“The Innovators”
The Age of the Digital Revolution

“How a Group of Hackers, Geniuses and Geeks Created the Digital Revolution.”

Session 1, March 25,2015

Boundaries [Confessions and Limitations]

- We start with Walter Isaacsons's Book. I add to it.
- We have 8 — hour and a half sessions — to cover the book's 12 chapters.
- There are college degrees through Post Doc research on many of the subjects in the various chapters.
- I will attempt to stay out of the weeds.

- I only knows enough to be dangerous, even though I have worked with computers, software and digital communications since 1960.
- My first computer "work" was in 1961 [this encounter was nothing to write home about]

Mentorship

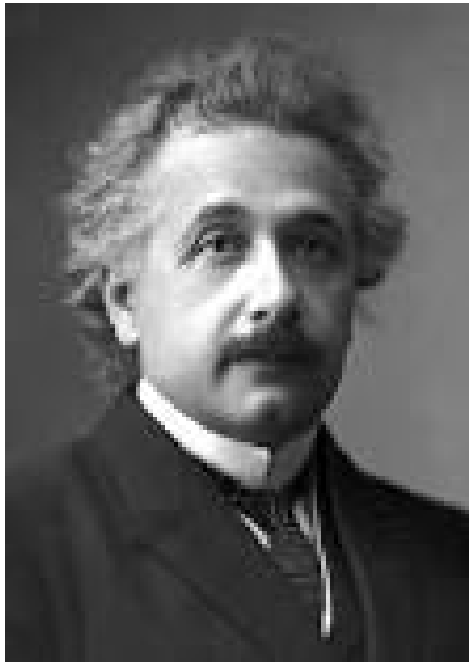
- My first encounter with computers was in 1958, when the Tufts Physics Department decided to experiment with a 2 credit hour computer course.
- They had a new adjunct Professor from South Africa, Dr. Allan Cormack and a new off- the-press computer text book. Allen, see what you can do. But…
  - The University had no digital computers
  - The Mechanical Engineering department a had an analogue computer that they operated for the Boston Gas Company managing network product flow efficiency.
  - I don't remember anything from it…. But,
  - Dr. Cormack was awarded the 1979 Nobel Prize in Physiology or Medicine (along with Godfrey Hounsfield) for his work on developing X-ray computed tomography, the CAT Scan.
  - How may can say that they have studied under a Nobel Laureate?

More Than a Book Report

- **"The Innovators: How a Group of Hackers, Geniuses and Geeks Created the Digital Revolution."**

  "… A gripping narrative about the visionaries whose imagination and zeal continue to transform our lives."
- **This is a review of Walter Isaacson 2014 volume plus additional material to round out the discussion and make it appear to be more than *an audio book*.**

How a Group of Hackers, Geniuses and Geeks Created the Digital Revolution."



For those who consider themselves to be one. It is a badge of Honor

We know What Geniuses and Geeks Are. What/Who Are Hackers?

- **Beginning in the late 1940s, members of the MIT Model Train Society, Signal and Power Committee embraced the title *Hackers.***

- **It invokes technical virtuosity and playfulness, not (as in the more recent usage) lawless intrusions into a network.**
- **They were tinkerers, ham radio builders and operators, teenagers working in basements and garages, salvaging broken TVs/radios, trying different things to see what would happen.**
  - **The occasional backyard explosion!**
- **Inquisitive! How does it work? Make it better!**

Proximities/Technical Clusters that Aided Collaboration – Primordial Soup

- Boston Metro: Harvard/MIT and the Route 128/495 corridor.
- England: Government Research Establishments, Cambridge U, Oxford U and U of Manchester
- Palo Alto/San Jose: Stanford and the future Silicon Valley
- Extended Metro NY/NJ/Long Island: IBM, Bell Labs and the large number of electronic instrument mfgs.
- Extended Philadelphia Metro: Princeton and U of Penn
- Salt Lake City: U of Utah
- Los Angeles Metro: USC/UCLA/Cal Tech
- Seattle: Microsoft and spin-offs

Bletchley Park, England
Cambridge, Oxford,
U of Manchester

University of Penn,
Moore School of
Electrical
Engineering

Bell
Labs

Massachusetts Institute
of Technology

Harvard
University

Institute for Advanced
Studies – Princeton
University

Early Years Were in Academia

Stanford University

Thanks!

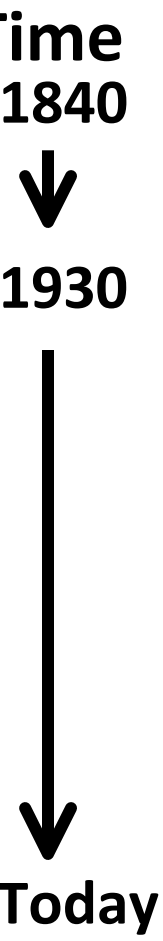
- **Walter Isaacson – his extensive interviews [with a 1008 footnotes] that have been quoted, summarized and paraphrased**
- Google
- **Wikipedia**
- ***www.computerhope.com***
- **http://internethalloffame.org**
- **A bunch more**

