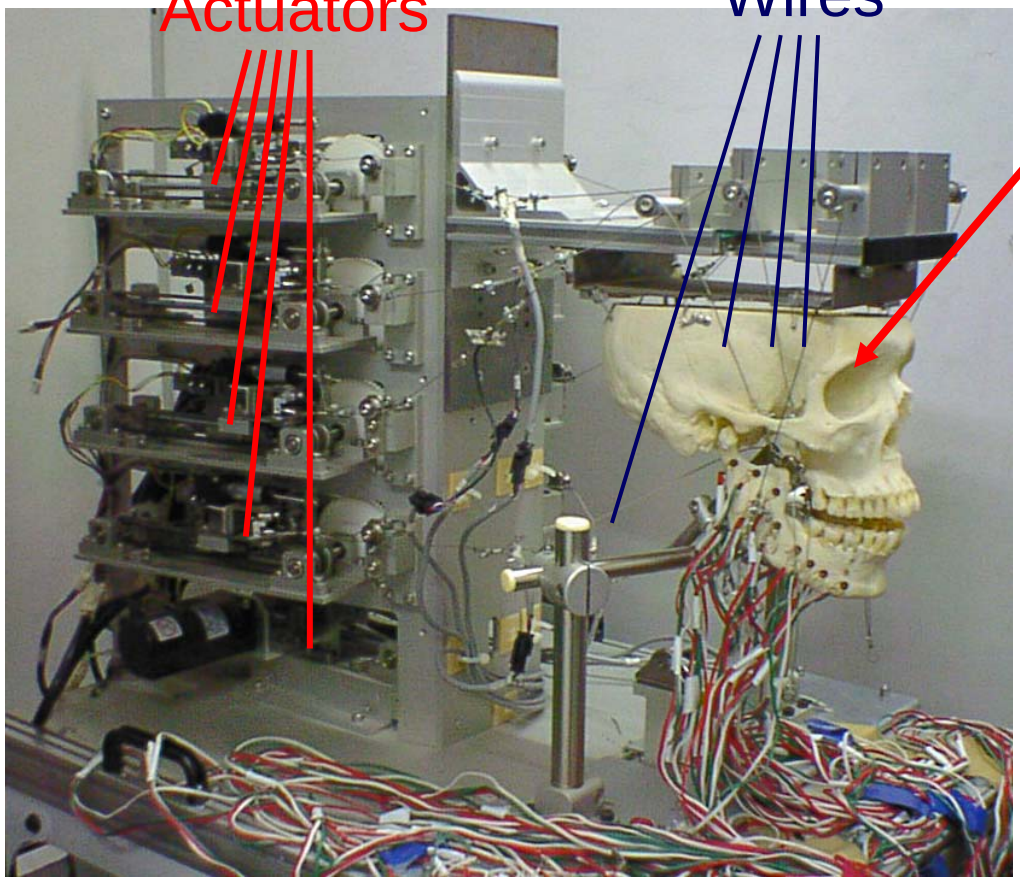
Dental Robotics: Clarify Human Mastication with Mastication Scientists

WASEDA UNIV. HRI

Artificial Muscle Actuators

Tendon Driving Wires



Real Human Dry Skull

Height : 510 [mm]
Width : 450 [mm]
Depth : 600 [mm]

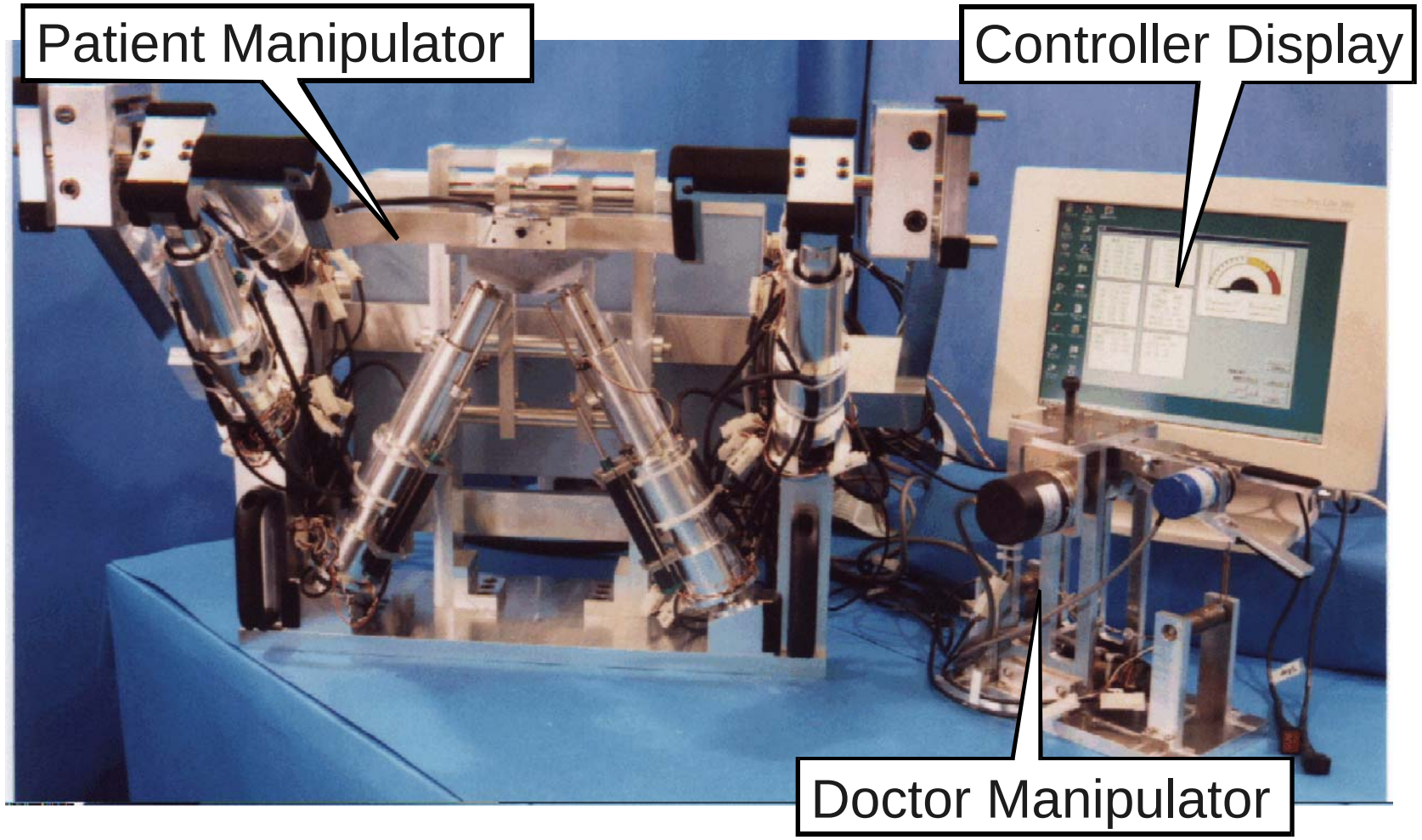
9 DOF

-9 AC Servo Motors
-Wire Drive
-Nonlinear Viscoelasticity

With OKINO Industries

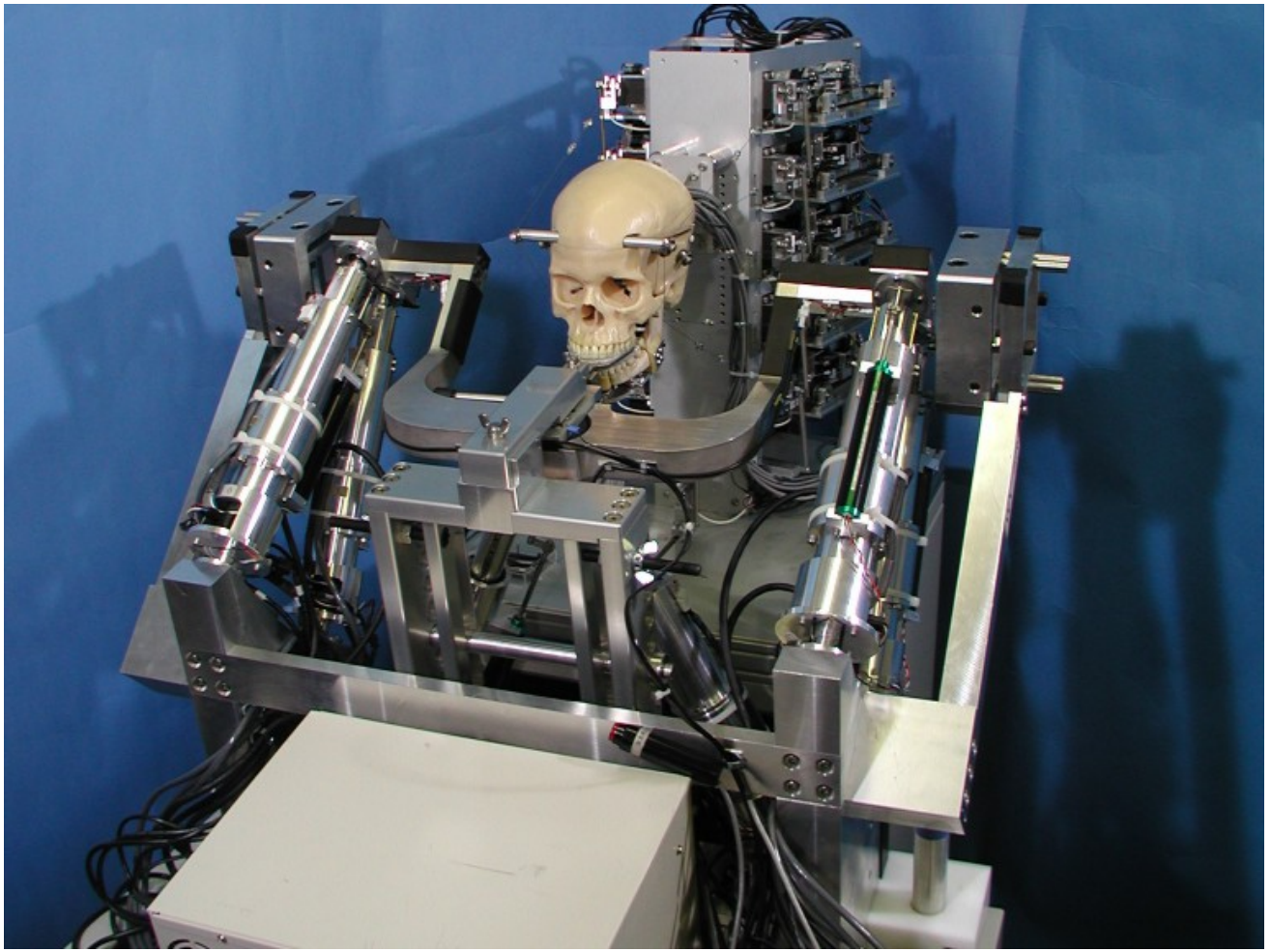
Jaw Training Robot for TMD Patients Designed using Human Mastication Model

