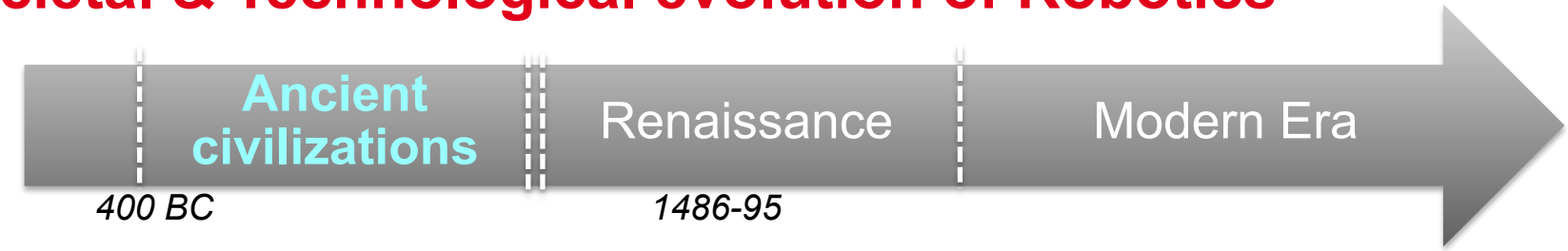
W1. Objectives, Challenges, State of the Art, Technologies

- Socio-economic context
- **Technological evolution of Robotics & State of the Art**
- New challenges for Robotics in Human Environments
- Decisional & Control Architecture for Autonomous Mobile Robots & IV
- Sensing technologies: Object Detection
- Sensing technologies: Robot Control & HRI
- Basic technologies for Navigation in Dynamic Human Environments
- Intelligent Vehicles: Context & State of the Art
- Intelligent Vehicles: Technical Challenges & Driving Skills

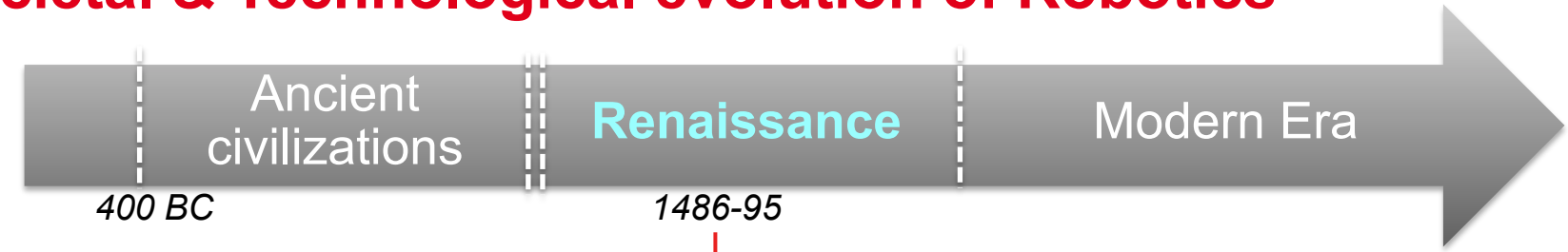
Societal & Technological evolution of Robotics



Humanity quest for "artificial creatures"

