

# Ethics by Design

A Conceptual Approach to Personal and Service Robot Systems

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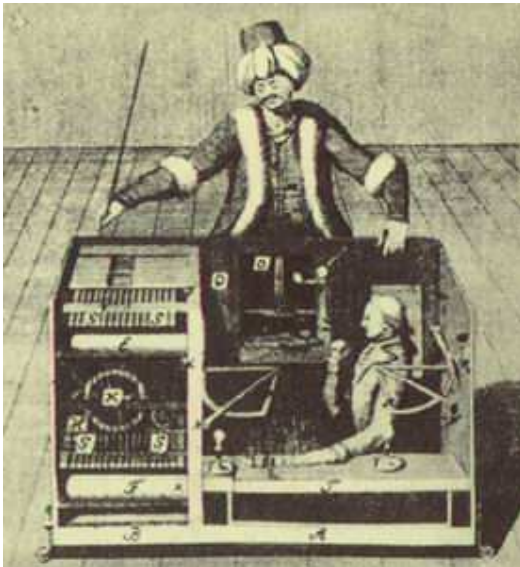
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# Design of Robots through History

- ◆ **The Vision of Design**
  - ◆ Deceptive automata of the past
  - ◆ Fictional humanoids of the present
  - ◆ Assistive robots of the future



Von Kempelen's  
Chess-playing Robot, 1770



I, Robot,  
20th Century Fox, 2004



Wakamaru, Mitsubishi  
Heavy Industries, 2005



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# Design of Robots through History

- ◆ Real humanoid robots are changing the equation
  - ◆ Focus on basic functionality
  - ◆ Explore human-robot interface issues
  - ◆ Embody a transparency of action

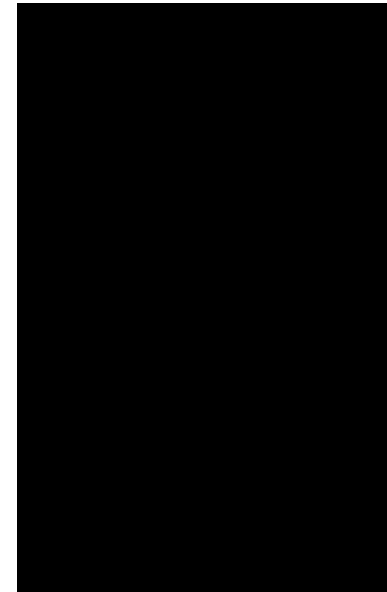


**Karakuri Tea-serving Robot, 1700s**

The word 'Karakuri' means a "mechanical device to tease, trick, or take a person by surprise". It implies hidden magic, or an element of mystery.



**Maillardet's Writing Robot, 1805**



**Honda's Asimo Robot, 2000**



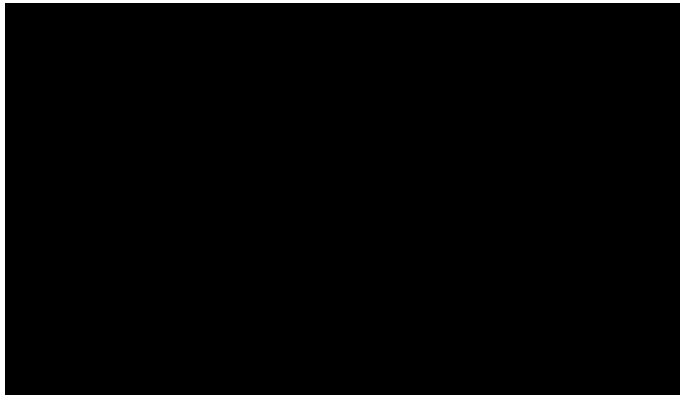
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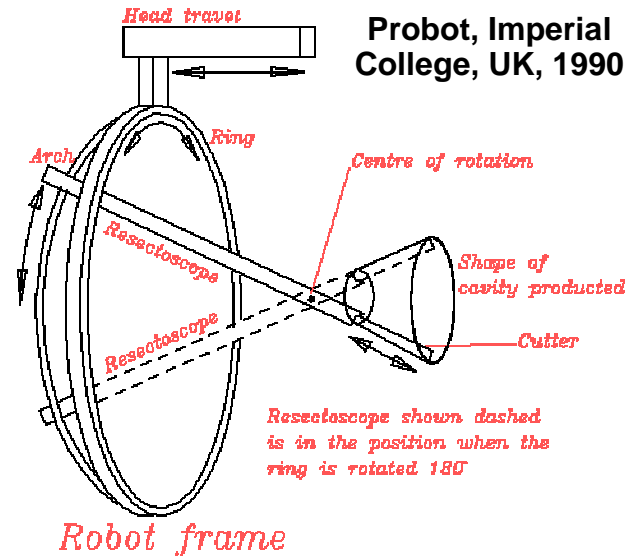