WASEDA UNIV. HRI

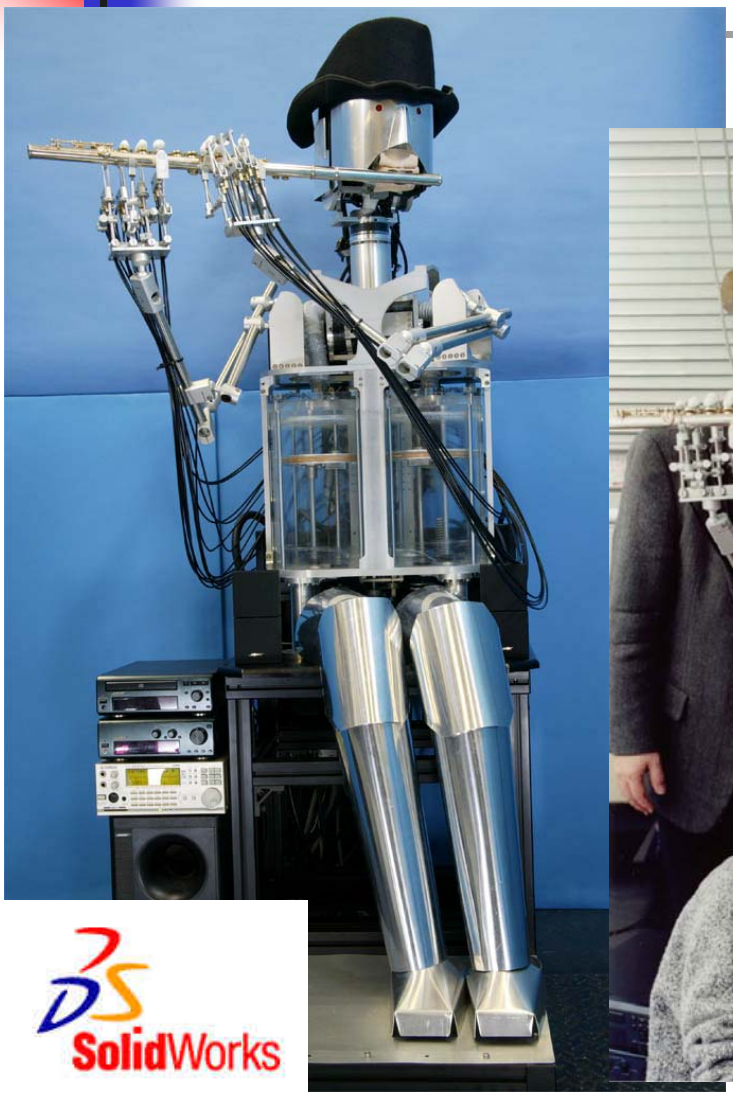


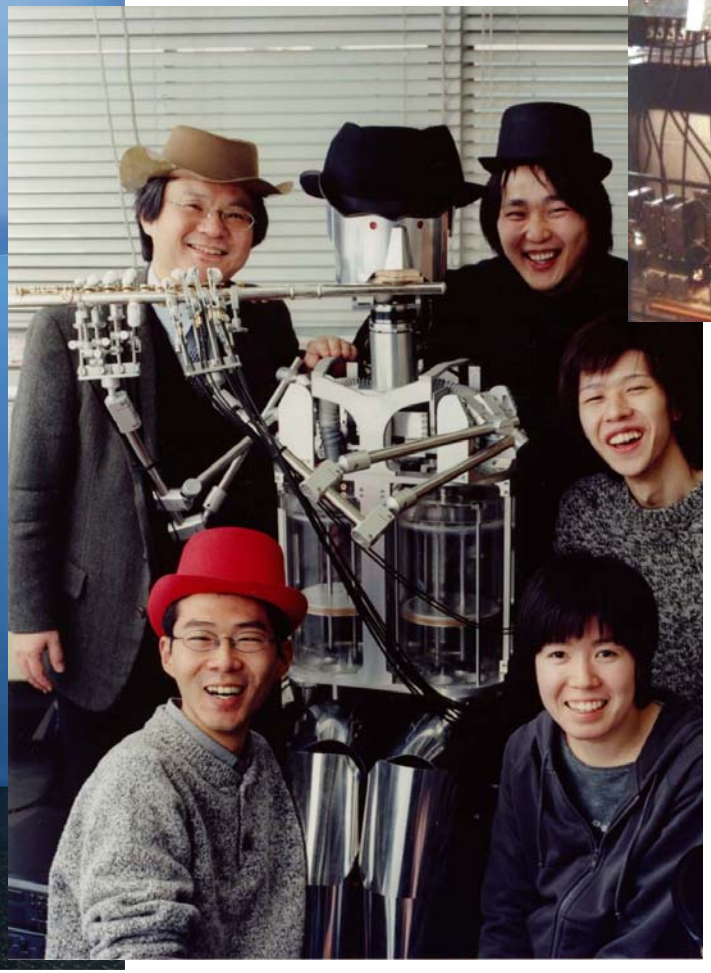
Jaw Training Robot and Patient Simulator Robot for Exploring New Robotic Treatment Methodology

