

# Software Platform Concepts and Cognitive Robotics

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iCub examples courtesy of the RobotCub Project  
[www.iCub.org](http://www.iCub.org)

# Software Platform Concepts

## *Technological Issues*

- Cognitive systems are complex software systems
- Integration
  - Many researchers
  - Many years
  - Teamwork: both academic & industrial
- Must be
  - Modular
  - Interoperable
  - Industrial-grade software engineering (e.g. build, test, documentation, ..)

# Software Platform Concepts

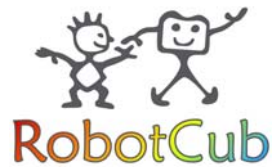
## *Technological Issues*

### Robotics middleware

- Hot topic
- Major players taking an interest
- Way forward
  - Open source or
  - “Hierarchically” proprietary software projects

# iCub

Open Cognitive Humanoid Robot

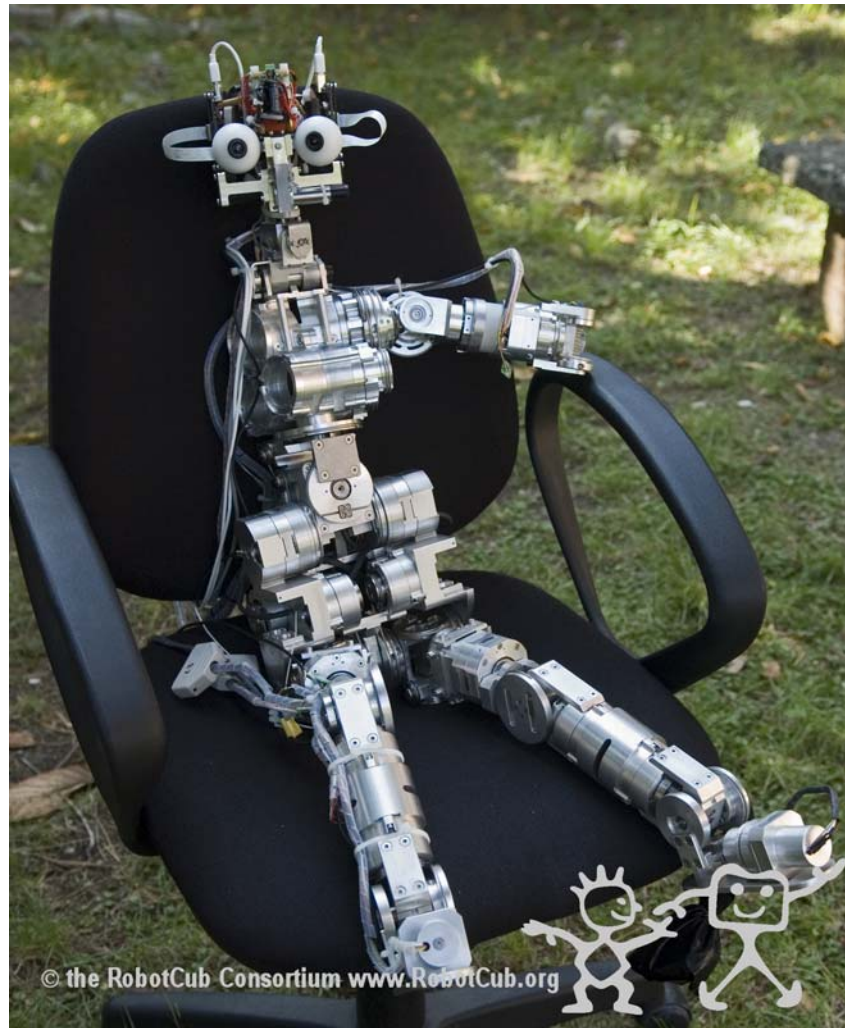


Created to support Community research on embodied cognition

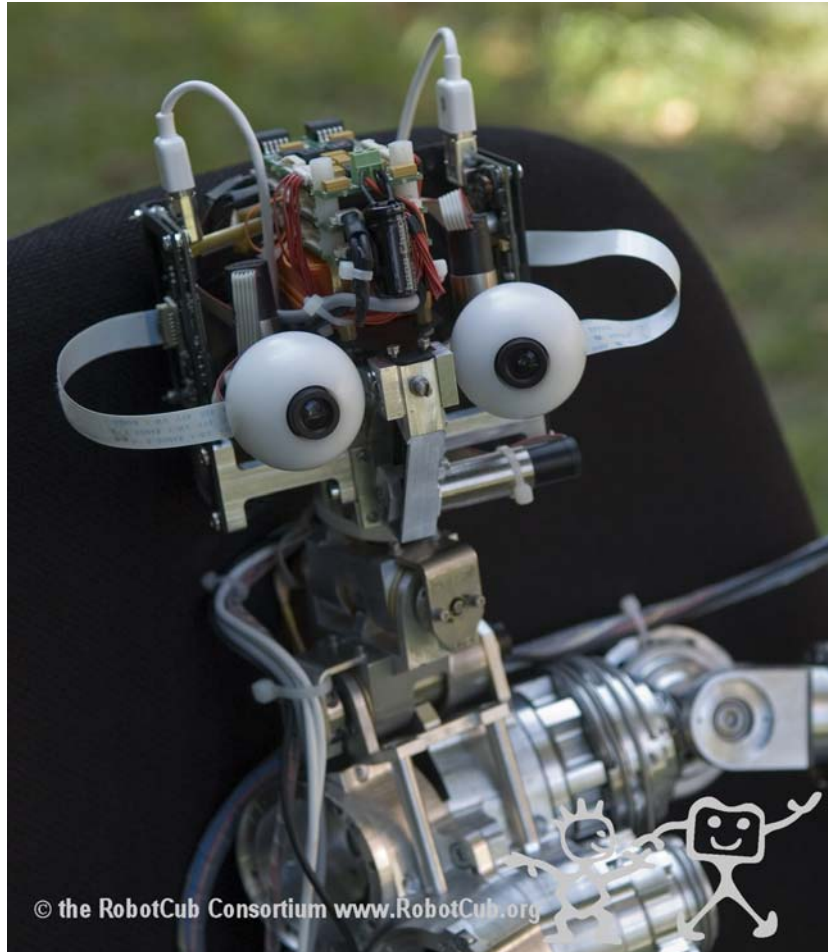
Goal: research platform of choice

- Exploit it quickly and easily
- Collaborate & Share results
- Benefit from the work of other users

