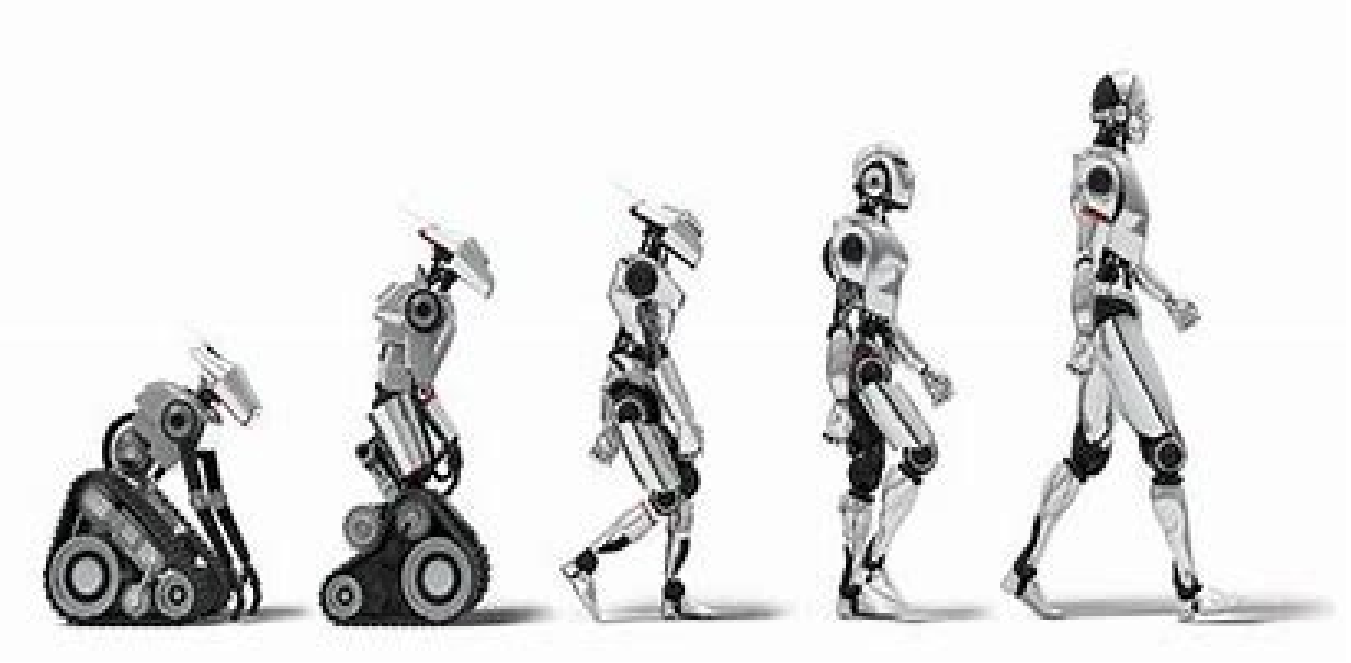
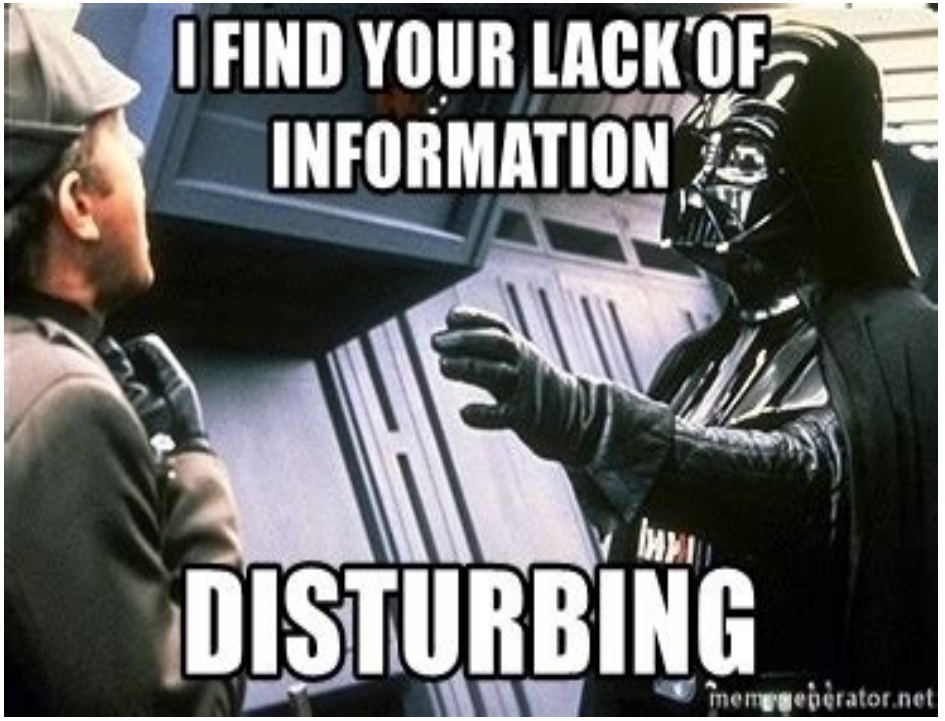
Robotics
Their History and Status

