FORTRAN
- RAMAC and disks
- First automated transistor production
- Chain and train printers
- Input/Output Control System (IOCS)
- STRETCH computer
- "Selectric" typewriter
- SABRE airline reservation system
- Removable disk pack
- Virtual machine concept
- Hypertape
- System/360 compatible family
- Operating System/360
- Solid Logic Technology
- System/360 Model 67/Time-Sharing System
- One-transistor memory cell
- Cache memory
- Relational data base
- First all-monolithic main memory
- Thin-film recording head
- Floppy disk
- Tape group code recording
- Systems Network Architecture
- Federal cryptographic standard
- Laser/electrophotographic printer
- First 64K-bit chip mass production
- First E-beam direct-write chip production
- Thermal Conduction Module
- 288K-bit memory chip
- Robotic control language
- Masterslice and the Engineering Design System

Roger-
Let's tell about our innovative method of designing and integrating logic chips into our large computers.
Abby



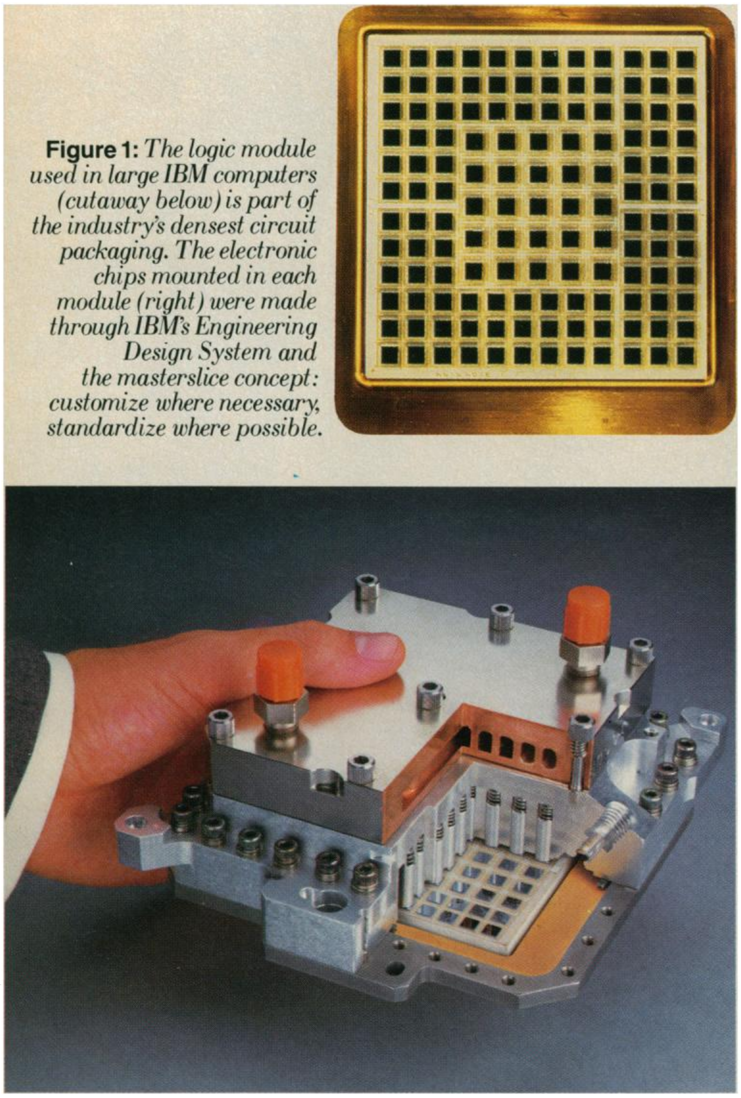


Figure 1: *The logic module used in large IBM computers (cutaway below) is part of the industry's densest circuit packaging. The electronic chips mounted in each module (right) were made through IBM's Engineering Design System and the masterslice concept: customize where necessary, standardize where possible.*

As computer applications continue to expand, designers of large computers are faced with many challenges. One of the biggest of these is designing semiconductor chips: not only do engineers have to design chips to contain the desired function, but they must also integrate the chips into the rest of the system and accomplish this quickly and inexpensively.

For nearly two decades, IBM designers have been leaders in this field, pioneering the technologies of chip customization, automated design, and automated manufacturing. In the mid-1960s, IBM researchers began developing a chip customization technology—known as gate array or masterslice—as well as a totally integrated set of design automation tools called the Engineering Design System.