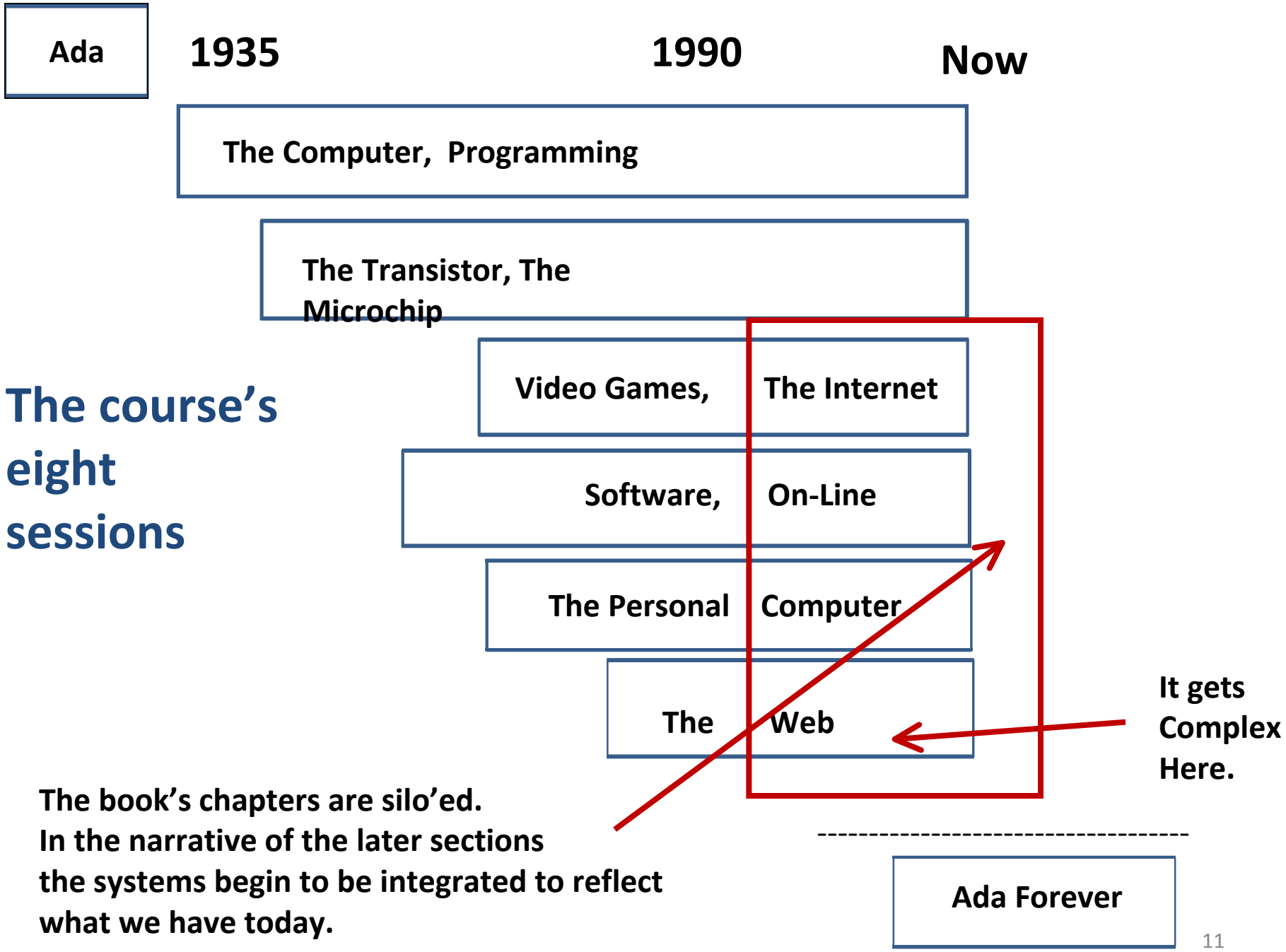
L814 “The Innovators”
The Age of the Digital Revolution

Subjects

- **Session 1 Ada, Countess of Lovelace**

- **Session 2 The Computer, Programming**
- **Session 3 The Transistor, The Microchip**
- **Session 4 Video Games, The Internet**
- **Session 5 The Personal Computer**
- **Session 6 Software, On-Line**
- **Session 7 The Web**
- **Session 8 Ada Forever**





The course's eight sessions

The book's chapters are silo'ed.
In the narrative of the later sections the systems begin to be integrated to reflect what we have today.

Session 1

- **What is this about?**
  - **Definitions**
  - **Timelines**
  - **Early Organizations**

- **Ada, Countess of Lovelace**

What is this about?

The pieces that make up the Digital Revolution

1: Computers, Programming and Software

- **Computer hardware, the device's physical components.**

- **Programming, a library of standard instructions [add, divide, move, compare, if/then, etc.] that the software assembles to solve a problem or to control something.**

- **Software is any set of machine-readable instructions that directs a computer's processor to perform specific operations. It directs data to be inputted and results to be displayed or do some thing.**
  - **Computer hardware, programs and software require each other and neither can be used without the other.**

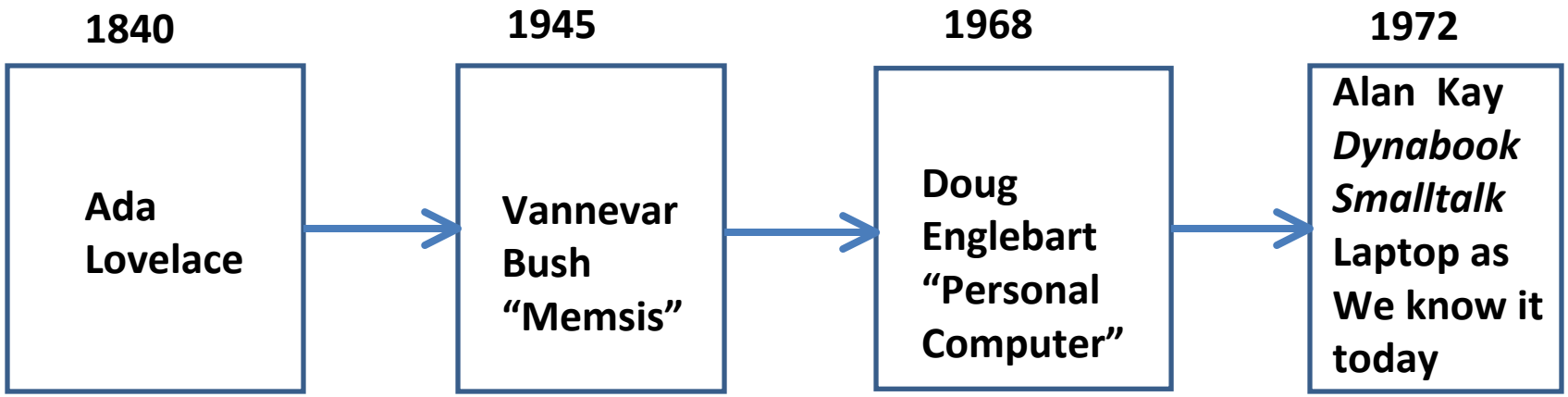
- **Musical analogy: Hardware is the instruments, programming is the sheet music and software are the notes played on the instrument. Conductor is the operating system.**

2. Comm Systems–What are the Differences?

- **The Internet is the global system of interconnected computer networkS that use the standard *Internet protocol suite* (TCP/IP) to link several billion devices worldwide. It is a *network of networkS* consisting of millions of private, public, academic, business, and government networks of local to global in scope, linked by a broad array of wirelines, wireless, and optical networking technologies.**
- **World Wide Web is the infrastructure to support email, and peer-to-peer networks for file sharing and telephony. It is an extensive range of information resources and services, such as the inter-linked *hypertext* documents and applications [think Aps].**
- **To be Online, information, actions, activities or entertainment accessible via a computer or computer network.**

There Is More to the Digital Revolution Than the Personal Computer, But….