➔ *Objective to mimic living creatures*

Societal & Technological evolution of Robotics



Leonardo Da Vinci *(15th century)*
First technological studies & mock-ups

Societal & Technological evolution of Robotics

Ancient civilizations | Renaissance | Modern Era

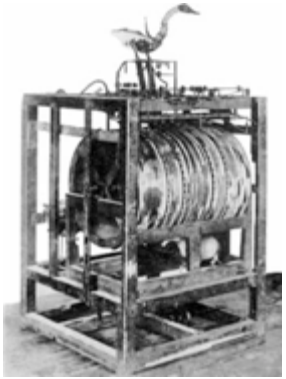
400 BC

1730-38

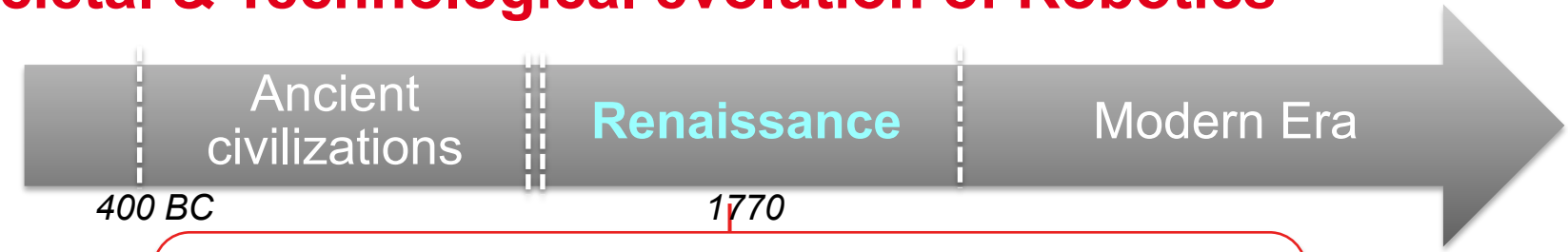
Jacques Vaucanson *(18th century)*

Early construction of smart Androids

- ➔ *1 year exhibition in Grenoble (France)*
- ➔ *Impressive illusion of life…but a few tricks*



Societal & Technological evolution of Robotics



Wolfgang von Kempelen *(18th century)*

« Intelligent » Android: Mechanical Turk / Chess player

- ➔ *Exhibited in several places in the world until 1854*
- ➔ *Impressive illusion of intelligence…but based on a trick !*

Societal & Technological evolution of Robotics

Ancient civilizations | Renaissance | **Modern Era**

400 BC — *1893*

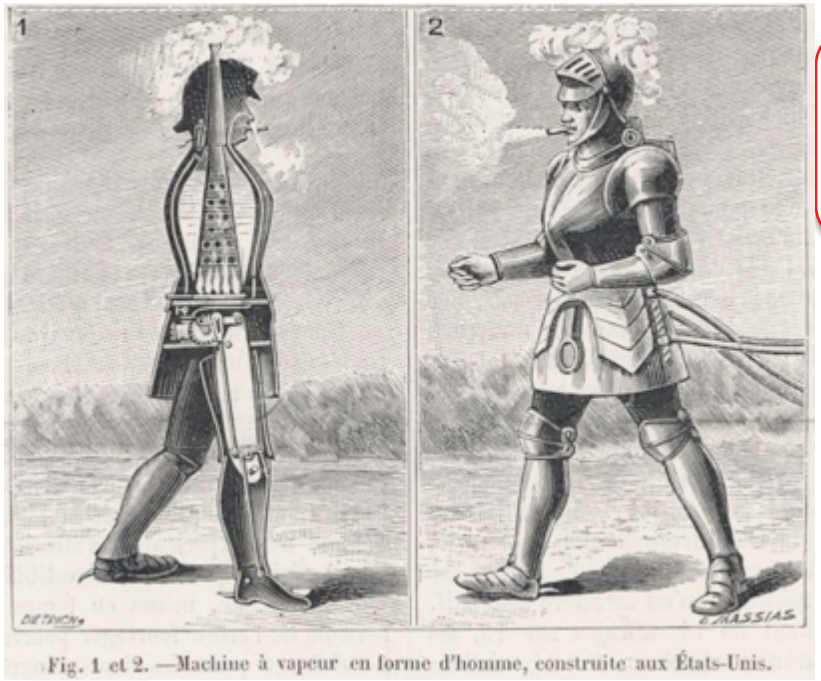


Fig. 1 et 2. —Machine à vapeur en forme d'homme, construite aux États-Unis.

