

# Robotics: Principles and Practice

## Module 1: Introduction and Robot Components

### Lecture 2: A short history of robotics

David Vernon  
Carnegie Mellon University Africa

[www.vernon.eu](http://www.vernon.eu)

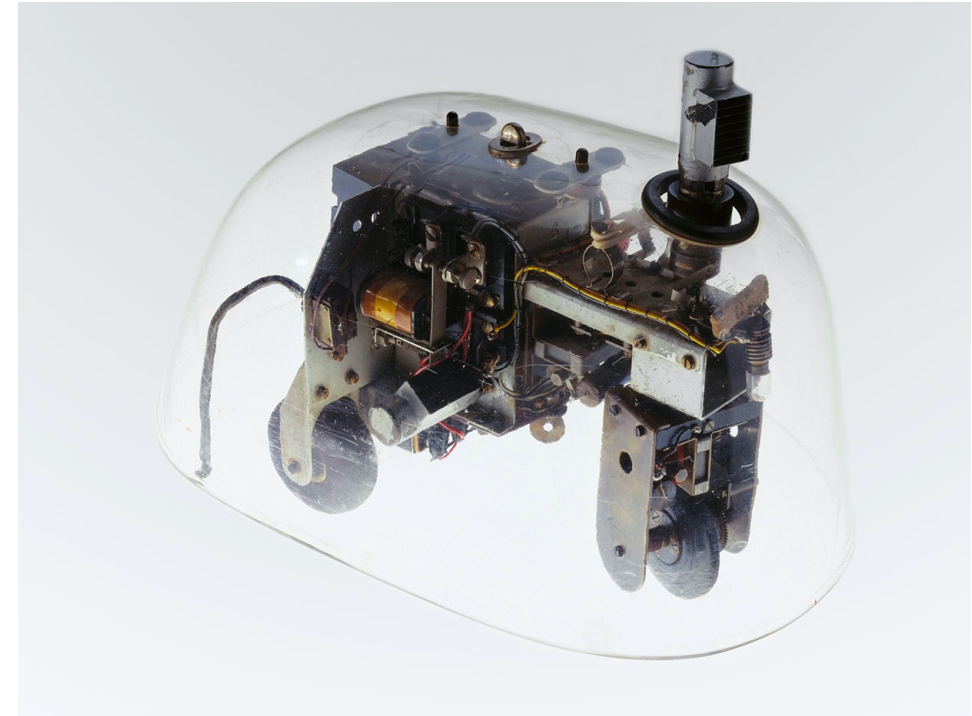
# History of Robotics

- The word **robot** was popularized by the Czech playwright Karel Capek  
pronounced Kha-rel Cha-pek  
in his 1921 play Rossum's Universal Robots (R.U.R.).
- It resulted from combining the Czech words **rabota**, meaning “obligatory work” and **robotnik**, meaning “serf”

# History of Robotics

## W. Grey Walter's Tortoises (1950)

- Neurophysiologist **W. Grey Walter** built his cybernetic tortoises to understand the functions of the brain
  - Elmer and Elsie
- Part of the emerging field of **cybernetics**
  - The field's founder, **Norbert Wiener**, defined cybernetics as “the scientific study of **control** and **communication** in the **animal** and the **machine**.”