# Design and Safety



Puma 560,  
1985

Probot, Imperial  
College, UK, 1990



- ◆ Industrial robots used to prototype new application areas
- ◆ Special-purpose prototypes
- ◆ Mechatronic products



DaVinci, ISI, 2005



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# Post-Stroke Therapy Robots



**MIME,  
Puma 560,  
1990**

**Driver's SEAT,  
1995**



**Reo™Pro  
ReoTherapy, Inc., 2007**



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# Reharob, Fiziorobot

QuickTime<sup>a</sup> and a  
Cinepak decompressor  
are needed to see this picture.

<http://reharob.manuf.bme.hu/overview/workplan.html>  
[http://www.manuf.bme.hu/Projects/FIZIOROBOT\\_projekt\\_info.htm](http://www.manuf.bme.hu/Projects/FIZIOROBOT_projekt_info.htm)



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# Factors in Safety and Design

**Mechanical Design**

**Electronics** (redundancy)

**Control** (multi-DoF)

**Software Architecture** (RTOS)

**Task / Planning**

**Behavior, Interaction** (Brooks, Croft)

**Ethical Models** (McLaren, Scasselati, Gips)



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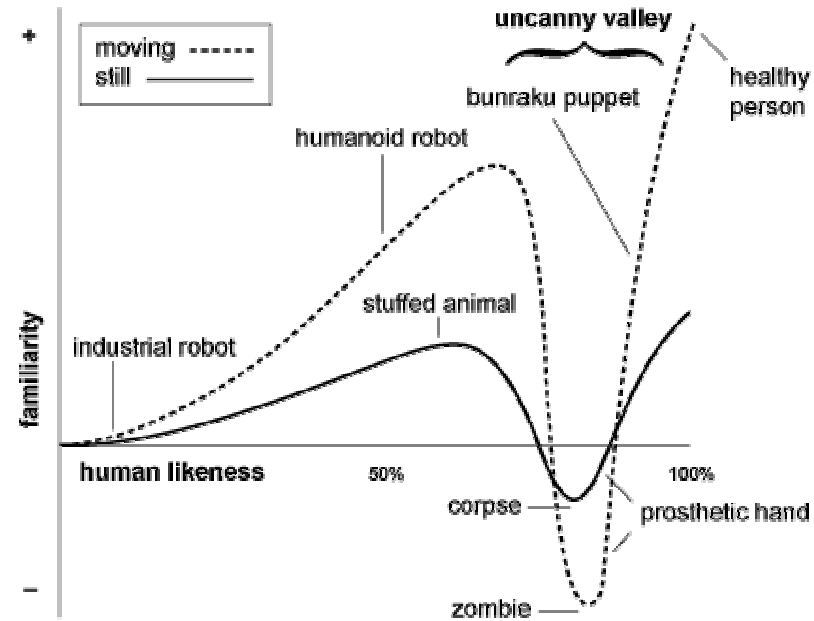
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# Safety and Believability

- ◆ Successful believability emerges from interactions in shared experiences
- ◆ Transparency of action is a prerequisite for trust



M. Masahiro, The uncanny valley (translated by K. F. MacDorman and T. Minato), *Energy*, 7(4), 1970, pp. 33-35.



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# Which would you trust more?