The Early Years



"The analytic engine weaves algebraic patterns, just as the Jacquard loom weaves flowers and Leaves."
The Salons

Carnegie Foundation
NDRC
ARPA
NSF

Stanford Research Institute

The Mouse

Xerox PARC

Digital Revolution
The Wheel as an example

Digital Environment Circa 1950

Digital Environment Circa 2015

Early Timeline/Events

- **1840 Ada, the Countess of Lovelace, the start of computing**
- **1843-1940 [100 years] Wireline digital (telegraph and wire service teletype and facsimiles) and later telephone and radio analogue communications.**
- **1911 The Computing Tabulating Recording Company (Renamed IBM in 1924)**
- **Early 1940s North Atlantic conveys and the Pacific War and the breaking of Axis codes**

Underlying Needs

- **The initial problem that confronted the computer's inventors, both individually and collectively, was the need to do tedious, complex and often repetitive calculations.**
- **There had to be a better way than sitting with paper and pencil for months on end.**
- **Later in the post industrial revolution was the need to model complex and often non-linear problems.**

1950 >The New Industrial Revolution The Age Of The Digital Revolution

- **Most of our discussions picks up after WW II, but first a little background and early history**
- **Much of the Allied technology was developed by collaboration fueled by combat imperatives.**
- **The digital age is also a collaborative age. There are notable individuals with seminal ideas, but their ultimate products are typically the results of collaboration.**
- **The post WW II digital age was and is driven by economic imperatives.**

Probing Question

- **"What were the talents that allowed certain inventors and entrepreneurs to turn their visionary ideas into *disruptive* realities?**
- **What led to their creative leaps?**
- **Why did some succeed and others fail?"**

Bose® Wave SoundTouch Music System

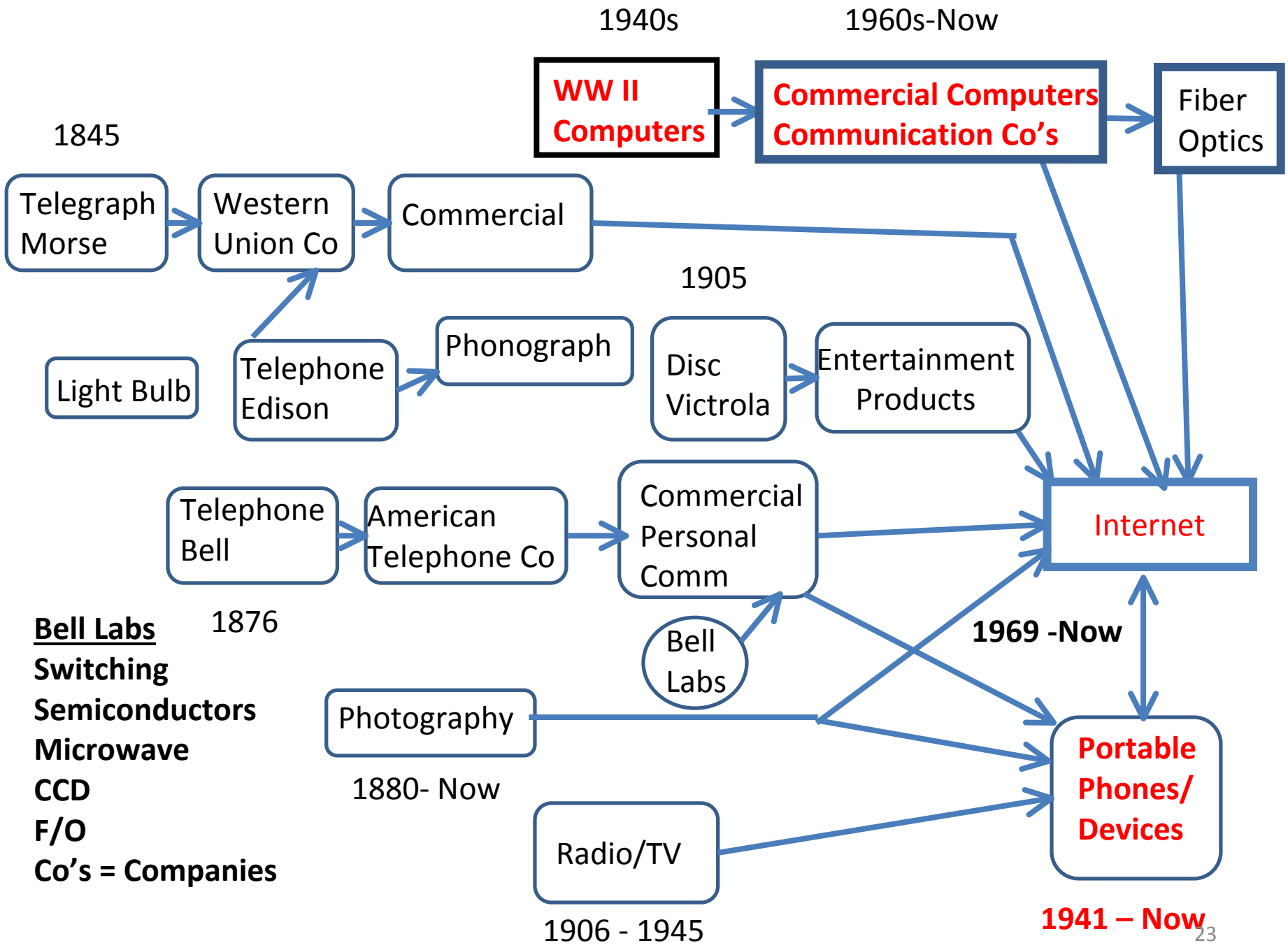
~~$600.00~~

$550.00

This 2014 product is the merger of Plastic, Mass Production, Semiconductors, Radio technology, the Computer and its software, the Internet and all their underlying technologies. Plus a clock.

