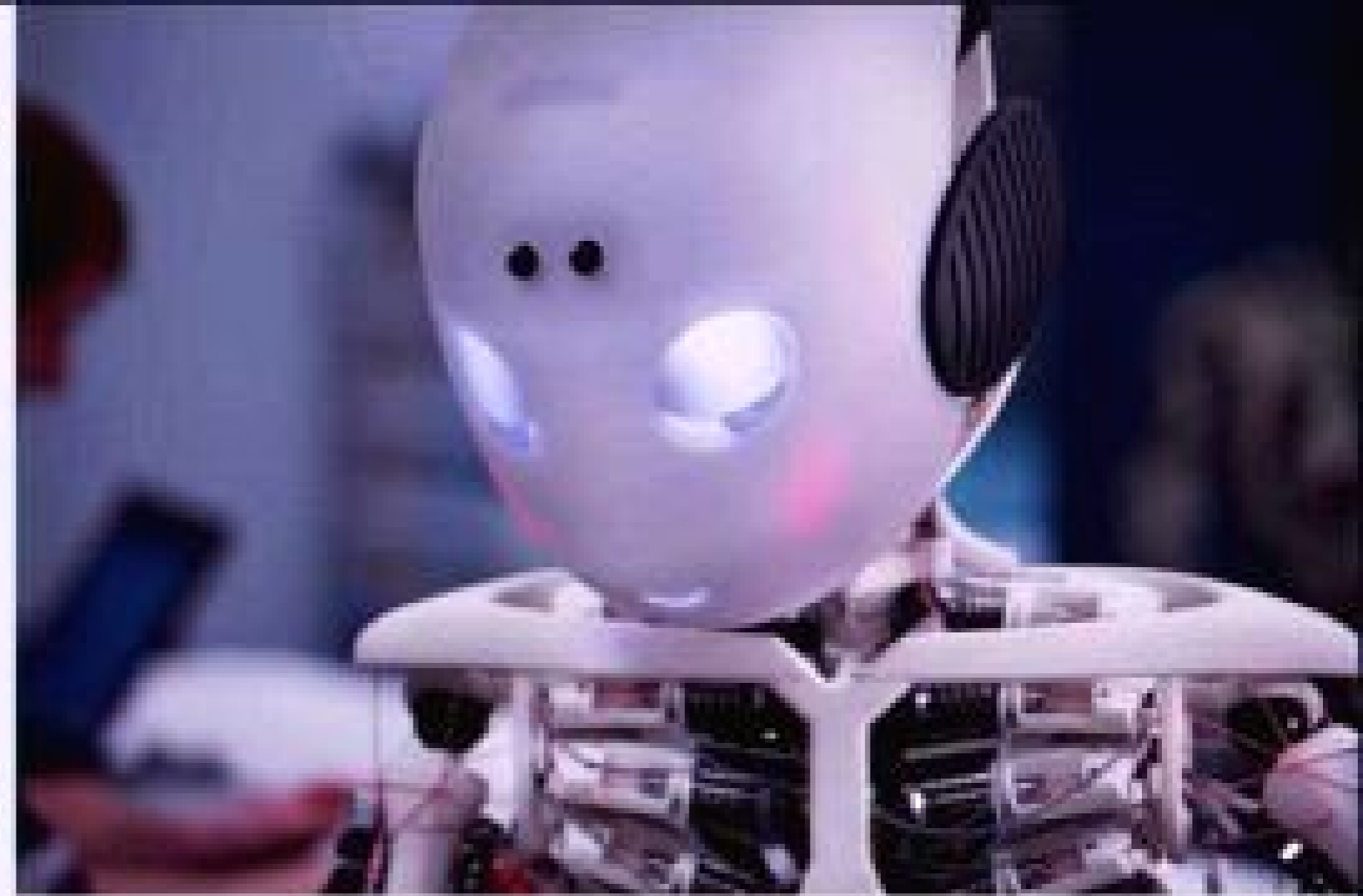


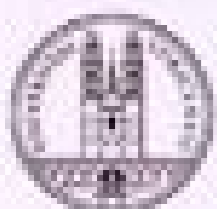
“Soft robotics” — the next generation of intelligent machines

“The four messages of embodiment”



TNG BigTechDay 6, 14 June 2013

**Rolf Pfeifer, Artificial Intelligence Laboratory
Department of informatics, University of Zurich
NCCR National Competence Center Robotics, Switzerland**



**University of
Zurich** UNIVERSITÄT ZÜRICH

robotics Swiss National
Centre of Competence
in Research

ai lab

Relation to cognition/ intelligence?

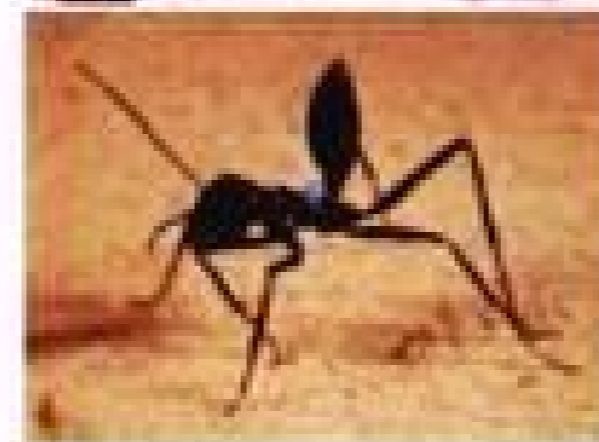
“Why do plants not have brains? The answer is actually quite simple: they don’t have to move.” Lewis Wolpert, UK

—> evolutionary selectionist pressure
on brain development

**brain/intelligence always part of complete
organism**

Cognitive Systems/ Artificial Intelligence — goals

1. Understanding biological systems



animals

humans

2. Principles, theory

3. Applications

robot "bar man"

Engkey

Baxter



vacuum cleaner



Artificial Intelligence — goals

Slogan: “**Understanding by building**”
(synthetic methodology)