# iCub



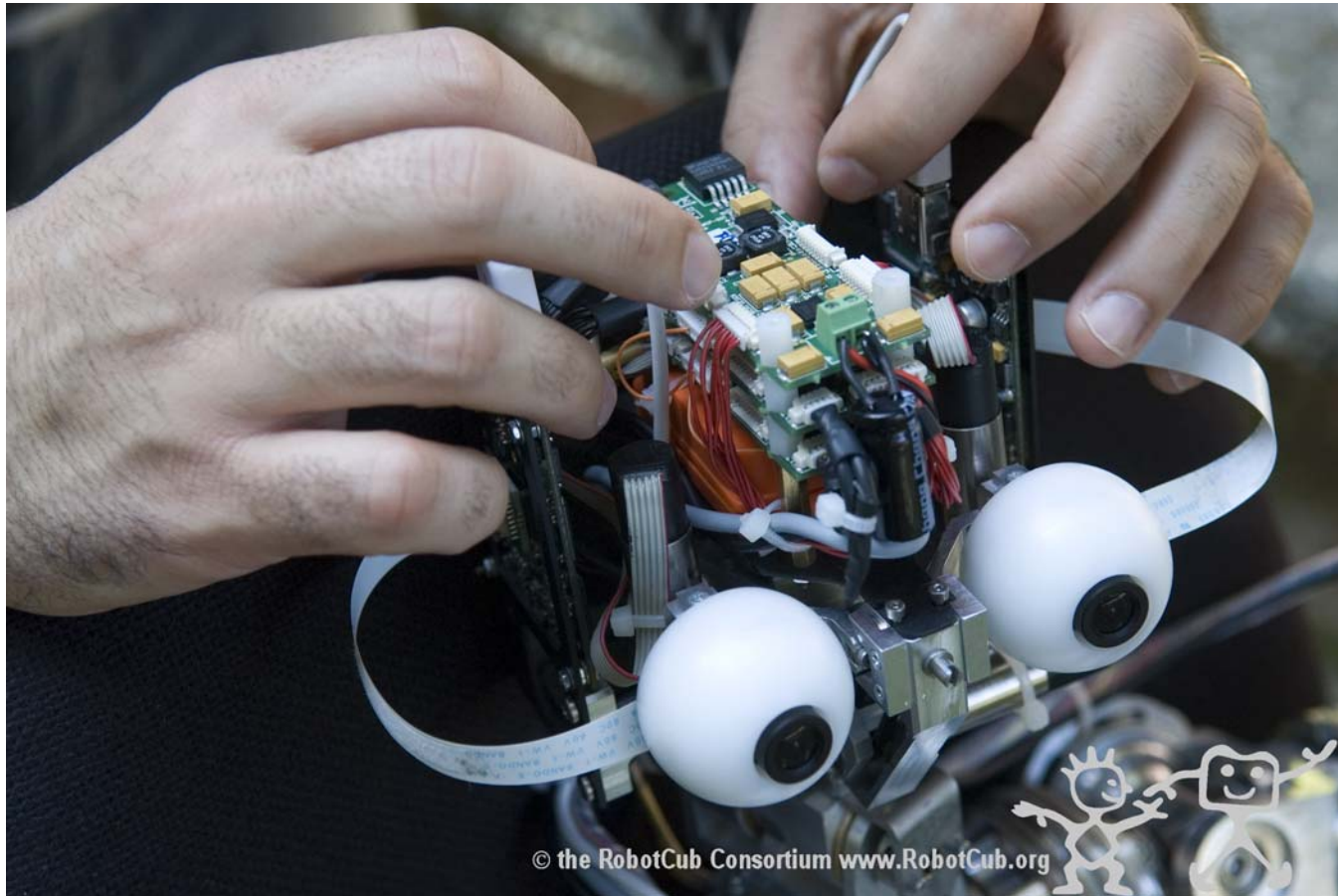
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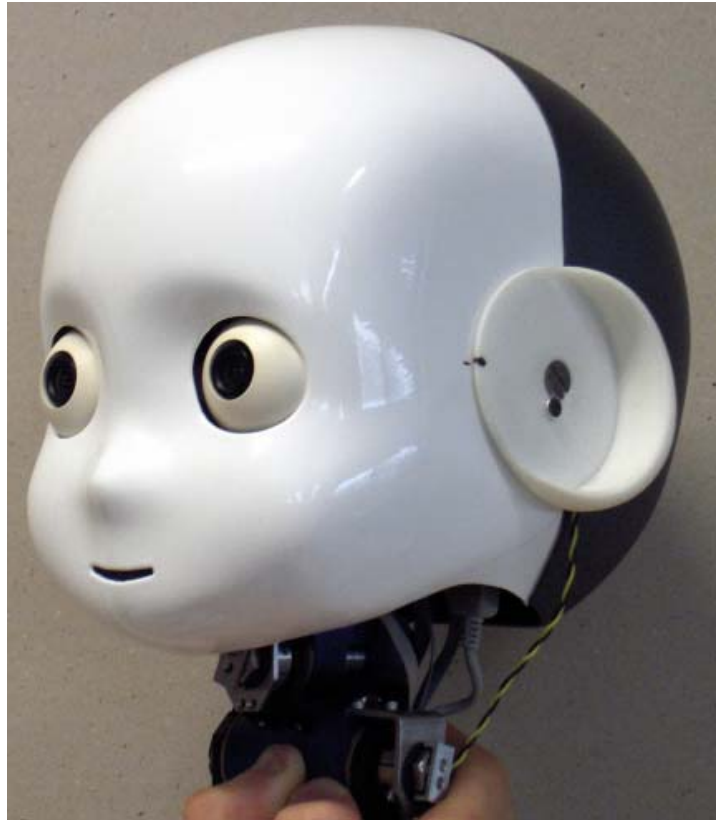