The first masterslice chip came off IBM production lines in 1967 and was part of the System/3 announced in 1969. Growing increasingly important as an element in IBM computers, masterslice became the basis for the logic in the System/38 in 1978. This marked the first major impact of masterslice technology on computer architecture, making masterslice a driving force in semicustom, large-scale integration of chips in the computer industry.

In masterslice, a predefined pattern of circuit elements is fabricated in an area of a silicon chip called a cell. The pattern is then repeated so that almost the entire chip is covered with identical cells. In this manner, many chips

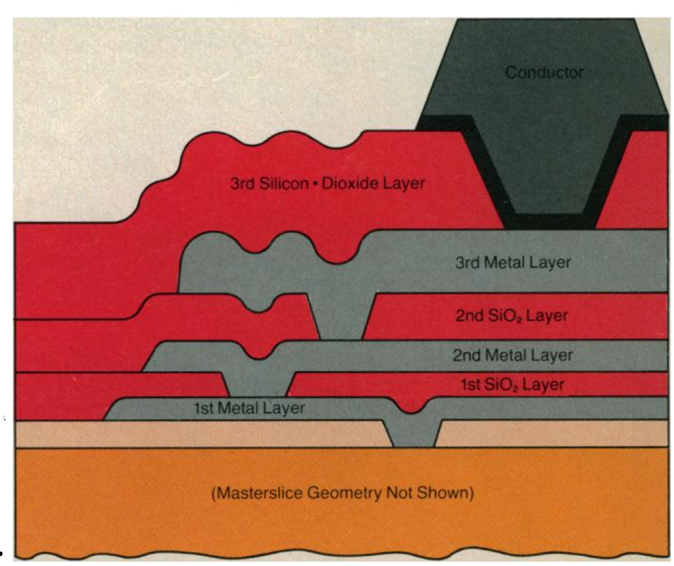


Figure 2: *This simplified side view of a logic chip shows three layers of metallization (along with three layers of insulating silicon dioxide) that are put on top of the masterslice to produce a semicustom chip. The metallization process enables designers to customize chips for a specific job. And a standard "base"—the masterslice—allows quicker turnaround times and lower manufacturing costs.*

Masterslice and the Engineering Design System

may be produced with identical arrays of identical cells.

Customization takes place in "metallization"—the adding of alternate layers of insulators and metal wiring interconnections over the masterslice pattern of the circuit elements. This gives chip designers the freedom to make hundreds of variations in their design and still maintain the economic standardization of parts.

Masterslice technology has grown into an important process for implementing logic in IBM products. It is the basis of the 1,200 logic chips that make up the 500 different logic configurations of the central processing unit of IBM's largest computers, the 308X family.

IBM's Engineering Design System (now a full family of integrated design tools) has a data base that contains a complete description of each chip and its relation to the rest of the system, from the physical properties of individual devices to the requirements of the entire logic system of the computer. Thus, this design system enables

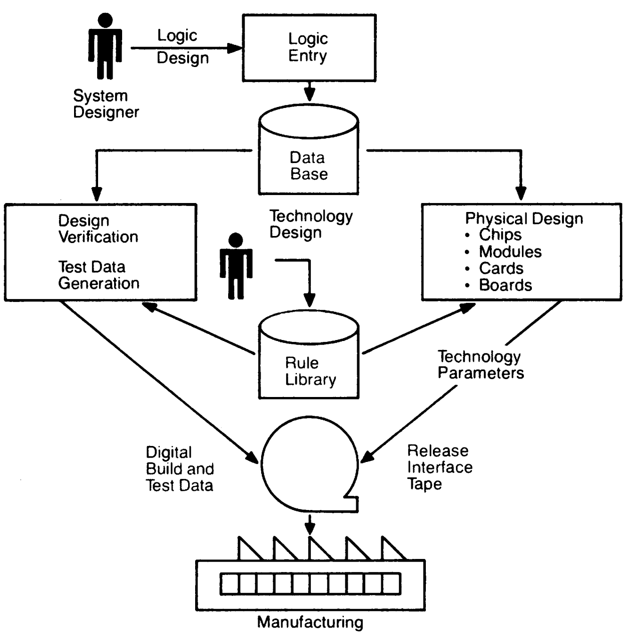


Figure 3: *With IBM's Engineering Design System, machine designers use terminals to input logic functions for a chip and establish a data base. Through simulation, the system provides logic verification and performs logic delay checking. Test patterns are then automatically generated for each part. In the meantime, physical design of the chip is done with computer programs that perform the following tasks: circuit placement, I/O assignment, wiring, and checking. All physical design information is then transformed into shapes, patterns, and precise locations of interconnections and circuit elements required for manufacturing.*