vacuum cleaner



beer-serving robot

Zurich AI Lab robots



Rufus T.
Firefly

Didabot



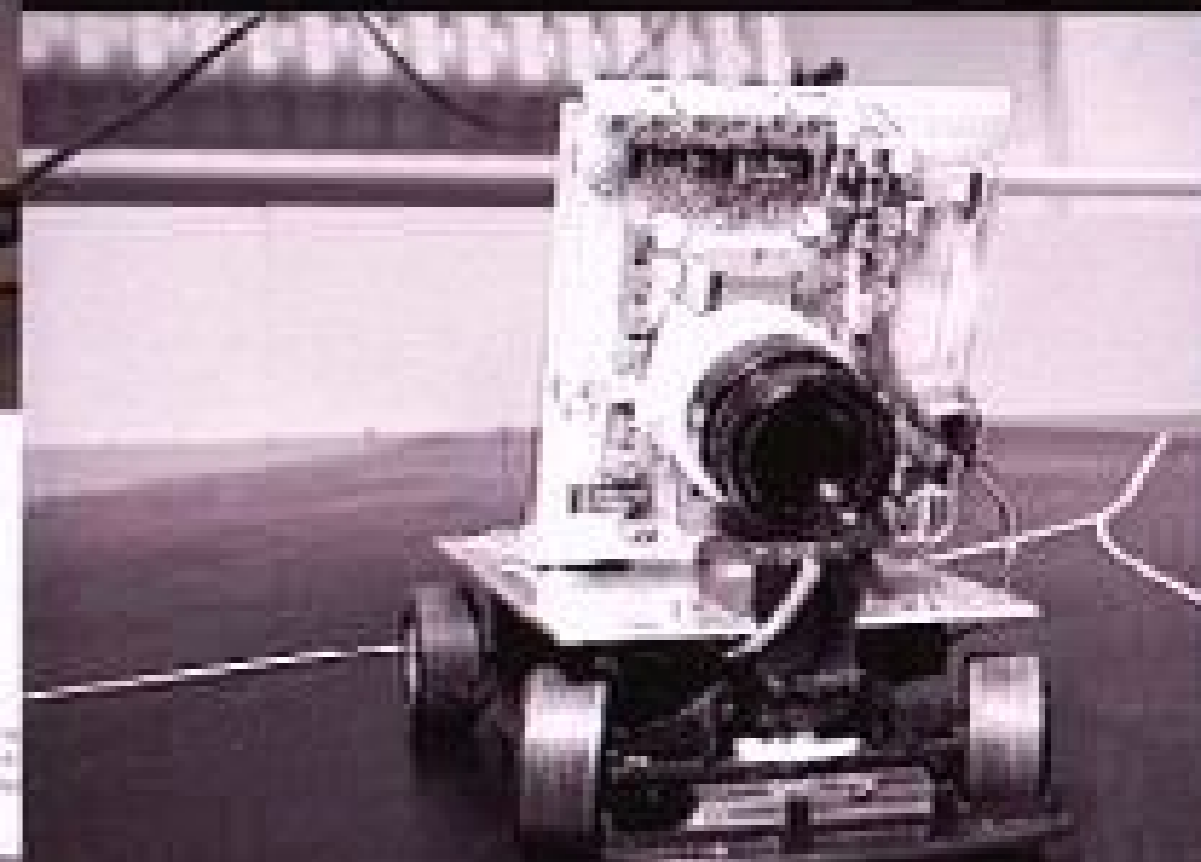
Famez



Sita



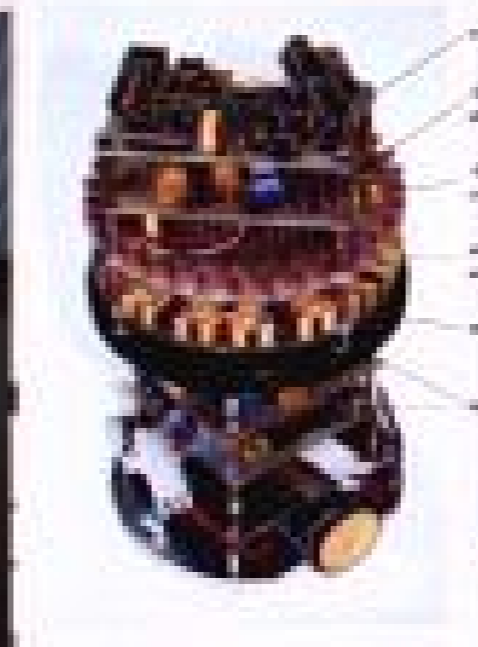
Ms. Gloria
Teasdale



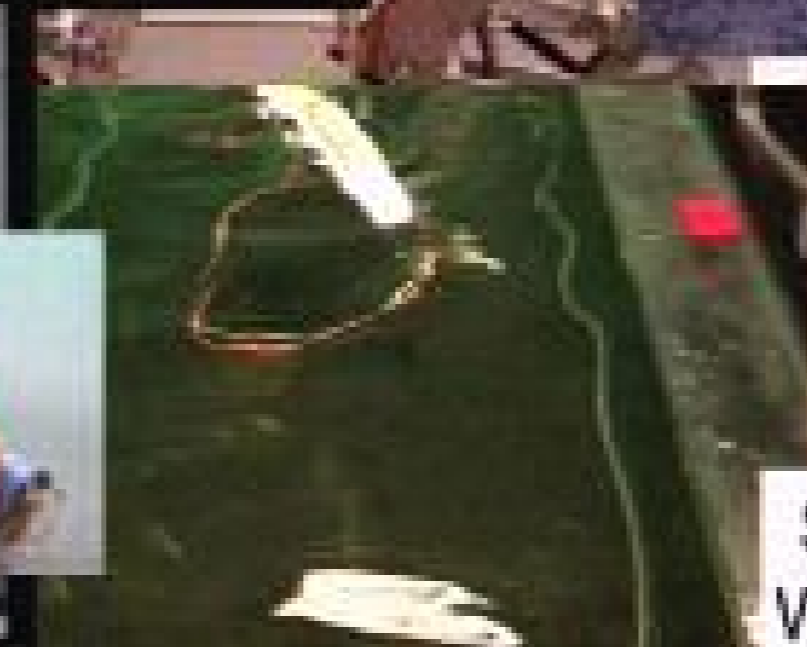
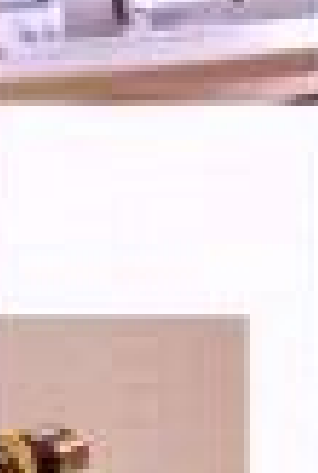
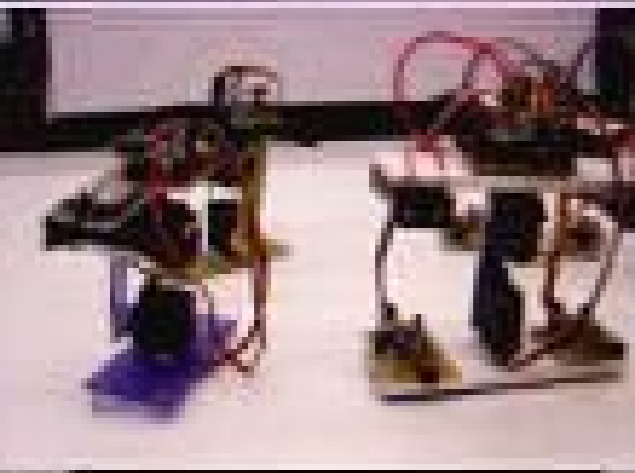
Zurich AI Lab robots



- Amouse
- Sahabot II
- Melissa
- Tripp
- Samurai
- Analogrob
- Dexterolator
- Stumpy
- Eyebot
- Mindstorms
- Kheperas
- Mitsubishi
- Forkleg