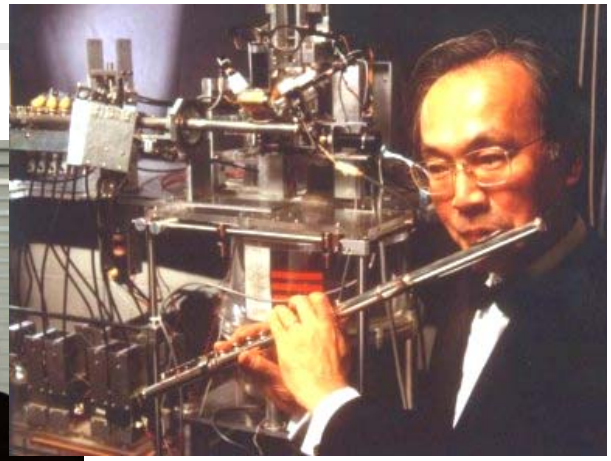
WASEDA UNIV.
HRI



Flutist Robot for Simulating Human Flute Playing:WF-4







Professional Flutist: Mr. Kunimitsu Wakamatsu

GIFU-WASEDA WABOT-HOUSE Project

Modeling of Human Speech Production Using Talking Robots: WT-3/4

WASEDA UNIV.
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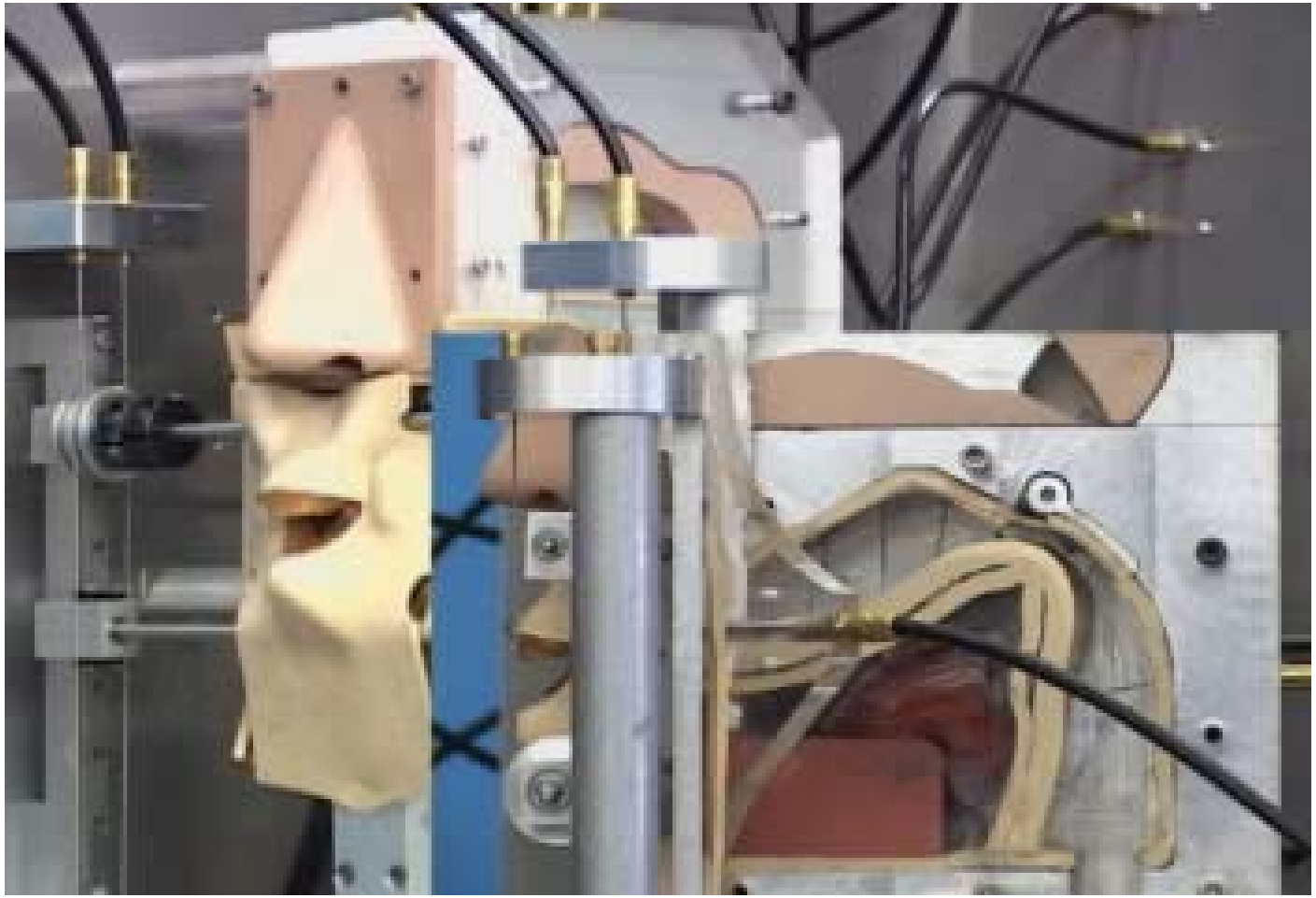
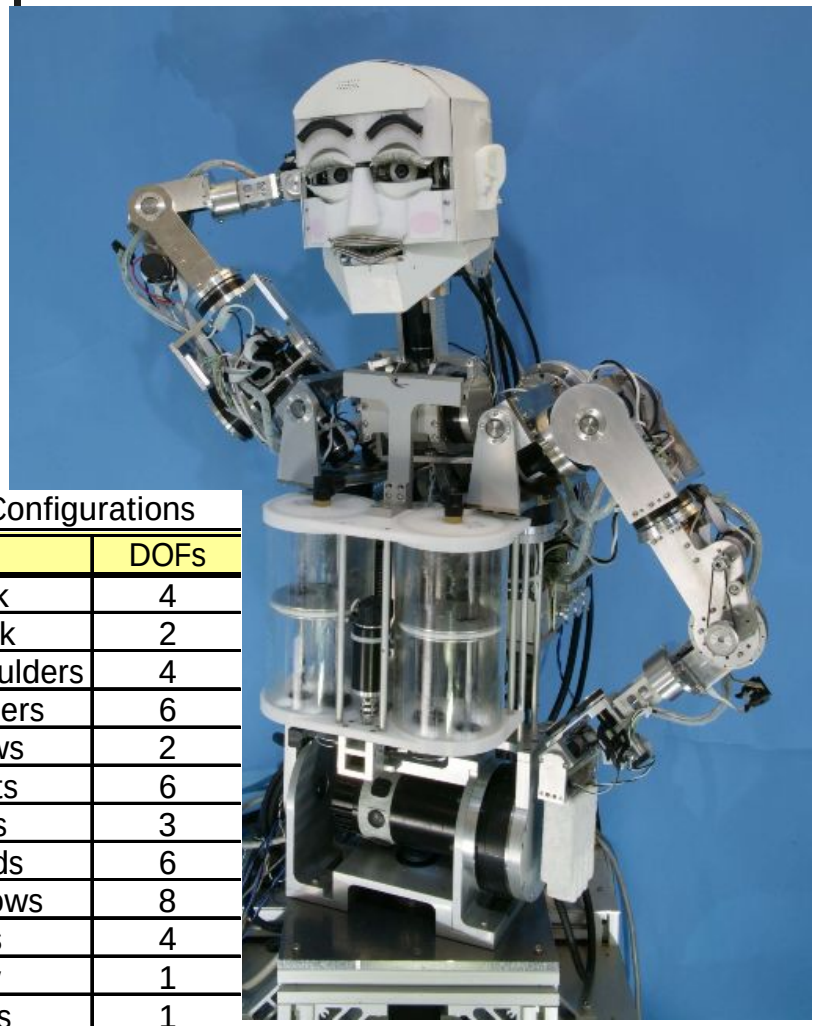
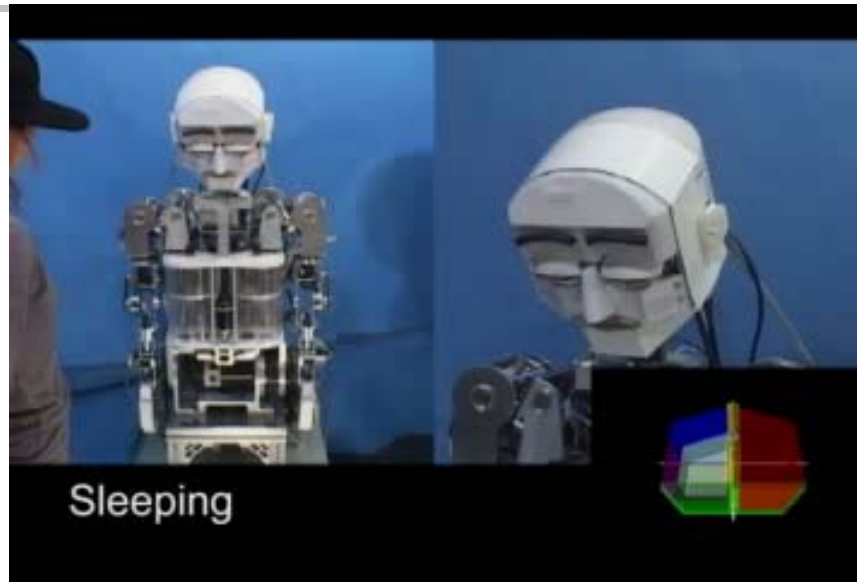


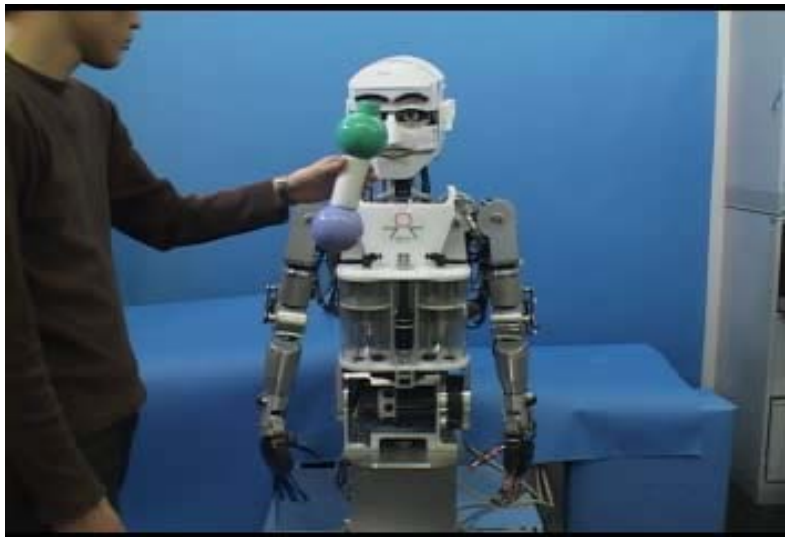
Waseda Daigaku (Waseda University)

Emotion Expression Humanoid **EYE-Chan**: WE-4R for Modeling Human Mind

WASEDA UNIV. HRI







DOFs Configurations	
Part	DOFs
Neck	4
Trunk	2
Base Shoulders	4
Shoulders	6
Elbows	2
Wrists	6
Eyes	3
Eyelids	6
Eyebrows	8
Lids	4
Jaw	1
Lungs	1
Total	47

SANT'ANNA WASEDA
PARTNERSHIP

ROBOCASA
HUMANOID & PERSONAL ROBOTICS
ロボ・カーサ
ヒューマノイド＆パーソナル ロボティクス

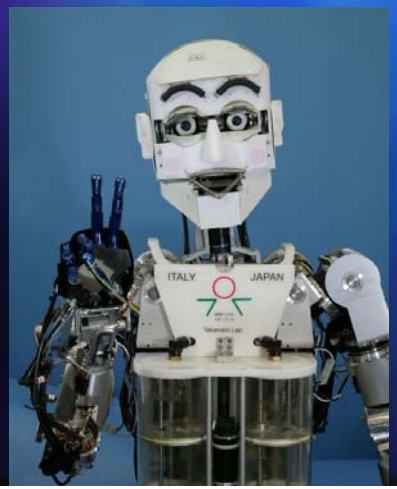
Con il contributo del Ministero degli Affari Esteri, Direzione Generale per la Promozione e la Cooperazione Culturale

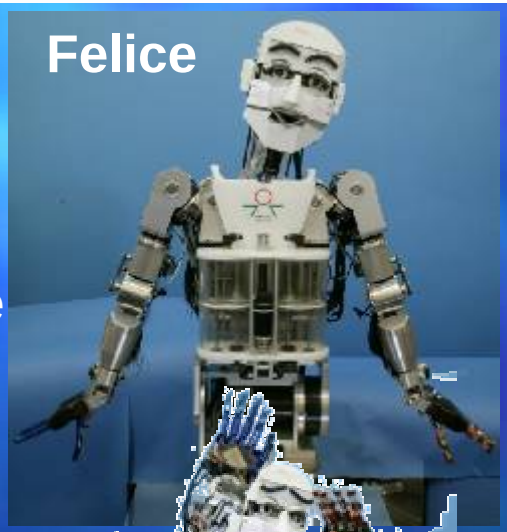
With the support of the Italian Ministry of Foreign Affairs, General Directorate for Culturale Promotion and Cooperation

本連携は、イタリア外務省文化交流振興局の支援による研究、振興、産業応用事業です

Un laboratorio congiunto per la ricerca in Robotica Umanoide & Personale
A joint laboratory for research on Humanoid & Personal Robotics
ヒューマノイド国際共同研究室

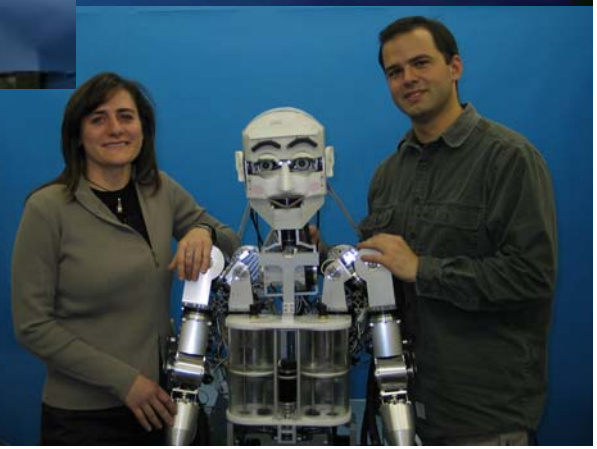
Robot come strumenti per studiare l'interazione uomo-robot





RoboCasa Tokyo

Robot come strumenti per le neuroscienze



Robot-An, Laboratorio congiunto italo-giapponese

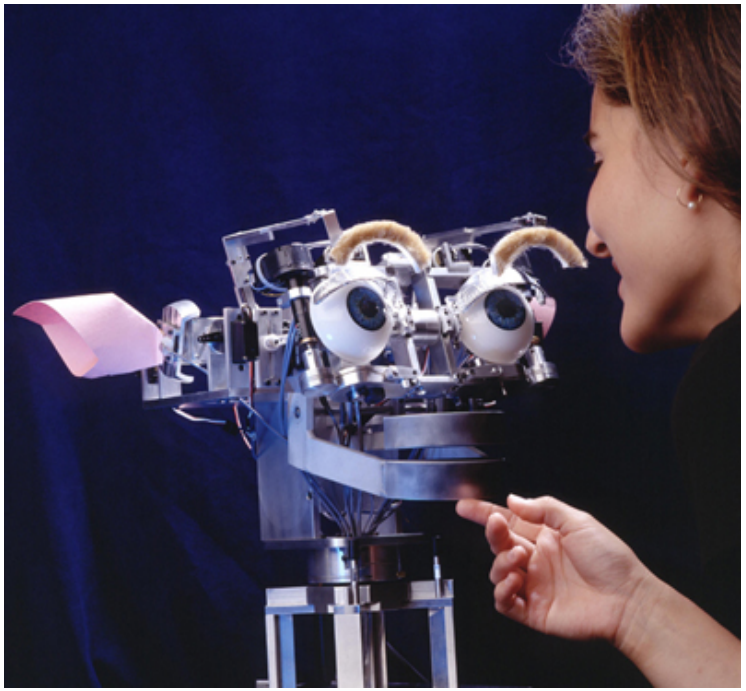
Inaugurazione ufficiale di RoboHan, Laboratorio congiunto italo-giapponese, Pisa, Febbraio 2006

