Steve Jobs, Bill Gates, and the PC
and
Course Review

Radical Innovation and the Transformation of Daily Life

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Course Administrator: Catherine Eiben  ceiben@princeton.edu

Computers for NOTETAKING ONLY
Please - NO Cell Phones, Texting, Internet use
Components of Innovation

Inventor and Entrepreneur

Noyce and Hoff – Intel Microcomputer

[Image of two men working on a document]

[Graph showing the performance of supercomputers, mainframes, minicomputers, and microprocessors over time, with significant milestones marked: Intel 4004, Apple I, TCP/IP]
Components of Innovation

Inventor and Entrepreneur

Noyce and Hoff – Intel Microcomputer
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Homebrew Computer Club
Silicon Valley 1975
Components of Innovation

Inventor and Entrepreneur

Wozniak and Jobs
Apple Computer founded in 1976

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Wozniak and Jobs
Apple Computer founded in 1976
Think different.
Apple Introduces the First Low Cost Microcomputer System with a Video Terminal and 8K Bytes of RAM on a Single PC Card.

The Apple Computer, a truly complete microcomputer system on a single PC board. Based on the MOS Technology 6502 microprocessor, the Apple also has a built-in video terminal and sockets for 8K bytes of on-board RAM memory. With the addition of a keyboard and video monitor, you'll have an extremely powerful computer system that can be used for anything from developing programs to playing games or running BASIC.

Combining the computer, video terminal, and dynamic memory on a single board has resulted in a large reduction in chip count, which means more reliability and a lowered cost. Since the Apple comes fully assembled, tested & burned-in and has a complete power supply on-board, initial set-up is essentially "hassle free" and you can be running within minutes. At $666.66 (including 8K bytes RAM) it opens many new opportunities for users and systems manufacturers.

You Don't Need an Expensive Teletype.

Using the built-in video terminal and keyboard interface, you avoid all the expense, noise and maintenance associated with a teletype. And the Apple video terminal is six times faster than a teletype, which means more throughput and less waiting. The Apple communicates over a video interface or over a TV with an inexpensive RF modulator and displays 690 easy-to-read characters in 21 rows of 40 characters per line. Full automatic scrolling. The video display section contains its own 8K bytes of memory, so all the RAM memory is available for user programs. And the keyboard interface lets you use almost any ASCII-encoded keyboard.

The Apple Computer makes it possible for many people with limited budgets to step up to a video terminal as an I/O device for their computer.

No More Switches, No More Lights.

- Compared to switches and LEDs, a video terminal can display vast amounts of information simultaneously. The Apple video terminal can display the contents of 192 memory locations at once on the screen.

- The firmware in PICS enables you to enter, display and debug programs all in one box from the keyboard, rendering a front panel unnecessary.

The firmware also allows your programs to paint characters on the display, and since you'll be looking at letters and numbers instead of just LED's, the door is open to all kinds of alphanumeric software (i.e., Commodore BASIC).

8K Bytes RAM in 16 Chips!

The Apple Computer uses the new 16-pin 4K dynamic memory chips. They are faster and take up less space and power (over the low power 2K chips that everyone else uses). That means 8K bytes in sixteen chips. It also means no more 8K static power supplies.

The system is fully expandable to 64K via an edge connector which carries both the address and data bus, power supplies and all timing signals. All dynamic memory refreshing for both on and off-board memory is done automatically. Also, the Apple Computer can be upgraded to use the 16K chips when they become available.

Mr. That's 32K bytes on-board RAM in 16 IC's—the equivalent of 256 2102's!

A Little Cassette Board
That Works!

Unlike many other cassette boards on the marketplace, ours works every-time. It plugs directly into the upright connector on the main board and stands only 2.5" tall. And since it is very fast (500 bits per second), you can read or write 4K bytes in about 20 seconds. All timing is done in software, which results in crystal-controlled accuracy and uniformity from unit to unit.

Unlike some other cassette interfaces which require an expensive tape recorder, the Apple Cassette Interface works reliably with almost any audio-grade cassette recorder.

Software:

A tape of APPLE BASIC is included free with the Cassette Interface. Apple BASIC features immediate error messages and fast execution, and lets you program in a higher level language immediately without added cost. Also available now are a disk assembler and many games, with many software packages, including a macro assembler in the works. And since our philosophy is to provide software for our machines free at minimal cost, you won't be continually paying for access to this growing software library.

The Apple Computer is in stock at almost all major computer stores. (If your local computer store doesn't carry our products, encourage them or write us direct). Dealer inquiries invited.

Byte into an Apple ... $666.66*

*includes 4K bytes RAM

APPLE Computer Company • 770 Welch Rd., Palo Alto, CA 94304 • (415) 326-4248
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Combining the computer, video terminal and dynamic memory on a single board has resulted in a large reduction in chip counts, which means reliability and lowered cost. The Apple comes fully assembled, tested & burned-in and has a complete power supply on-board, initial setup is essentially "plug and play" and you can be running within minutes. At $666.66 (excluding 8K bytes RAM) it opens many new possibilities for users and systems manufacturers.