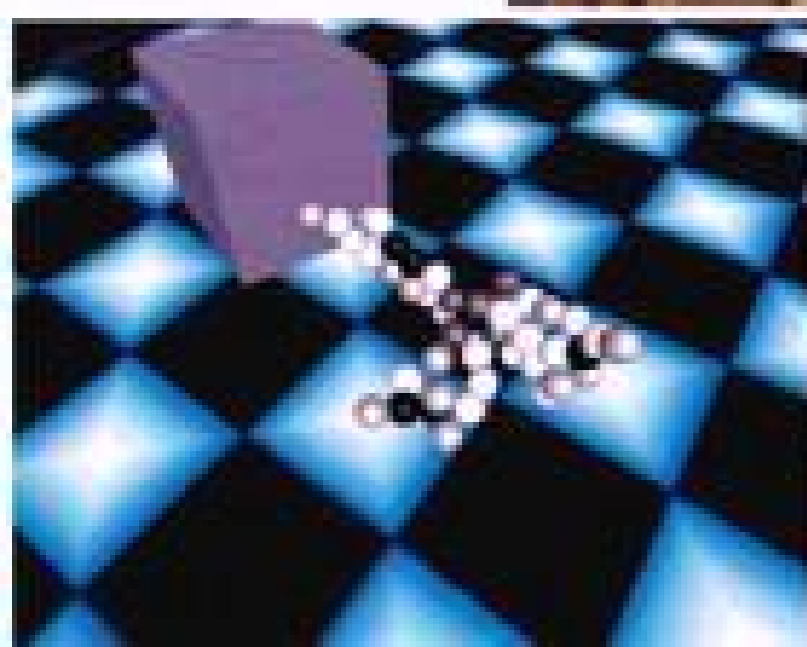
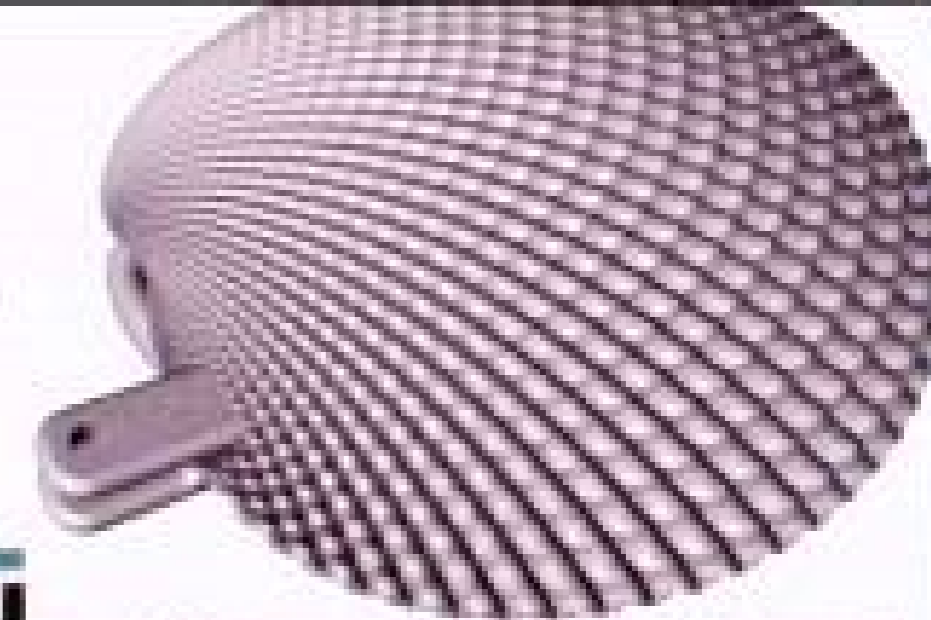
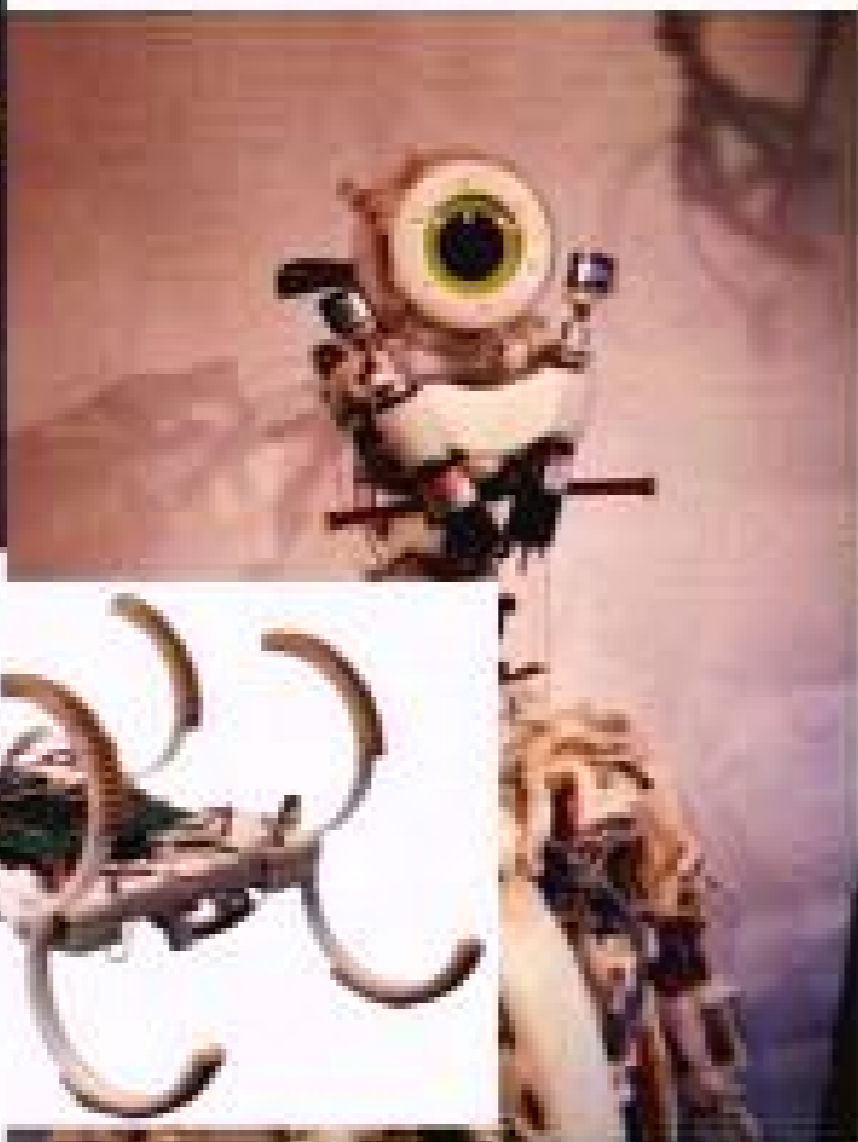


Zurich AI Lab robots

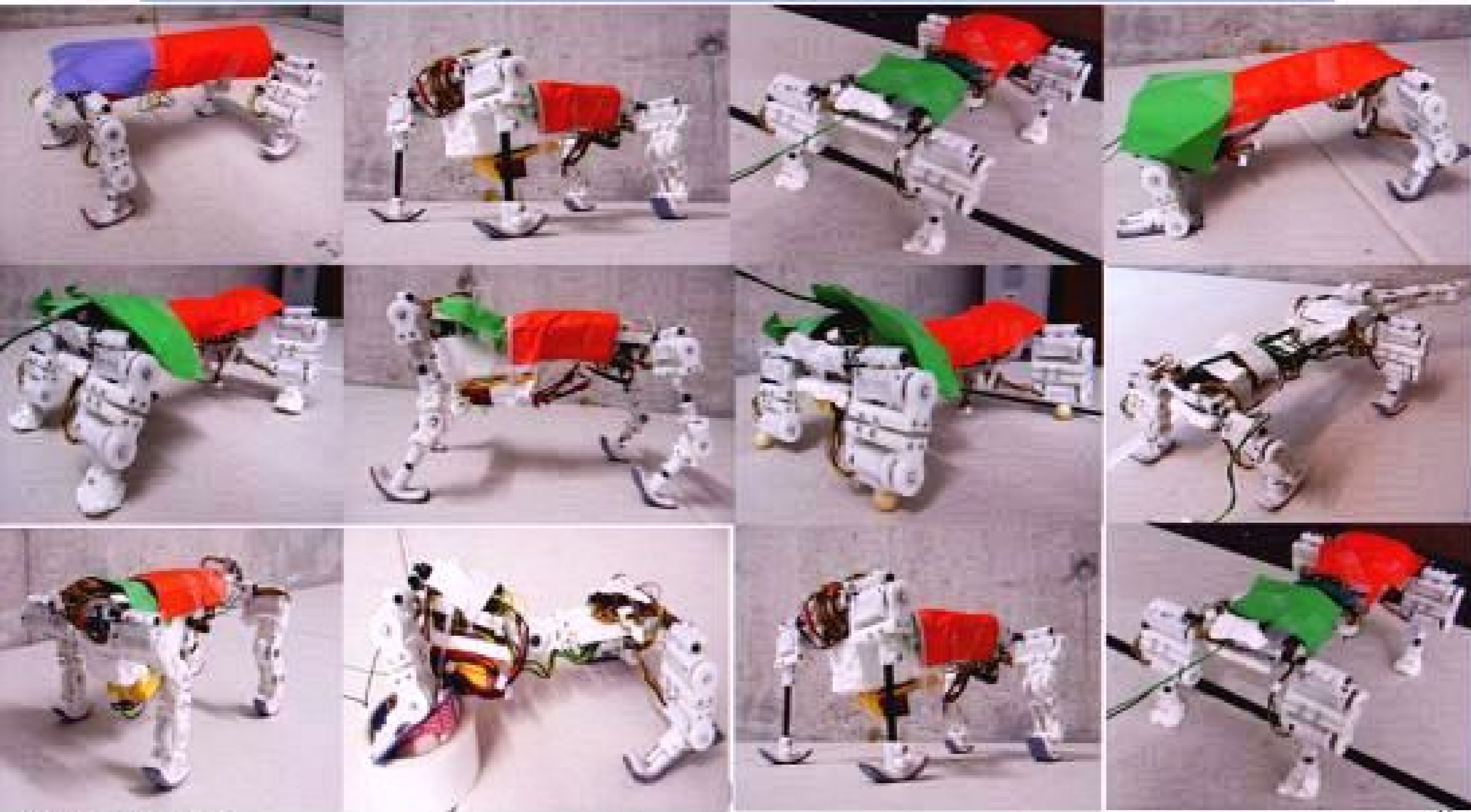


Stumpy, Monkey, Puppy, Min-dog, Wheeled Walker, Mini-Stumpy, Wanda, Dumbo, Rabbit