Un robot gemello del **Wabian2** viene sviluppato a Robot-An

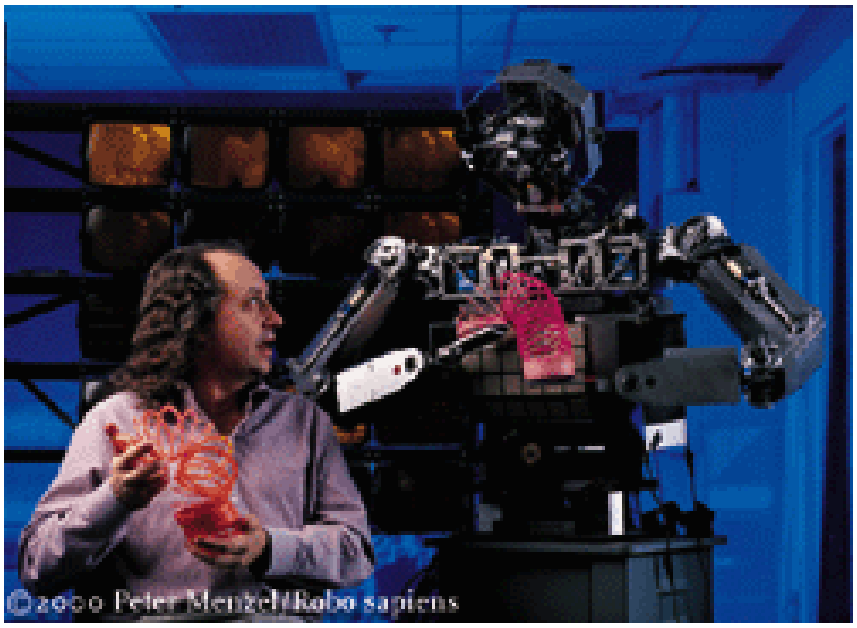
COG and Kismet, MIT

- *Human-like intelligence cannot be developed without a human-like body*

Prof. Rodney Brooks, MIT

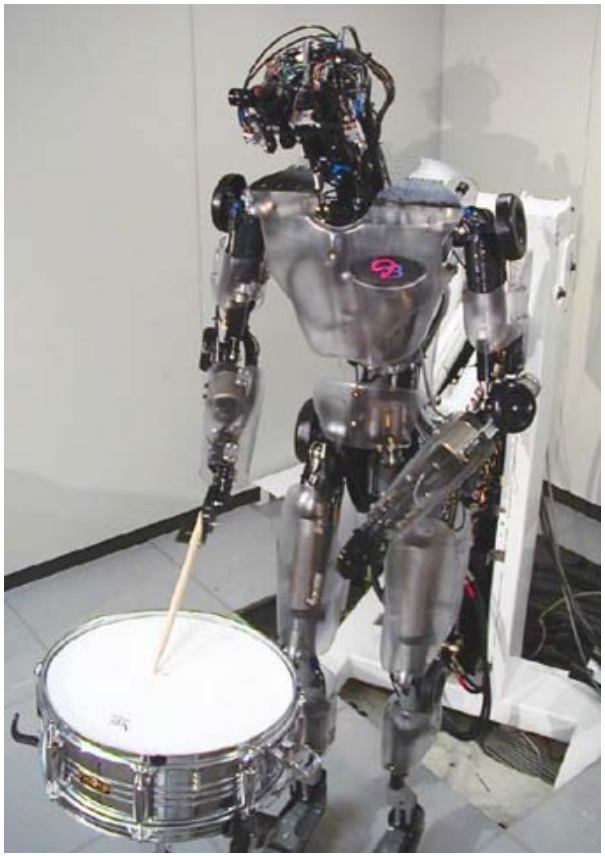


Kismet: a sociable humanoid



COG (Cognitive Robot)

Neuro-Robotic research at the Human Information Science Lab, ATR, Japan



Computational Neuroscience Project
Prof. Mitsuo Kawato

to understand brain mechanisms, including vision and motor systems, which support the adaptive behaviour of humans by adopting a “Computational approach”, i.e. developing an artificial brain in order to understand the brain

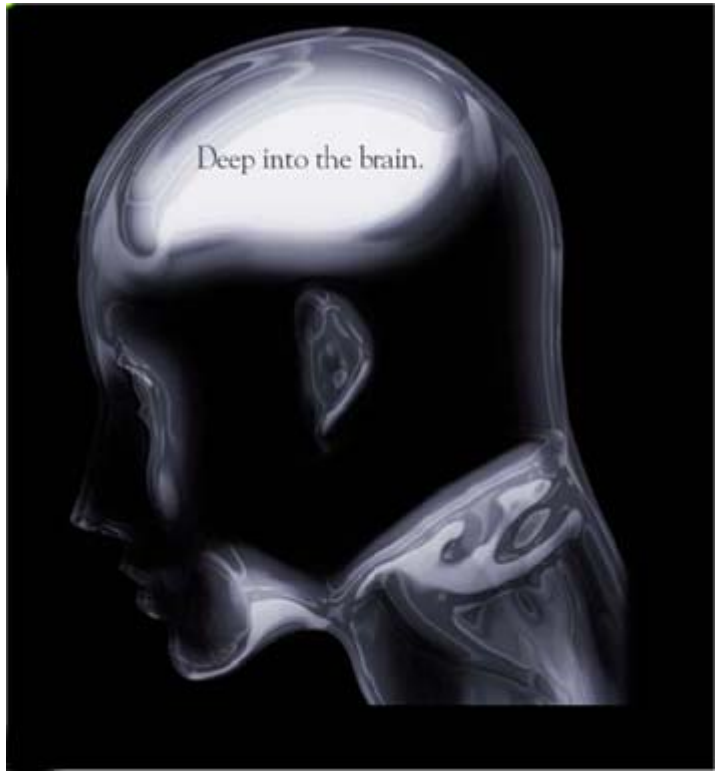
Neuro-Robotic research at the AI Lab, Department of Information Technology, University of Zürich, Switzerland

to understand natural forms of intelligence (humans, animals) by designing and build intelligent systems (computer programs, robots, other artefacts)

"Understanding by building" approach

- modelling aspects of a biological system,
- abstracting and exploring general principles of intelligence,
- using these principles in the design of artefacts.

Neuro-Robotic research at the RIKEN Brain Science Institute, Japan



Research Groups and Laboratories

Understanding the Brain

- Neuronal Function Research Group
- Neuronal Circuit Mechanisms Research Group
- Cognitive Brain Science Group
- RIKEN-MIT Neuroscience Research Center

Protecting the Brain

- Developmental Brain Science Group
- Molecular Neuropathology Group
- Aging and Phychiatric Research Group
- Recovery Mechanisms Research Group

Creating the Brain

- Brainway Group
- Brain-Style Inteligence Research Group
- Brain-Style Information Systems Research Group

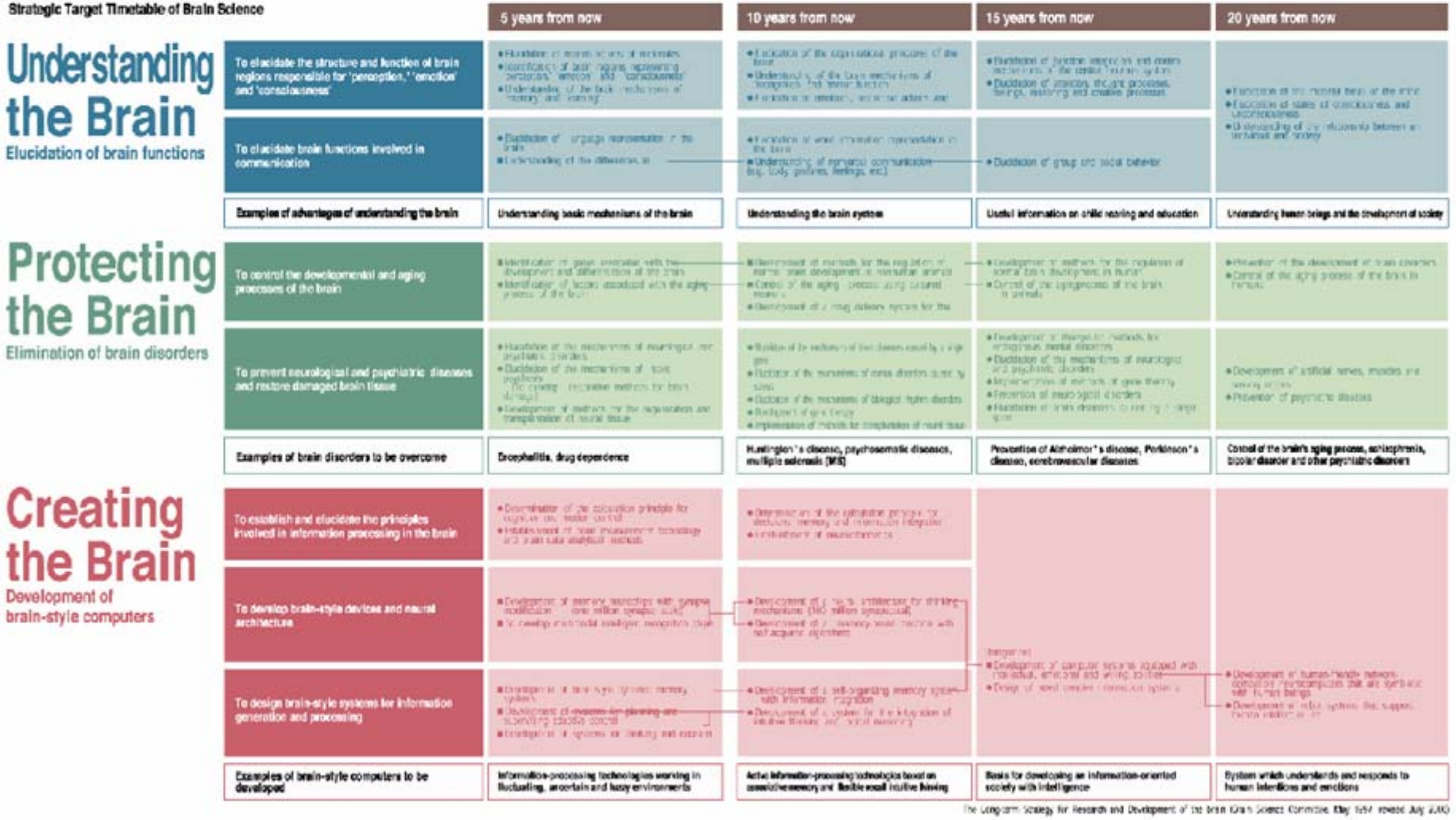
Brain Science Institute
Strategic target timetable

前進

Striding Forward

A Strategic Target Timetable developed for the areas of "Understanding the Brain," "Protecting the Brain" and "Creating the Brain."

