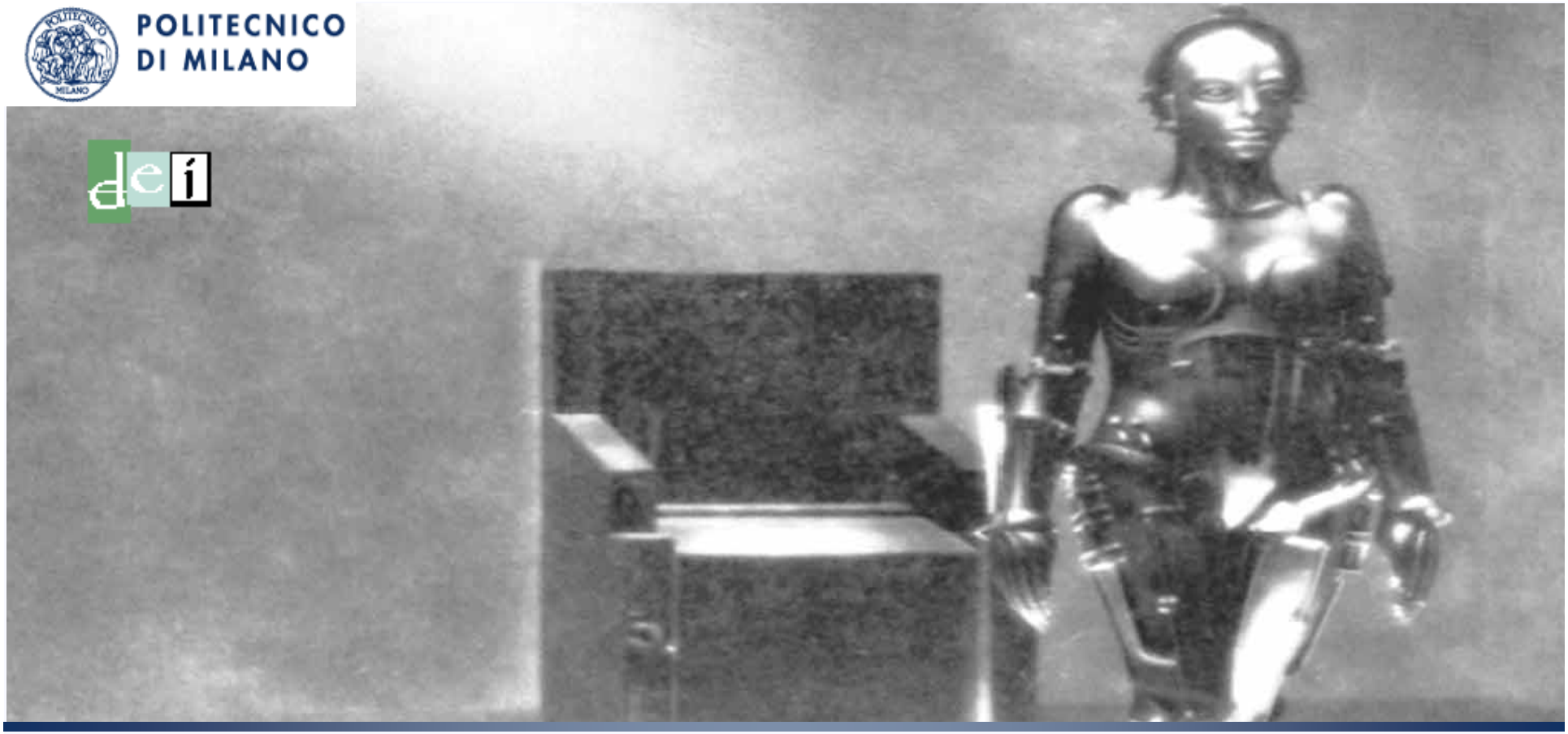
POLITECNICO DI MILANO



070342 – Robotica

http://home.dei.polimi.it/gini/robot/

Introduzione e definizioni

organization

- 50 hours (30 + 20)

  - Wednesday 13:15-15:15
  - Thursday 15:15-17:15
- site

http://home.dei.polimi.it/gini/robot

- G. Gini
- P. Belluco

examination

- “in itinere” – 05/05/2009
- written + oral presentation on a paper

books

G. Gini, V. Caglioti, "Robotica", Zanichelli 2003.

Bibliografia

G. A. Bekey, "Autonomous Robots - From Biological Inspiration to Implementation and Control", MIT Press, Cambridge (Mass), 2005.

H. Choset et al. "Principles of robot motion", MIT Press, Cambridge (Mass), 2005.

R Siegwart and Illah R. Nourbakhsh, "Introduction to autonomous mobile robots", MIT Press, Cambridge (Mass.), 2004.

G. Dudek, M. Jenkin, "Computational Principles of Mobile Robotics", Cambridge University Press, New York 2000.

J. J. Craig, "Introduction to Robotics: Mechanics and Control", 2nd edition, Addison-Wesley, 2000.

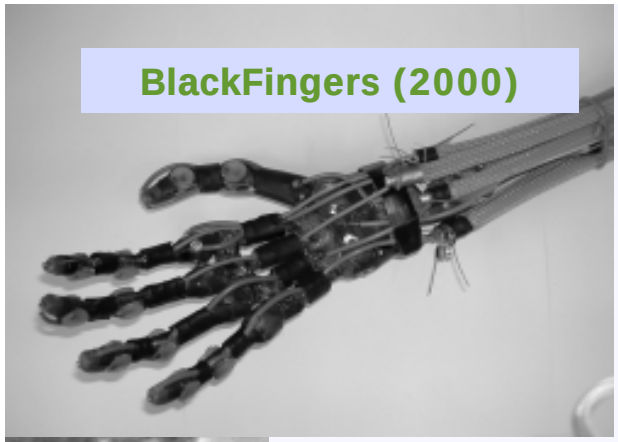
R. L. Paul, "Robot manipulators: mathematics, programming, and control, The MIT Press, Cambridge (Mass), 1981