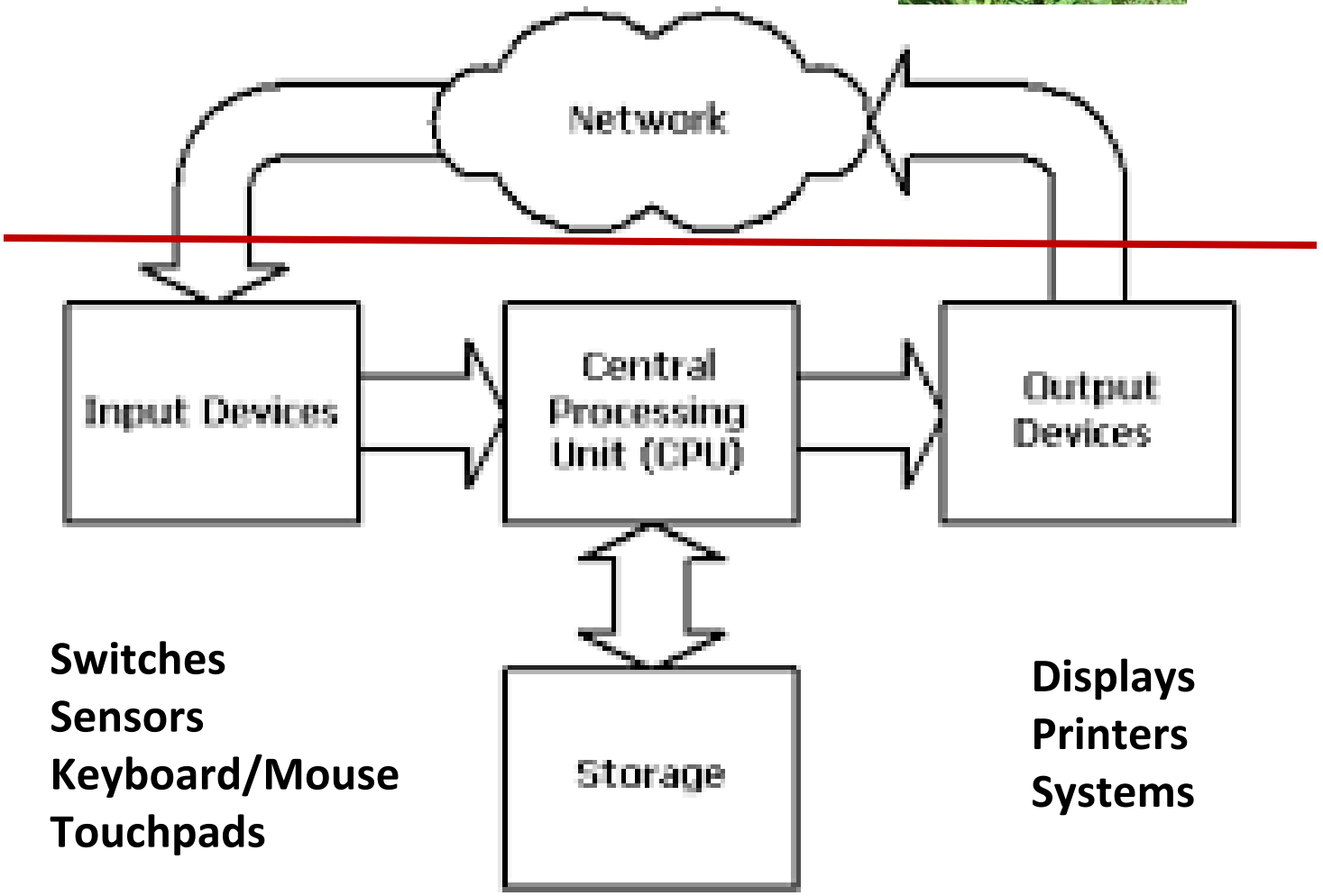
Bose ad:

- **"CDs, FM/AM radio, and the vast universe of streaming music—millions of songs, thousands of Internet radio stations, popular services like Pandora.®**
- **Enjoy it all with the rich, room-filling sound of the Wave® SoundTouch™ music system.**
- **This small, versatile system fits in just about anywhere around your home where you want to enjoy your music—living room, kitchen, bedroom.**
- **If you have a home Wi-Fi® network, you have everything you need."**


1940s
1960s-Now
WW II Computers
Commercial Computers Communication Co's
Fiber Optics
1845
Telegraph Morse
Western Union Co
Commercial
1905
Light Bulb
Telephone Edison
Phonograph
Disc Victrola
Entertainment Products
Telephone Bell
American Telephone Co
Commercial Personal Comm
Internet
1876
Bell Labs
1969 -Now
Switching
Semiconductors
Microwave
CCD
F/O
Co's = Companies
Photography
1880- Now
Portable Phones/ Devices
Radio/TV
1906 - 1945
1941 – Now