C. M. Zelhart



Definition – Commonly Accepted

Robot: A machine – especially one programmable by a computer – capable of carrying out a complex series of actions automatically. Wikipedia (other sources similar)



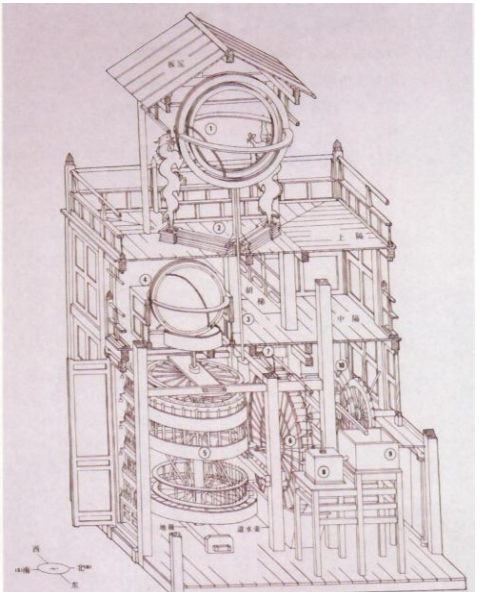
Let's Re-Calibrate

- From their inception in the Third Century BC (or before), early automatons were ingenious and clever, but essentially little more than articulated music boxes
- Early automatons took the form of human figures, animals, and other forms

Early Automatons
3rd Century BC to 12th Century CE

- Automatons created in Greece, China, India, Arabia, Japan, and other cultures

- Constructs were mechanical and were spring-driven, water-driven, or air-driven

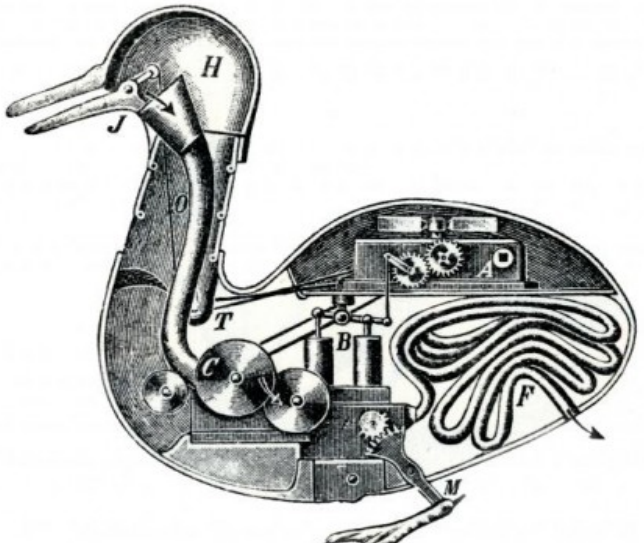


- Control & actuation was by means of cams, levers, gears...

Renaissance & Later Automatons Pt. 1

- Leonardo da Vinci (ca 1495)
  - Mechanical walking lion
  - Mechanical life-size knight

- Jacques de Vaucanson (ca 1739)
  - Life-size operating flute player
  - Mechanical duck

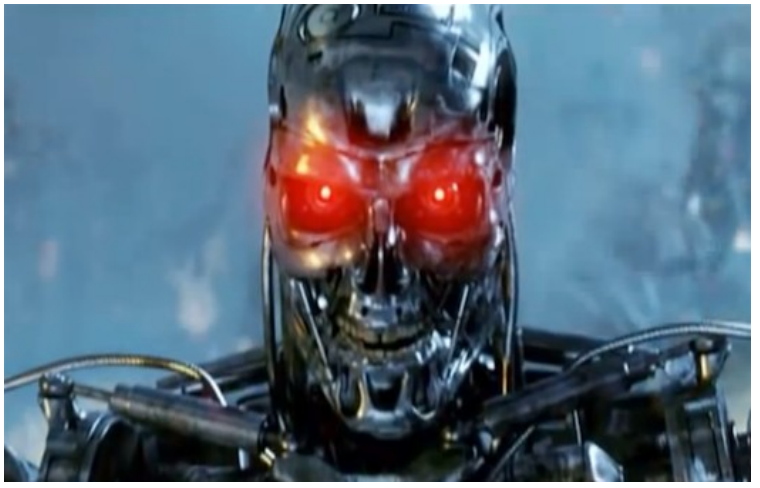


Renaissance & Later Automatons Pt. 2

- Pierre Jacquet-Droz (ca 1768)
  - Musician, Draughtsman, Writer
  - Writer was able to draft any customized forms up to forty letters or characters
- Al-Jazari's Floating Orchestra (ca 1206)

