

## *Beyond Robotics*

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## FET mission in the 6th Framework Programme



- To help new IST-related science and technology fields and communities to emerge, some of which will become strategic for economic and social development in the future and will feed into the mainstream IST activities in the future.
- To ensure openness to unforeseeable ideas, critical mass of research where strategic focus is needed, and seamless coverage of IST frontier, two complementary approaches will be utilised: one receptive and open - the other proactive.



## Beyond robotics - incorporation of IT into physical mobile artifacts



- **Objectives:**
  - **Cognitive robots as ‘assistants’ or ‘companions’ to humans**
    - open-ended conceptual learning of new skills and tasks in the context of embodied systems and beyond fixed domains
    - to grow in constant interaction and co-operation with humans
  - **Hybrid bionic systems**
    - augmenting human interaction and perception of the environment
    - smooth integration of robotic and information systems with human perception-action systems using bi-directional interfaces with the human nervous system
  - **Autonomous microrobot groups (‘robot ecologies’)**
    - many heterogeneous members exhibiting collective behaviour and intelligence
    - able to self-organise, adapt, co-operate and evolve in order to attain a global objective



## Beyond robotics - incorporation of IT into physical mobile artifacts



### ■ Scope:

- To aim at breakthroughs and go well beyond the state of the art
- To seek new approaches, e.g.:
  - robust perception (multisensory/modal fusion at multiple levels of presentation and processing, recognition and categorisation of objects, events and contexts in open environments)
  - learning (open-ended, beyond fixed domains, by demonstration,..)
  - scalability (>>1)
  - integration (theory, design and implementation for generalised environments)
  - task and environment adaptation (flexibility in embodiment, perception, representation, reasoning and action)
  - interaction with humans (invasive/non-invasive interfaces to the nervous system, multimodal interfaces)
  - evaluation (scientific basis of system evaluation)



## Beyond robotics - incorporation of IT into physical mobile artifacts



### ■ Scope:

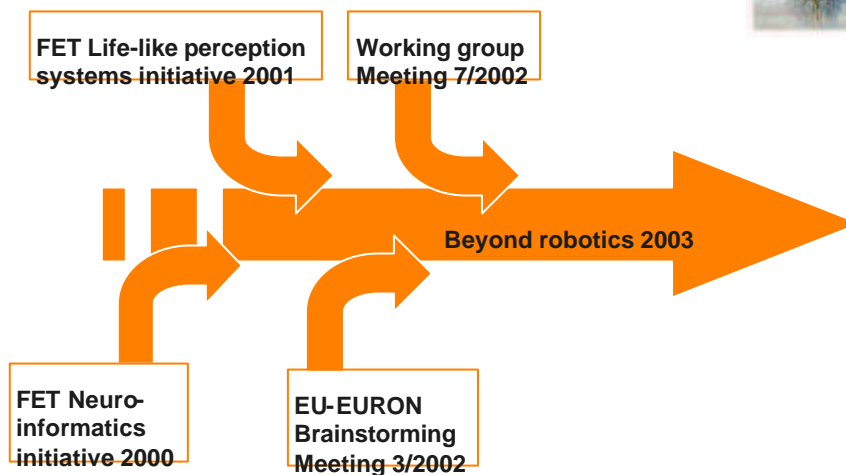
- No “classical” robotics although existing state-of-the-art solutions may be adopted, i.e. the focus is **not** on:
  - GOFAI, ANN, Artificial life
  - flexible manufacturing systems
  - humanoids
  - simulations
  - basic physical design
- Robust evaluation >> demonstration
- To build partly on NI and LPS initiatives with augmented scope for integration and systems research and system-level objectives

## Beyond robotics emphases



Demonstrators/Topics	Cognitive robots	Hybrid bionic systems	Microrobot groups
Qualifiers for systems	<i>cooperative open ended</i>	<i>integrated</i>	<i>scalability</i>
Interfaces	multi-modal interaction	brain-computer interfaces	?
Learning	dim red., skill, task, open-ended	dimensionality reduction	transfer, co-op, self-organisation
Action (only as required for system)	flexible material, hands, mobility	prosthetics or embodiment	co-operative, embedded
Perception	fusion categorisation	categorisation or cogn. interf.	Communication & representation
Integration & "intelligence"	theory of systems? cognitive models morphology (1 vs many)	cognitive models of perception-action integration	task adaptation & distribution, self org., async coord.
Performance evaluation	Scalability Time of instruction Robustness	Degree of perf boast / deterioration	Scalability Adaptability