QuickTime<sup>a</sup> and a decompressor are needed to see this picture.



**Honda Asimo, 2006**

**Sony SDR, 2003**  
Yoshihiro Kuroki



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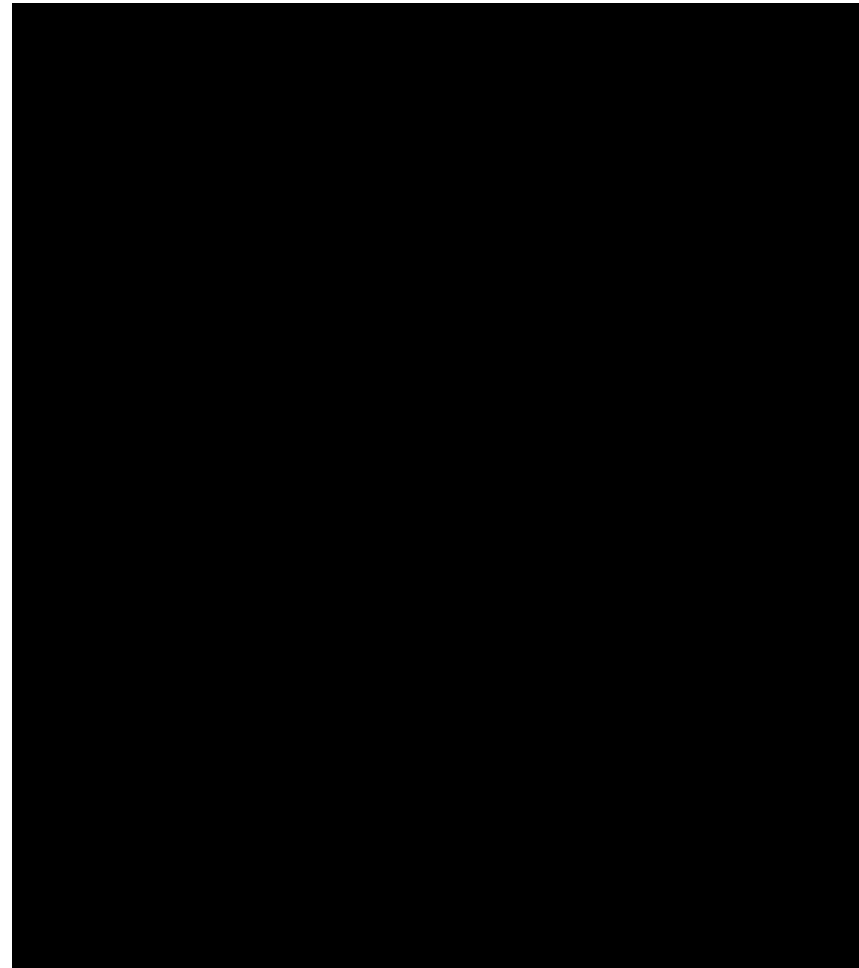


# “Let the body do the thinking” \*

## MIT COG Project: Domo

- ◆ Anthropomorphic arm design
- ◆ RTOS design employs “ready-to-hand”, “present-at-hand” duality.
- ◆ Human-like gesture design for effective communication

\* A. Edsinger, C.C. Kemp, Designing robots that assist people in everyday manual tasks, ICAR'07, Aug. 21-24, 2007, Jeju Island, Korea