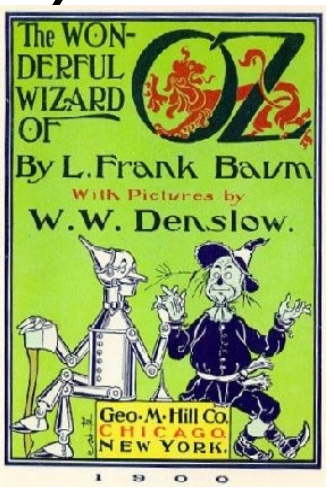
Let's Re-Calibrate

- Literature and film serve as a “mirror” for society, allowing us to examine our thoughts and feelings about a variety of subjects
- The depiction of robots from the earliest films varied ...and continues to vary...all over the map



The Early 20th Century – Pt. 1

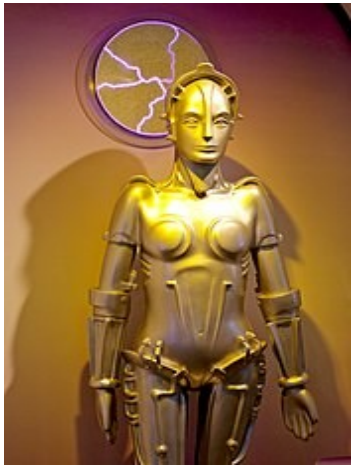
- *The Wizard of Oz* – Frank Baum (1900)
  - The Tin Man – One the “metal men”
  - Tik-Tok – Round mechanical man



- *R.U.R.* (1920)
  - Rossum's Universal Robots
  - Author – Karel Capek
  - Satiric play about bio-robots meant to do menial labor
  - First use of “robot” - Czech word meaning forced labor

The Early 20th Century – Pt. 2

- *The Mechanical Man* (1921)
  - Silent Italian film by Andre' Deed
  - First film depicting robots



- *Metropolis* (1927)
  - Fritz Lang film
  - Robots shown as workers
- "Lilliput" (1939)
  - Japanese walking robot toy
  - Precursor of bad 1950s monster movies?

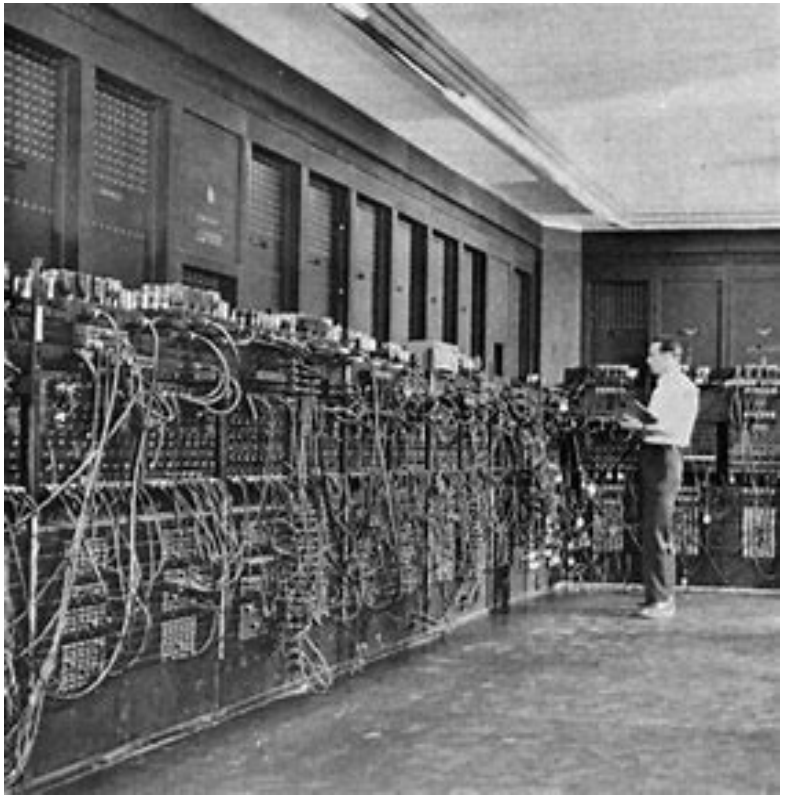
The Early 20th Century – Pt. 3

- "Elektro" – New York World's Fair (1939)
  - Seven feet tall, 265 lbs., & could walk on command
  - Could "speak" via 78 rpm record
  - Could move its head and arms
  - Could blow up balloons
  - Could smoke cigarettes (?)