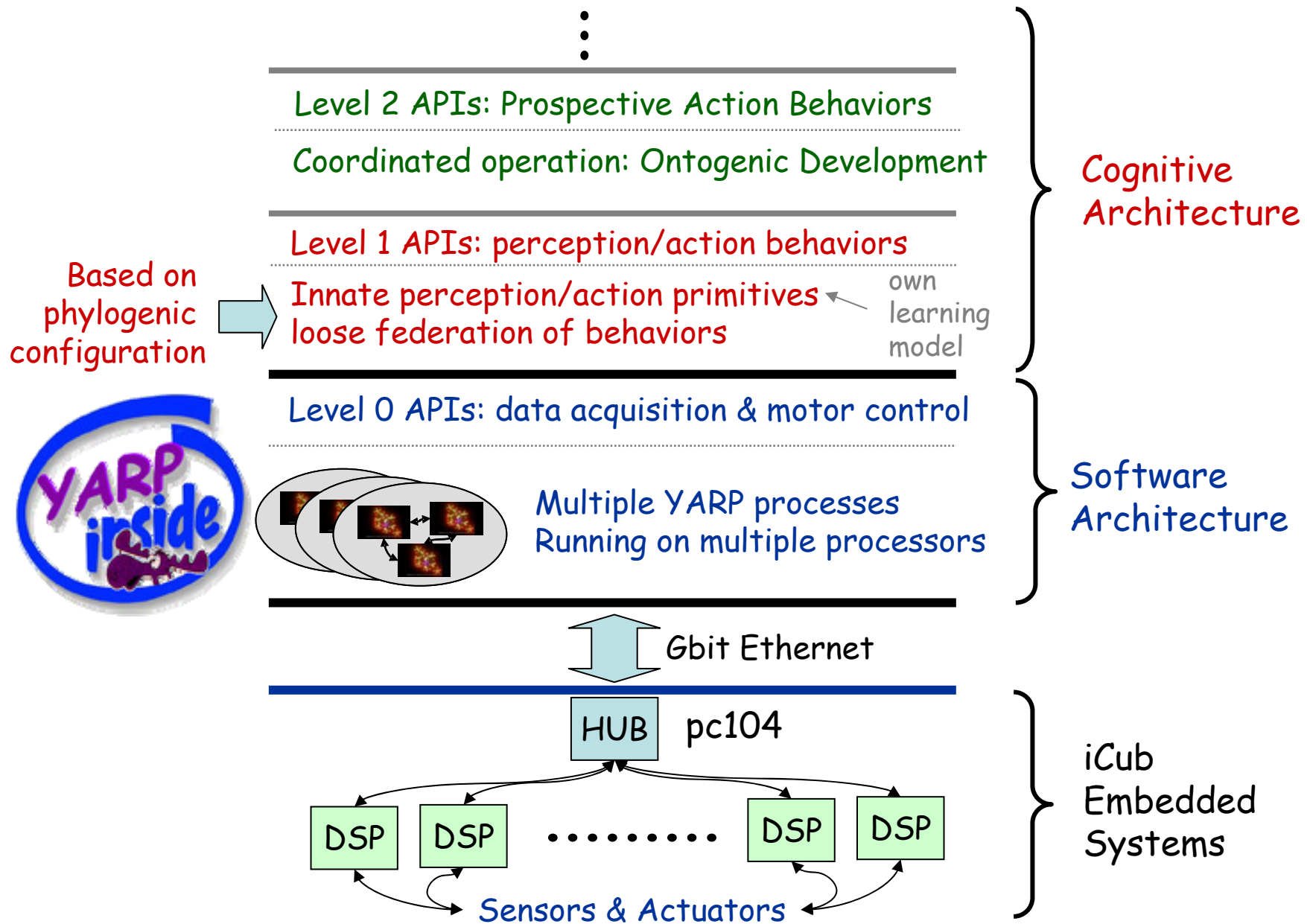
# iCub





# iCub





# What is YARP?



- An open-source software library for humanoid robotics; born on Kismet, grew on COG
  - University of Genoa / MIT collaboration
  - G. Metta, P. Fitzpatrick, L. Natale. *YARP: yet another robot platform*. In the International Journal on Advanced Robotics Systems, Special Issue on Software Development and Integration in Robotics. March 2006.
- Designed to support and encourage:
  - Collaboration (code-sharing across space)
  - Longevity (code-sharing across time)

# Software Platform Concepts

## *Technological Issues*

Modularity and interoperability  $\Rightarrow$  Incremental development & configuration

- switch between different hardware platforms  
e.g. robot and automobile
- combine different functional modules  
e.g. different sensors and actuators
- processing needs  
e.g. speed can be adjusted for different hardware requirements

**RE-USE!**

# Software Platform Concepts

## *Scientific Issues*

- Research projects
  - Well-defined, functionally-oriented problems  
e.g. face recognition, dialogue system
- System-level properties receive much less attention
  - Why? Need an operational base system as a starting point
- BUT systems properties are extremely important
  - robustness, graceful degradation, e.g. safety critical applications (cars)
  - efficiency – increase operation time for mobile platforms
  - security & safety (e.g. a 60 kg humanoid robot being hacked)
  - learning – True learning is a system-wide property
    - control of learning & the learning path  
e.g. organization of short-term to long-term memory