30 Second In-Place Stretch

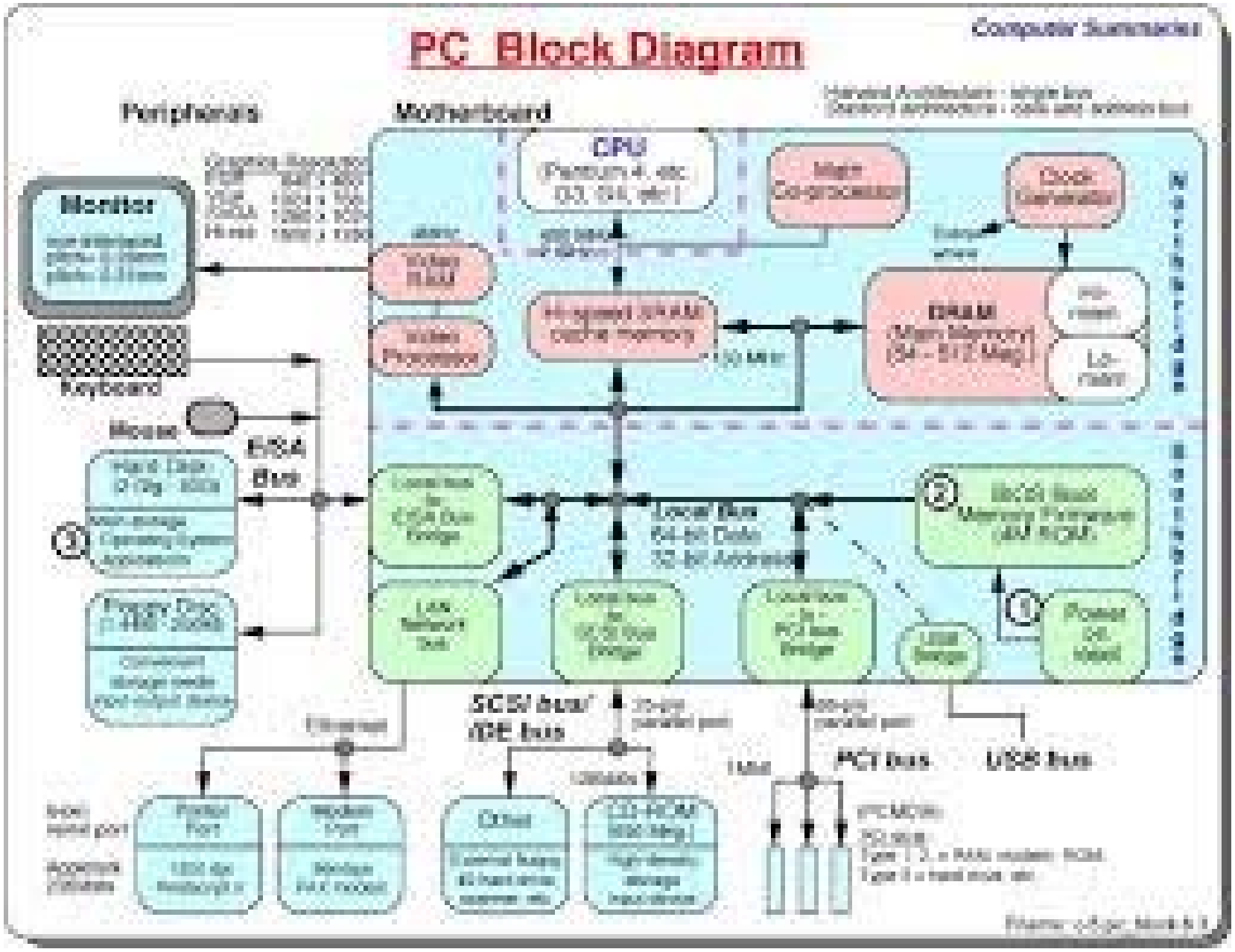
Finally a Computer, the Digital Age



Switches
Sensors
Keyboard/Mouse
Touchpads

Displays
Printers
Systems

An overly simplified diagram of a computer's parts



A Little More detailed, 30 parts, let's talk about the parts

Standards

- **Often more than one way to do something**
  - **But, an A must always work with a B the same way**
  - **There are huge financial stakes**

- **Eventually business driven solutions**
- **Institute of Electrical and Electronic Engineers (IEEE) Standards Association, been around since the 1912**

Who is the IEEE-Standards Association?

- ***"We are a leading consensus building organization [Added: don't overlook $s] that nurtures, develops & advances global technologies. Our work drives the functionality, capabilities and interoperability of a wide range of products and services that transform the way people live, work and communicate."***
- **20 groups of standards**

Another Lost Opportunity?

- in 1970, I went to work at Sylvania, then a predominantly radio and comm systems equipment company.
- I picked up the story that Sylvania management in the early 1950s commissioned the Arthur D. Little Technical consulting firm to investigate whether there were any commercial opportunities in this new computer device.
- Report: No, there would only be a few big computers constructed and they would only be research tools.
- Put your investments $$ and engineering talents into other opportunities.
- So, they did! Radios and then data communications systems; but we just couldn't stop tripping over these computers. We had a large software department.
- Arthur D. Little itself flubbed in 2002 and is now a

Let's begin, Countess Ada

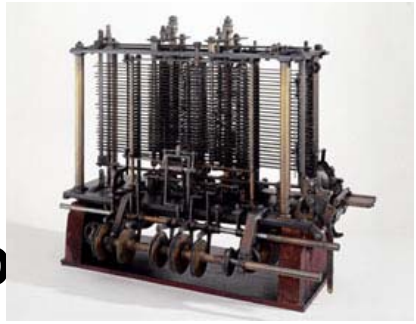
Ada, Countess of Lovelace

- Ada was Lord Byron's only "legitimate" child.
- Her mother left Byron when Ada was an infant.
- She live at her mother's Surry estate and to keep her occupied her mother engaged math tutors.
  - She outpaced them
  - She is fluent in Romance languages
  - As a young women she married Lord Lovelace and continued her mathematical pursuits.
  - She met Charles Babbage at a London "salon" and the story goes on ….