- *Mysterious Dr. Satan* (1940)
  - "Killer" robot
  - Looked like a bad hot water tank

Let's Re-Calibrate

- The primary “missing piece” in the creation of an actual robot, as generally envisioned, was a means of intelligent control
- It required the invention and development of electronic data processing to permit the creation of functional robots



The Mid 20th Century

Development of Data Processing Pt. 1

- **Z1**
  - Conrad Zuse – 1938
  - Electro-mechanical, binary, programmable
- **Colossus**
  - Tommy Flowers – 1943
  - Electric, programmable
- **ABC**
  - J. Atansoff/C. Berry – 1943
  - Binary, digital, not readily programmable

The Mid 20th Century
Development of Data Processing Pt. 2

- **ENIAC**
  - J. Eckert/J. Mauchly – 1948
  - Fully functional digital computer
- **Manchester Mark 1**
  - F. Williams/T. Kilburn – 1949
  - Pioneered the use of index registers
- **EDSAC**
  - Maurice Wilkes – 1949
  - Electronic, stored program

Let's Re-Calibrate

- While the invention of electronic data processing was a crucial step in the development functional robots, other contributors added missing “key pieces”
- These “pieces” dealt more with the utilization and control of future robots and less with pure data processing

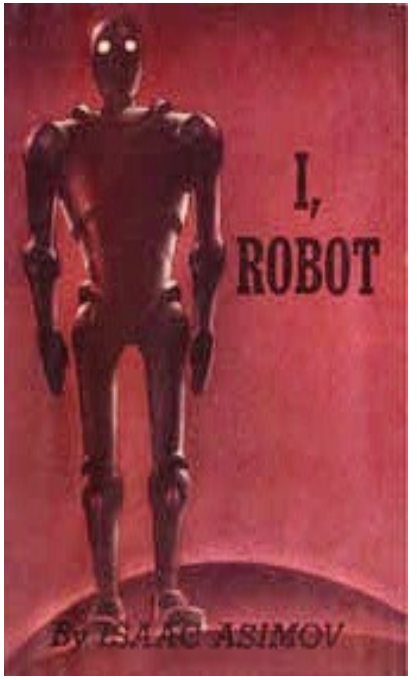
The Mid 20th Century
Other Key Contributions Pt. 1

- Vannevar Bush essay “As We May Think” (1945)
  - Rise of computers
  - Digital word processing
  - Voice recognition/machine translation

- J. von Neumann “thought experiments” (1940s)
  - von Neumann cellular automata
  - Von Neumann Universal Constructor

The Mid 20th Century Other Key Contributions Pt. 2

- Short story “Runaround” - Isaac Asimov (1942)
- Postulated the Three Laws of Robotics
  - First Law – A robot may not harm a human being or, through inaction, allow a human being to come to harm.
  - Second Law – A robot must obey the orders given it except where such orders would conflict with the First Law.
  - Third Law – A robot must protect its own existence as long as such protection does not conflict with First or Second Laws.

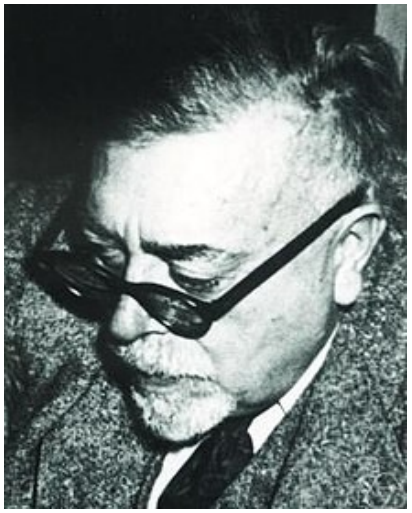


Let's Re-Calibrate

- As stated, the development of robotics required not only physical structures, but complex (“intelligent?”) control mechanisms as well
- These control mechanisms required/require not only basic data processing capability, but also more esoteric and intangible considerations
- Cybernetics was the field that addressed this, until the “Dartmouth Workshop” of 1956, when Artificial Intelligence split off and became its own field of study (more about AI later)