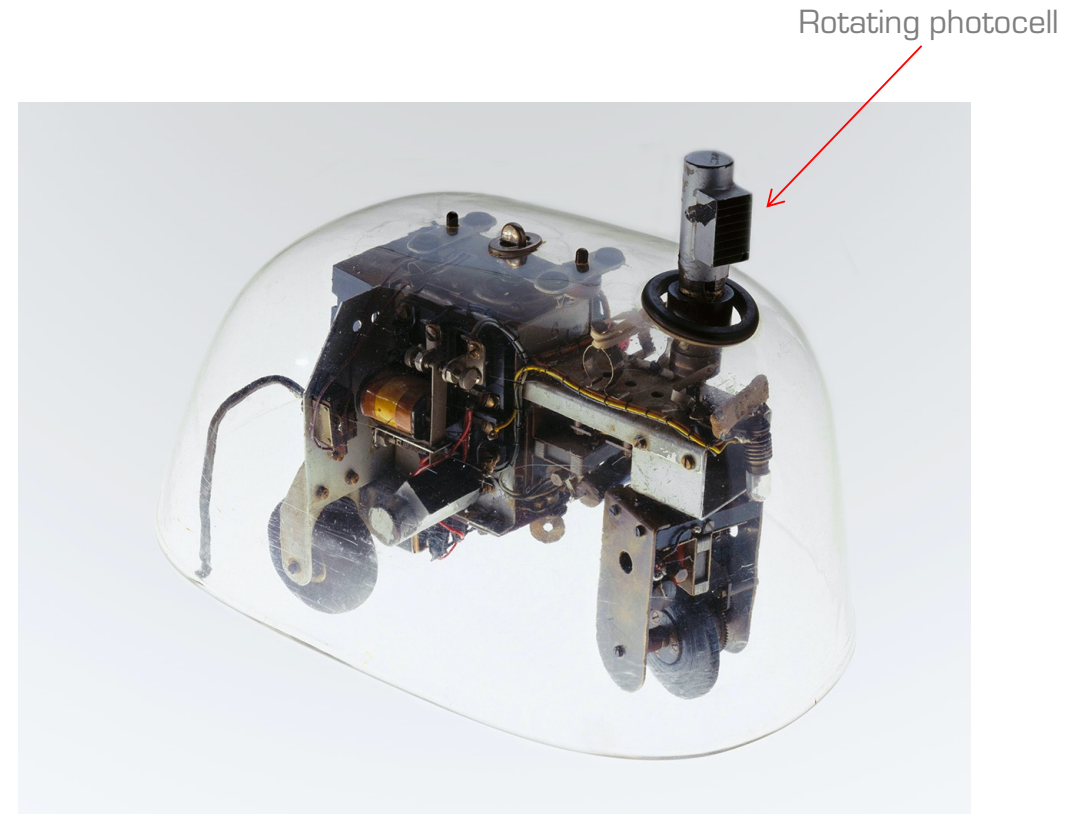


Meet the Roomba's Ancestor: The Cybernetic Tortoise, IEEE Spectrum, 2020  
<https://spectrum.ieee.org/tech-history/space-age/meet-roombas-ancestor-cybernetic-tortoise>

# History of Robotics

## W. Grey Walter's Tortoises (1950)

- "With just a photocell, a touch sensor, and two vacuum tubes, the robo-tortoise mimicked the way real animals move"



Meet the Roomba's Ancestor: The Cybernetic Tortoise, IEEE Spectrum, 2020  
<https://spectrum.ieee.org/tech-history/space-age/meet-roombas-ancestor-cybernetic-tortoise>

# History of Robotics

## Claude Shannon's Mouse (1950)

- This was one of the world's first examples of machine learning: a robotic maze-solving mouse known as Theseus



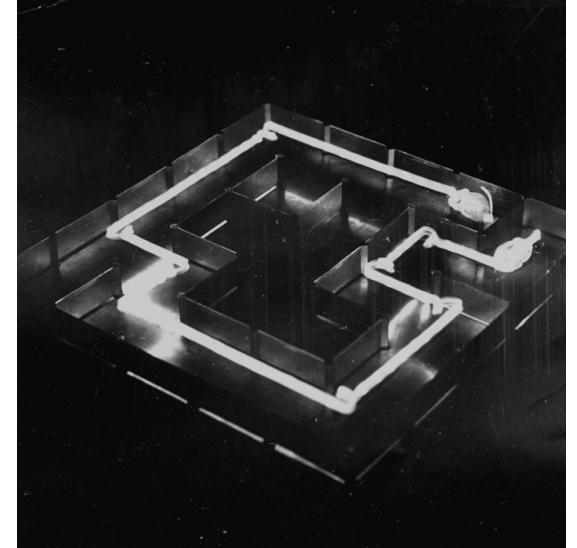
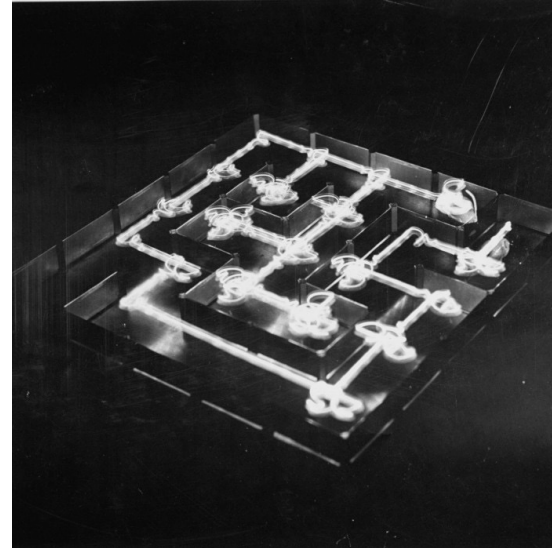
<https://www.technologyreview.com/2018/12/19/138508/mighty-mouse/>