George Moore *(end 19th century)*

Walking "Iron Man" powered by steam

➔ *A quite natural walking imitation (hip, knee, ankle)*

Societal & Technological evolution of Robotics

Ancient civilizations | Renaissance | **Modern Era**

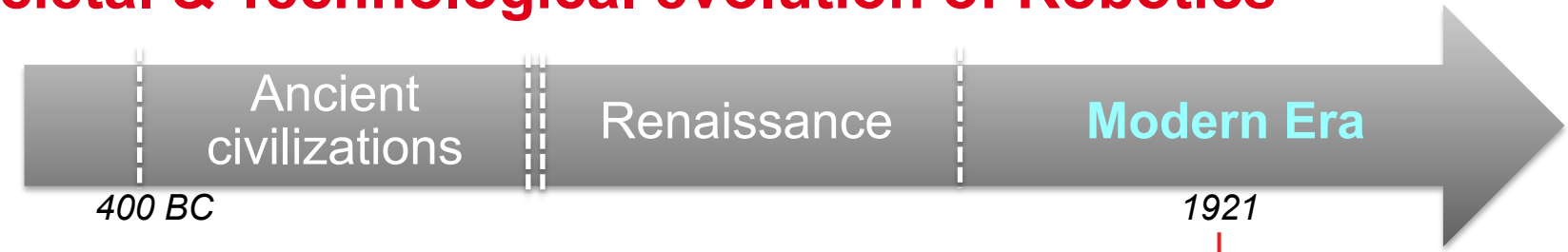
400 BC — *1939-40*

Westinghouse Electro & Sparko *(20th century)*

New York Universal Exhibition

➔ *First Automaton controlled by electric components (motions, voice ..)*

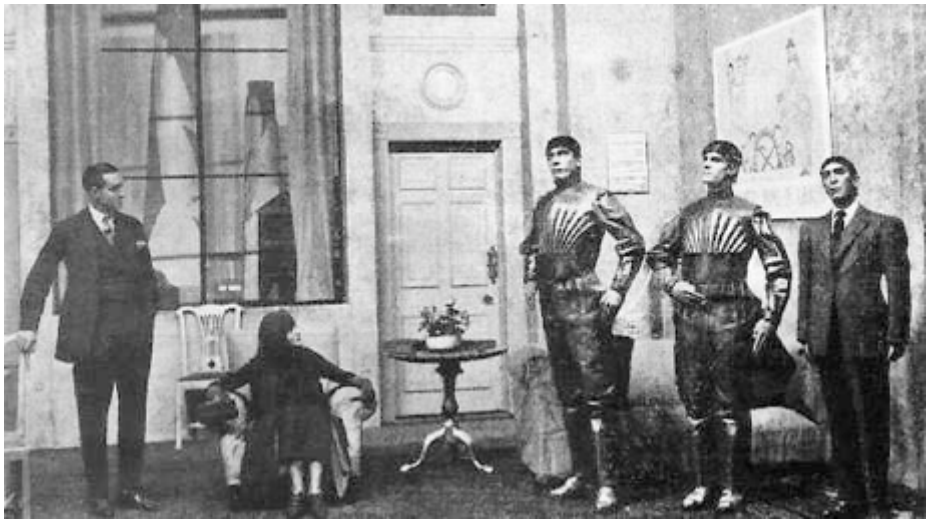
Societal & Technological evolution of Robotics



Josef Capek *(20th century)*

Show "Rossum's Universal Robots"

➔ *First introduction of the term/concept of "Robot"*



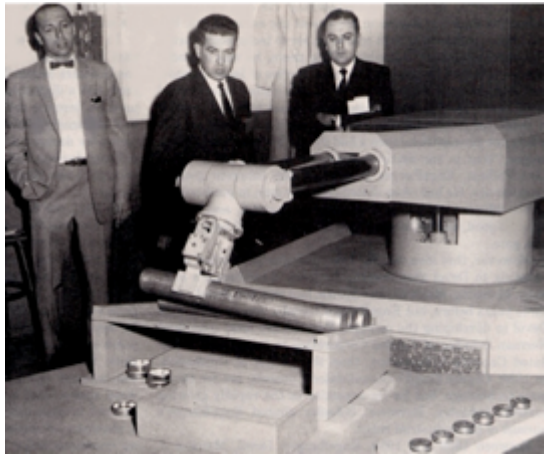
First Industrial, Mobile, Tele-operated Robots