The Mid 20th Century Other Key Contributions Pt. 3

- Cybernetics can be dated back to Plato's *The Alcibiades* (390s BC) and dealt with the idea of governance
- Modern cybernetics dealt with control mechanisms and feedback loops, largely done by Bell Labs (1920s - 1950s)
- Key work: *Cybernetics: Or Control and Communication in the Animal and the Machine* Norbert Wiener (1948)



Let's Re-Calibrate

- Cybernetics was the first field of stud
  explore concepts in control and governance
- However, after the split between cybernetics and AI the areas of interest began to diverge

Learning	Convergence
Cognition	Communication
Adaptation	Efficiency
Social Control	Efficacy
Emergence	Connectivity

Let's Re-Calibrate II

- AI's Problems/Focus Areas exhibit very limited overlap with those of cybernetics
- AI Problems/Focus Areas:

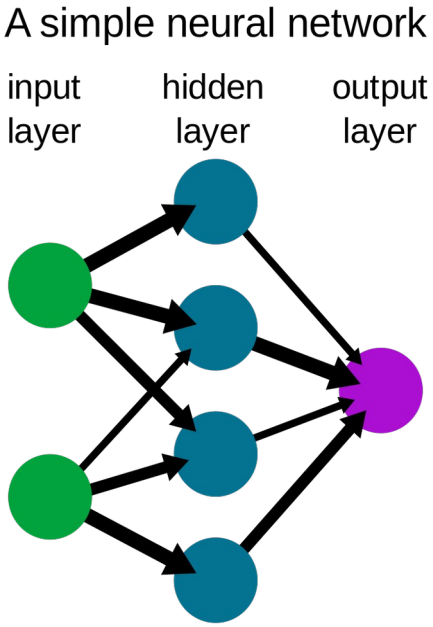
Reasoning	**Learning**
Knowledge	Natural Language Processing
Representation	Perception
Planning	Ability to Move/Manipulate

Let's Re-Calibrate III

- Artificial Intelligence (AI), also called “machine intelligence”, is posited on the claim that human intelligence “...can be so precisely described that a machine can be made to simulate it....” (???)
- AI - “...a system's ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation.” (Kaplan & Haenlein)

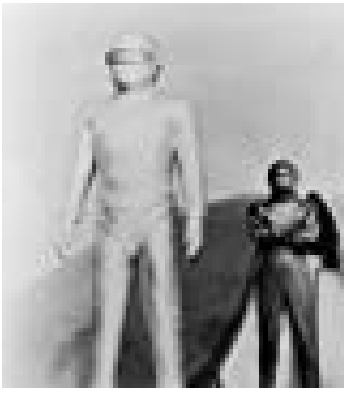
Let's Re-Calibrate IV

- AI has experienced multiple waves of optimism followed by periods of stagnation and disappointment (“AI winters”).
- AI has employed many tools in furthering itself:
  - Search algorithms
  - Mathematical optimization
  - Artificial neural networks
  - Statistics
  - Probability
  - Economics

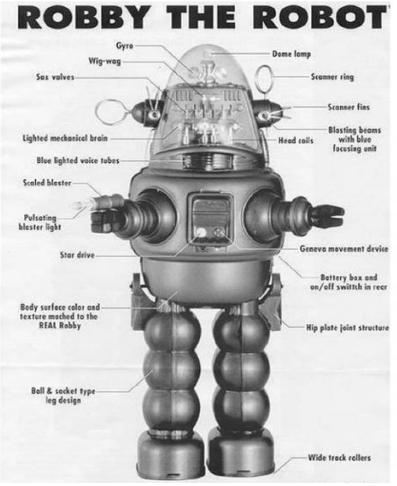


The Mid 20th Century
The Eve of the Robots

- William Grey Walter – Bristol, England(1949)
  - Proposed that limited brain cells with high connectivity can yield high functionality
  - Built first functional robots (Elmer & Elsie)
    - Three-wheeled units that resembled tortoises
    - Roamed around and plugged themselves in to charge up



- Robots and Film
  - *Day the Earth Stood Still* (1951) Gort
  - *Forbidden Planet* (1956) Robby

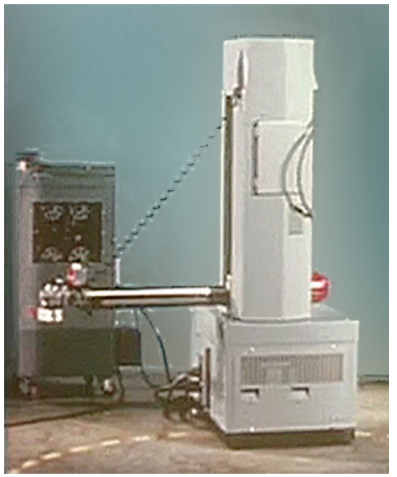


The 20th Century
The Birth of Real Robots Pt. 1

- "Unimate" - George Devol (1954)
  - First digital programmable, operating robot
  - Foundation of the modern robotics industry