# History of Robotics

## Claude Shannon's Mouse

"These photos, published in Life magazine in 1952, show the path Theseus took while learning a maze pattern and the direct path taken on its second trip through the same maze"

<https://www.technologyreview.com/2018/12/19/138508/mighty-mouse/>





W. Ross Ashby, Warren McCulloch, Grey Walter, Norbert Wiener  
at the 1951 Congress on Cybernetics, Paris

[https://www.researchgate.net/publication/287293010\\_Warren\\_McCulloch\\_and\\_the\\_British\\_Cyberneticians/figures?lo=1](https://www.researchgate.net/publication/287293010_Warren_McCulloch_and_the_British_Cyberneticians/figures?lo=1)

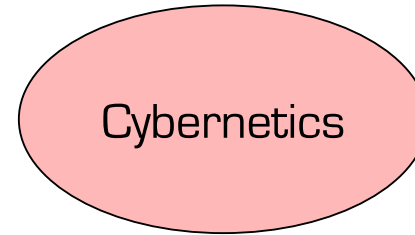
N. Wiener

Cybernetics: or the Control and Communication in the Animal and the Machine, 1948.

[κυβερνητης or kybernetes: steersman]

W. Ross Ashby

Design for a Brain, first edition, 1952 ... 1956, 1960.  
Introduction to Cybernetics, 1957



Walter McCulloch

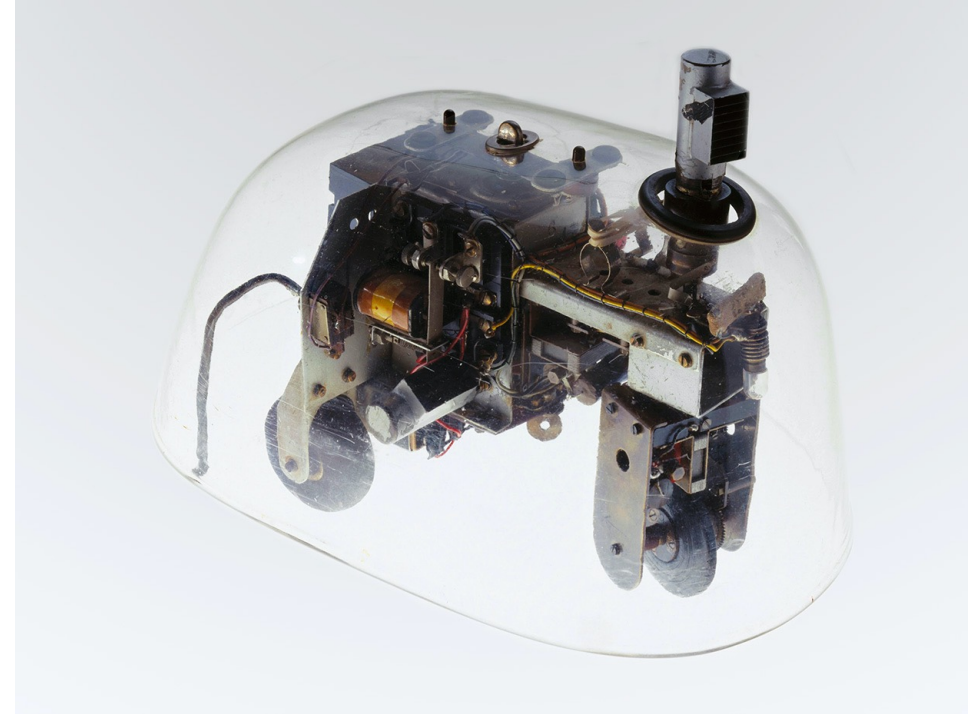
W. S. McCulloch and W. Pitts "A logical calculus of ideas immanent in nervous activity". Bulletin of Mathematical Biophysics 5:115–133, 1943