Ada, Countess of Lovelace

and the Path to Programming

- The Jacquard loom
  - Punched cards
- Babbage's difference and analytical engines
  - Technology wasn't there yet,
  - They are mechanical
    - No British support
    - Congress of Italian Scientists
    - Italian Army Luigi Menabrea's paper on D



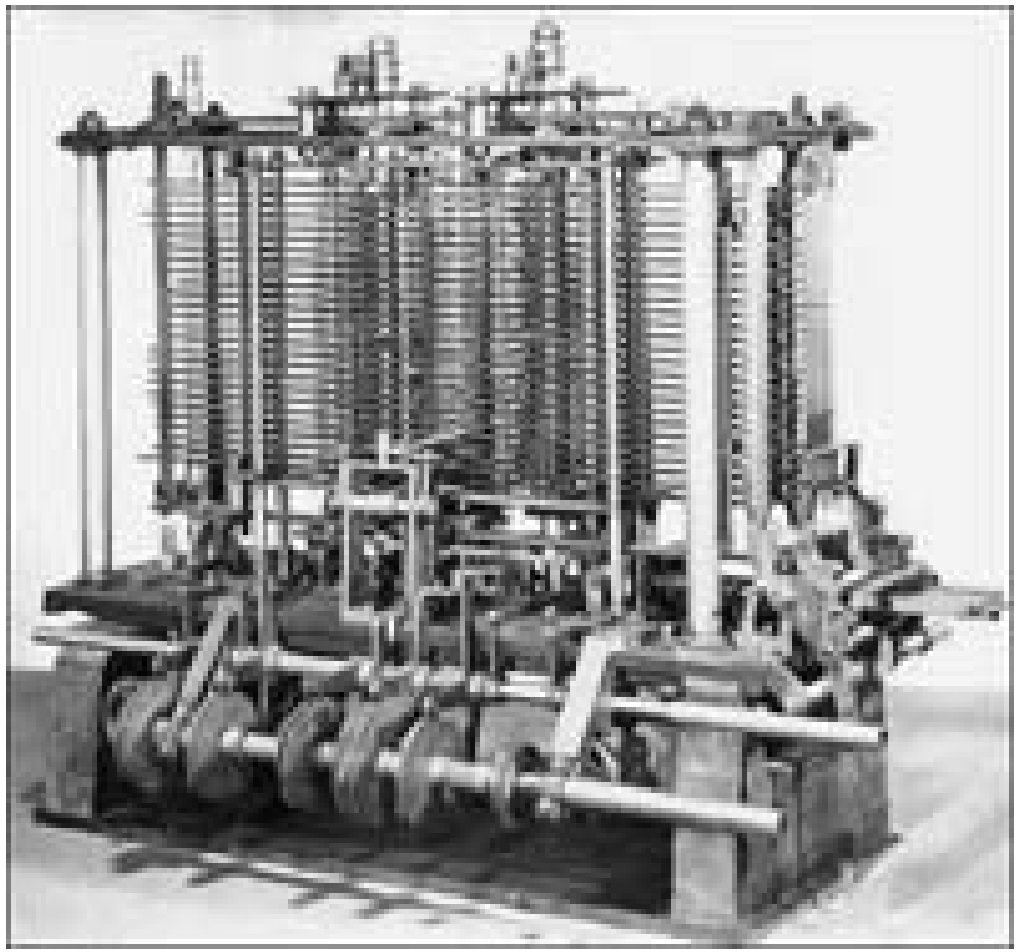
- Ada translates Luigi and expands it with her notes
- This leads to more collaboration on solving a Bernoulli number problem.
- Here Ada visualizes the structure of a set of instructions that a machine can accomplish to solve mathematical structured problems or any problems that can be presented as "data"— Programming!

Luigi Menabrea

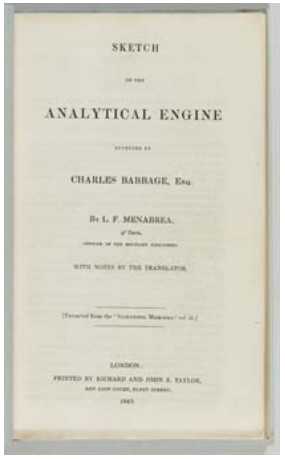
- **Obscure military engineer.**
- **Becomes Italian Prime Minister under Garibaldi in the Second Republic.**

Charles Babbage's 1837 proposed first general mechanical computer, the Analytical Engine.

The gears are individually built for the problem to be Solved.



First Digital Innovation and Collaboration


SKETCH

OF THE

ANALYTICAL ENGINE

CHARLES BABBAGE, Esq.