- Later purchased by General Motors and used to handle hot die-cast parts (1961)

The 20th Century
The Birth of Real Robots Pt. 2

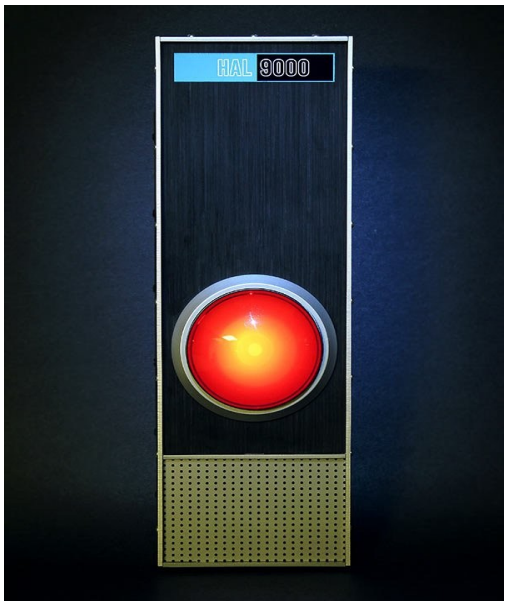


- "Versatran" (1962)
  - Cylindrical industrial robot
  - Ford installed six (6) at its Canton, OH plant
- "Stanford Arm" - Victor Scheinman (1969)
  - Six-axis, computer controlled; used to assemble small parts using touch and pressure sensitive functionality
  - Milestone in the evolution of industrial robots

The 20th Century
The Birth of Real Robots Pt. 3

- Other arm-type industrial robots developed and deployed world-wide (1970s - 1980s)

- Robots and Film
  - *Santa Claus Conquers the Martians* (1964)
  - *2001: A Space Odyssey* (1968)

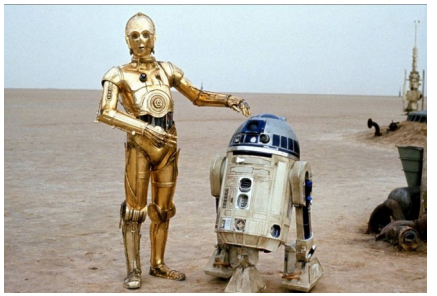


The 20th Century
The Birth of Real Robots Pt. 4

- Chevrolet Vega (1971 – 1977)
  - 95% of each body's 3,900 welds done by robot
  - Employees suspected of slowdowns & sabotage

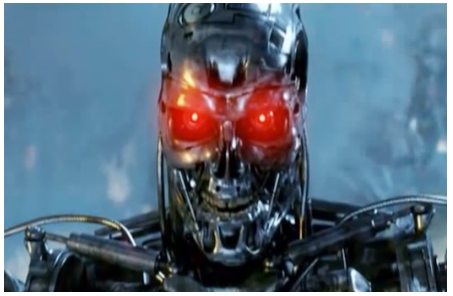
- Robots in Film
  - *Westworld* (1973)

  - *The Stepford Wives* (1975)
  - *Star Wars* (1977)



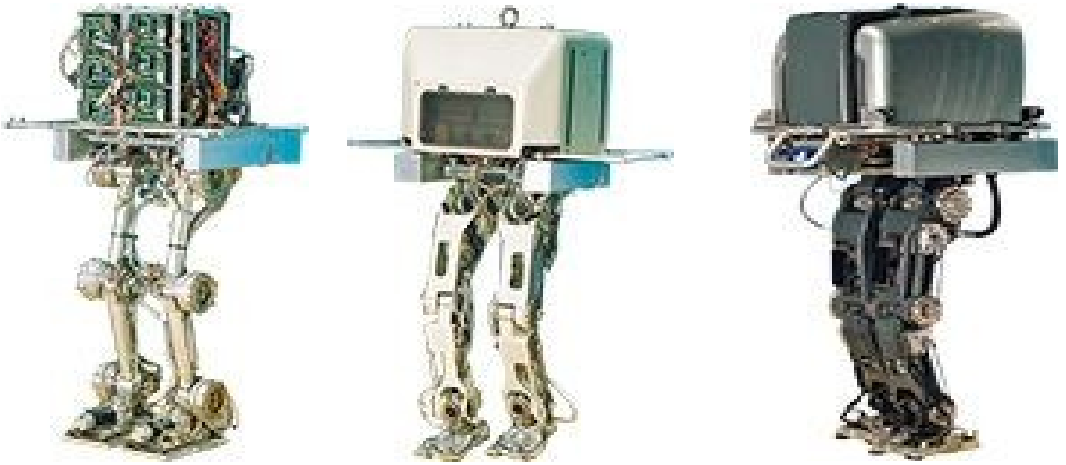
The 20th Century
The Birth of Real Robots Pt. 5