Progetti

- Available on the site a list of projects
- 2.5 cfu
  - For 1 student or small groups
- Laboratorio di intelligenza artificiale e robotica
- 5 cfu

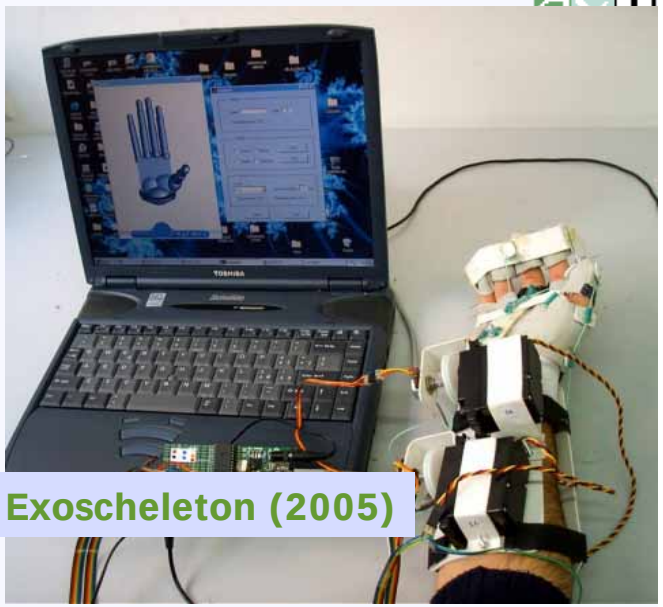
PYRO Python Robotics

In the lab



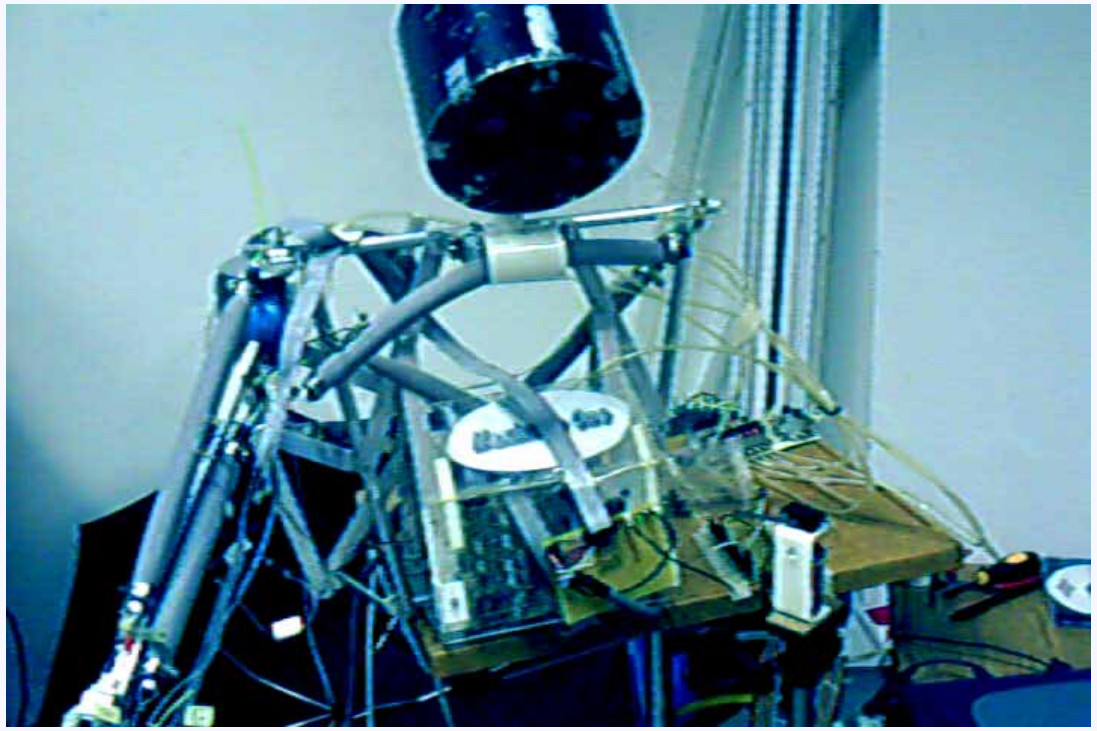
BlackFingers (2000)

WhiteFingers (2002)