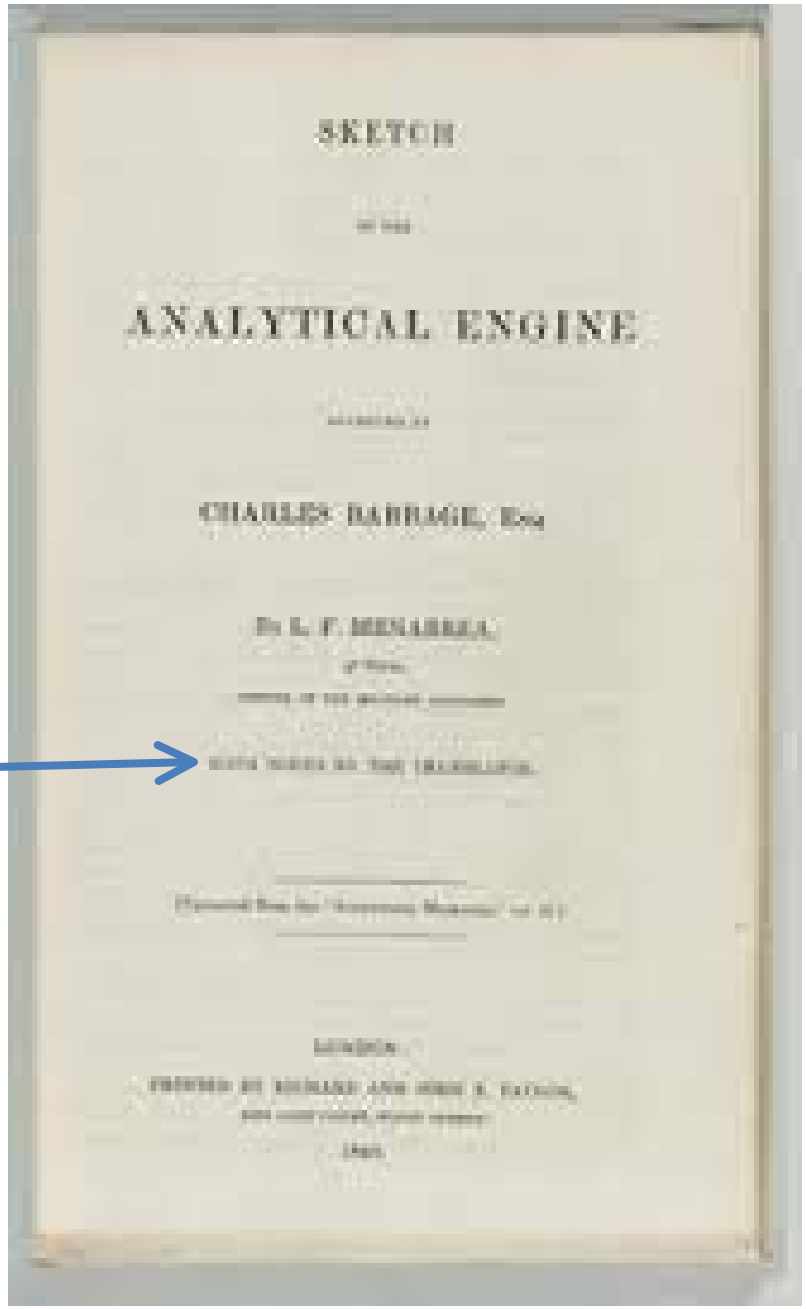
By L. F. MENABREA,

WITH NOTES BY THE TRANSLATOR.

LONDON:

- Babbage Innovates—Menabrea describes — Ada corrects and expands in 2x more detail.
- She defined that a machine like the Analytical Calculator could store, manipulate, process and act upon anything that could be represented symbols: numbers, logic, music, etc.
- She defined what a computer operation was.
- She laid out in step by step detail the workings of what is now called a computer program or algorithm.
- She described the solution of a Bernoulli number problem. How the algorithm would work: It had numbered coded instructions, destinations, registers and notes.
- What coding in C++ would be today!

With notes by his translator



SKETCH

OF THE

ANALYTICAL ENGINE

INVENTED BY

CHARLES BABBAGE, Esq.

By L. F. MENABREA,

OF TURIN,

OFFICER OF THE MILITARY ENGINEERS

WITH NOTES BY THE TRANSLATOR.

[Translated from the Bibliothèque Universelle de Genève, No. 82, October, 1842]

LONDON:

PRINTED BY RICHARD AND JOHN E. TAYLOR,

RED LION COURT, FLEET STREET.

1843.

What Else Did Ada Visualize?

- **The metaphysical topic of artificial intelligence — Can computers think?**
- **Ada believed not.**
- ***"A machine can perform operations as instructed, but could not come up with ideas or intentions of its own…it has no power to anticipate any analytic relations or truths."***
- **"Lady Lovelace's objections" as dubbed by Alan Turing* a century later.**

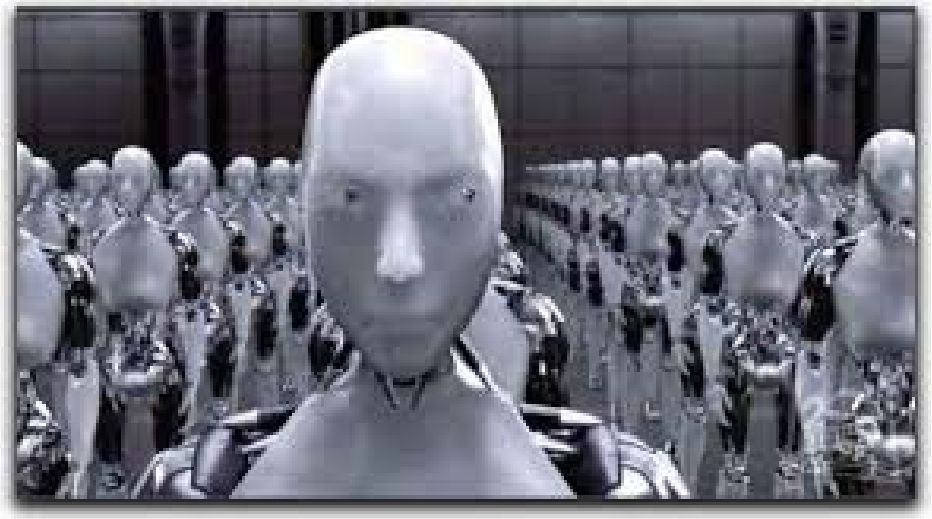
***of *The Imitation Game movie* fame**

Metaphysical Question:

Can Computers Think and Have Emotions?

- **Dr. Chandra and his HAL 9000**

Todays Droids are beneficial; they do what they are instructed, and no more because they were programmed [softwared?] that way