## How did we end up in this initiative ?





## Background I - the neuroinformatics initiative



- **Objective:** To explore new synergies between Neurosciences and Information Technologies in order to enable the construction of hardware/software “artefacts that live and grow”, i.e. artefacts that self-adapt and evolve beyond pure programming
- 8 robotics-related proposals selected (both full robot systems and robotics subsystems) and started late 2001
- EU funding 10,8 M€



## Background I - the neuroinformatics initiative



- **Examples of projects:**
  - **AMOUSE**

to understand the neural processes underlying adaptive natural behavior of rodents and the creation of a “living artefact” which operates based on the same principles. The central technological achievement of the project will be the construction of an artificial whisker system and its test on a mobile robot.
  - **NEUROBIT**

to develop the tools and technologies for connecting portions of living nervous tissue (cultured, and kept alive in-vitro) bi-directionally with external devices (i.e., a robot) in order to teach the biological component of the hybrid system to process information in a goal-oriented way



## Background II - the life-like perception systems initiative



- **Objective:** To create integrated perception-action systems that are inspired by the sophistication of solutions adopted by living systems. "Perception is meant to include sensorial, cognitive, and control aspects, whether it refers to vision or hearing, or to any other element of interaction with the environment by a biological organism. Such systems would extend the capabilities of machines or be used to augment the human senses.
- 6 robotics-related proposals selected started May-June 2002
- EU funding 15,1 M€



## Background II - the life-like perception systems initiative



- **Examples of projects:**
  - **BIOLOCH**

to understand motion and perception systems of lower animal forms such as parasites, worms, insects and even snakes and eels, and to design and fabricate an entirely new generation of autonomous smart mini- and micro-machines inspired by such biological systems
  - **CIRCE**

to reproduce, at a functional level, the echolocation system of bats by constructing a bionic bat head that can then be used to systematically investigate how the world is not just perceived but actively explored by bats



### Background III - how the initiative was planned



- **EU-EURON Brainstorming Meeting on Robotics, March 6-7, 2002**
  - 16 experts from Europe and one from the US
  - Result: (1) Super Human Systems, (2) Robot Ecology, (3) Adaptive Robotic Servant
- **Working Group Meeting, July 10-11, 2002**
  - 4 experts
  - research challenges
  - focus of the initiative
  - *modus operandi*
  - identification of related national initiatives



### Parallel initiative - Complex systems research



- **Objective:**

Create scale-free, autonomously evolving IT systems endowed with adaptive and stable self-regulatory mechanisms. Such systems need to continue operating reliably in dynamically changing environments.
- **Scope:**
  - Link information sciences to complex system research
  - concepts from physics, biology, economics, etc.
  - Work should be grounded in a unified set of concepts and methods in complex system analysis.
  - New design tools via reverse engineering of complex systems

## Complex systems research



Complex systems research - a paradigm of knowledge

- .....
- Extract meaning from huge, unstructured, dynamically evolving sets of data. Guide societies of heterogeneous - simulated or **embodied** - agents to develop shared knowledge systems or languages.
- Create scale-free computational structures composed of **self-assembling building blocks that are capable of developing** - through spontaneous differentiation - organised structures and greater capabilities.

## How ?



### Advisory Board

"Stakeholders"

Scientific  
guidance

Commission

IP1

IP2

NoE

- Budget allows for new partners & tasks
- Dynamic re-adjustment of objectives & workplan



## When ?



- Call for proposals: 1 December 2002
- Information day in Brussels: 13-14 January 2003
- Preproposal deadline: 28 February 2003
- Proposal deadline: 24 April 2003

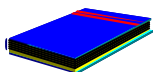
## For further information



[www.cordis.lu/ist/fethome.htm](http://www.cordis.lu/ist/fethome.htm)  
[www.cordis.lu/rtd2002](http://www.cordis.lu/rtd2002)  
[www.euron.org](http://www.euron.org)



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