- AT&T Robotic Ckt. Bd. Assy. Lines (1984-2001)
  - Robotic component insertion machines
  - Robotic transport machines moved clips of boards
  - Focus was quality & precision, not labor reduction
- Robots and Film
  - *The Terminator* (1984)
    "..I'll be back...*and* back..."
  - *Short Circuit* (1986)
    "...your mother's a snow blower!"



The 20th Century
The Robots Evolve Pt. 1

- Honda “E” Series
  (1986 - 1993)



- Honda “P” Series
  (1993 – 1997)

–

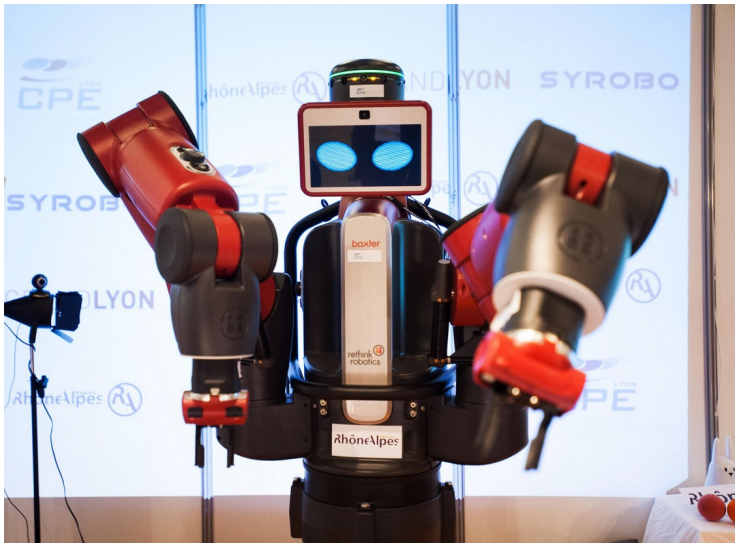
The 21st Century
"They're already here...."

Honda "ASIMO"

Hitachi "EMIEW3"

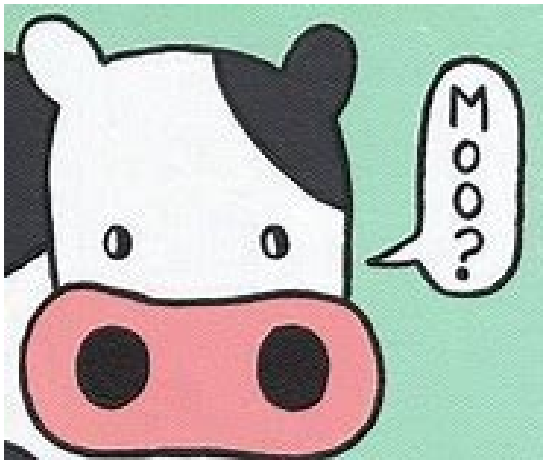
"Baxter"

- Manually programmable by unskilled associates through manual movements
- Fine adjustment via external controls



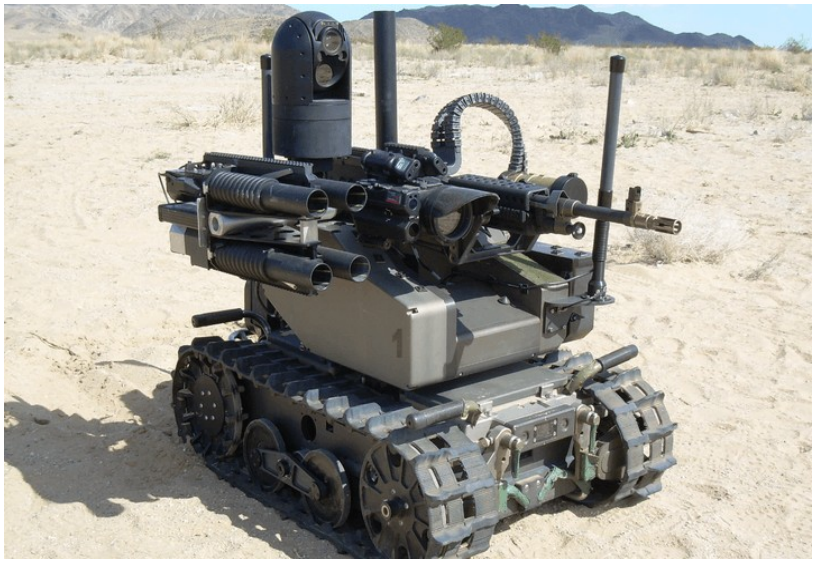
The 21st Century
"…AND here…."