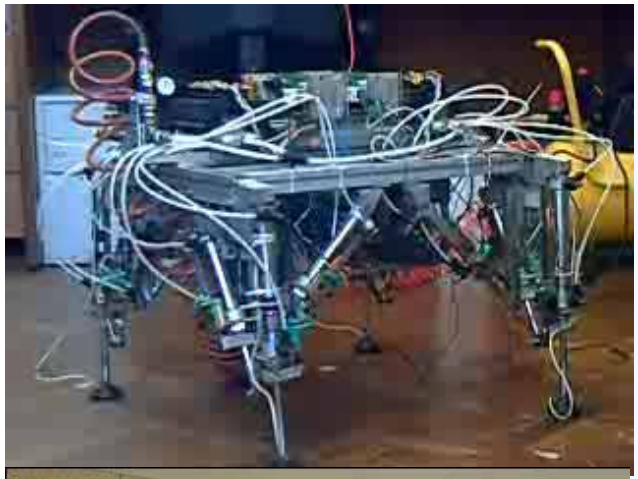


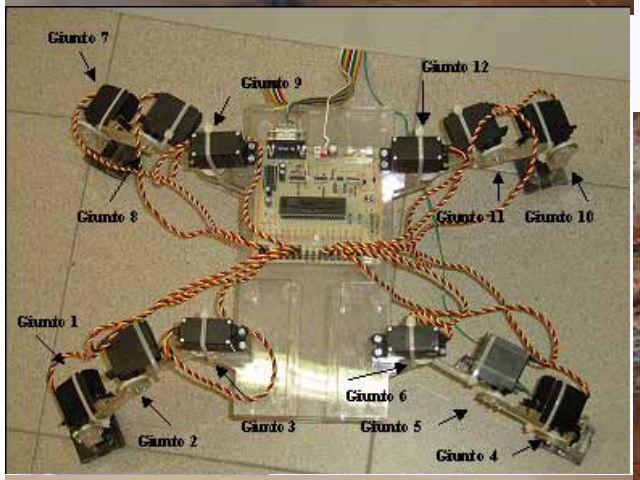
Exoscheleton (2005)

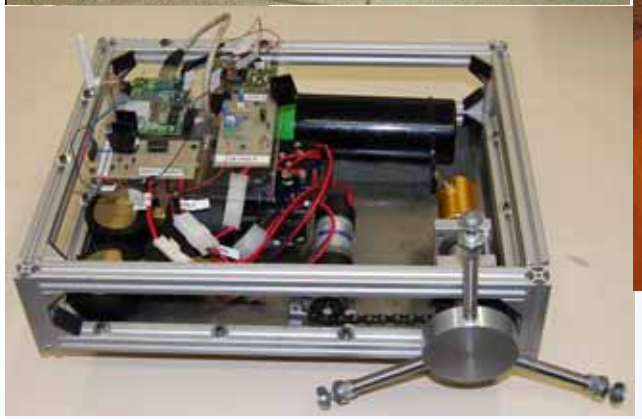
gloves (2002)



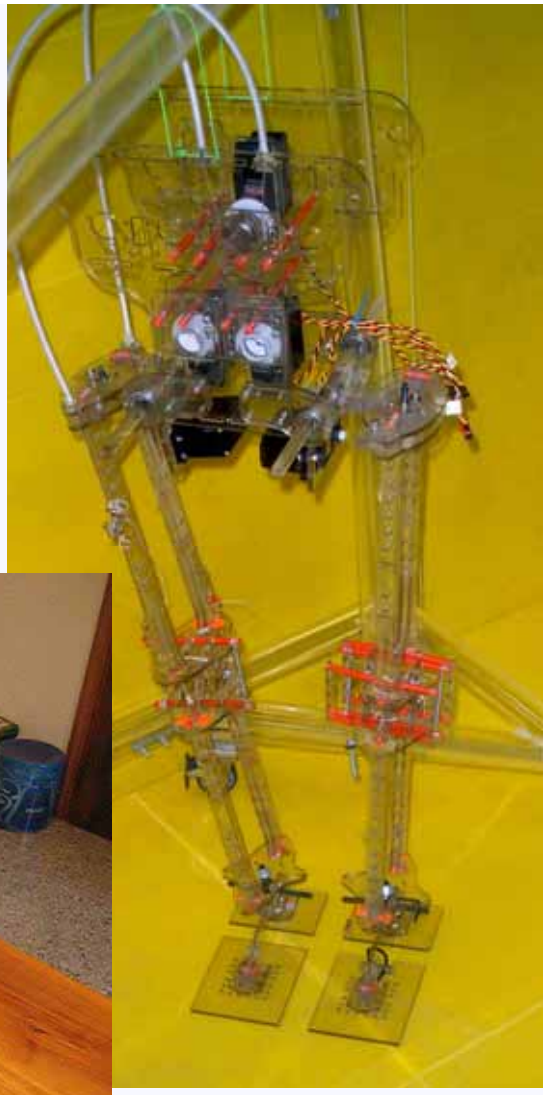
Maximum One (2003)





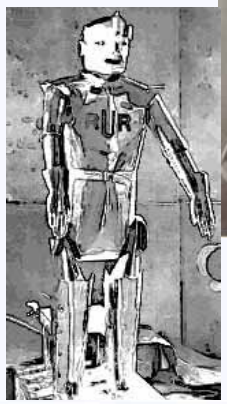


- Ulisse (1994)
- LARP (2003)
- WARUGADAR(2008)
- EMBOT (2008)
- ZOIDBERG (2008)



Robot?

- Mechanics age: 1700, puppets, karakuri-ningyo
- Fiction age: 1920, "*robot*"
- Cybernetics age: 1940, turtle…
- Telemanipulation age: 1940, telerobot
- Automation age: 1960, industrial robotics
- Informatics age: intelligence, autonomy, cooperation, exploration

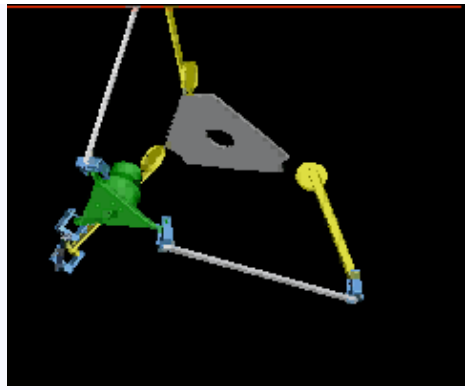


The first robots

- **1961** - "UNIMATE, the first industrial robot, began work at General Motors. Obeying step-by-step commands stored on a magnetic drum, the 4,000-pound arm sequenced and stacked hot pieces of die-cast metal.