You Don't Need an Expensive Teletype.

Using the built-in video terminal and keyboard interface, you avoid all the expense, noise and maintenance associated with a teletype. And the Apple video terminal is six times faster than a teletype, which means more throughput and less waiting. The Apple connects directly to a video monitor or home TV with an inexpensive RF modulator and displays 960 easy to read characters in 32 rows of 40 characters per line with automatic scrolling. The video display section contains its own 8K bytes of memory, so all the RAM memory is available for user programs. And the byte into an Apple .......... $666.66*

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Demonstration:
Single board computer
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Macintosh 128K – 1984
Graphical User Interface
STRIKING IT RICH
America’s Risk Takers

Steven Jobs
Of Apple Computer

EXCLUSIVE: Inside the Apple-Microsoft Deal

“Bill, thank you. The world’s a better place.”

—Steve Jobs talking to Bill Gates by cell phone last week about saving Apple
Steve's Jobs

He saved Apple with his hot new iMac. He struck gold at Pixar with digital movies like Toy Story 2. You'd think he'd learn to chill. Think different.

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IRAQ: SUICIDE TRAINER  THE GREAT PLANET HUNT  FAT FIGHTERS

THE MAN WHO ALWAYS SEEMS TO KNOW...

WHAT'S NEXT

PLUS
TRENDSPOTTING with Moby, Malcolm Gladwell, David Brooks and Esther Dyson
5 NEW THINGS that will blow your mind
CLINT EASTWOOD'S revolutionary movie for 2006

AFGHANISTAN: DEADLY HUNT  INDIA & PAKISTAN: WAR DANCE

FLAT-OUT COOL!

Steve Jobs thinks he has seen the future—again. Apple's new iMac is an all-in-one hub for music, pictures and movies. It's elegant and affordable. But will millions of PC users get it?
Homebrew Computer Club
30th Anniversary in 2005 - Silicon Valley
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Bill Gates and Paul Allen – Micro-Soft Basic for Altair 8800 in 1975
Bill Gates and Paul Allen – Micro-Soft Basic for Altair 8800 in 1975
February 3, 1976

An Open Letter to Hobbyists

To me, the most critical thing in the hobby market today now is the lack of good software courses, books and software itself. Without good software and an owner who understands programming, a hobby computer is wasted. Will quality software be written for the hobby market?

Almost a year ago, Paul Allen and myself, expecting the hobby market to expand, hired Kenie Davidoff and developed Altair BASIC. Though the initial work took only two months, the three of us have spent most of the last year documenting, improving and adding features to BASIC. Now we have 4K, 8K, EXTENDED, ROM and DISK BASIC. The value of the computer time we have used exceeds $40,000.

The feedback we have gotten from hundreds of people who say they are using BASIC has all been positive. Two surprising things are apparent, however: 1) Most of these “users” never bought BASIC (less than 10% of all Altair owners have bought BASIC), and 2) the amount of royalties we have received from sales to hobbyists makes the time spent of Altair BASIC worth less than $2 an hour.

Why is this? As the majority of hobbyists must be aware, most of you steal your software. Hardware must be paid for, but software is something to share. Who cares if the people who worked on it get paid?

Is this fair? One thing you don’t do by stealing software is get back at MIT for some problem you may have had. MIT doesn’t make money selling software. The royalty paid to us, the manual, the tape and the overhead make it a break-even operation. One thing you do do is prevent good software from being written. Who can afford to do professional work for nothing? What hobbyist can put 3-5 man years into programming, finding all bugs, documenting his product and distribute for free? The fact is, no one besides us has invested a lot of money in hobby software. We have written 8000 BASIC, and are writing 8080 APL and 6800 APL, but there is very little incentive to make this software available to hobbyists. Most directly, the thing you do do is theft.

What about the guys who re-sell Altair BASIC, aren’t they making money on hobby software? Yes, but those who have been reported to us may lose in the end. They are the ones who give hobbyists a bad name, and should be kicked out of any club meeting they show up at.

I would appreciate letters from any one who wants to pay up, or has a suggestion or comment. Just write me at 1180 Alvarado SE, #14, Albuquerque, New Mexico, 87108. Nothing would please me more than being able to hire ten programmers and deluge the hobby market with good software.

Bill Gates
General Partner, Micro-Soft

Bill Gates and Paul Allen – Micro-Soft
Basic for Altair 8800 in 1975
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Bill Gates
General Partner, Micro-Soft
IBM Personal Computer Command Line Interface DEMONSTRATION

Bill Gates and Paul Allen – MiCROSOFT MS- DOS for IBM PC in 1981
Bill Gates and Paul Allen – MiCROSOFT MS- DOS for IBM PC in 1981
Key Ideas

