Computer Architecture Brings Together:

Device physics
Device circuits
Digital design
Mask layout
Processing

Programming languages
Assembly (machine) language
Instruction set architecture
Automata theory

How to do tradeoffs
How to handle complex problems
How to use interfaces

Business and economics
e.g. of consumer price:
1/3 is parts and labor
1/3 advertizing, marketing, ship
1/3 overhead and profit

***Requirements* – everyone contributes:**

Customer

Computer Architect

Digital Logic Designer

IC Circuit Designer – circuits – cell family

IC Mask - layout and route

IC Process and Fabrication

Packaging Designer – IC – PWB – connectors

Operating System Designer

Compiler Designer

It takes a large team to create a new CPU

Units, dimensions, size and scale

10^{-12}	pico-	picosecond ps
10^{-9}	nano-	nanosecond ns, nanometer nm
10^{-6}	micro-	microsecond us, micrometer=micron
10^{-3}	milli-	millisecond ms

10^{3}	2^{10}	kilo-	kilobit Kb, kilobyte KB
10^{6}	2^{20}	mega-	megabyte MB, megahertz MHz
10^{9}	2^{30}	giga-	gigabyte GB, gigahertz GHz
10^{12}	2^{40}	tera-	terabyte TB
10^{15}	2^{50}	peta-	petabyte PB

speed of light

300,000,000	meters per second
300,000	meters per millisecond
300	meters per microsecond
0.3	meters per nanosecond (about 1 foot)

1 Ghz clock has a 1 ns period: 0.5 ns '1' 0.5 ns '0'
electrons can travel about 4 inches in an
integrated circuit in 0.5 ns with 130 nm features

DVD's use a laser with a wavelength 650 nm
a bit length of 133nm with a track pitch of 740 nm

Some Steps a CPU May Perform:

- increment/set Program Counter, PC
- send (PC) to Memory Controller, as address
- send read request to MC
- wait for MC to return instruction
- decode instruction
- compute operand memory address, EAR
- send (EAR) to MC with read request
- wait for MC to return operand
- perform instruction operation
- update register(s) and condition status
- send result and (EAR) to MC, write request

Some or all steps may be used by a single instruction.
Some or all steps may be performed in parallel.

THE I.S.A. DEFINES THE
REGISTERS, INSTRUCTIONS, etc.

CHEMICAL LAB ON A CHIP
MICRO PUFFS OF AIR
MICRO MIXING
ANALYSIS

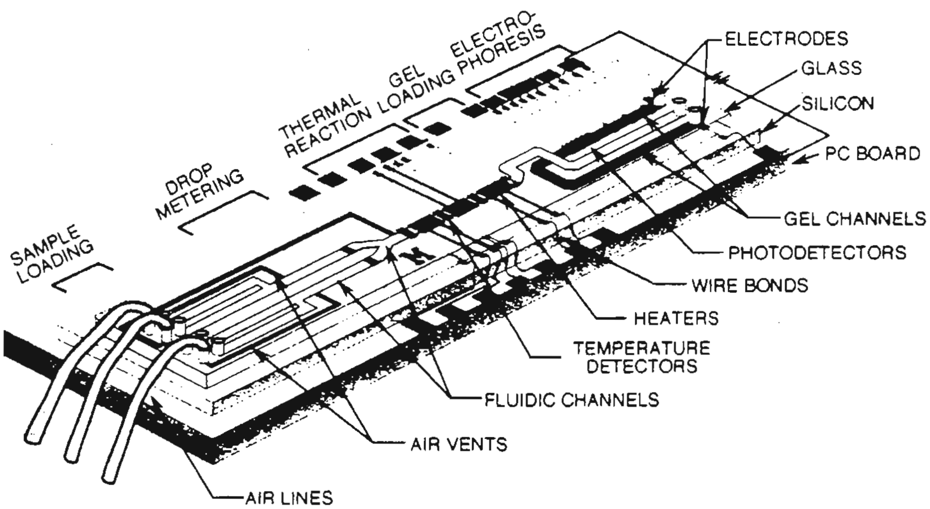
"The goal of designing a nanoliter DNA analysis device was to replace conventional hardware and trained technicians," said Burns. "DNA analysis methods have improved over the last decade. However, the cost for reagents and labor remain high. And if high throughput is needed, the cost of supporting equipment becomes prohibitive."

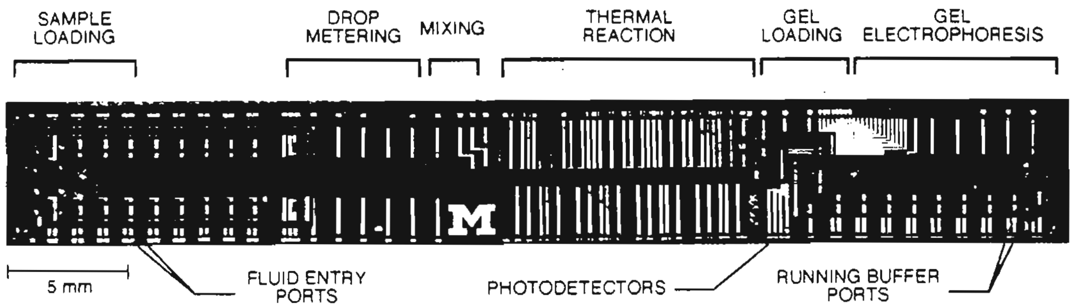
Preliminary estimates by Burns suggest that the cost of producing the DNA-testing chip in research-sized quantities may be approximately $6 per device. Mass production would lower that amount considerably.

"We can do things so cheaply by relying on the principles that currently make computers so cheap,"

The invention is the product of five years of work by Professors Burns, Mastrangelo, and Burke and their colleagues. In a short time, these three professors were able to construct a trial microfabricated system, perform preliminary experiments, and write several successful National Institutes of Health (NIH) proposals. Their work was funded by NIH grants totaling nearly $3 million. Also, the team received the inaugural Team Excellence Award in 1998 from the College of Engineering.

Their method of microfabricating a fluid and electronic chip capable of complex chemical analysis was detailed in the October 16, 1998, issue of the journal *Science*, in an article by Dr. Burns et.al. titled "An Integrated Nanoliter DNA Analysis Device" (pages 484-487).





$DNA Testing