- **1968** - Marvin Minsky developed the *Tentacle Arm*, which moved like an octopus. It had twelve joints designed to reach around obstacles. A PDP-6 computer controlled the arm, powered by hydraulic fluids. Mounted on a wall, it could lift the weight of a person.

Industrial robots



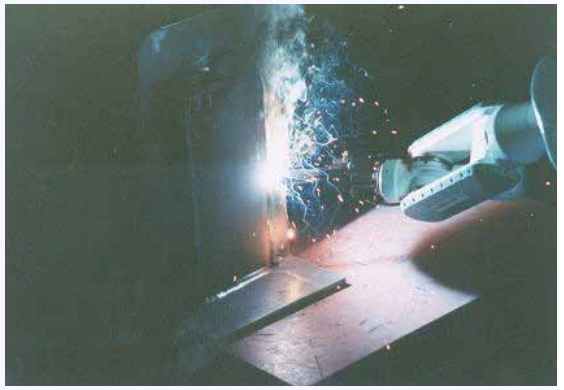
Manipulators (serial and parallel)

Repetitive actions

to move parts,

to operate on parts,

…

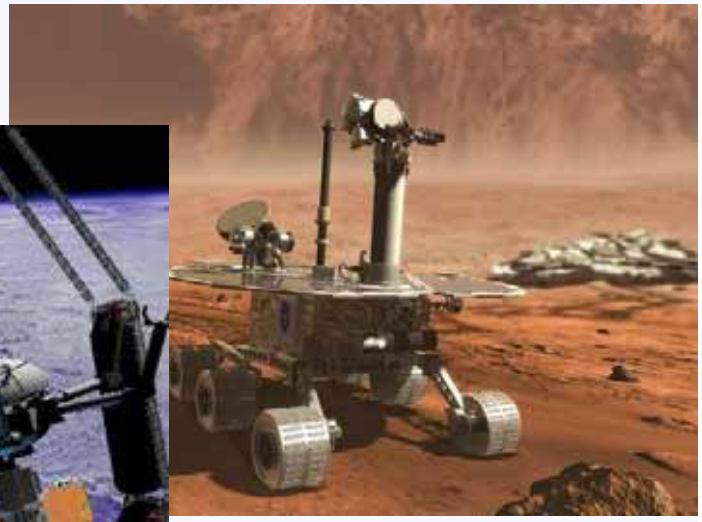


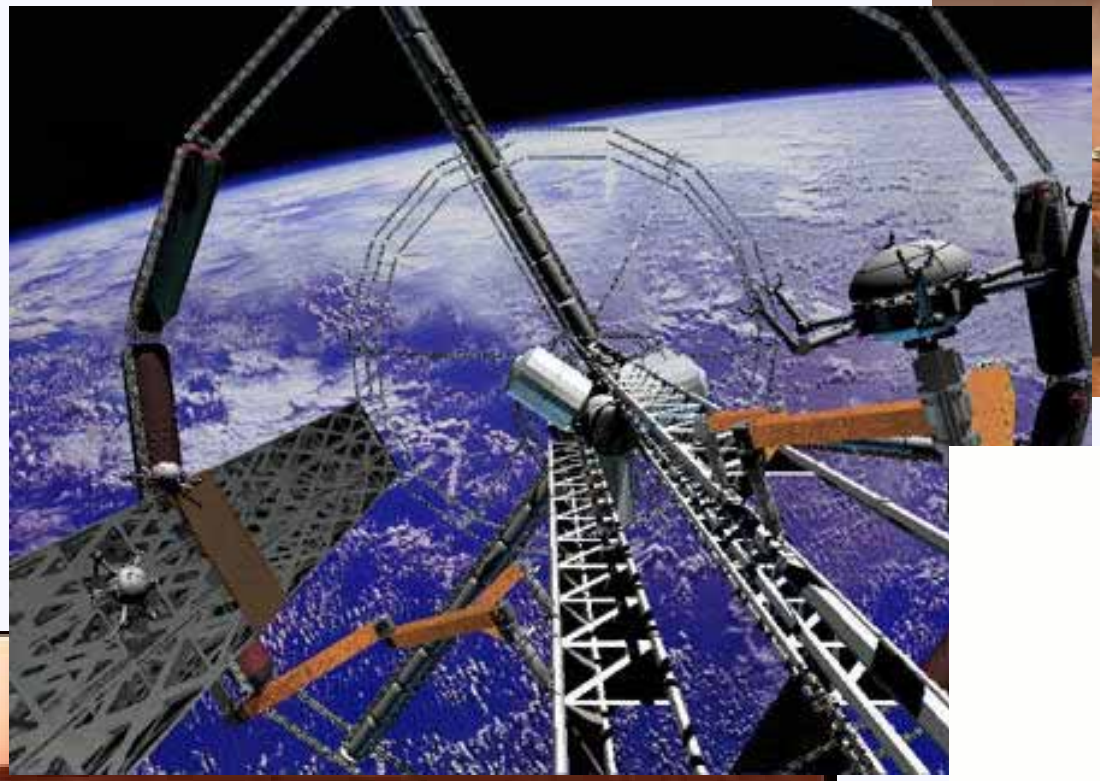
Autonomous robots

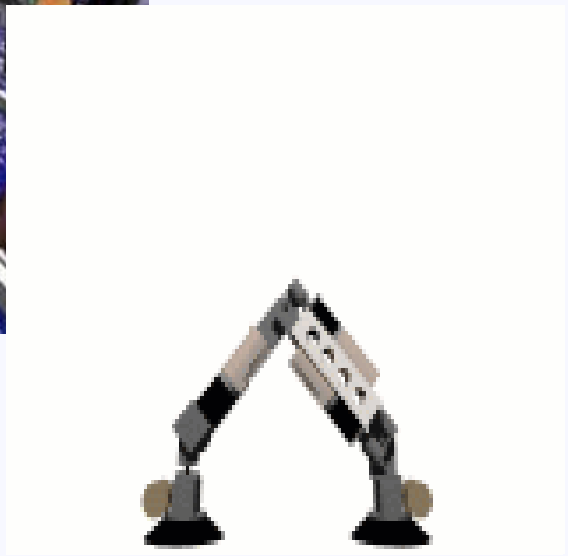
- Find a market
  - games
  - security
  - home
  - exploration
  - war