Scientific:
- Computer on a Chip
- Graphical User Interface

Social:
- Computation
- Communication
- Commerce

Symbolic:
- Individual Genius
Engineering in the Modern World

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Immigrants

Alexander Graham Bell
Andrew Carnegie
John Von Neumann
Othmar Ammann

Telephone
Immigrants

Alexander Graham Bell
Andrew Carnegie
John Von Neumann
Othmar Ammann

Steel

Telephone
Steel

Iconic Suspension Bridges
Digital Computer

Iconic Suspension Bridges
Inventors

Thomas Telford  
Wright Brothers  
Thomas Edison  
Henry Bessemer

Flat Bridge  
Flying Machine  
Efficient Network  
Strong Material

Digital Computer

\[ H = \frac{1}{8} qL \frac{L}{d} \]
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Thomas Telford
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Thomas Edison
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Flat Bridge
Flying Machine
Efficient Network
Strong Material

\[ L = 0.00257 \, V^2 \, C_L \, A \]

\[ H = \frac{1}{8} \, qL \, \frac{L}{d} \]
\[ L = 0.00257 \, V^2 \, C_L \, A \]

\[ P_L = I^2 \, R \]
Safety Factor: \( \frac{f_B}{f} \)

\[ P_L = I^2 R \]
Partners

James Watt – Mathew Boulton
Robert Fulton – Robert Livingston

Safety Factor $= \frac{f_B}{f}$
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Robert Fulton – Robert Livingston
Patents
Steamboat
Telephone
Electric Light
Airplane
Radio
Rocket
Transistor
Integrated Circuit

What are positive and negative effects of patents?
Patents

Steamboat
Telephone
Electric Light
Airplane
Radio
Rocket
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Integrated Circuit

What are positive and negative effects of patents?

delays competition

Bell Telephone wins captures Edison patents from Western Union
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“War of the Currents”

delays competition
Westinghouse wins
Wright Brothers Patent delays competition

WWI – patent suspended in national interest

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Sarnoff (RCA) fights Armstrong FM Patents

Armstrong’s widow wins
1964 – 50th Anniversary of Multi-Stage Patent

Goddard not taken seriously until the V2

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1956 Nobel Prize applications in telephone, radio, space
Kilby and Noyce share Credit and Revenue

Independently invented by Jack Kilby and Robert Noyce, the integrated circuit was first available commercially in 1961. It led to smaller, inexpensive, mass-produced electronic circuits, revolutionizing the computer industry.

CELEBRATE THE CENTURY - 1960s

1956 Nobel Prize applications in telephone, radio, space
Artist as Engineer

Telford
Morse
Ammann

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Structural Art
Intelligence at a distance

Artist as Engineer

Telford
Morse
Ammann

Structural Art
Intelligence at a distance

Structural Artist and Entrepreneur
Political Entrepreneurs

Amman Livingston Norris

Structural Artist and Entrepreneur
Political Entrepreneurs

Amman
Livingston
Norris

TVA Architect
Advocate for Public Power
TVA Architect
Advocate for Public Power
Focus on Whole System

Edison
Ford
Marconi

Competition with Gas Lighting
Focus on Whole System

Edison
Ford
Marconi

Assembly Line
Integrated Factory

Competition with Gas Lighting
Assembly Line
Integrated Factory

Global Wireless Network
Energy Conversion

Steam Engine
IC Engine
Jet Engine
Rocket Motor

Animal to Machine
External Combustion

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Animal to Machine
External Combustion

Internal Combustion
Compact and Efficient
Gas Turbine
Batch to Continuous

Internal Combustion
Compact and Efficient
Gas Turbine
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Rocket carries own $O_2$
Power in the Vacuum of Space
Government Fixes

<table>
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<th>Port Authority</th>
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<td>Depressed</td>
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<tr>
<td>River Compact</td>
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Rocket carries own $O_2$
Power in the Vacuum of Space

Port Authority Bridge
Government Fixes

Port Authority  Congested
TVA           Depressed
River Compact  Undeveloped

Port Authority Bridge

Valley Authority Dam
River Compact Dam
Flood Control and Electric Power
Daring ‘Firsts’

Water
Air
Space

River Compact Dam
Flood Control and Electric Power

First Trip - Colorado River
Daring ‘Firsts’

Water
Air
Space

First Flight - Heavier than Air
First Trip - Colorado River
First Flight - Heavier than Air

Faster than Sound
bullet-shaped rocket plane
First Earth Orbit

Faster than Sound bullet-shaped rocket plane
Society Transformed

Railroad
Telephone
Automobile
Airplane
Canal
Computer

Continent Crossed - 1869

Iron Road
Society Transformed

Railroad
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Continent Crossed - 1869
Iron Road

Continent Crossed – 1915
Copper Wire
Roads replace Rails
Asphalt, Concrete, and Steel

Continent Crossed – 1915
Copper Wire
Travel Farther and Faster

Roads replace Rails

Airplanes made of Aluminum powered by Kerosene

Asphalt, Concrete, and Steel
Uniting the Oceans
Uniting the Continents

Bridges, Locks, and Dams made of Steel and Concrete

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made of Steel and Concrete

Global and Fast
Information Age

made of Silicon and Glass
How do Innovations Happen?

Scientific:
- applied science

Social:
- motivation - transformation
  - economics
  - politics
  - culture

Symbolic:
- individual genius