# History of Robotics

Both Walter's and Shannon's robots built on **behaviorist psychology**

- using associative and reinforcement learning in relatively simple neural networks
- rather than focussing on internal models and symbolic computation
- Precursor to **reactive** and **behaviour-based** robotics (more on this later when we discuss paradigms of robotics)



Meet the Roomba's Ancestor: The Cybernetic Turtle, IEEE Spectrum, 2020  
<https://spectrum.ieee.org/tech-history/space-age/meet-roombas-ancestor-cybernetic-turtle>

# History of Robotics

## Shakey (1966 – 1972)

- “Shakey” was the first mobile robot with the ability to perceive and **reason** about its surroundings and its actions
- Developed at the Artificial Intelligence Center of Stanford Research Institute (now called SRI International)
- Charles Rosen, Nils Nilsson, Alfred Brain, Sven Wahlstrom, Bertram Raphael, Richard Duda, Peter Hart, Richard Fikes, Richard Waldinger, Thomas Garvey, Jay Tenenbaum, Helen Chan Wolf and Michael Wilber

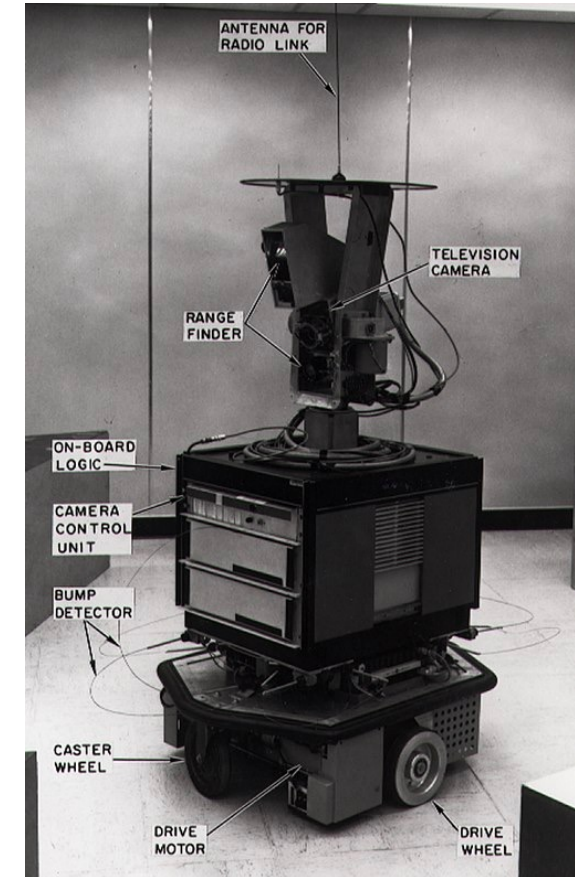


<https://www.sri.com/hoi/shakey-the-robot/>

# History of Robotics

Shakey built on **computationalist (cognitivist) psychology and symbolic AI**

- Programming was primarily done in LISP
- Using the Stanford Research Institute Problem Solver (STRIPS) planner
- The first robot that was a logical, goal-based agent
- Precursor to **hierarchical** "sense-plan-act" robotics (more on this later when we discuss paradigms of robotics)