Space robotics

Exploration, space construction







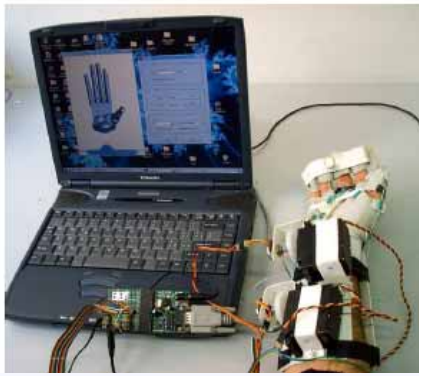
Medical robotics

exoscheleton

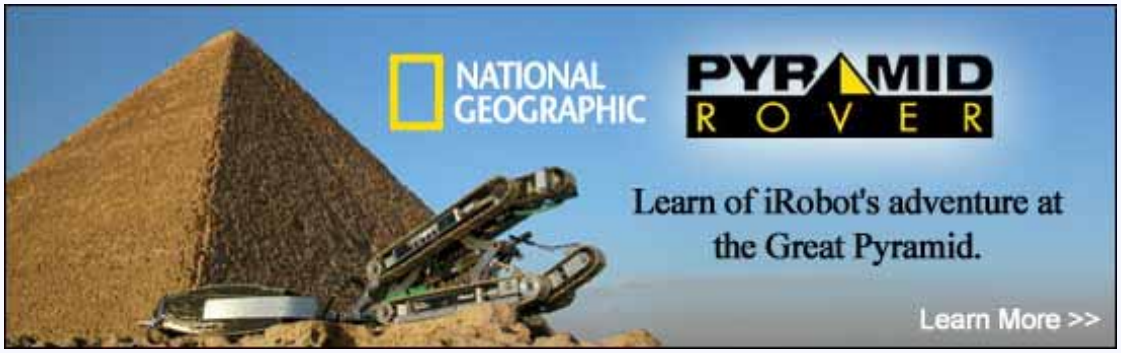
surgery assistant

rehabilitation

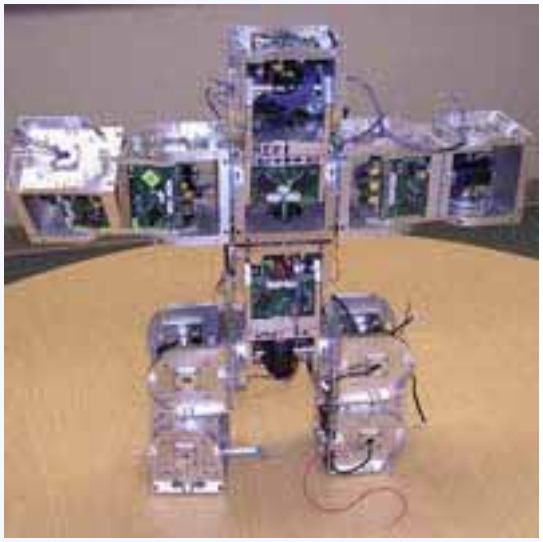
prosthesis

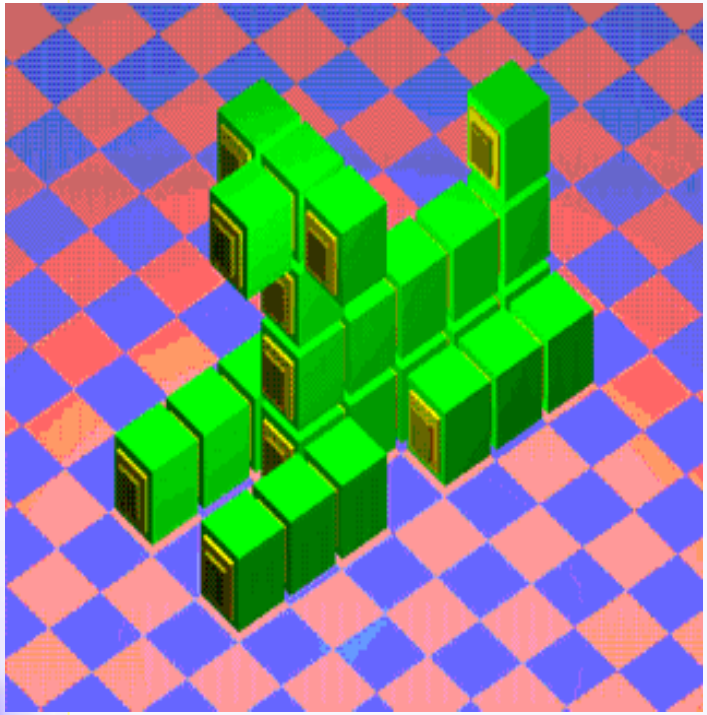


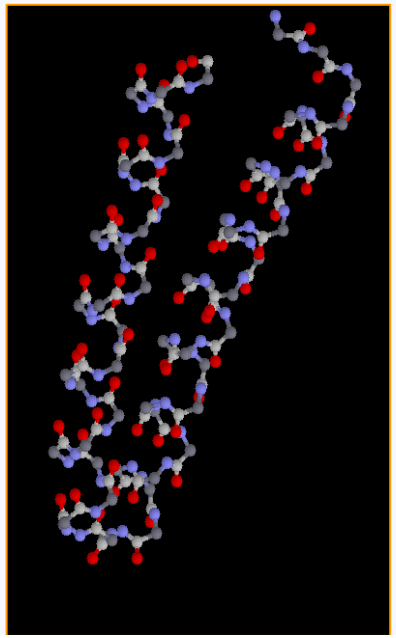
Unmanned vehicles



Modular robots



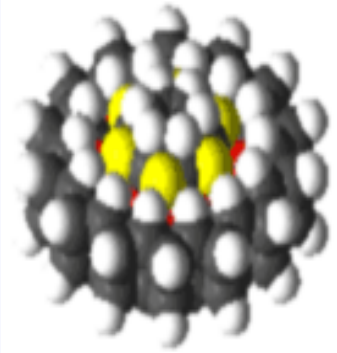


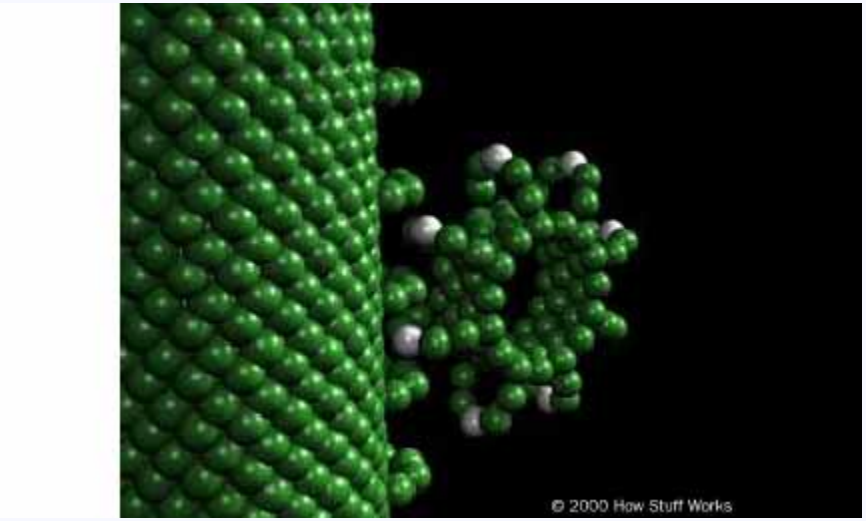


nanomachines

Nanotechnology

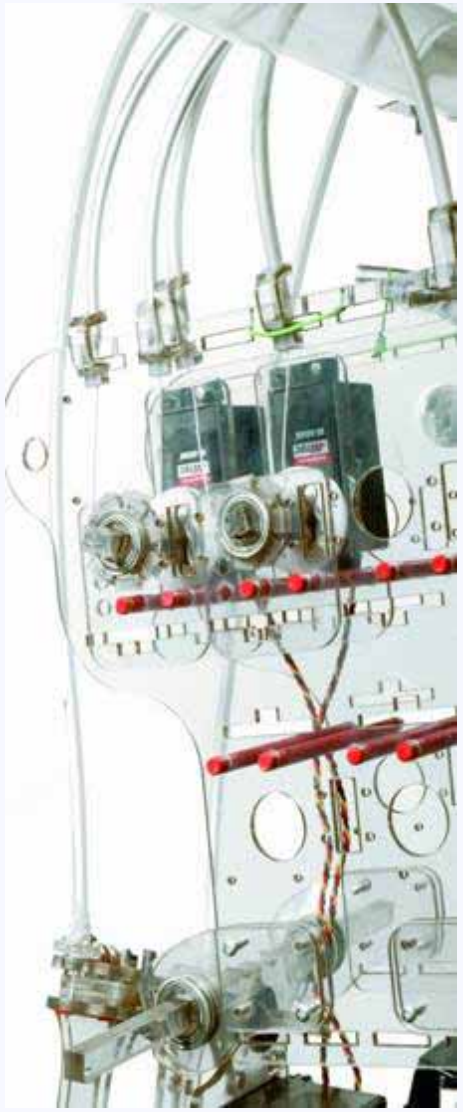
Nanorobot = molecular level





Robotics research problems

- **Design** (mechanics, sensors, actuators)
- **Control** (adaptability, intelligence …)
- **Planning** (non repetitive actions)