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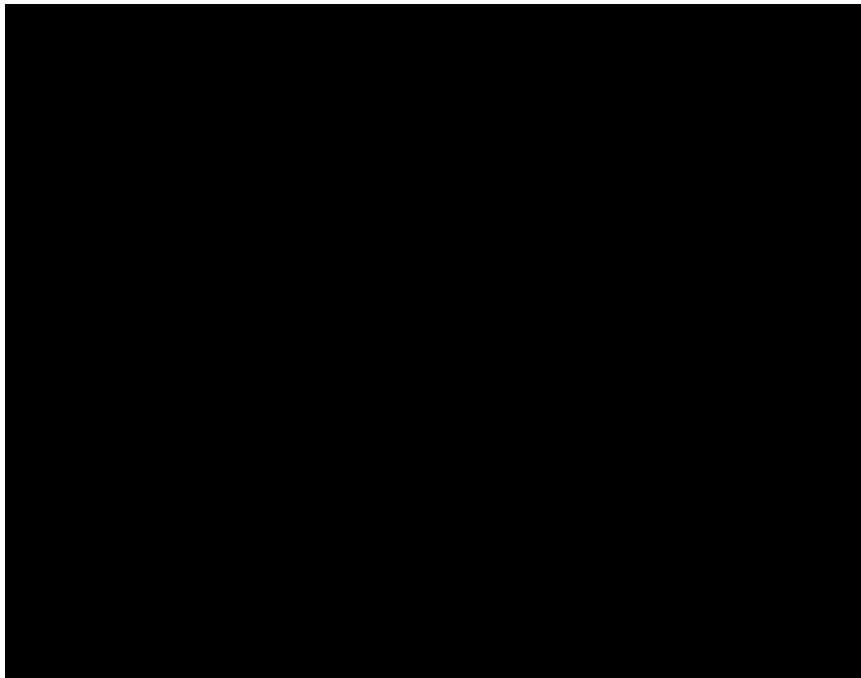
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# Neurotechnologies and Robot Interfaces

Matthew Nagle and Braingate  
<http://cyberkineticsinc.com>



Kevin Warwick and arm implant  
(1998)  
<http://www.kevinwarwick.com>



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# External Brain Machine Interfaces

## Record:

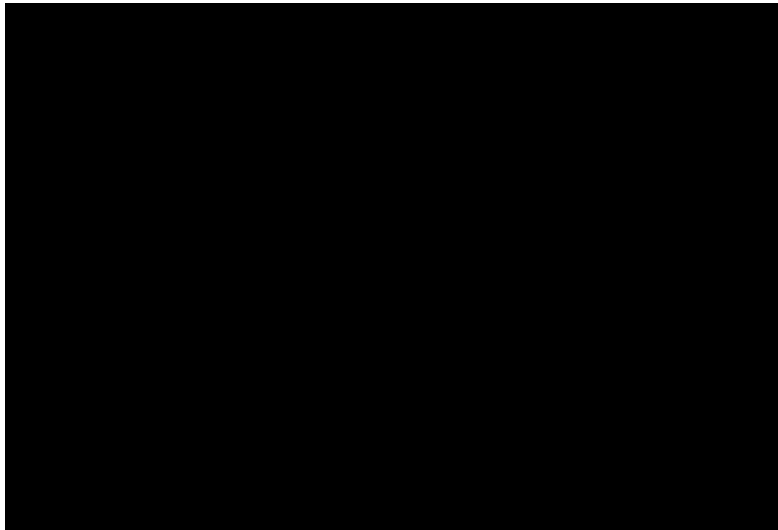
- ◆ EEG
- ◆ EOG
- ◆ EMG



Benjamin Blankertz, Guido Dornhege, Matthias Krauledat, Klaus-Robert Müller, Volker Kunzmann, Florian Losch, and Gabriel Curio. The Berlin Brain-Computer Interface: EEG-based communication without subject training. *IEEE Trans. Neural Sys. Rehab. Eng.*, 14(2):147-152, 2006.

## Stim:

- ◆ TMS
- ◆ tDCS
- ◆ FES
- ◆ ECoG
- ◆ DBS



<http://youtube.com/watch?v=yJXT88FBQWM>

James Gips and Peter Olivieri, EagleEyes: An Eye Control System for Persons with Disabilities, Eleventh International Conference on Technology and Persons with Disabilities, Los Angeles, California, March 1996.