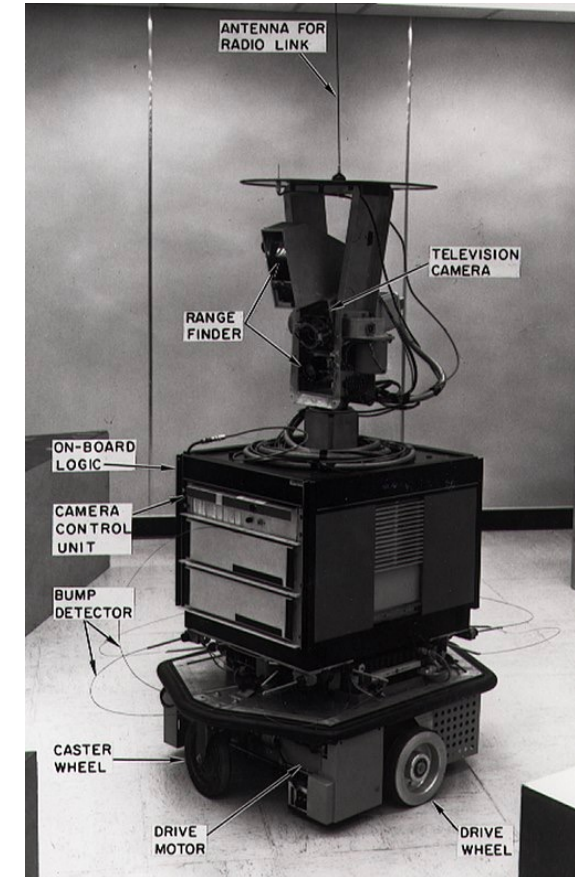
Shakey in 1972

[https://en.wikipedia.org/wiki/Shakey\\_the\\_robot](https://en.wikipedia.org/wiki/Shakey_the_robot)

# History of Robotics

## Some research results

- The A\* search algorithm
- The Hough transform
- The visibility graph method
- Major impact on the development of robotics & AI  
[and computer science, generally]



Shakey in 1972

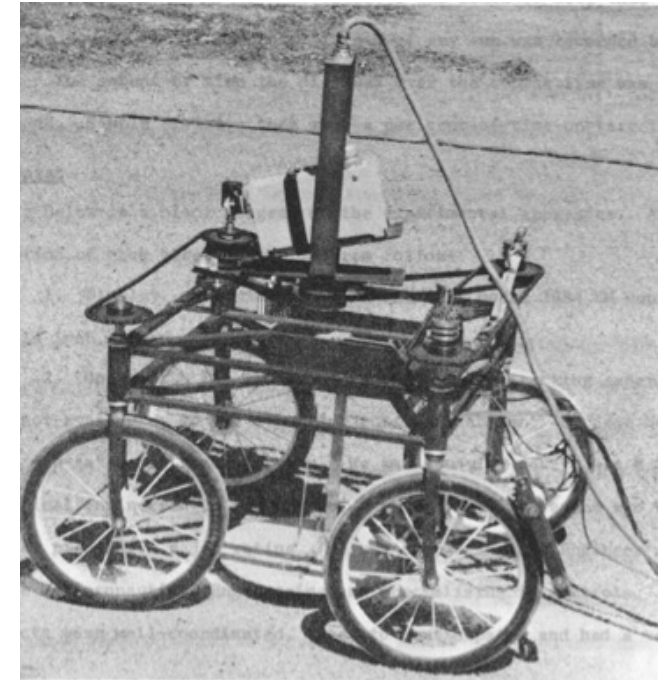
[https://en.wikipedia.org/wiki/Shakey\\_the\\_robot](https://en.wikipedia.org/wiki/Shakey_the_robot)

# History of Robotics

## Stanford Cart (1960 - 1980)

James Adams  
Stanford University

<https://web.stanford.edu/~learnest/sail/oldcart.html>



Stanford Cart with cable, 1961

<https://web.stanford.edu/~learnest/sail/oldcart.html>

# History of Robotics

## Stanford Cart (1961 - 1980)

Hans Moravec

Stanford Artificial Intelligence Laboratory SAIL

- Sensors
  - Stereo vision (camera on a slider)
- Speed
  - ~1 meter per 10-15 minutes
  - Full run: 5 hours
- Accomplishments:
  - Successfully navigated 20 meter courses, avoiding obstacles using visual sensing
  - Used graph search to find shortest path