Poor Autonomy & Reactivity

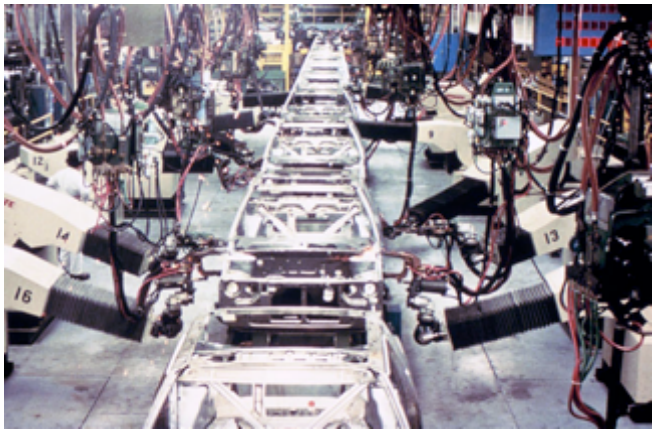
1st Industrial Robots
1960-70

1st Academic Mobile Robots
1968-80

First Tele-operated Robots
1948-60



1959 - *Unimate by George Revol*



1969 – *Line of welding robots in a factory (GM)*

=> Poor Autonomy & Reactivity

First Industrial, Mobile, Tele-operated Robots

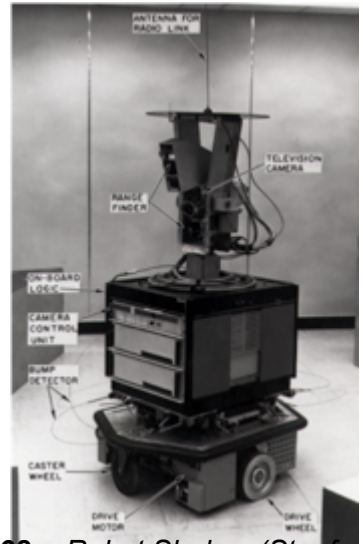
Poor Autonomy & Reactivity

1st Industrial Robots
1960-70

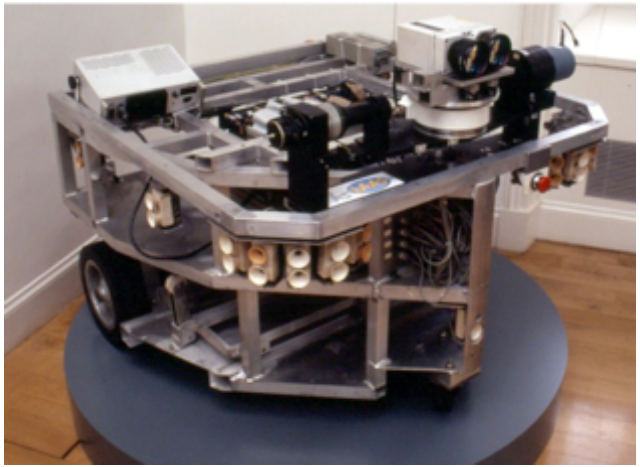
1st Academic Mobile Robots
1968-80

First Tele-operated Robots
1948-60

More sensors & autonomy



1968 – *Robot Shakey (Stanford)*



1977-1980 – *Hilare (LAAS, Toulouse)*

First Industrial, Mobile, Tele-operated Robots

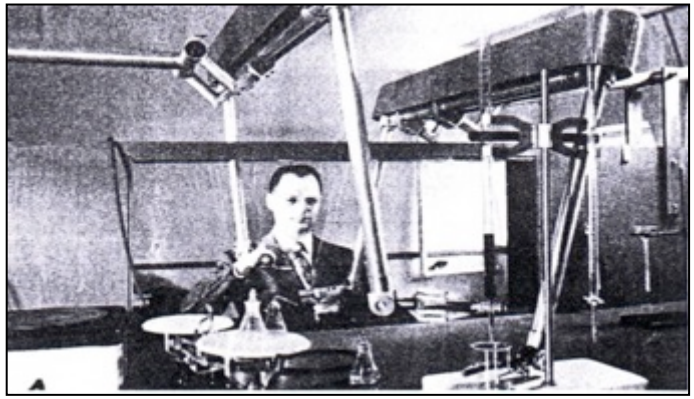
Poor Autonomy & Reactivity

1st Industrial Robots
1960-70

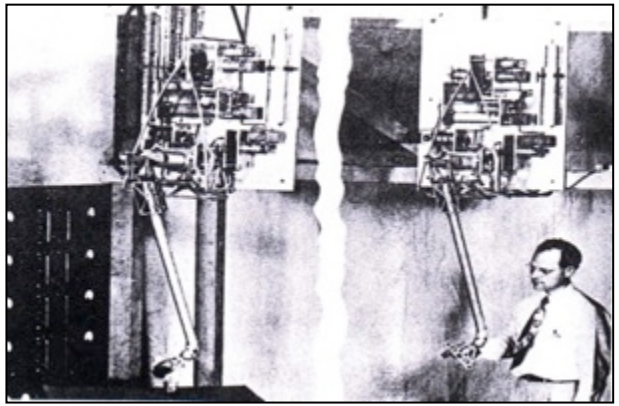
1st Academic Mobile Robots
1968-80

First Tele-operated Robots
1960-70

First Prototypes



1948: First mechanical MS-System
Goertz, Argonne Nat. Lab.



