



Chapter 1

Introduction to Electronics

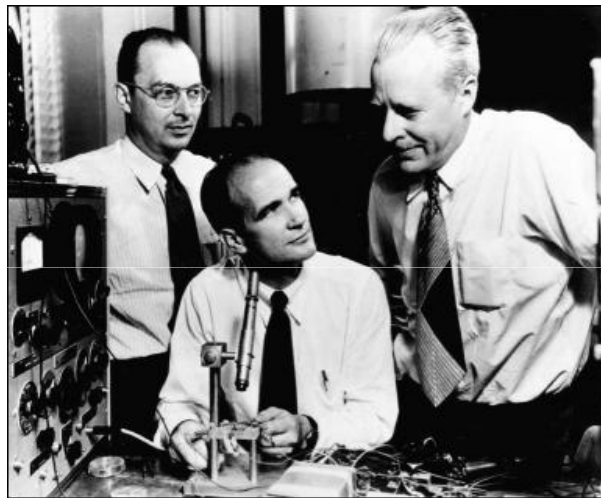
Microelectronic Circuit Design

Richard C. Jaeger

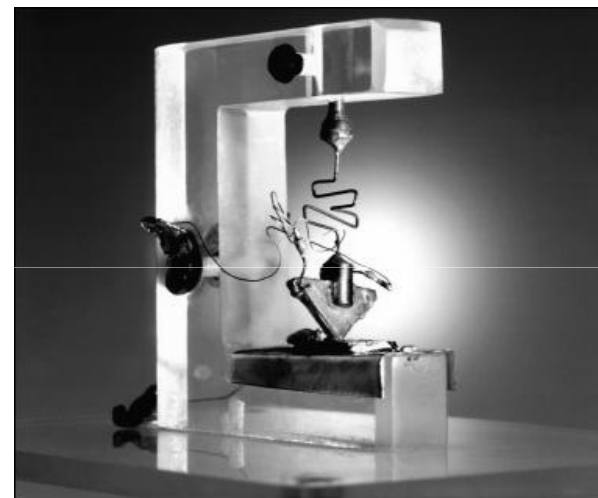
Travis N. Blalock



The Start of the Modern Electronics Era



Bardeen, Shockley, and Brattain at Bell Labs - Brattain and Bardeen invented the bipolar transistor in 1947.



The first germanium bipolar transistor. Roughly 50 years later, electronics account for 10% (4 trillion dollars) of the world GDP.

Electronics Milestones

- | | | | |
|-----------|---|------|--|
| 1874 | Braun invents the solid-state rectifier. | 1958 | Integrated circuit developed by Kilby and Noyce |
| 1906 | DeForest invents triode vacuum tube. | 1961 | First commercial IC from Fairchild Semiconductor |
| 1907-1927 | First radio circuits developed from diodes and triodes. | 1968 | First commercial IC opamp |
| 1925 | Lilienfeld field-effect device patent filed. | 1970 | One transistor DRAM cell invented by Dennard at IBM. |
| 1947 | Bardeen and Brattain at Bell Laboratories invent bipolar transistors. | 1971 | 4004 Intel microprocessor introduced. |
| 1952 | Commercial bipolar transistor production at Texas Instruments. | 1978 | First commercial 1-kilobit memory. |
| 1956 | Bardeen, Brattain, and Shockley receive Nobel prize. | 1984 | 8080 microprocessor introduced. |
| | | 1984 | Megabit memory chip introduced. |
| | | 2000 | Alferov, Kilby, and Kromer share Nobel prize |

Evolution of Electronic Devices

Vacuum
Tubes



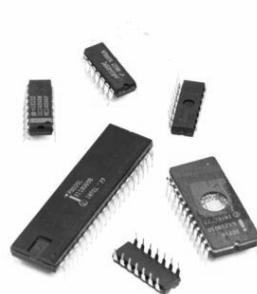
(a)

Discrete
Transistors



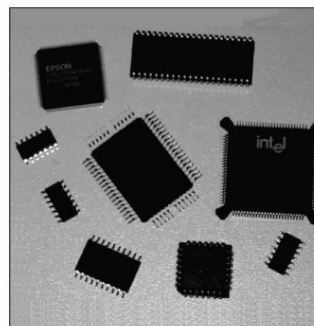
(b)