Zurich AI Lab robots



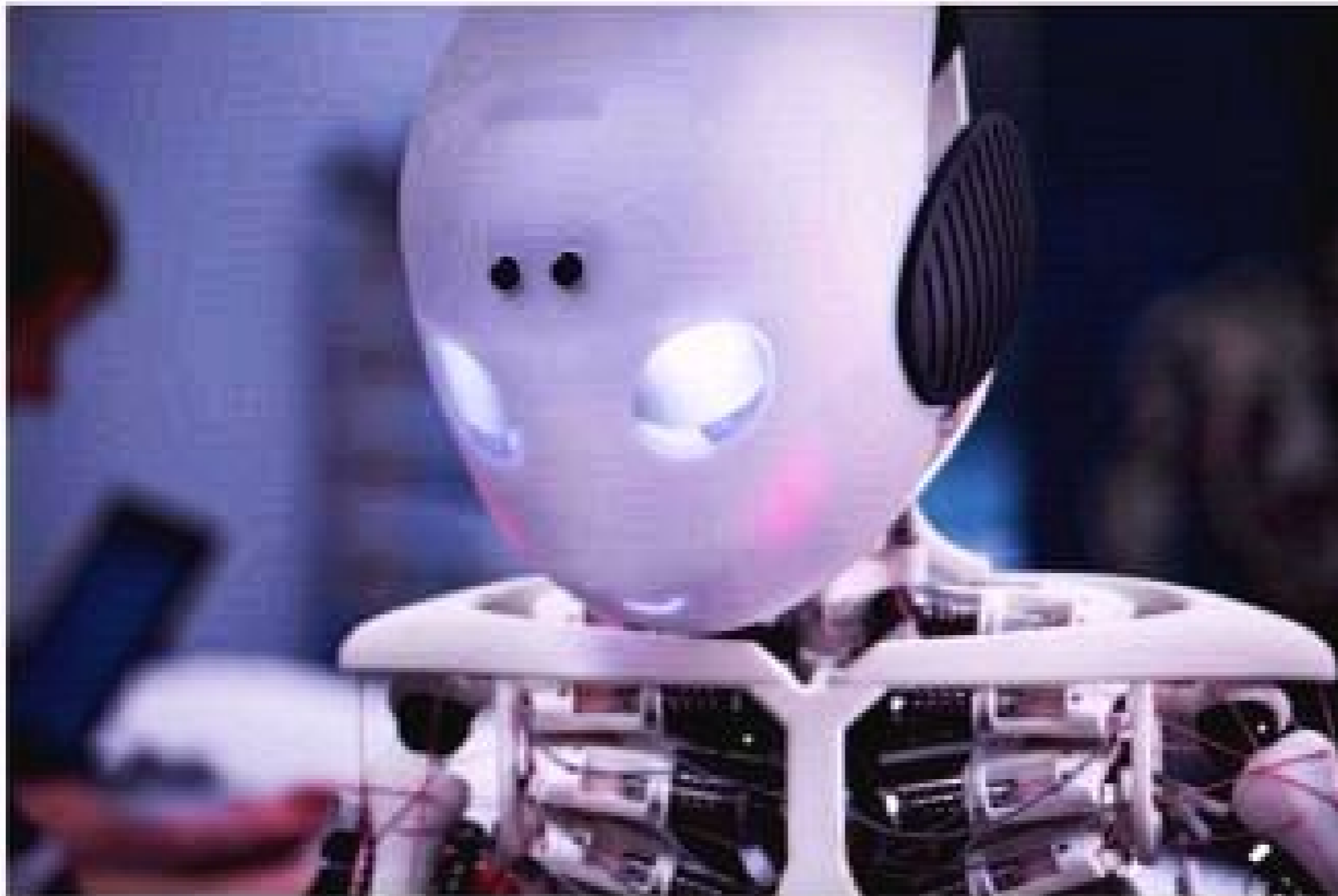
AI Lab Robots (exploration of morphology)



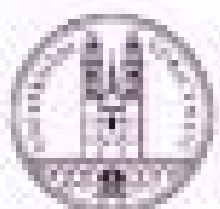
floating; hair-bot;
adaptive leg press



Recent development: Roboy

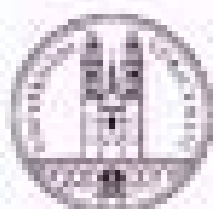


more later

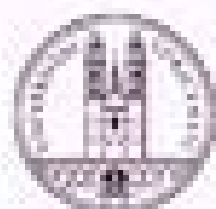


Contents

- introduction and background
- **the four messages of embodiment**
- **the “power of materials”**
- **summary and conclusions**
- **the “Roboy” project**