Stanford Cart 1980  
© Mark Richards

<https://www.computerhistory.org/revolution/artificial-intelligence-robotics/13/293/1277>

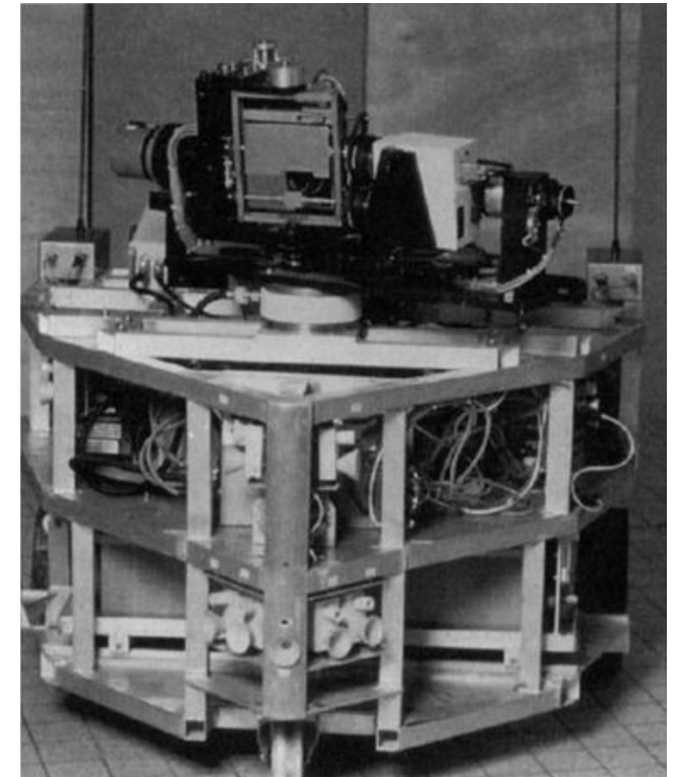
# History of Robotics

## HILARE (late 1970s)

LAAS Lab

Laboratoire d'Analyse et D'Architecture des Systemes,  
Toulouse, France

- Sensors
  - Video camera
  - 14 sonar sensors
  - Laser range finder
- Actuators
  - Three wheels: two actuated, one caster
- Weight
  - 400 kg