- **Perception** (non structured world)



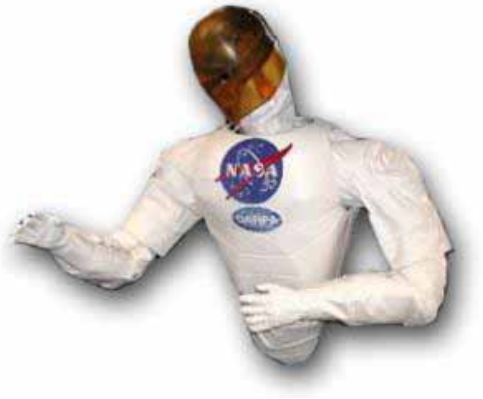
Which one is the robot?

biorobotics

Imitation from nature

…humanoids

- *"In the early days of robotics humanoids existed only in science fiction. While these creatures boasted intelligence far superior to humans, the real robot in field use today is still a relatively unintelligent device performing programmed repetitive tasks with few sensors and little or no flexibility at all…."*



human aspect

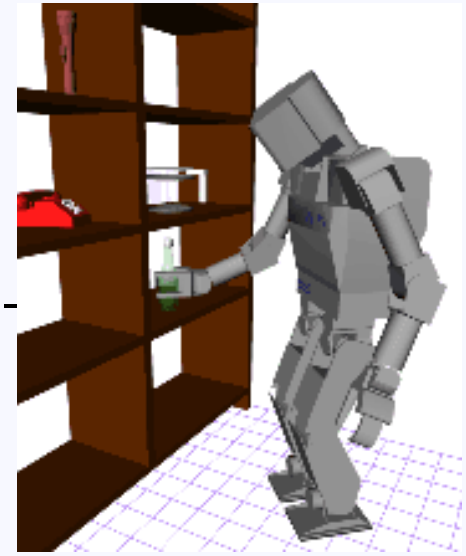
Pro

•Uses common objcts

•Cooperates in real environments

•emotions

❖Easy to teach - same mobility



Cons

- difficult
- Not the best solution for some environments
- Complex kinematics
- Will never reach the real target?