Getting into the spirit of embodiment



The spirit of embodiment



The spirit of embodiment



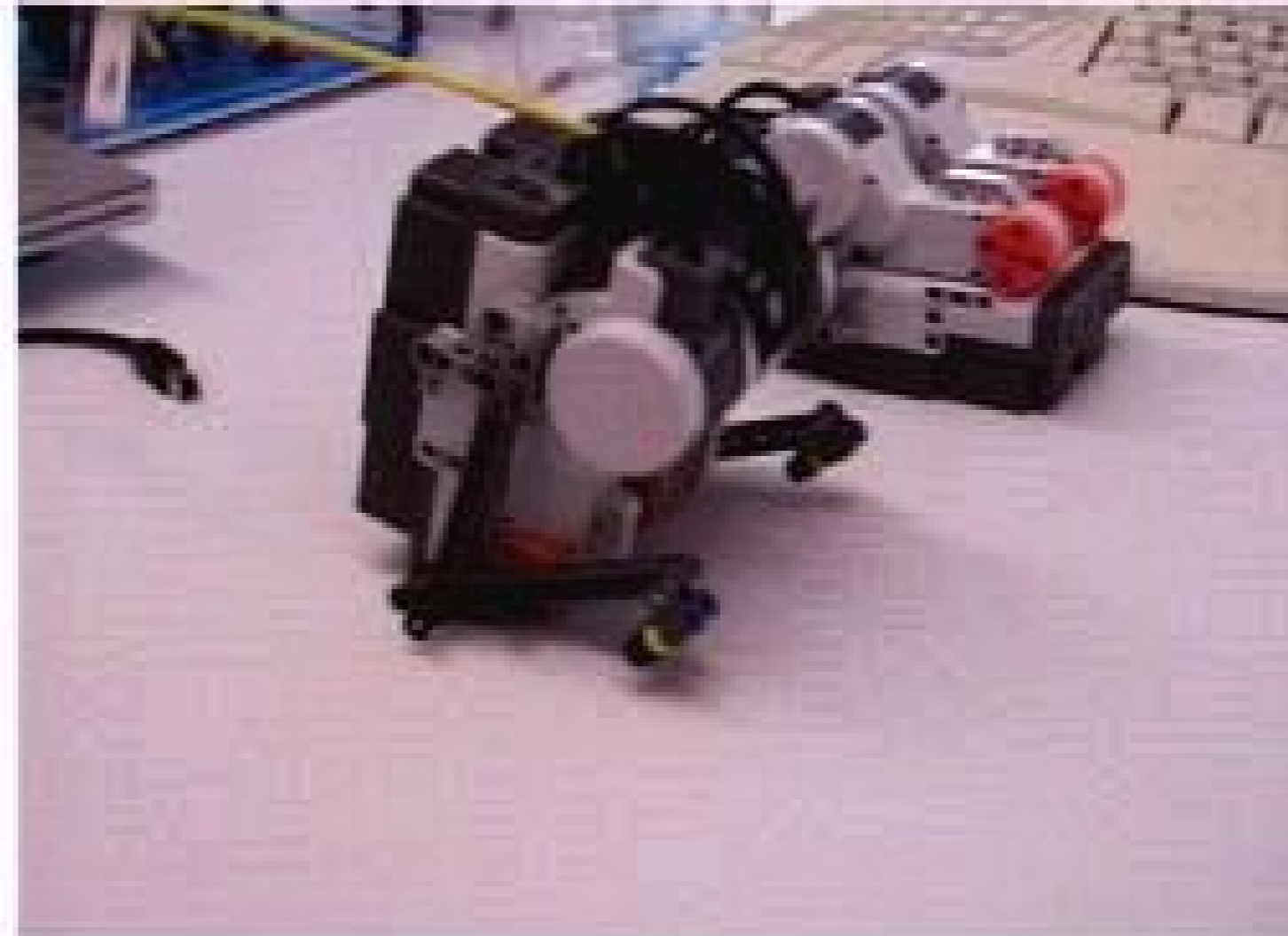
The spirit of embodiment



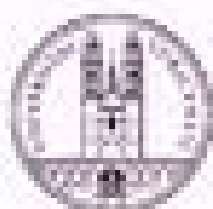
The spirit of embodiment



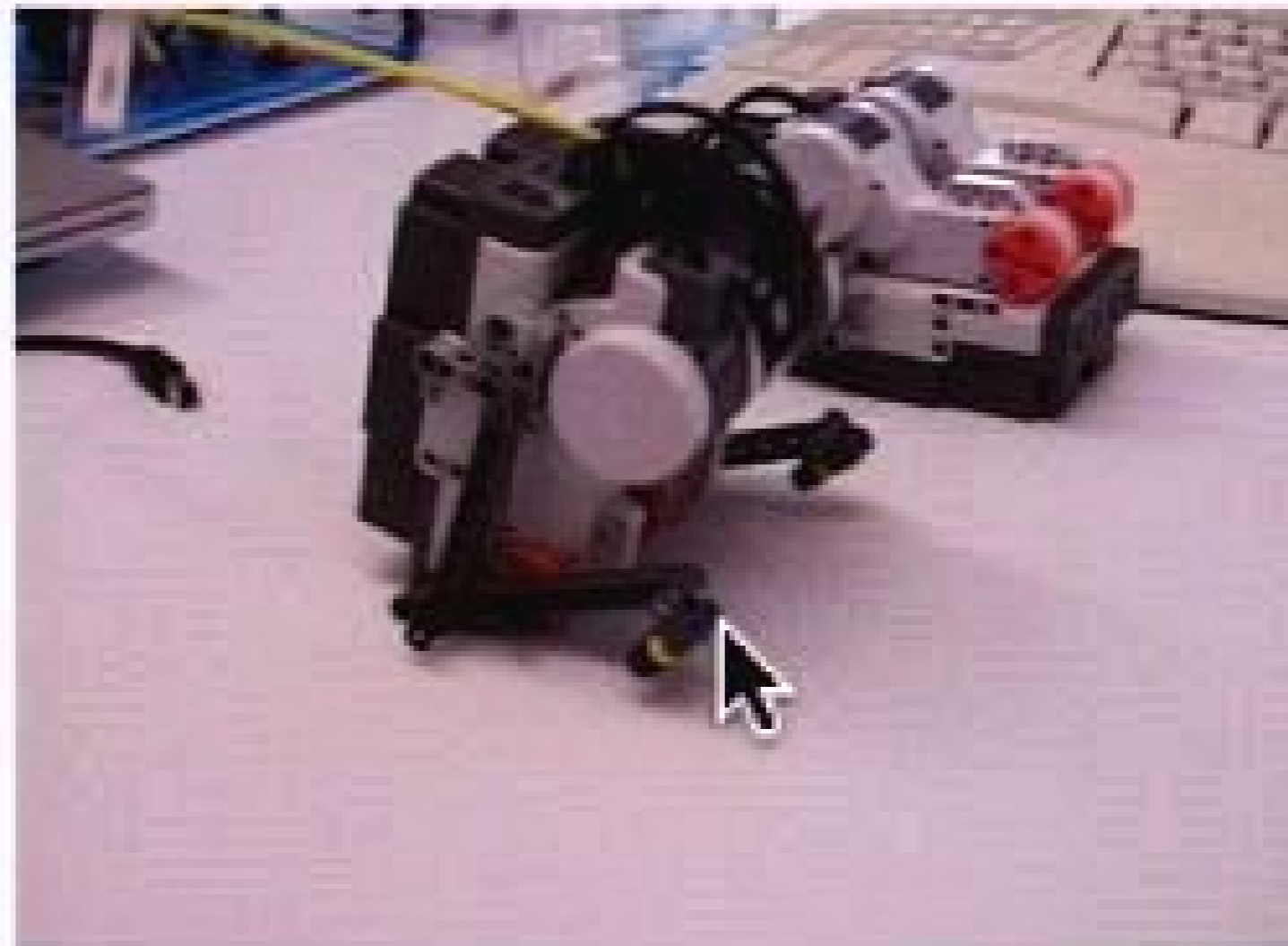
“Crazy Bird” — Morphology, Control



loosely hanging feet
rubber/plastic

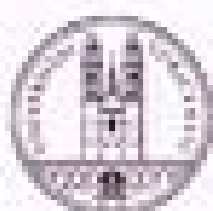


“Crazy Bird” — Morphology, Control



loosely hanging feet
rubber/plastic

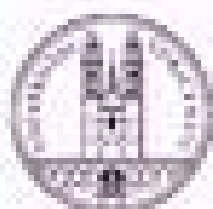
behavior of “Crazy Bird”:
only program?



Message 1: Physical embedding

Studying brain (or control) not sufficient: Understanding of

- **embedding of brain into organism**
- **organism's morphological and material properties**
- **environment required**



Let me be clear

The brain is important!

Let me be clear

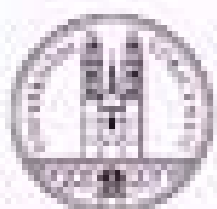
**The brain is important!
but not the whole story ...**

Message 2: Real/ Artificial-constructed worlds

Understanding the differences between

- **artificial/constructed worlds (e.g. industrial)**
- **real worlds (e.g. downtown area, shopping mall, school, home, soccer field)**

—> **different requirements for robots**



industrial environment

real-world environment

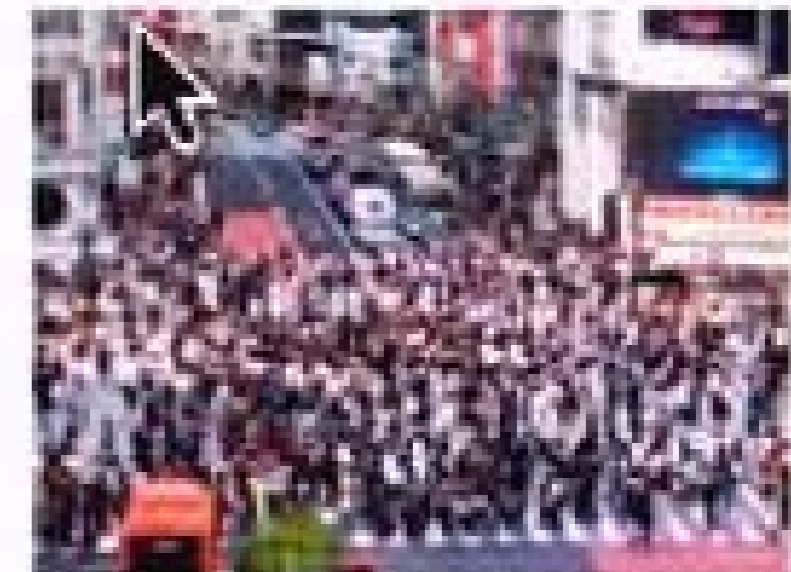


- high predictability
- programmability

- low predictability
- coping with uncertainty



industrial robots
("hard")



humans
("soft" to
varying
degrees)



industrial environment

real-world environment



- high predictability
- programmability

- low predictability
- coping with uncertainty



industrial robots
("hard")

humans
("soft" to
varying
degrees)

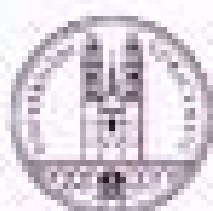


→ no direct transfer of methods

Transfer of methods?



Sony Qrio:
high stiffness
centralized control
computationally intensive



By comparison: The “Passive Dynamic Walker”



the “brainless” robot:
walking without control



Design and construction:
Ruina, Wisse, Collins: Cornell University
Ithaca, New York



Design and construction:
Bendy (Paul, Yokoi, Matsushita),
Tripp (Chandana Paul)



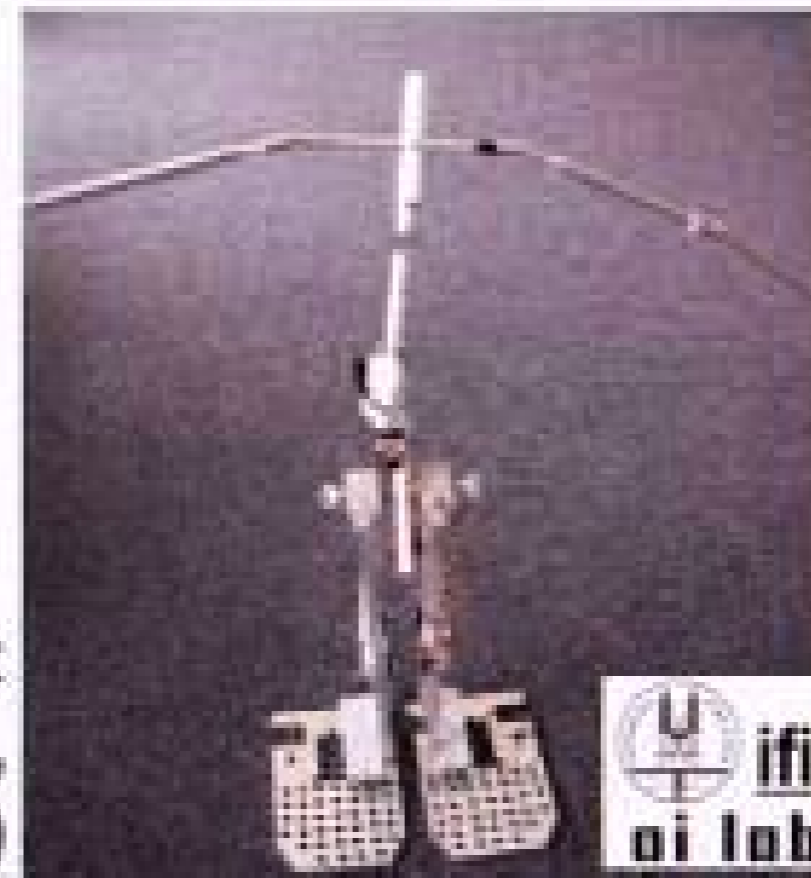
By comparison: The “Passive Dynamic Walker”



the “brainless” robot:
walking without control



Design and construction:
Ruina, Wisse, Collins: Cornell University
Ithaca, New York