Research programs aimed at achieving specific goals, together with the scientific knowledge accumulated to date allow us to forecast the next 20 years of scientific research. During this period, science will present many research findings that can be formulated into strategic objectives in the three main branches of "Understanding the Brain," "Protecting the Brain" and "Creating the Brain."



http://www.brain.riken.go.jp/res-outline/image/timetable.gif

Brain Science Institute
Strategic target timetable

Understanding the Brain

Elucidation of brain functions

	5 years from now	10 years from now	15 years from now	20 years from now
To elucidate the structure and function of brain regions responsible for 'perception,' 'emotion' and 'consciousness'	● Elucidation of neurofunctions of molecules ● Identification of brain regions representing 'perception,' 'emotion', and 'consciousness' ● Understanding of the brain mechanisms of 'memory' and 'learning'	● Elucidation of the organizational principles of the brain ● Understanding of the brain mechanisms of 'recognition' and 'motor function' ● Elucidation of emotions, instinctive actions and	● Elucidation of function integration and control mechanisms of the central nervous system ● Elucidation of attention, thought processes, feelings, reasoning and creative processes	● Elucidation of the material basis of the mind ● Elucidation of states of consciousness and unconsciousness ● Understanding of the relationship between an individual and society
To elucidate brain functions involved in communication	● Elucidation of language representation in the brain ■ Understanding of the differences in	● Elucidation of word information representation in the brain ■ Understanding of nonverbal communication (e.g. body gestures, feelings, etc.)	● Elucidation of group and social behavior	
Examples of advantages of understanding the brain	Understanding basic mechanisms of the brain	Understanding the brain system	Useful information on child rearing and education	Understanding human beings and the development of society

Brain Science Institute
Strategic target timetable

Protecting the Brain

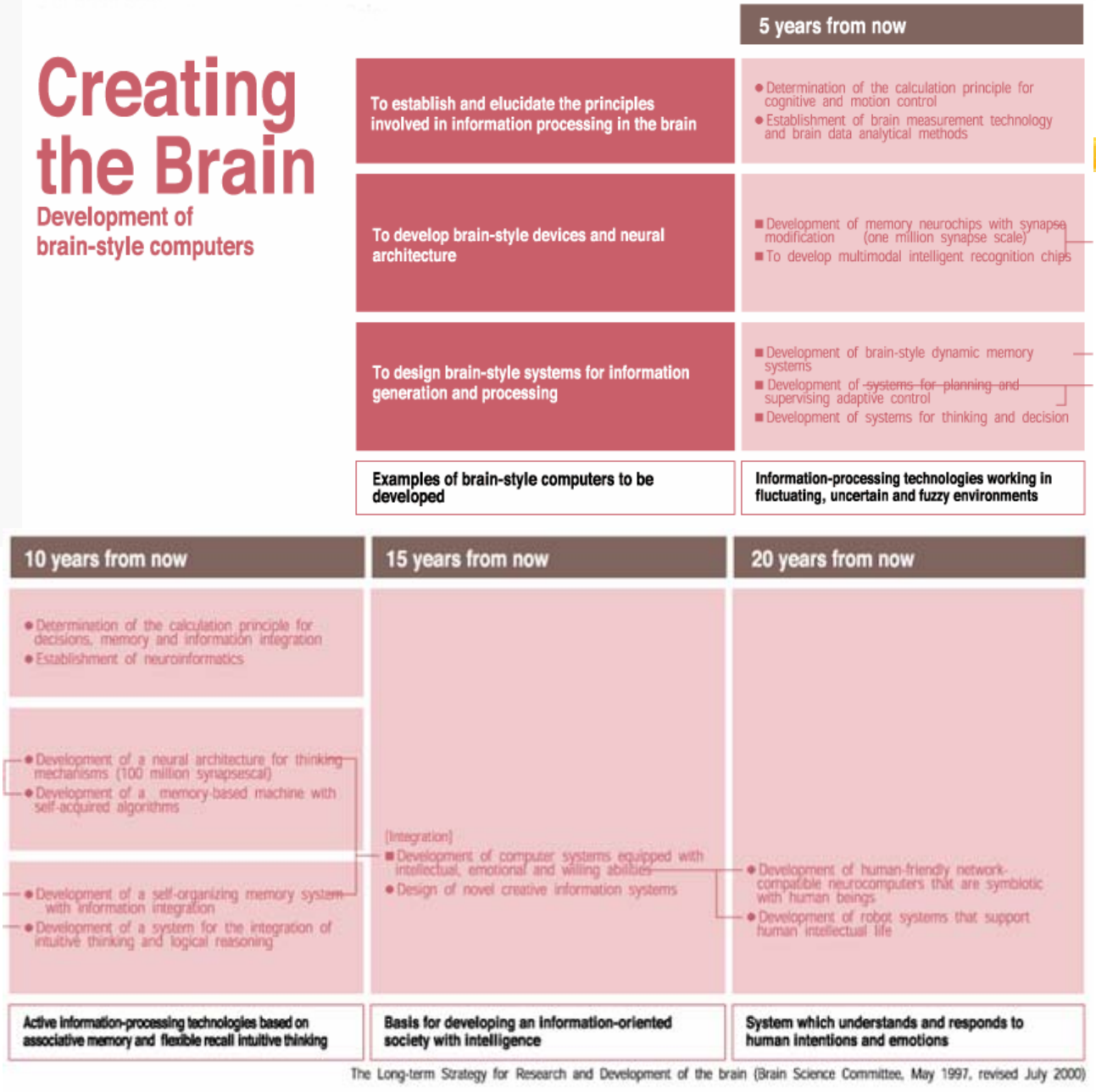
Elimination of brain disorders

	5 years from now	10 years from now	15 years from now	20 years from now
To control the developmental and aging processes of the brain	■ Identification of genes associated with the development and differentiation of the brain ■ Identification of factors associated with the aging process of the brain	■ Development of methods for the regulation of normal brain development in nonhuman animals ■ Control of the aging process using cultured neurons ● Development of a drug delivery system for the	● Development of methods for the regulation of normal brain development in human ■ Control of the agingprocess of the brain in animals	● Prevention of the development of brain disorders ● Control of the aging process of the brain in humans
To prevent neurological and psychiatric diseases and restore damaged brain tissue	● Elucidation of the mechanisms of neurological and psychiatric disorders ● Elucidation of the mechanisms of toxic psychosis [To develop restorative methods for brain damage] ● Development of methods for the regeneration and transplantation of neural tissue	● Elucidation of the mechanisms of brain disorders caused by a single gene ● Elucidation of the mechanisms of mental disorders caused by stress ● Elucidation of the mechanisms of biological rhythm disorders ● Development of gene therapy ● Implementation of methods for transplantation of neural tissue	● Development of therapeutic methods for endogenous mental disorders ● Elucidation of the mechanisms of neurological and psychiatric disorders ● Implementation of methods of gene therapy ● Prevention of neurological disorders ● Elucidation of brain disorders caused by a single gene	● Development of artificial nerves, muscles and sensory organs ● Prevention of psychiatric diseases
Examples of brain disorders to be overcome	**Encephalitis, drug dependence**	**Huntington's disease, psychosomatic diseases, multiple sclerosis (MS)**	**Prevention of Alzheimer's disease, Parkinson's disease, cerebrovascular diseases**	**Control of the brain's aging process, schizophrenia, bipolar disorder and other psychiatric disorders**