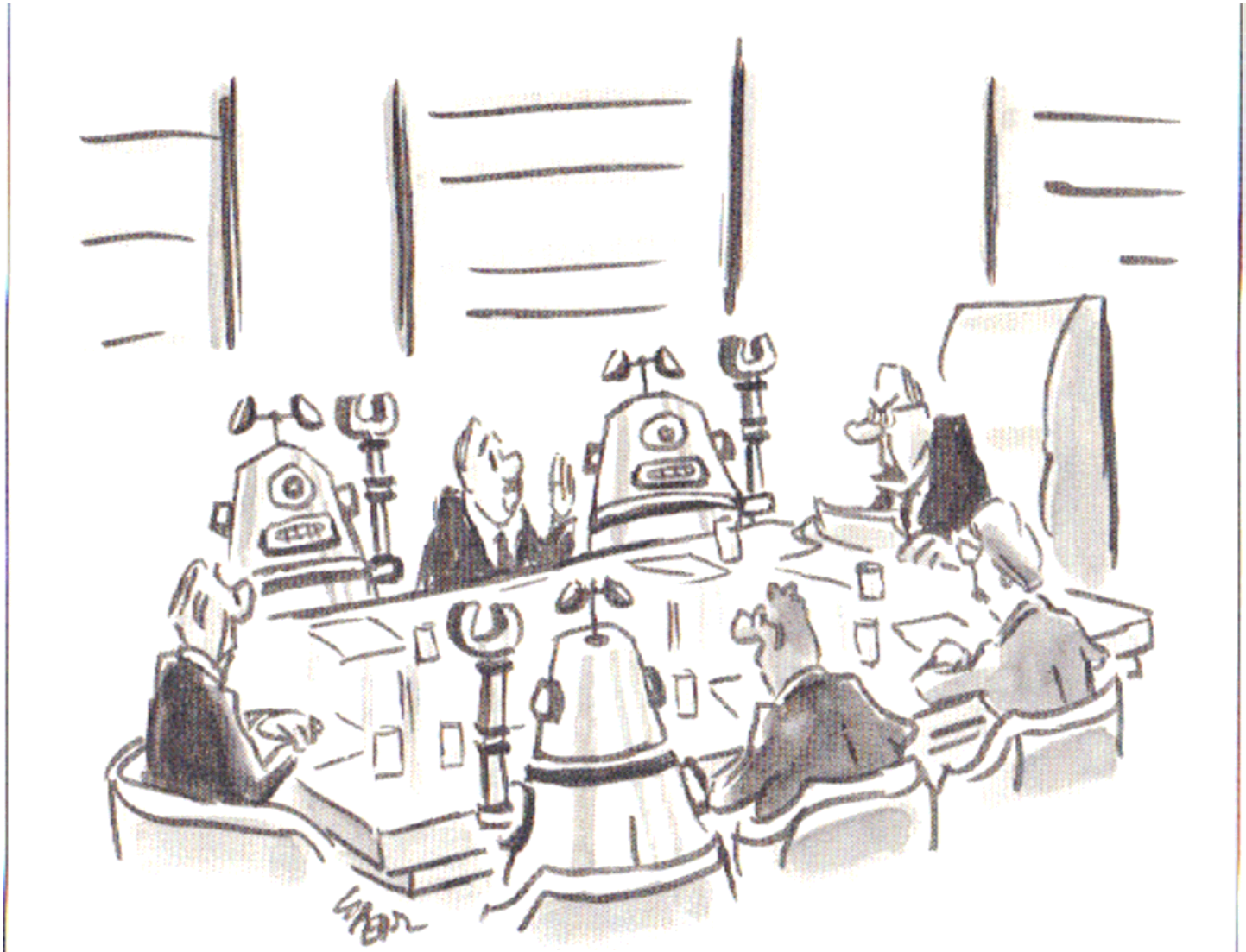
2015 Industrial Robot, it only attacks human employment in tedious repetitive jobs.

2035, a US Robotic Nestor-5 (NS-5) with a Posnitronic brain (computer?) can think. So, is it still Three Laws Safe?

“Three Laws of Robotics”

Isaac Asimov

- **First Law: A robot must never harm a human being or, through inaction, allow any human to come to harm.**
- **Second Law: A robot must obey the orders given to them by human beings, except where such orders violate the First Law.**
- **Third Law: A robot must protect its own existence unless this violates the First or Second Laws.**
- **If you think about it; these laws need to be in a computer like device in a robot.**



"Jenkins, if I want another yes-man I'll build one."

Computer Timeline -1 [1]

When was the first computer invented?

•There is no easy answer to this question due to the many different classifications of computers. The first mechanical computer, created by Charles Babbage, doesn't really resemble what most would consider a computer today.

•What will follow is a list of computer firsts, starting with Babbage's Difference Engine and leading up to the computers we use today.

The word "computer" was first used

•In 1613 and was originally used to describe a human who performed calculations or computations.

•The definition of a computer remained the same until the end of the 19th century when people began to realize machines never get tired and can perform calculations much faster and more accurately than any team of human computers ever could.

[1] When was the first computer invented? - Computer Hope

*www.**computer**hope.com/issues/ch000984.htm*

Computer Timeline -2.1

First mechanical computer or automatic computing engine concept

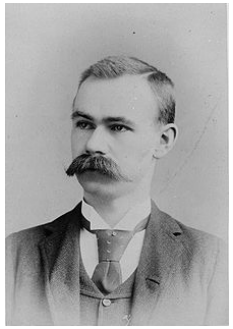
1.In 1822, Charles Babbage conceptualized and began developing the Difference Engine, considered to be the first automatic computing engine that was capable of computing several sets of numbers and making hard copies of the results.

- Unfortunately, because of funding he was never able to complete a full-scale functional version of this machine.
- In June of 1991, the London Science Museum completed the Difference Engine No. 2 for the bicentennial year of Babbage's birth and later completed the printing mechanism in 2000.

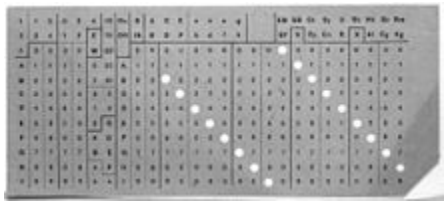
Computer Timeline -2.2

2. Later, in 1837 Charles Babbage proposed the first general mechanical computer, the Analytical Engine. The Analytical Engine contained an Arithmetic Logic Unit (ALU), basic flow control, and integrated memory and is the first general-purpose concept computer.
   - Unfortunately, because of funding issues this computer was also never built while Charles Babbage's was alive. In 1910, Henry Babbage, Charles Babbage's youngest son was able to complete a portion of this machine and was able to perform basic calculations.

Dr. Herman Hollerith, Ph.D. and His Electric Tabulating Machine



- It took 8 years to completely tabulate the 1880 census by hand. There had to be a better way!
- Hollerith was teaching math at MIT when he became interested in tabulating data using punched cards.



- He built his Electric Tabulating Machine [Jan 8, 1889, U.S. *Patent* 395,782] used in the 1890 census and completed in one year.

The Intermediate Computer
In the Beginning IBM [Big Blue]

- In the 1880s, various technologies came into existence that would form part of IBM's predecessor company. Julius E. Pitrat patented the computing scale in 1885; Alexander Dey invented the dial recorder (1888); in 1889, Herman Hollerith patented the Electric Tabulating Machine and Willard Bundy invented a time clock to record a worker's arrival and departure time on a paper tape.
- On June 16, 1911, these technologies and their respective companies were merged by Charles Ranlett Flint to form the *Computing-Tabulating-Recording Company* (C-T-R). It manufactured and sold machinery ranging from commercial scales and industrial time recorders to meat and cheese slicers, along with tabulators and punched cards.
- In 1924, C-T-R was renamed the *International Business Machines Corporation* (IBM).