Design and construction:
Bendy (Paul, Yokoi, Matsushita),
Tripp (Chandana Paul)



By comparison: The “Passive Dynamic Walker”



the “brainless” robot:
walking without control



Design and construction:
Ruina, Wisse, Collins: Cornell University
Ithaca, New York



Design and construction:
Bendy (Paul, Yokoi, Matsushita),
Tripp (Chandana Paul)

By comparison: The “Passive Dynamic Walker”

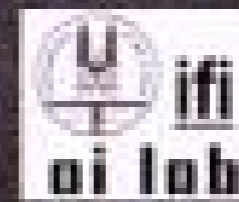


the “brainless” robot:
walking without control



Design and construction:
Ruina, Wisse, Collins: Cornell University
Ithaca, New York

Design and construction:
Bendy (Paul, Yokoi, Matsushita),
Tripp (Chandana Paul)



By comparison: The “Passive Dynamic Walker”



the “brainless” robot:
walking without control



self-stabilization

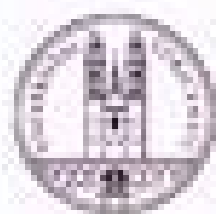
Design and construction:
Ruina, Wisse, Collins: Cornell University
Ithaca, New York

Design and construction:
Bendy (Paul, Yokoi, Matsushita),
Tripp (Chandana Paul)



Short question

memory for walking?



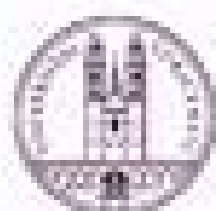
The Cornell Ranger



design and construction:
Andy Ruina
Cornell University



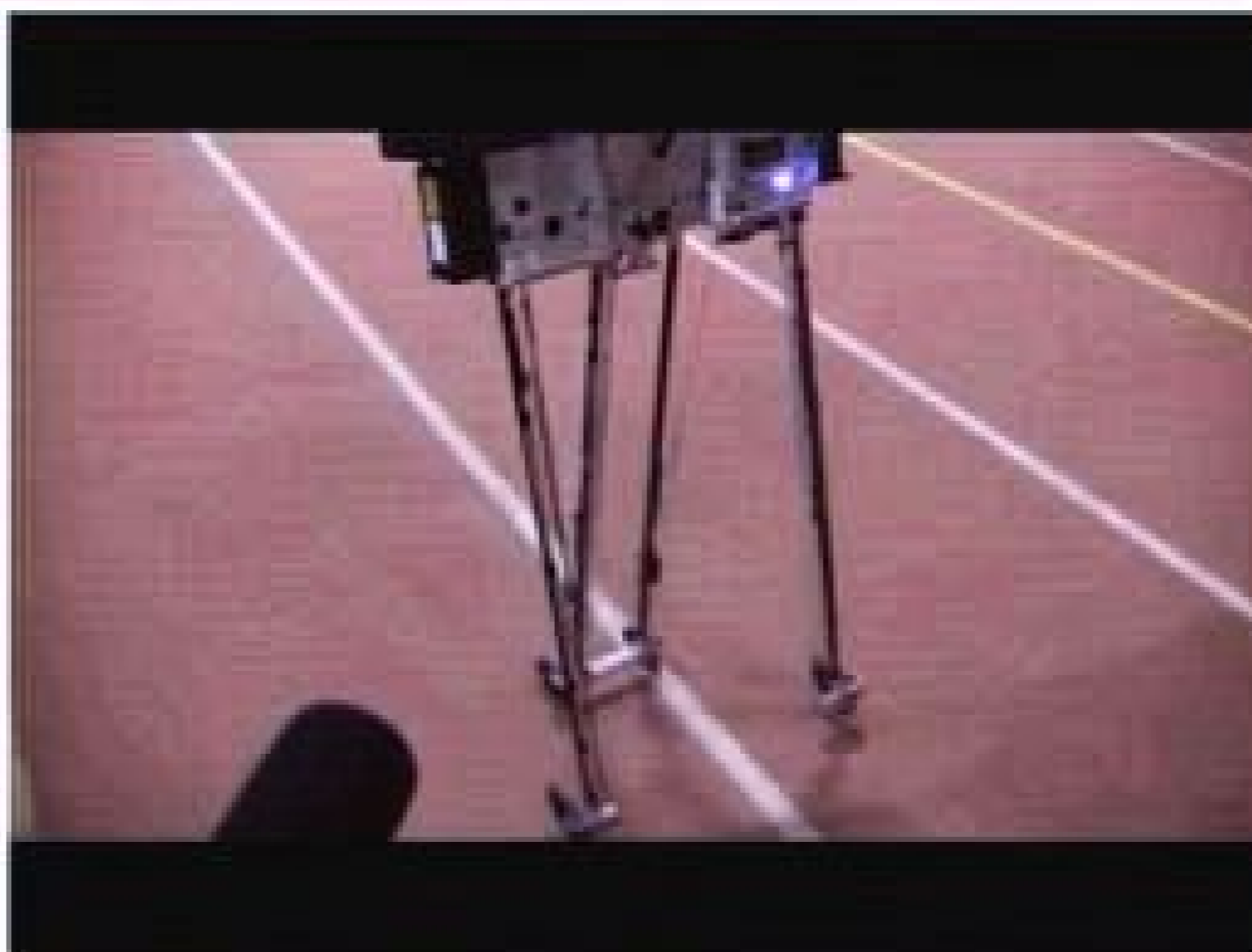
exploitation of passive dynamics



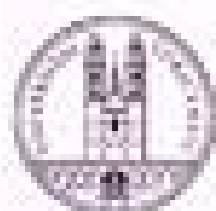
The Cornell Ranger



design and construction:
Andy Ruina
Cornell University



exploitation of passive dynamics



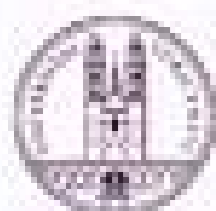
The Cornell Ranger



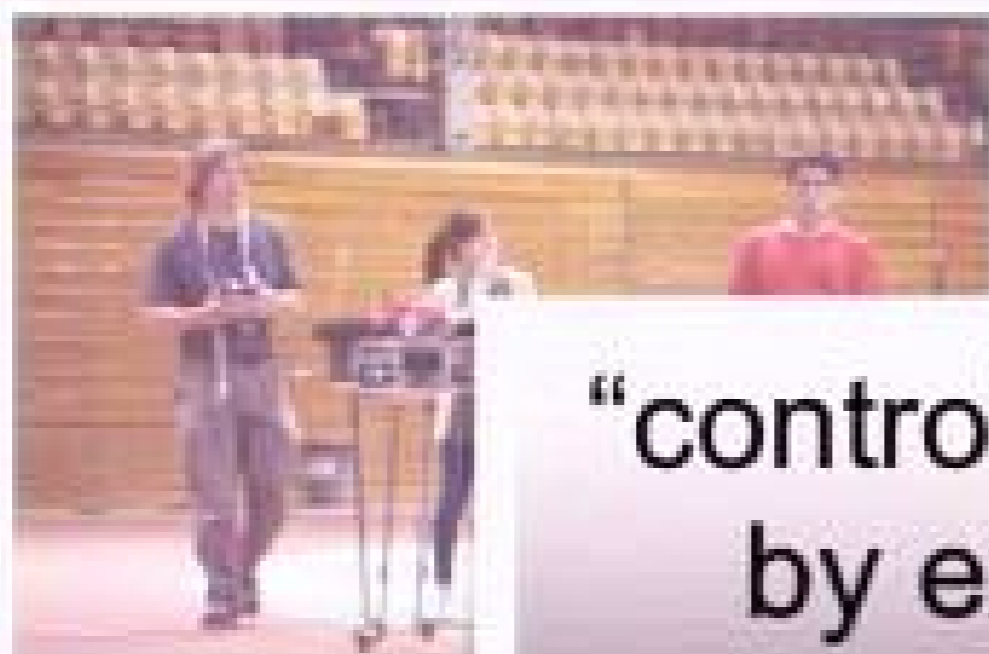
conception et construction:
Andy Ruina
Cornell University



65km with one battery charge!