SSI and MSI
Integrated
Circuits



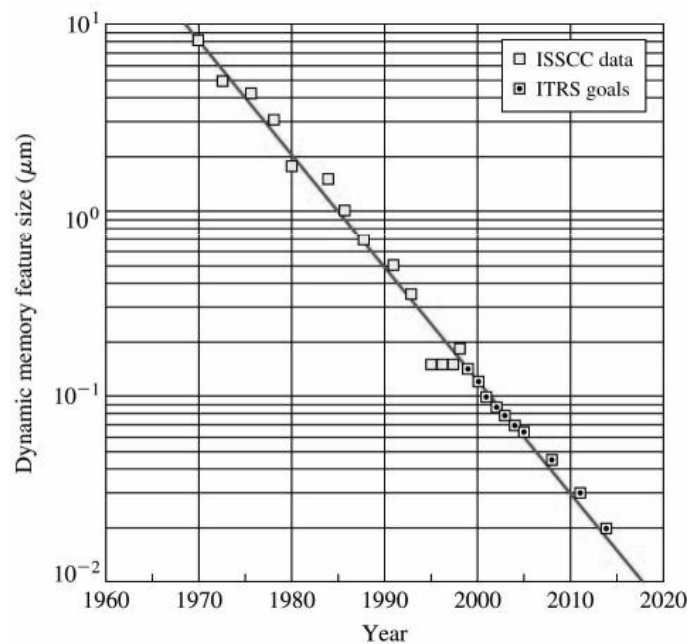
(c)

VLSI
Surface-Mount
Circuits



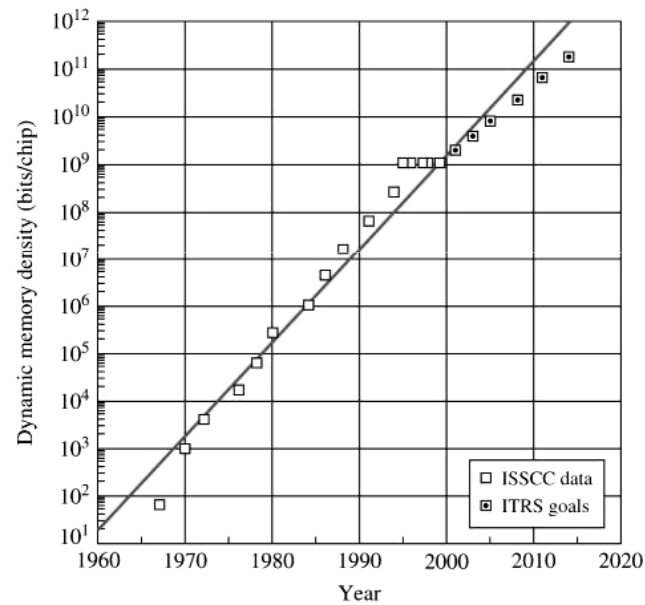
(d)

Device Feature Size

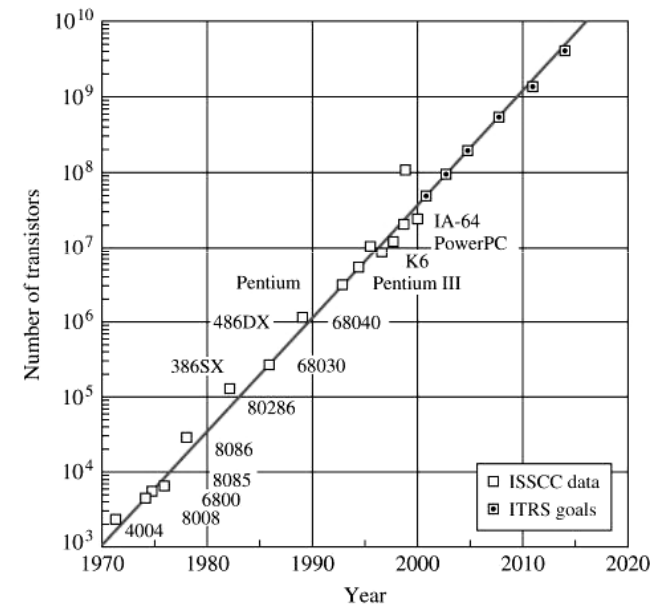


- Feature size reductions enabled by process innovations.
- Smaller features lead to more transistors per unit area and therefore higher density.

Rapid Increase in Density of Microelectronics



Memory chip density versus time.



Microprocessor complexity versus time.