# Cognitive Robotics

## *Developmental Embodiment*

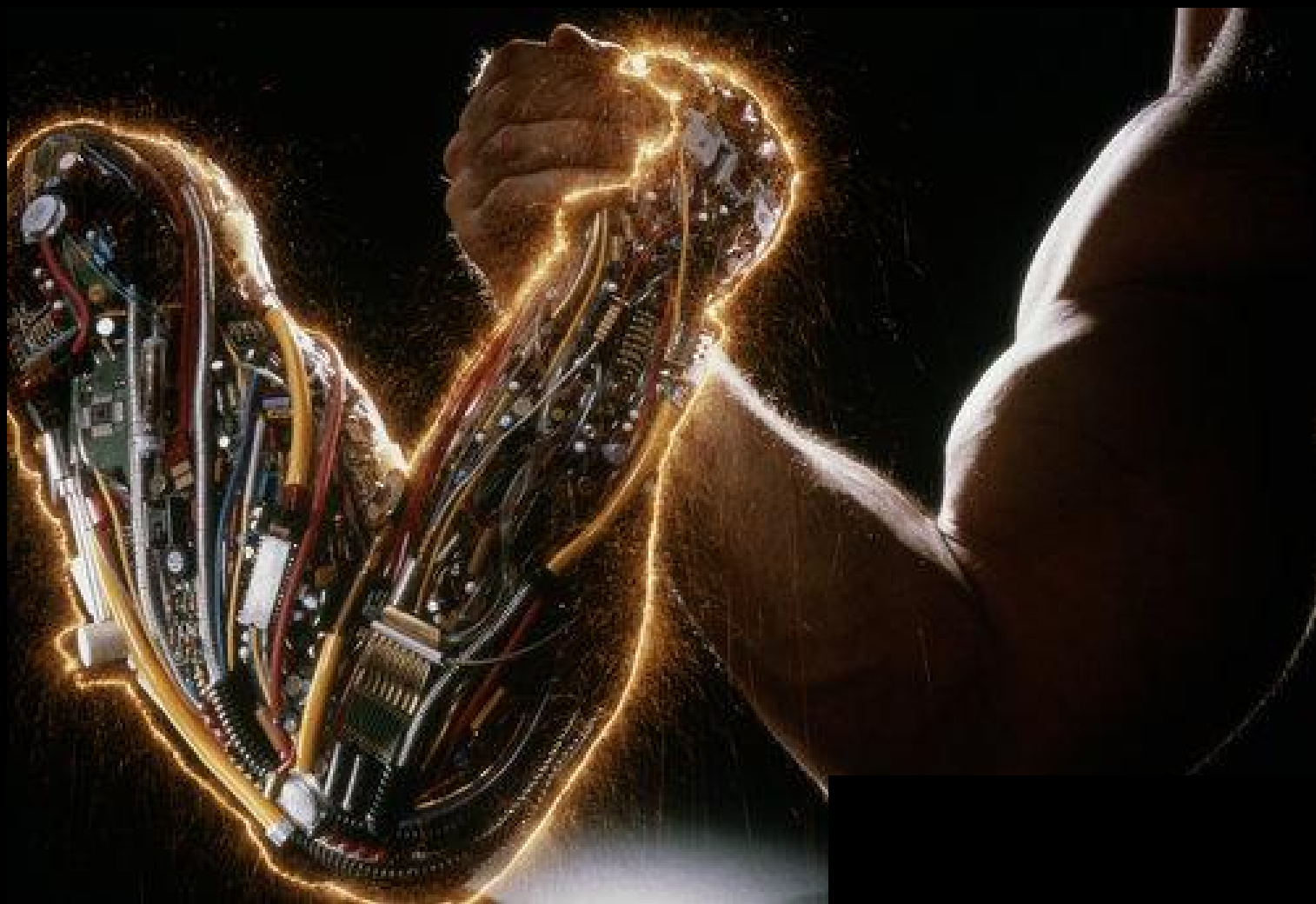
- Embodiment & situatedness: well-established
- BUT, from an evolutionary point of view, morphology and processing structure are much stronger coupled.
- Genetic encoding of structure of brain and body: same mechanisms
- Embodiment and intelligence grow and develop *together*





IMAGE BANK  
IMAGE BANK







# Cognitive Robotics

## *Developmental Embodiment*

- Robots will be one element of a personalized information infrastructure
- The future: NOT a 'brain in a machine
- Machine will be part of a personalized information infrastructure
  - (ad hoc) information networks
  - Mobile devices
  - Ubiquitous sensors
  - ...

# Automotive Intelligence

- Robustness, robustness, robustness .. must be system inherent
- Learning must be restricted (“fail-safe”)
- Single functionalities must be embedded
- The car will be part of a urban information infrastructure
  - intelligence will be distributed and available on demand
- The automobile must remain a personal space
  - that is part of its fascination
  - thus any cognitive aspect must be highly personalized

(cf. Christoph Eberst)

# Cognitive Systems

## *The Roadmap*

- Build simple systems
  - never(!) switched off
  - Incrementally change morphological and processing structure
- Build systems that can live – even a simple – life exploiting both a physical and a virtual presence
- Research system level properties (robustness/safety) in their own right
  - Not after the system functionality has been developed
- Regard intelligence and cognition as strategies to cope with limitations
- *Build toys as simple cognitive systems*