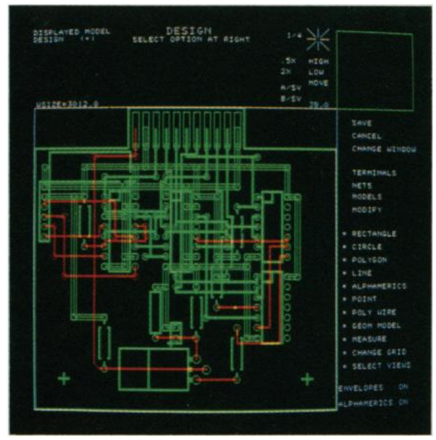


Figure 4: *Shown here is a display screen from the Interactive Graphic System (IGS), one of the many Engineering Design System tools developed by IBM to speed chip development and implementation. IGS is a powerful shape manipulation tool used to design new masterslices.*

the needs of a large system to be reflected in the design of its smallest components.

The thousands of individual software modules of the Engineering Design System can be used to take a chip from initial design, through simulation and testing, to manufacture. Linking such a wide range of functions through common interfaces to form a total system is a feat unmatched in the industry. A designer using this system can take a chip from the start of the physical design stage to the manufacturing line in about six days.

Many engineers, scientists, and programmers throughout IBM contributed to the development of masterslice and the Engineering Design System. Their contributions are only part of IBM's continuing commitment to research, development, and engineering.

4 January 1985, Volume 227, Number 4682

SCIENCE

Philip Hauge Abelson

In 1962 Philip Abelson assumed the editorship of *Science*. The publication at that time had a circulation of 75,000. The News and Comment section was two pages, and the Reports section eight pages, with four items. From that beginning, *Science* has expanded to a current circulation of 155,000, a News and Comment and Research News section of 14 pages, individual science reports of 30 pages, and lead articles that span the entire range of scientific disciplines. It has the widest circulation of any scientific journal that publishes articles on original research, science policy, and news. Special issues on such diverse subjects as landings on the moon, neurobiology, and computers have become scientific and educational landmarks.

Success in any complex undertaking cannot be dissected like a frog nor simulated by a computer. Its most prominent features catch the light and seem obvious. The subtleties are hidden in the shadows, yet they are the matrix that converts the good into the excellent. In Phil Abelson, the well-lighted features are the development of an organizational structure that has turned out a weekly magazine containing both high scholarship and interesting journalism, a willingness to take controversial positions and stand up to the criticism that they generate, and the decision to maintain a magazine devoted to all of science.

The subtleties of his leadership are more difficult to perceive, but one component is his enthusiasm for the discoveries of science. A significant new finding makes his eyes glisten. The narrator finds that she or he is bombarded with probing questions of both a good journalist and an indefatigable scientist. Phil Abelson's own research interests, which cover the disciplines of chemistry, microbiology, geophysics, and nuclear chemistry, explain why the magazine, under his leadership, continually probed the entire fabric of science—physical and social, academic and industrial, political and ivory tower.

There is a second quality, illustrated by a theoretical scientist who was asked by an irate colleague, "Don't you have any common sense?" The theoretician replied, "Common sense is a rare gift of God. I have only a technical education." Phil Abelson has that rare gift to discern the significant from the trivial, to ensure financial success while avoiding decisions that would compromise the integrity of the magazine, to discriminate between the major shifts and the ephemeral fashions of science. He has harmonized in the same magazine two potentially discordant goals, journalism and scholarship, so that the magazine has never succumbed to the meretriciousness of sensational journalism nor the desiccation of overspecialized scholarship.

Fortunately for his successor, Phil Abelson is not retiring but is moving to a position of consultant for the AAAS, which will involve continuing association with *Science* and assuming special projects for some major foundations and scholarly societies. Although he has received many awards, of which the Mellon Institute Award of the Carnegie-Mellon University and the Kalinga Prize of Unesco are indicative, he seeks new frontiers as always and is not content with well-earned relaxation and the enjoyment of his impressive past triumphs. I have exploited his love of science and disdain for protocol by persuading him to serve as Deputy Editor for Engineering and Applied Sciences, a situation that will allow me to draw on his general wisdom and allow *Science* to be kept up to date in important areas such as agriculture, materials, computers, and energy.

There are many prominent statues to generals in Washington, apparently only two to scientists, and none that I know of to an editor. Phil Abelson has a living monument, an edifice that provides fast-moving journalism for today and tomorrow and scholarly science for the ages. Scientists throughout the world are and will remain indebted to him for his contribution to science and to a better world.—DANIEL E. KOSHLAND, JR.