1954: First electrical MS-System
Goertz, Argonne Nat. Lab.

First Industrial, Mobile, Tele-operated Robots

Poor Autonomy & Reactivity

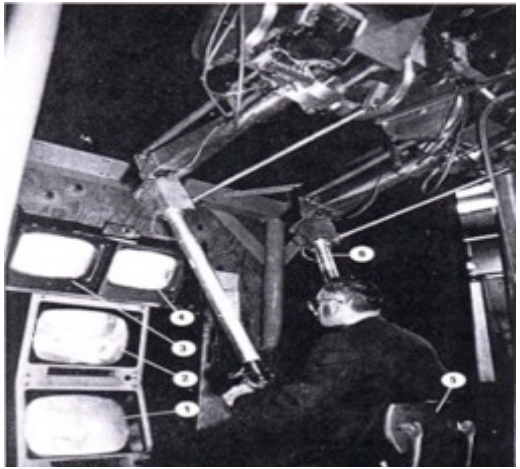
1st Industrial Robots
1960-70

1st Academic Mobile Robots
1968-80

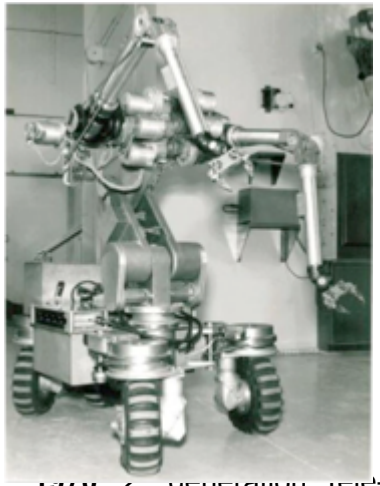
First Tele-operated Robots
1960-70

Working systems with Visual & Force Feedback

➔ *Remote manipulation tasks in dangerous environments (Space, Underwater, Nuclear …)*



1960: Typical control station with **visual feedback** (space, 1st generation)



1970: 2nd generation: Tele-manipulator with **force feedback** *J. Vertut, CEA (nuclear, 2nd generation)*

Modern Robotics & Applications

Increased Perception & Autonomy & HRI *(since the 90's)*

Automation & Manufacturing

Surveillance & Intervention in Hazardous Environments

➔ ***Current largest field of application***

Modern Manufacturing robot *(Kuka)*

Commercial Cobot: *Baxter (2013)*

Commercial Cobot: *Nextage (2014)*

Modern Robotics & Applications

Increased Perception & Autonomy & HRI *(since the 90's)*

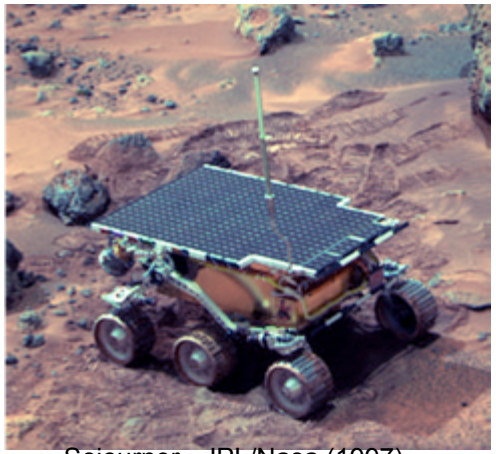
Automation & Manufacturing

Surveillance & Intervention in Hazardous Environments

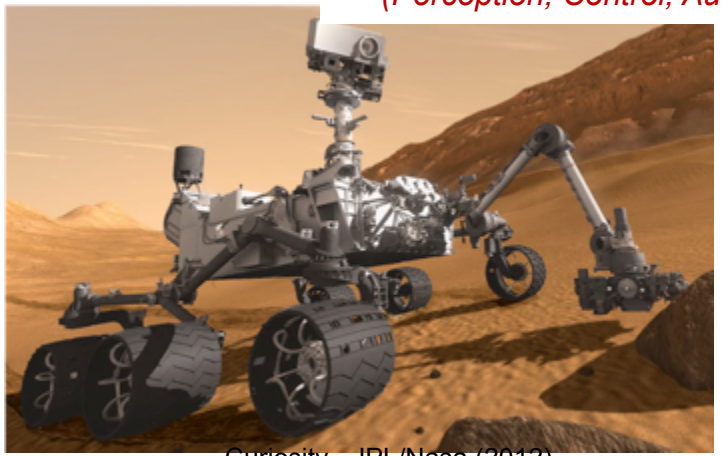
➔ ***An increasing field of application***