New research problems
in informatics and science

Disappearing computer - robot

- communication
- interface

Enbodied intelligence

- interact with the real world
- skills and learning

Robot as a model

- reproduce and demonstrate cognitive/neural/mechanical models

Robots are intelligent ?

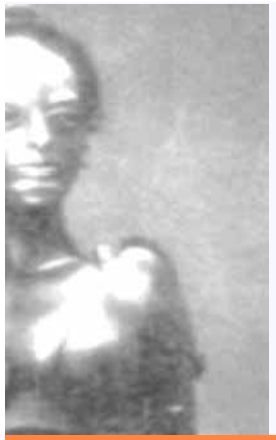
1. Automata and flexible machines (1954-63)
2. Mobile robots (1967, Shakey)
3. Androids ?
4. Cyborgs ?

- *The need of intelligent machines often confused with the existence of such machines*
  - *reasoning*
  - *adaptation and learning*

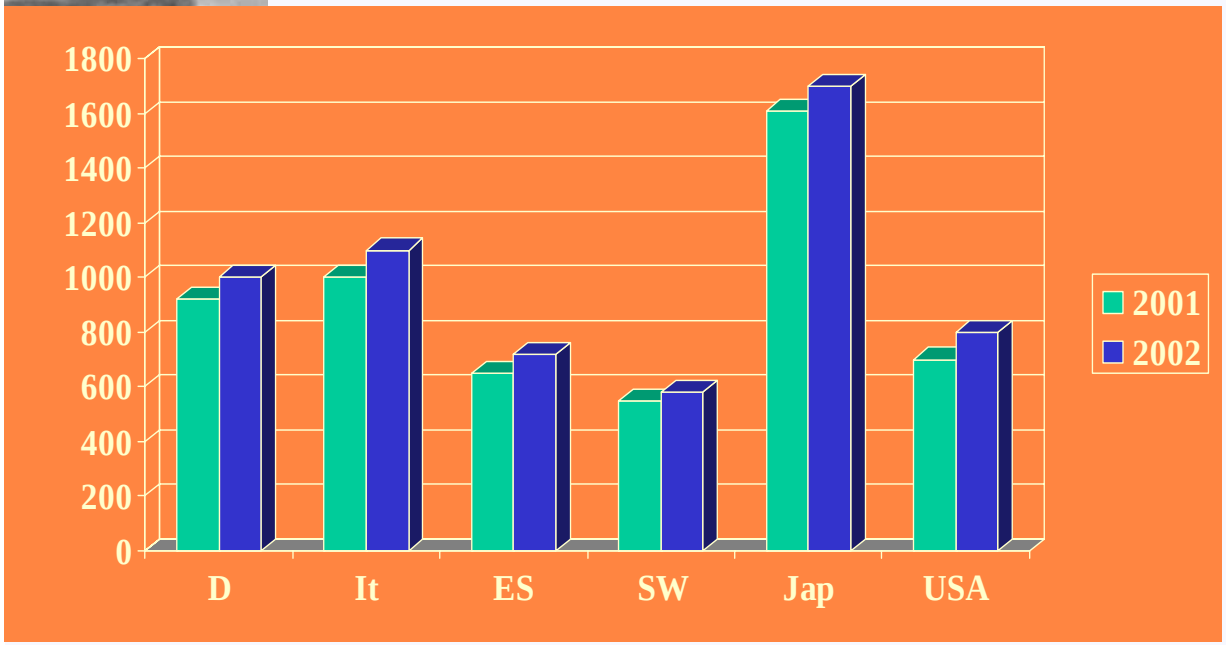
New areas of robotics

- Integration of biological/artificial tissues
- Bionic prostheses
- Neurophysiology
- Bio-informatics
- Cognitive psycology
- Etology