Brain Science Institute
Strategic target timetable

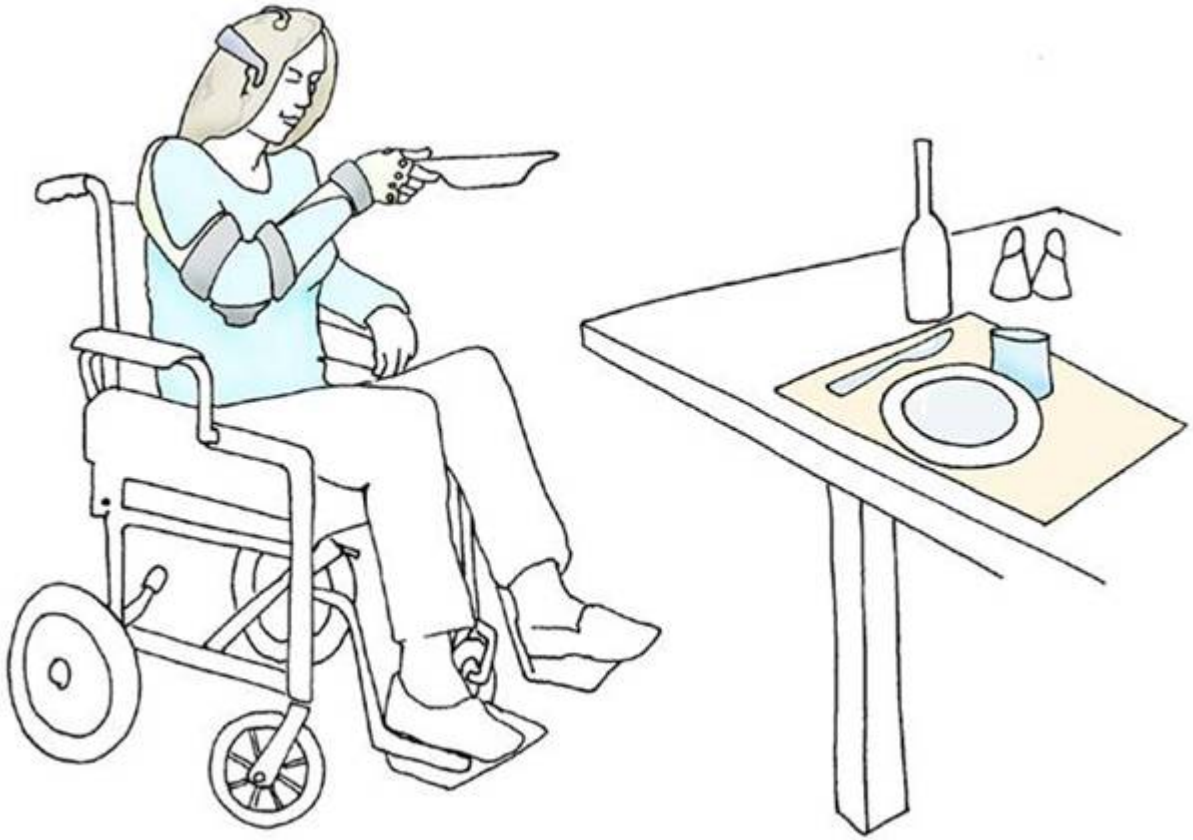
Creating the Brain

Development of brain-style computers



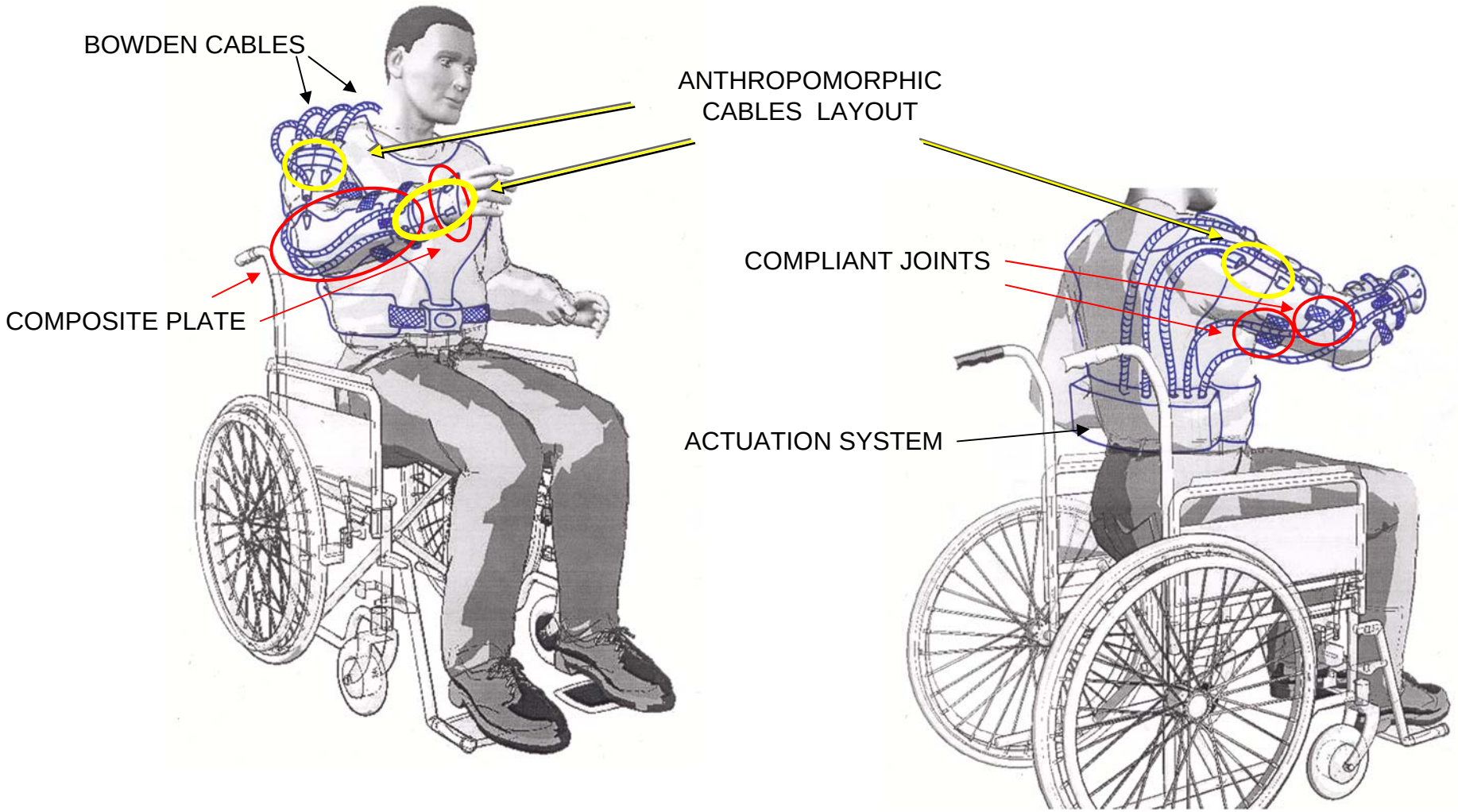
The Long-term Strategy for Research and Development of the brain (Brain Science Committee, May 1997, revised July 2000)

Bionica scenario ‘Beyond ortheses’



Recover the sensory-motor manipulation capabilities of a disabled person’s arm

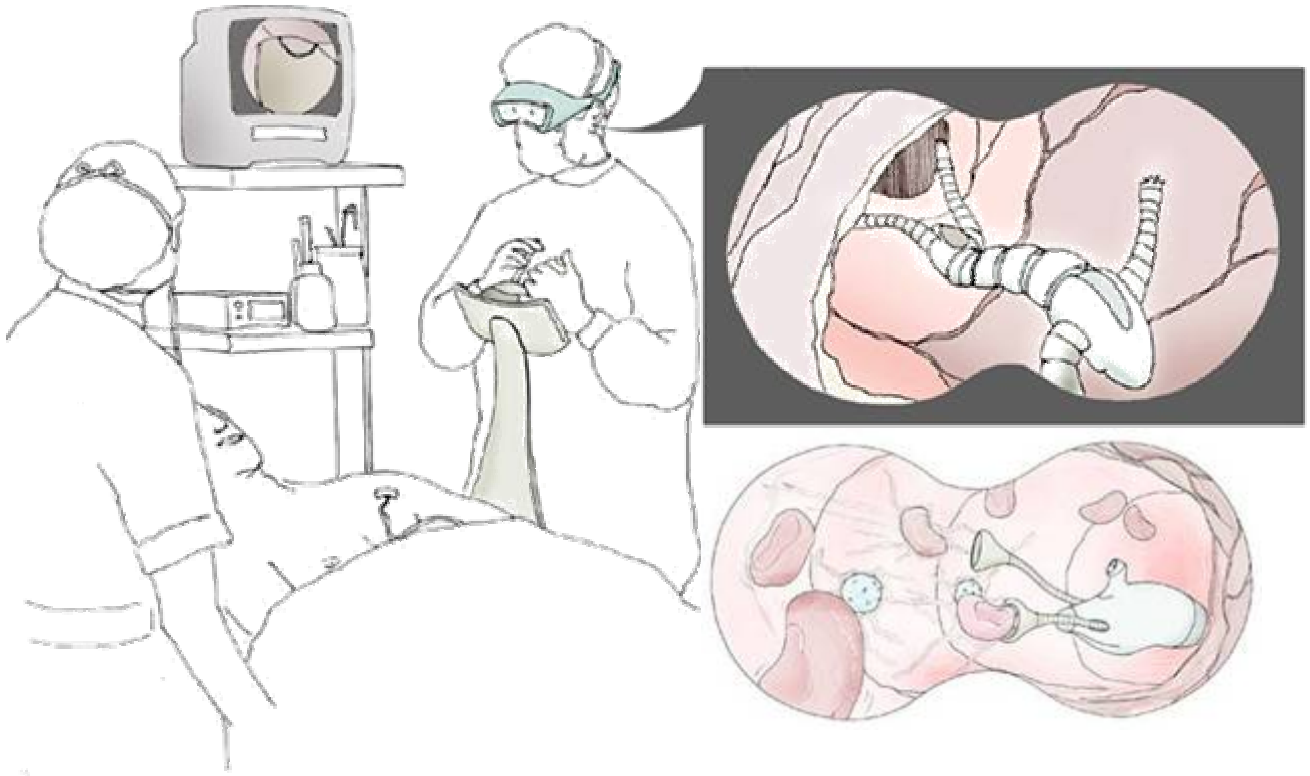
POWERSUITE under development by SSSA in the NEUROBOTICS Project



Bionica scenario ‘Beyond prostheses’

Additional arm/hand systems

Bionica scenario ‘Beyond teleoperation’



Explorations inside the human body, with full sensory feed-back

The NEUROBOTICS IP Project (Duration: 5 years)

The fusion of NEUROscience and RoBOTICS for augmenting human capabilities

Participants

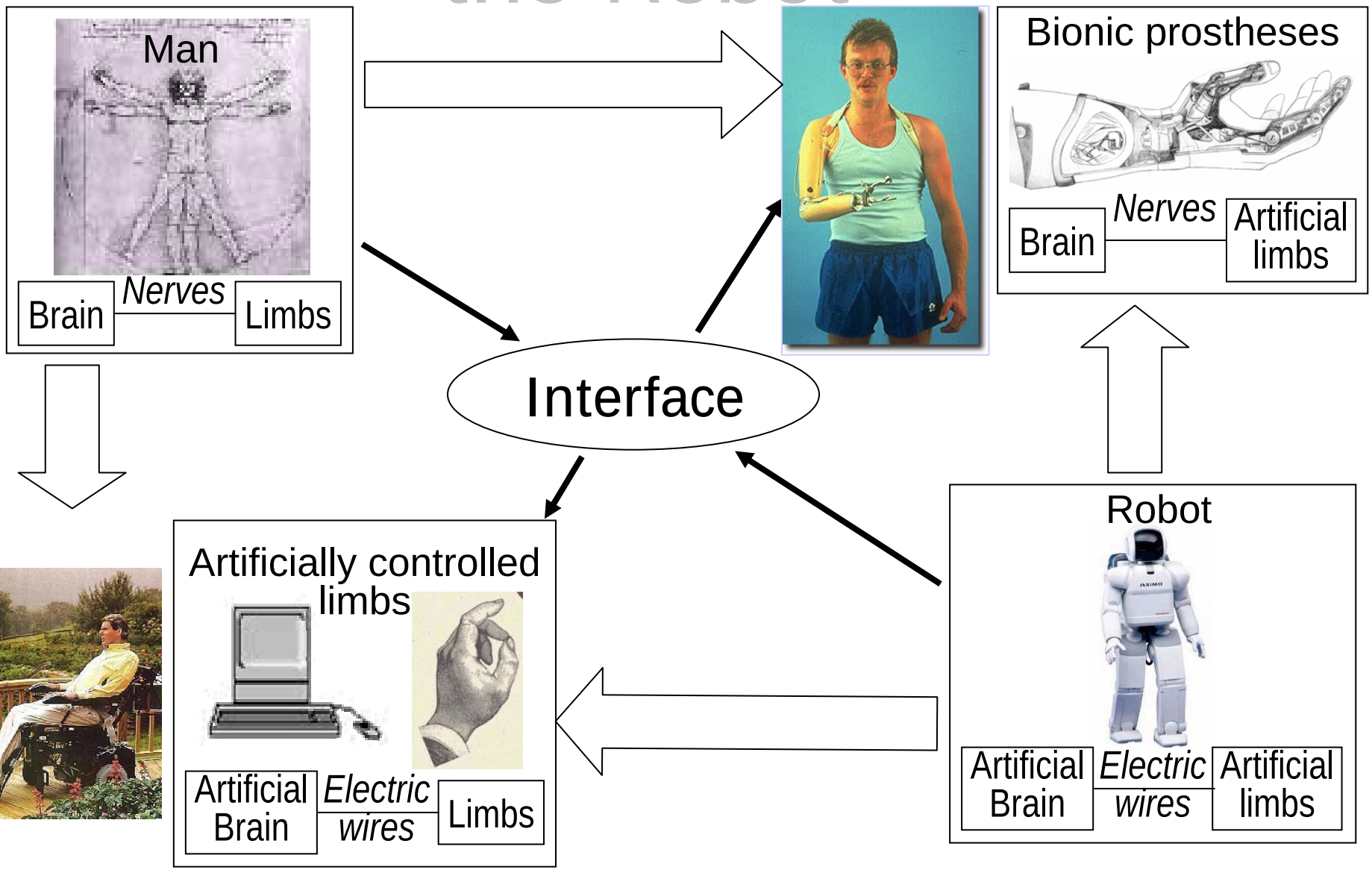
1. SSSA: Scuola Superiore Sant'Anna, Pisa, Italy (prof. Paolo Dario) – Project Coordinator