- Roomba robot vac
- Robot Taxi (Japan)
- Automotive sub-systems
- Robotically enhanced surgery
- Robotic news writing
- Robotic milking machines



The 21st Century
The Dark Side Pt. 1

- MAARS
  - Mfd. by QinetIQ
  - M240 machine gun



- Black Hornet
  - Mfd. by Prox Dynamics
  - Surveillance drone

The 21st Century
The Dark Side Pt. 2

- Kalashnikov Battle Robot
  - Mfd. by Kalashnikov
  - Developmental unit

- Predator Drone
  - Mfd. By General Atomics
  - Endurance – 14 hrs. +
  - Now retired

The 21st Century
The Dark Side Pt. 3

- Atlas
  - Mfd. by Boston Dynamics
  - Height 6' 2” - extreme balance
- Some historical background: The number of ground robots deployed in Iraq:
  - 2001 – 0
  - 2004 – 150
  - 2005 – 2,400
  - 2008 – 12,000

Robot Roles in the

- Industrial Welding, Assembly, Quality Measurement
- Military Reconnaissance, Assault, Bomb Disposal
- Medical Unit Stocking, Vital Sign Monitoring/Recording
- Exploration “Robonaut/Robonaut 2”, “Mars Rover”
- Automated Transportation Taxis, Aircraft (?)
- Store Operations Stocking, Inventory Mgmt.
- Heavy/Risky Tasks Mining, Excavation
- Teaching Tutoring, Test Monitoring, Classroom Assist
- Domestic Tasks Cleaning, Dusting, Cooking, Laundry

The 21st Century
Domestic Robots?

- The next major home appliance may well be the domestic robot
  - They will be capable of most home tasks and easily programmable to do others
  - They will be programmed not only for functionality, but also for safety and security
- Domestic robots will be comfortably anthropomorphic, four-limbed, and bipedal
  - Our environments are built for such entities
  - This will make them more appealing and less threatening to the owners

Let's Re-Calibrate

- The “Robot Revolution” has been underway for over 50 years
- The continuing insinuation of robots into multiple aspects of our lives will have impacts beyond our ability to fully comprehend
- The Robot Revolution will ultimately rival the Industrial Revolution
- As robots continue to grow in complexity, capability, and inter-connectivity they may begin exhibiting behaviors of self-awareness (?)

Predictions
Institute for Global Futures Pt. 1

Robots in both physical and electronic forms will become even more integrated into our society.

Robots will express functional emotions and reasoning.

Advanced robots (androids) will appear similar to human beings and fill roles in commerce, community, and government.

Robotic efficiency and precision will transform manufacturing, medicine, space travel, research, and industry...and continue displacing skilled human labor.

The robotics industry will become a multi-billion dollar global business, spawning many new careers and business opportunities.

Predictions
Institute for Global Futures Pt. 2

Human beings will adopt robotic human enhancements to achieve superhuman capabilities.

Cyborgs - part human, part robot - will develop skills superior to natural humans to meet the demand of specialized jobs.

We will encounter serious ethical, security, and social issues due to our robotic creations.

Robots will provide convenience, safety, and productivity that will benefit humanity and profoundly impact lifestyles.

What About the Future? Techno-Legal-Philosophical

- Exploding complexity will see machines increasingly designed by other machines
- AI may render machines' actions and decisions unclear to – and uncontrollable by – human beings
- The legal standing of multi-functional robots has yet to be defined
- The relationship of people to robots may further accelerate social isolation

What About the Future? Techno-Legal-Philosophical

- Exploding complexity will see machines designed more and more by other machines
- AI may render machines' actions and decisions unclear to – and uncontrollable by – human beings
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- The relationship of people to robots may further accelerate social isolation

What About the Future? Socio-Economic-Political

- Robots will continue to assume more work and daily life functions
- This will quietly drive further social, economic, psychological, and....political change
  - ...which will further widen the existing wealth gap in society...
  - ...and worsen the existing skills gap and state of personal denial and anxiety...
  - ...further hardening social & political polarization

“Questions? Comments? Coffee?”