The Cornell Ranger

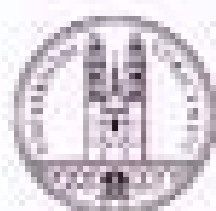


conception
Andy Ruina
Cornell University

“control” of locomotion
by exploitation of
passive dynamics



65km with one battery charge!



Contrast: Full control

Honda Asimo



Sony Qrio



Message 3: Task distribution

Task distribution between brain (control), body (morphology, materials), and environment

Message 3: Task distribution

Task distribution between brain (control), body (morphology, materials), and environment

no clear separation between control and hardware (“soft robotics”)

morphological
computation

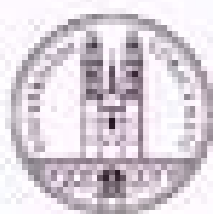
“Stumpy”: task distribution



almost brainless: 2 actuated joints
springy materials
surface properties of feet

Design and construction: Raja Dravid,
Chandana Paul, Fumiya Iida

self-stabilization



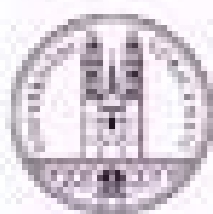
“Stumpy”: task distribution



almost brainless: 2 actuated joints
springy materials
surface properties of feet

Design and construction: Raja Dravid,
Chandana Paul, Fumiya Iida

self-stabilization



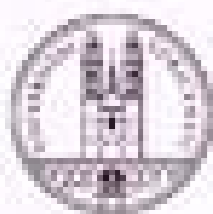
“Stumpy”: task distribution



almost brainless: 2 actuated joints
springy materials
surface properties of feet

Design and construction: Raja Dravid,
Chandana Paul, Fumiya Iida

self-stabilization



The dancing robot “Stumpy”

Collaboration with Louis-Philippe Demers,
Nanyang Technological University, Singapore




Movie:
Max Lungarella
Raja Dravid
Dynamic Devices
and Allab, Zurich

The “robot frog” driven by pneumatic actuators (UTokyo)

Design and construction:
**Ryuma Niiyama and
Yasuo Kuniyoshi**
University of Tokyo

pneumatic actuators:
compliant materials

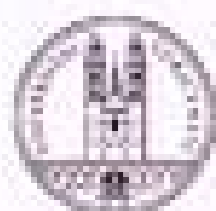


 THE UNIVERSITY OF TOKYO
Ryuma Niiyama, Yasuo Kuniyoshi,
“Mowgli: A Bipedal Jumping and Landing Robot”, ICRA 2007.

The “robot frog” driven by pneumatic actuators (UTokyo)

Design and construction:
**Ryuma Niiyama and
Yasuo Kuniyoshi**
University of Tokyo

pneumatic actuators:
compliant materials



The “robot frog” driven by pneumatic actuators (UTokyo)

High Speed Cam
(125 fps)



Design and construction:
Ryuma Niiyama and
Yasuo Kuniyoshi
University of Tokyo

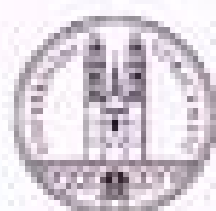
pneumatic actuators:
compliant materials



THE UNIVERSITY OF TOKYO

Ryuma Niiyama, Yasuo Kuniyoshi,

“Mowgli: A Bipedal Jumping and Landing Robot”, ICRA 2005



University of
Zurich ^{UNZ}

robotics  Swiss National
Centre of Competence
in Research

ai lab

The “robot frog” driven by pneumatic actuators (UTokyo)

High Speed Cam
(125 fps)

Design and construction:
Ryuma Niiyama and
Yasuo Kuniyoshi
University of Tokyo

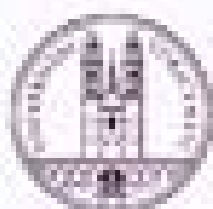
pneumatic actuators:
compliant materials



THE UNIVERSITY OF TOKYO

Ryuma Niiyama, Yasuo Kuniyoshi,

“Mowgli: A Bipedal Jumping and Landing Robot”, ICRA 2007.



University of
Zurich ^{LMR}

robotics ^o Swiss National
Centre of Competence
in Research

ai lab

Message 3: Task distribution

Task distribution between brain (control), body (morphology, materials), and environment

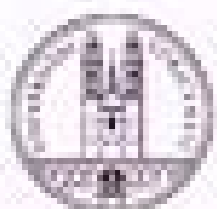
no clear separation between control and hardware (“soft robotics”)

morphological
computation
re-thinking of “control”
 (“orchestration”)

Morphological Computation also: sensory side

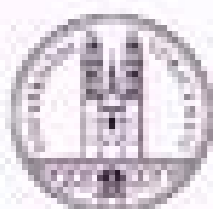
- non-homogeneous arrangement of facets in insect eye
- log-polar arrangement of receptors in human retina

strong contrast to
standard cameras



Contents

- introduction and background
- the four messages of embodiment
- **the “power of materials”**
- **summary and conclusions**
- **the “Roboy” project**



The power of materials: The robot fish “Wanda”

design and construction:
Marc Ziegler, AI Lab, UZH

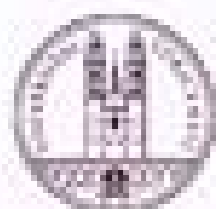
materials

changeable stiffness

**maneuverability in
3D space**



The Octopus Robot: a paradigmatic case study





Exploiting materials: Octopus (EU Project)



coordinator:
Cecilia Laschi (SSSA)



Octopus Arm
Design and construction:
Matteo Cianchetti (SSSA)
Cecilia Laschi (SSSA)
Tao Li (UZH)
naveen Kuppuswami (UZH)
Kohei Nakajima (UZH)



Octopus arm movements

Octopus Arm
Design and construction:

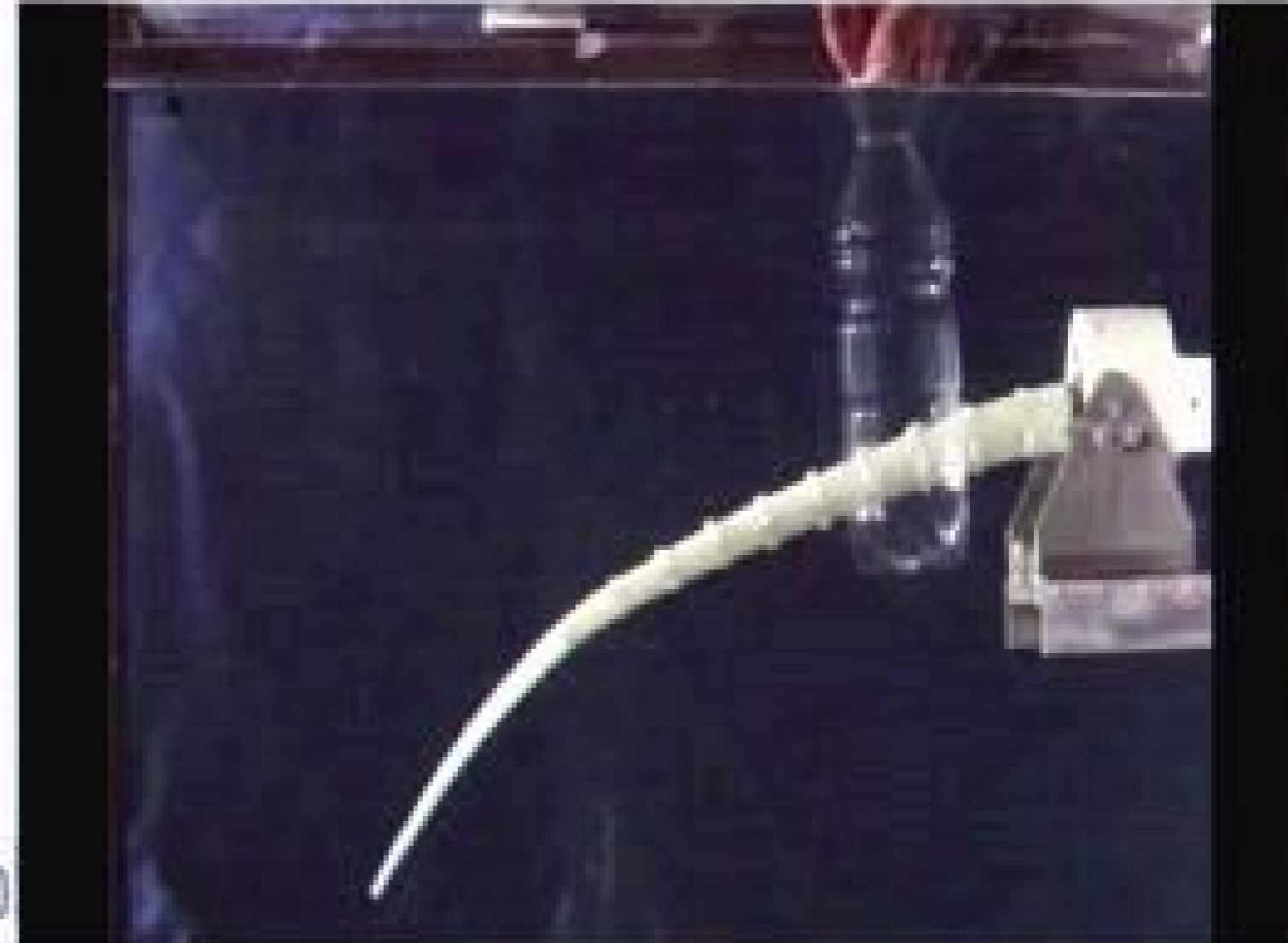
Matteo Cianchetti (SSSA)