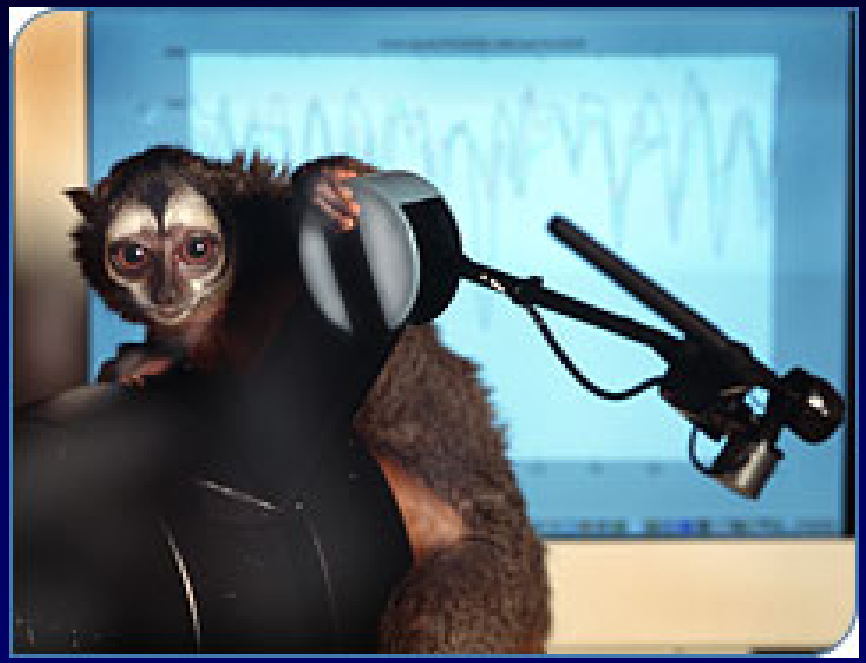
2. CDF: Collège de France, CNRS, Paris, France (prof. Alain Berthoz)
3. DLR: Deutsches Zentrum fur Luft und Raumfahrt, Oberpfaffenhofen, Germany (prof. Gerd Hirzinger)
4. IBMT: Fraunhofer Institute for Biomedical Engineering, St. Ingbert, Germany (Dr. Thomas Stieglitz)
5. KI: Karolinska Institutet, Stockholm, Sweden (prof. Sten Grillner)
6. KUL: KU Leuven, Belgium (prof. Guy Orban)
7. KTH: Kungl Tekniska Högskolan, Stockholm, Sweden (prof. Henrik Christensen)
8. NTUA: National Technical University of Athens, Greece (prof. Kostas Kyriakopoulos)
9. UMEA: Umea Universitet, Sweden (prof. Roland Johansson)
10. UAB: Universitat Autònoma de Barcelona, Spain (prof. Xavier Navarro)
11. UGDIST: University of Genova, Italy (prof. Giulio Sandini)
12. UNIPR: University of Parma, Italy (prof. Giacomo Rizzolatti)
13. UPMC: Université P. et M. Curie / INSERM U483, Paris, France (prof. Yves Burnod)

International Partners:

Brown University, Providence, RI, USA (Prof. John Donoghue)
Waseda University, Tokyo, Japan (Prof. Atsuo Takanishi)

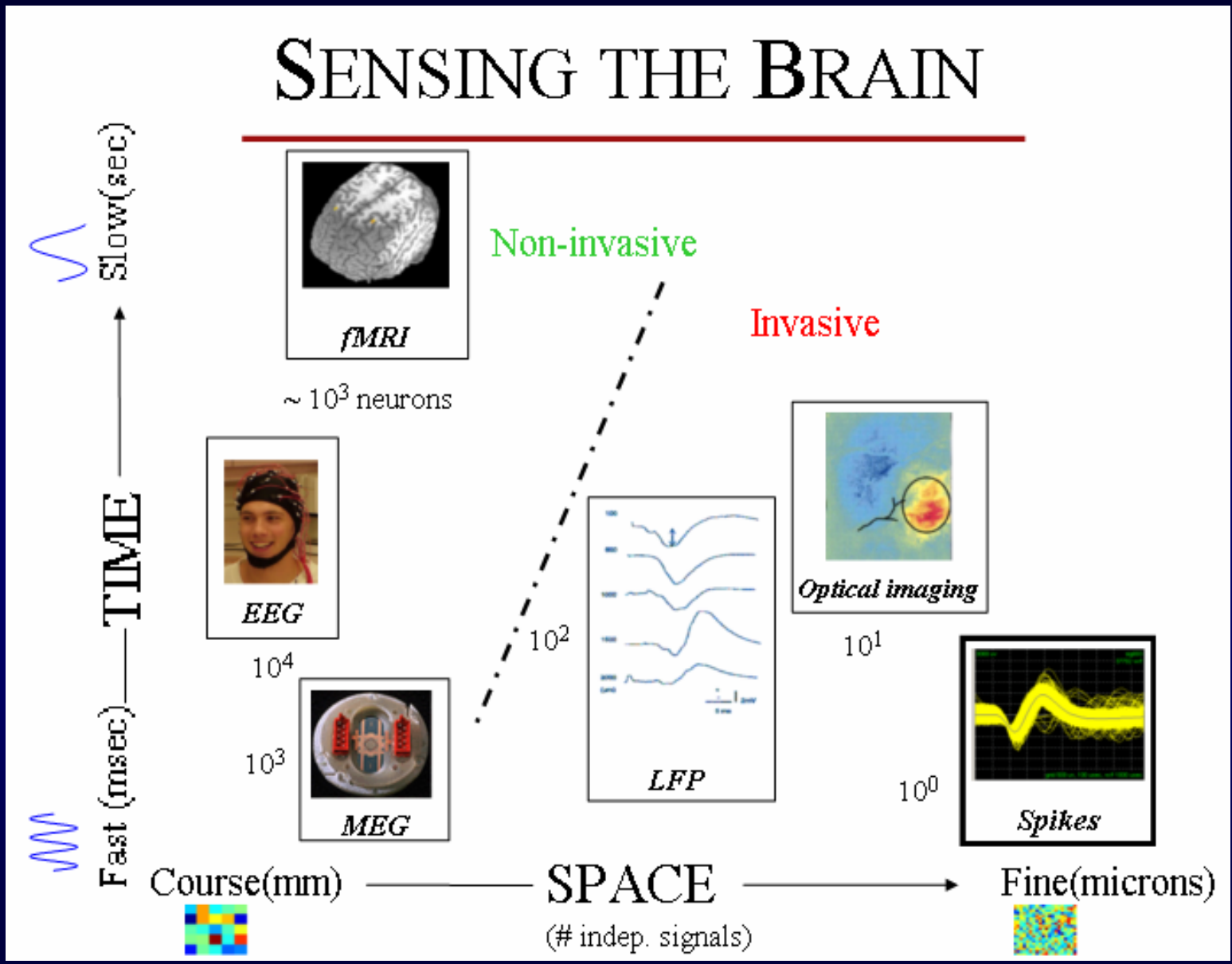
“Connecting” the Man and the Robot





"Brain to Computer Interface is one of the 10 Emerging Technologies that will change the world"

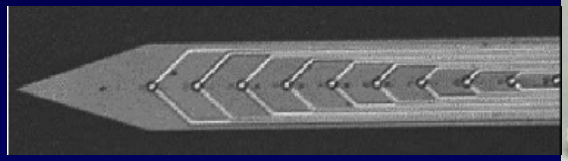
***Technology Review*, January/February, 2001**



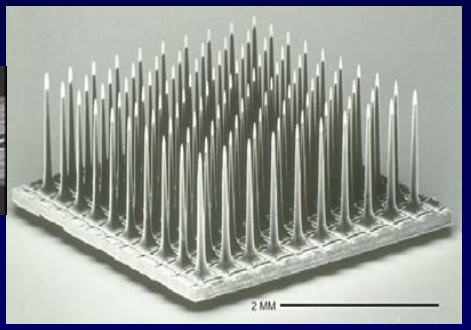
Sensing technologies that can be used to observe neural activity, divided by non-invasive vs. invasive, spatial and temporal resolution.