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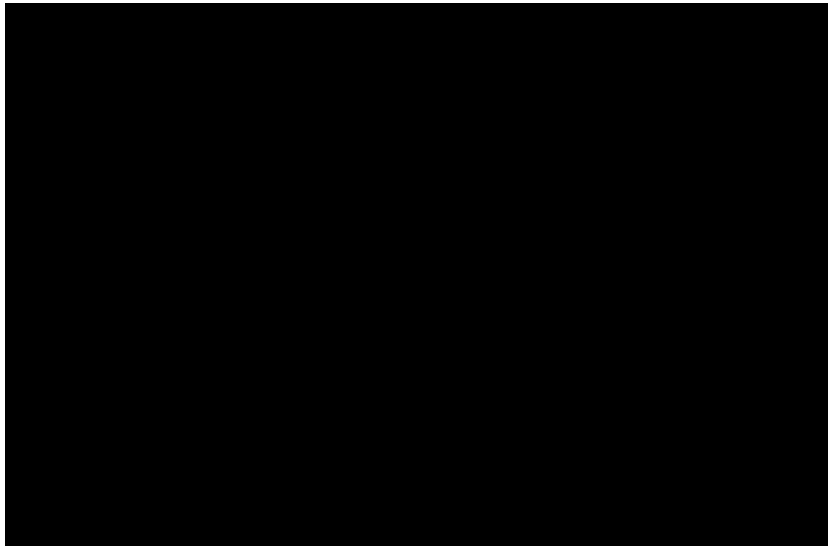
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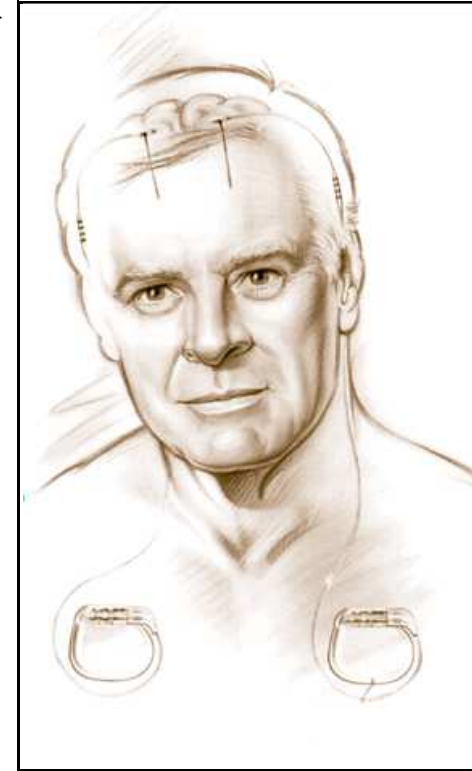


# Internal Brain Machine Interfaces

- ◆ Deep brain stimulation (DBS)
- ◆ ElectroCorticoGram (ECoG)
- ◆ Cortical surface neural arrays



J.V. Rosenfeld, Epilepsy surgery, hypothalamic hamartomas and the quest for a cure, *RACS/RCSEd meeting in Adelaide, May 2002.*



Activa (Medtronic, Inc.), Parkinson's Disease Foundation <http://pdf.org>



# Bioethics and Design Challenges

- ◆ Transparency of action

- ◆ Interfaces
- ◆ Social cues

- ◆ Connectivity with other agents

- ◆ Sensation - perception
- ◆ Intention - action



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# Final Thoughts

Michael Fincke, astronaut, said of the Star Trek Enterprise cast and crew: "Science fiction, in general, has inspired ... all humans by giving form to our dreams ..." ... and nightmares.

<http://www.space.com> 5/13/2005

## SCIFi:

- thought experiments for bioethics study.
- plausible future scenarios for society to test-drive.



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# Acknowledgments

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<http://roboethics.stanford.edu>

Stanford Center for Biomedical Ethics

<http://scbe.stanford.edu>

<http://neuroethics.stanford.edu>

Center for Design Research

<http://cdr.stanford.edu>

VA Palo Alto Health Care System:

Rehabilitation Research & Development Center

<http://ability.stanford.edu>

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# Culture and Ethics

**Will personal robots begin to define a new social artifact and operating affordances and norms?**

**OR**

**Will the similarity of their form and function to humans dictate that robots use human behavior, culture and ethics?**



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