"This is the robot age. In the future the robots will be us" (*R. Brooks)*

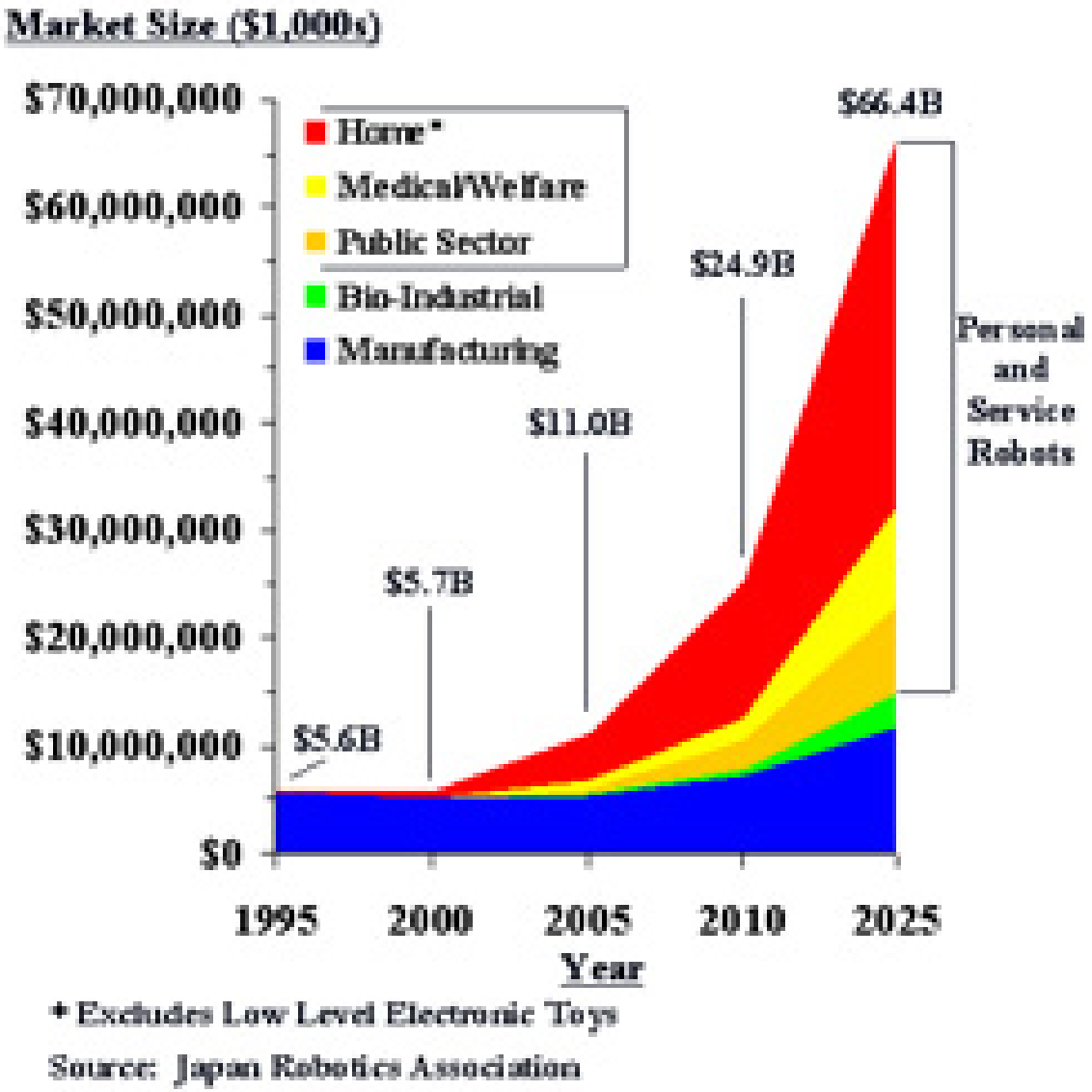


Italian Industry



- 4 top regions in industry in Europe: Germany, France, UK, Italy.
- Italy 2° in Europe and 4° in world as **USER OF INDUSTRIAL ROBOTS**
- The robot density in Italy is the highest in car industry
- Innovation is some areas: Pirelli, GLAXO, etc.
- Italy is 1° in industrial equipment, 2° in numerically controlled machines.

Robot market



- Industrial robot - +8%/year
  - Car industry
- hardware value: 3.6 billions of US dollars in 2005.

SCIENTIFIC AMERICAN.com

December 16, 2006

A Robot in Every Home

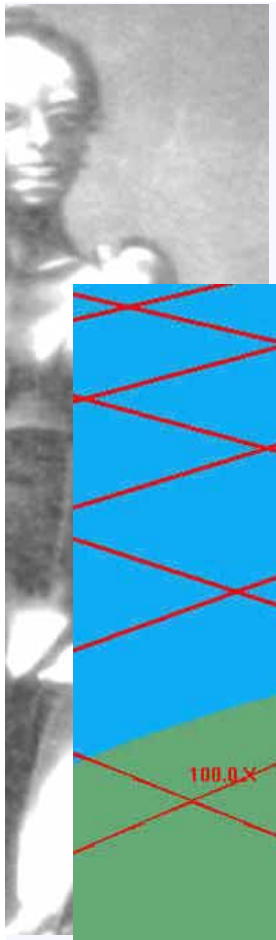
The leader of the PC revolution predicts that the next hot field will be robotics

By Bill Gates

Imagine being present at the birth of a new industry. It is an industry based on groundbreaking new technologies, wherein a handful of well-established corporations sell highly specialized devices for business use and a fast-growing number of start-up companies produce innovative toys, gadgets for hobbyists and other interesting niche products. But it is also a highly fragmented industry with few common standards or platforms. Projects are complex, progress is slow, and practical applications are relatively rare. In fact, for all the excitement and promise, no one can say with any certainty when—or even if—this industry will achieve critical mass. If it does, though, it may well change the world.

Of course, the paragraph above could be a description of the computer industry during the mid-1970s, around the time that Paul Allen and I launched Microsoft. Back then, big, expensive mainframe computers ran the back-office operations for major companies, governmental departments and other institutions. Researchers at leading universities and industrial laboratories were creating the basic building blocks that would make the information age possible. Intel had just introduced the 8080 microprocessor, and Atari was selling the popular electronic game Pong. At homegrown computer clubs, enthusiasts struggled to figure out exactly what this new technology was good for.

But what I really have in mind is something much more contemporary: the emergence of the robotics industry, which is developing in much the same way that the computer business did 30 years ago. Think of the manufacturing robots currently used on automobile assembly lines as the equivalent of yesterday's mainframes. The industry's niche products include robotic arms that perform surgery, surveillance robots deployed in Iraq and Afghanistan that dispose of roadside bombs, and domestic robots that vacuum the floor. Electronics companies have made robotic toys that can imitate people or dogs or dinosaurs, and hobbyists are anxious to get their hands on the latest version of the Lego robotics system.



shape

Absolute reference

controller