➔ ***A recent breakthrough in enabling technologies***

(Perception, Control, Autonomy, HRI)



Sojourner - JPL/Nasa (1997)



Curiosity - JPL/Nasa (2012)

Bio-inspired "legged robot "Big Dog" Exhibiting incredible dynamic behaviors (2007, Boston Dynamics)

Modern Robotics & Applications

Increased Perception & Autonomy & HRI *(since the 90's)*

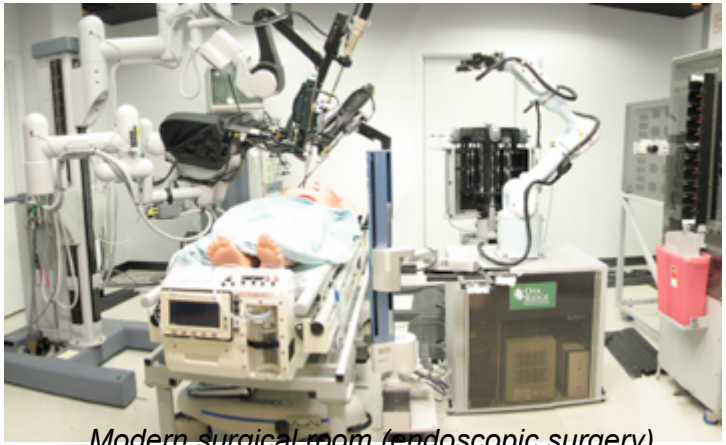
Health care, Surgery, Rehabilitation & Assistance

Service Robots & Entertainment

Intelligent Vehicles & ITS

➔ ***Surgery: A Technological Revolution in the two last decades … but still a niche market***

➔ ***An emerging future market for Assistance & Rehabilitation*** *(Silver Economy)*



Modern surgical room (endoscopic surgery)

Robotized Walking Aid

Modern Robotics & Applications

Increased Perception & Autonomy & HRI *(since the 90's)*

Health care, Surgery, Rehabilitation & Assistance

Service Robots & Entertainment

Intelligent Vehicles & ITS

And other various applications:

- Radiotherapy
- Exoskeleton
- Prosthetic arms, hands, legs
- …

Robotized Radiotherapy

Modern Robotics & Applications

Increased Perception & Autonomy & HRI *(since the 90's)*

Health care, Surgery, Rehabilitation & Assistance	**Service Robots & Entertainment**	Intelligent Vehicles & ITS

➔ ***Some commercial successes in the past decade***
➔ ***Still an emerging & promising market***

Vacuum Cleaner Roomba
(iRobot, 1st version: 2002)

Personal Assistant – Kompaï
(Robosoft)

Humanoid Robot Nao
(Aldebaran)

Modern Robotics & Applications

Increased Perception & Autonomy & HRI *(since the 90's)*

Health care, Surgery, Rehabilitation & Assistance

Service Robots & Entertainment

Intelligent Vehicles & ITS

➔ ***Important technological developments since the 90's***

➔ ***Some commercial products***

➔ ***Emerging & Wide future market***

Sustainable Mobility
=> People Movers

Next Car Generation
=> ADAS & Driverless Cars

Parkshuttle - Schiphol Airport (1997)

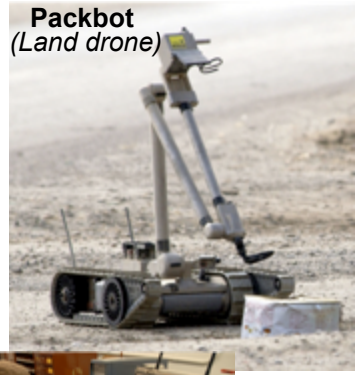
Toyota Prius modified by Google to operate as a driverless car (2011)

Merging of Robotics & Tele-Robotics

Share control & Tele-presence (Human user in the loop)

- *Increased use of Sensors feedback & Automated sub-Tasks*
- *Introduction of Virtual Reality functionalities for Tele-presence & Communication delays*

Packbot
(Land drone)



Light Control station

Military & Civil drones

Predator
(Aerial drone)

Control station (in a truck)

Parrot Aerial Drone

Tele-surgery

Da Vinci robot in Surgical Room

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