Brain Computer Interfaces

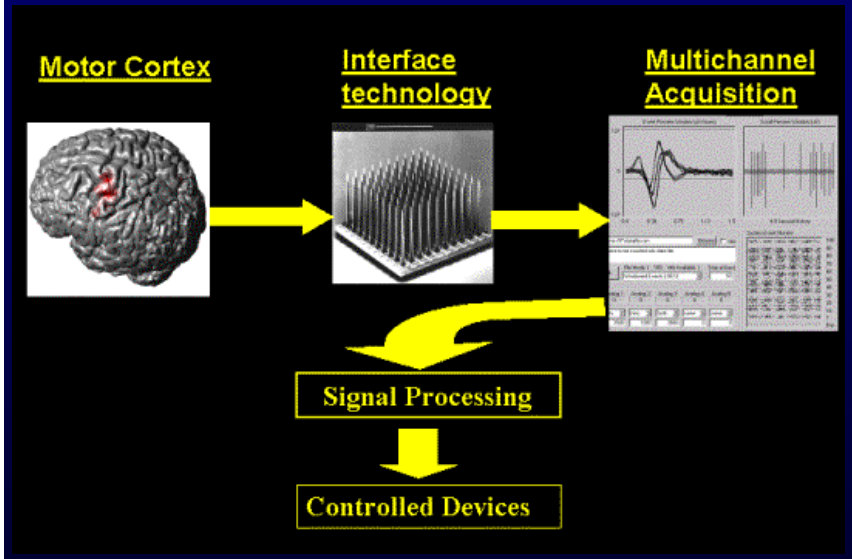
Develop new neural implant technologies to establish *reliable* ,*high-capacity* ,and *long-term* information channels between the brain and external world.

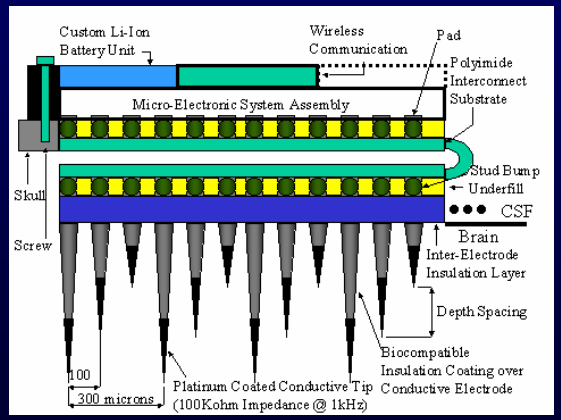


IBMT, Germany, Sensors and Actuators, 2002

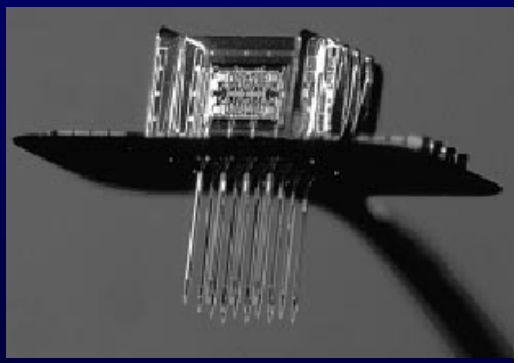


Utah Electrode Array, Bionic Technologies





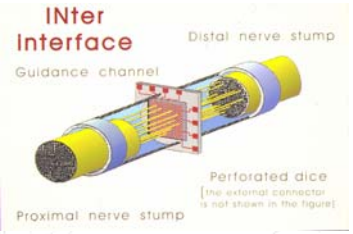
MIT Bioinstrum. Lab



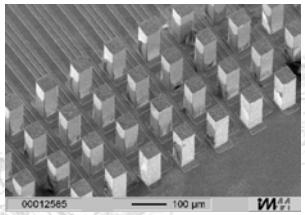
Bai and Wise, IEEE Trans Biomed Eng 2001

Interfaces with the PNS

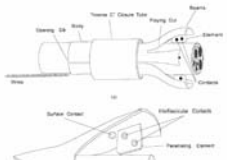
Sieve



Multi-needle



Intraneural



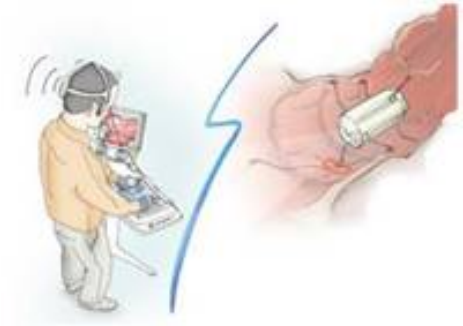
Cuff

Selectivity

Invasivity

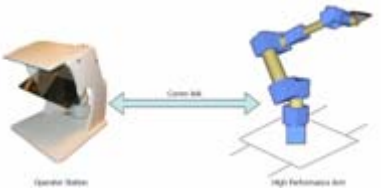
In order to control many DoFs and to deliver a sensory feedback a good selectivity is crucial

From concepts to real NEUROBOTICS platforms



Telepresence

Teleoperated catching



Goalkeeper

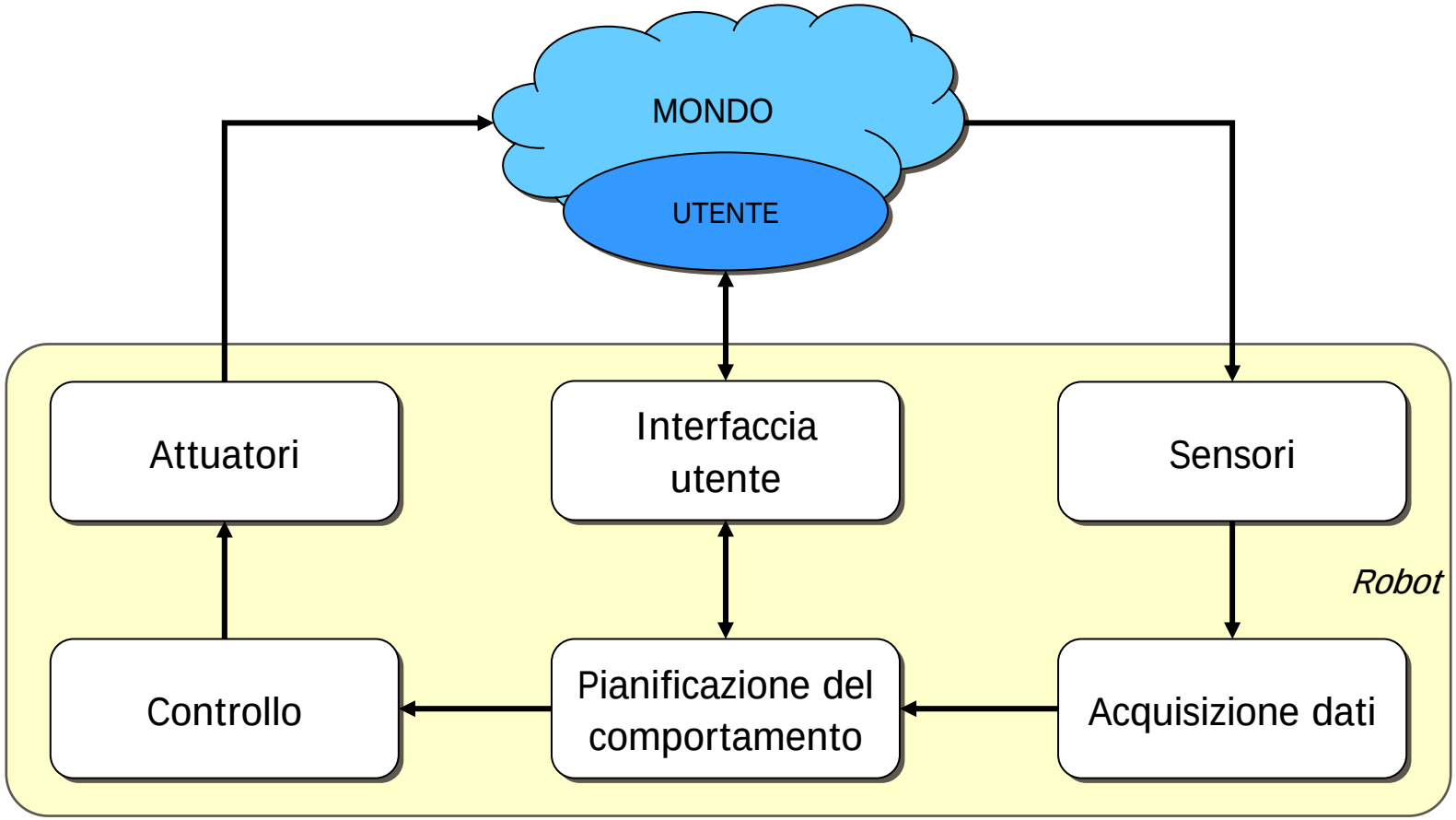
NEUROExos

EMG-controlled prosthesis

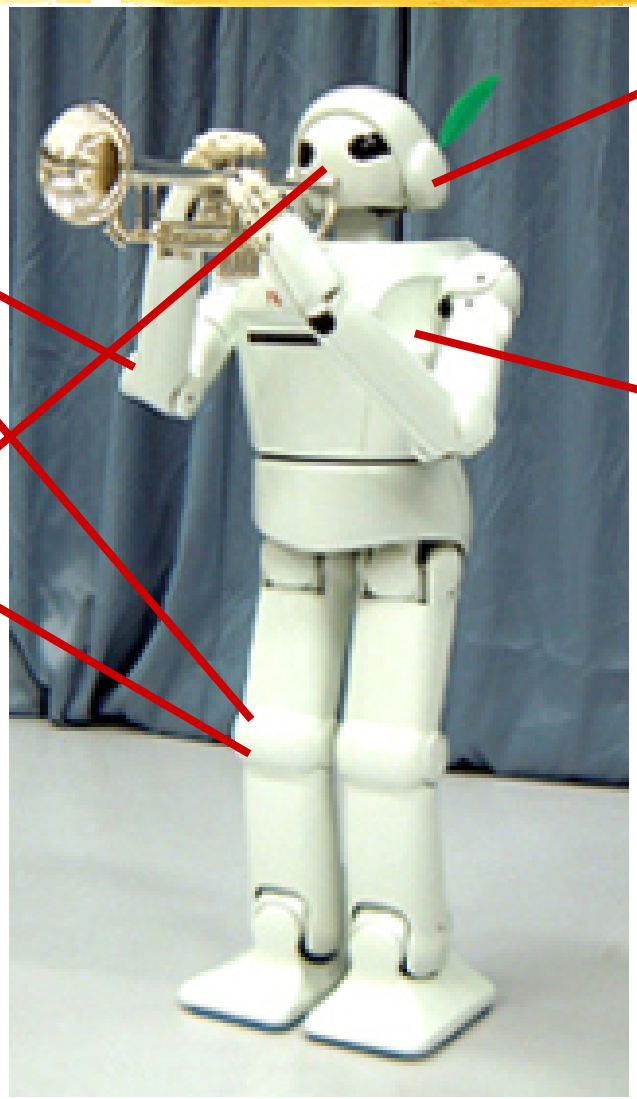
Third arm

Cybernetic prosthesis

Schema tipico di un sistema robotico



Componenti fondamentali di un sistema robotico



Interfaccia utente

Attuatori

Pianificazione del comportamento

Sensori

Componenti fondamentali di un sistema robotico