<https://slideplayer.com/slide/11973896/>



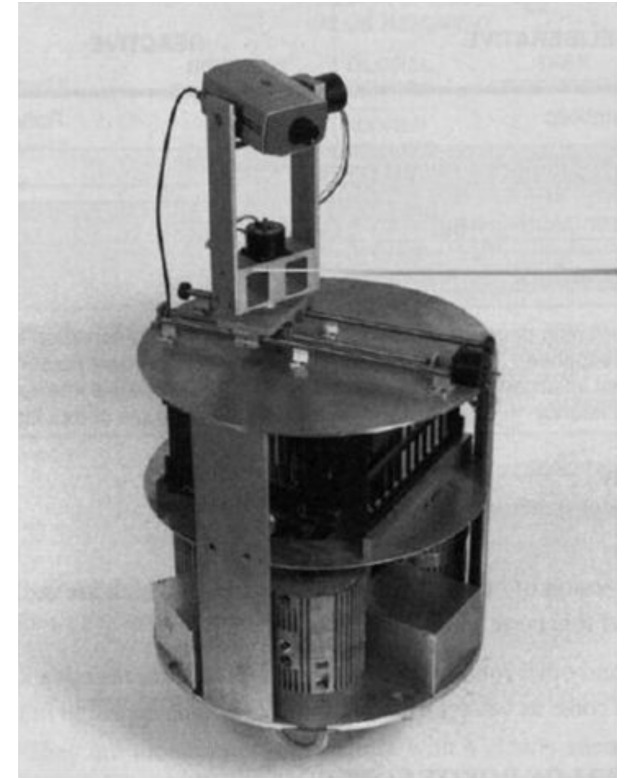
# History of Robotics

## Rover (1983)

Hans Moravec

Carnegie Mellon University

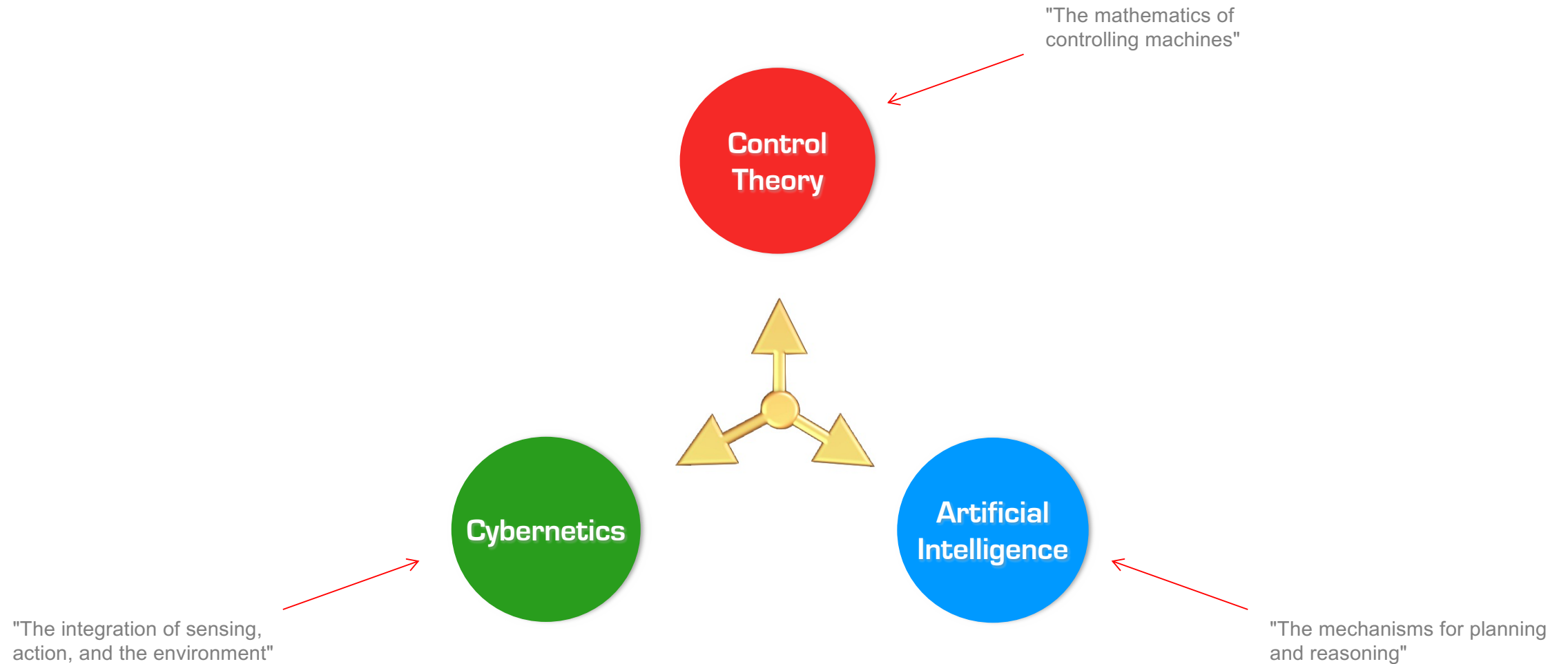
- Follow-on from the Stanford Cart
- Sensors
  - Video camera with pan and tilt
  - Sonar
  - Infrared
- Actuators
  - Three independently powered wheels
- Accomplishments: set the stage for behavior-based robotics



<https://slideplayer.com/slide/11973896/>



# Robotics



M. Mataric, The Robotics Primer, MIT Press, 2007; Chapter 2, p. 17.

# Reading

M. Mataric, The Robotics Primer, MIT Press, 2007. Chapter 2.