Cecilia Laschi (SSSA)

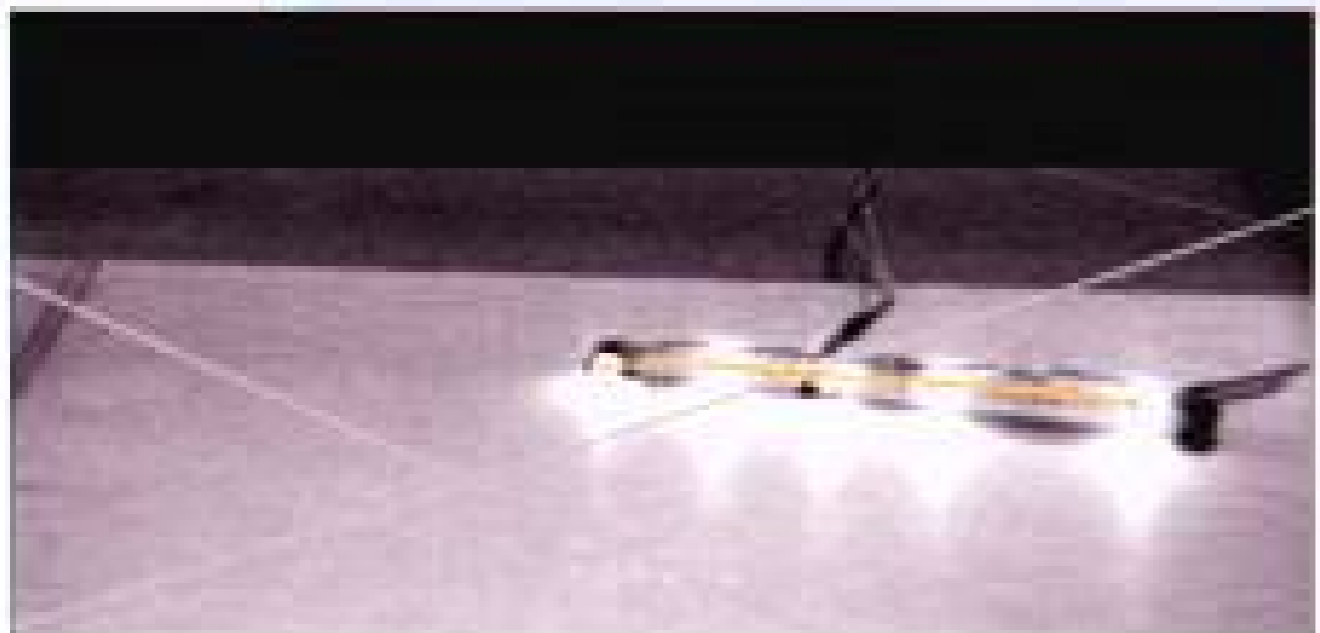
Tao Li (UZH)

Naveen Kuppuswami (UZH)

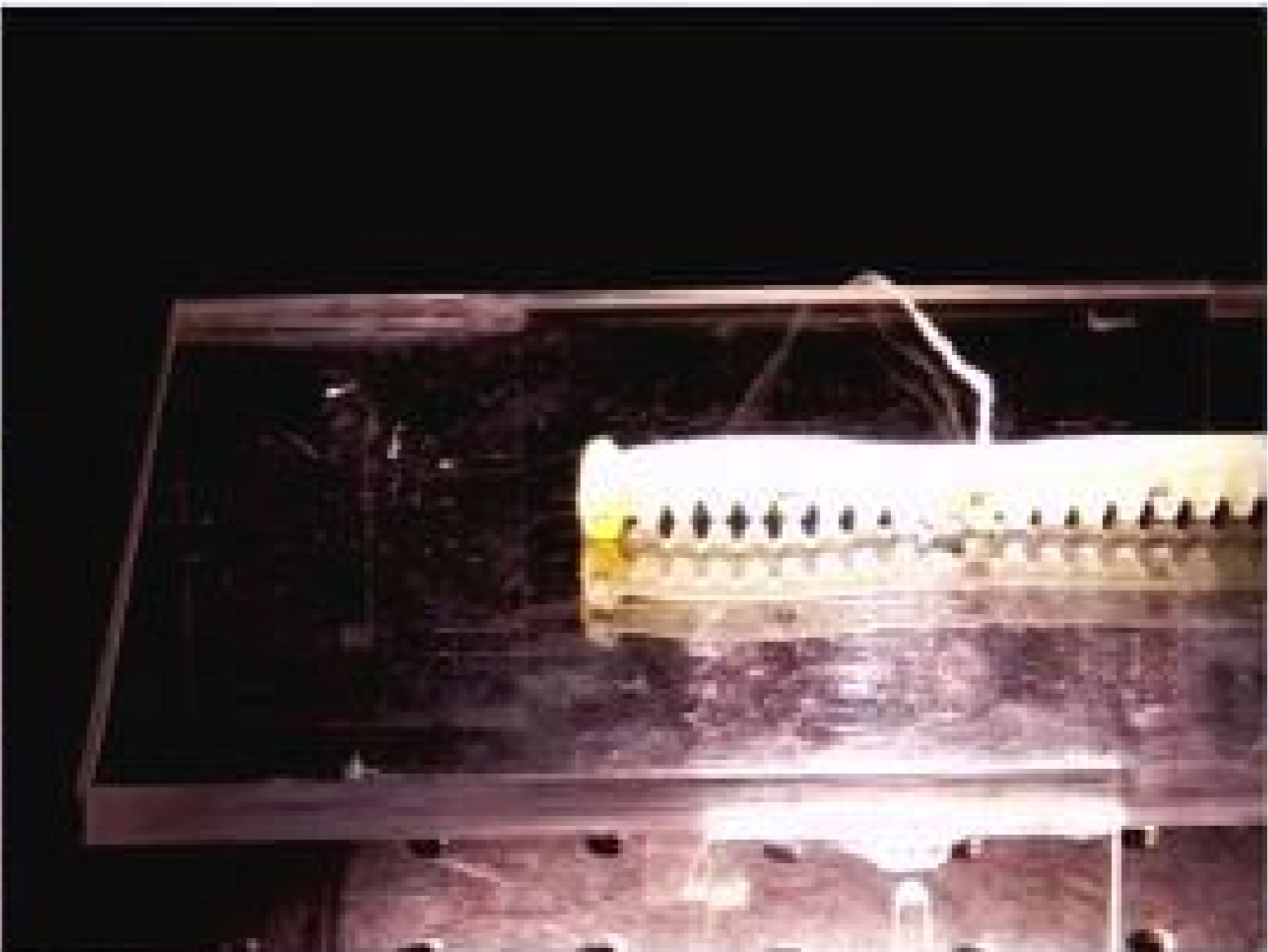
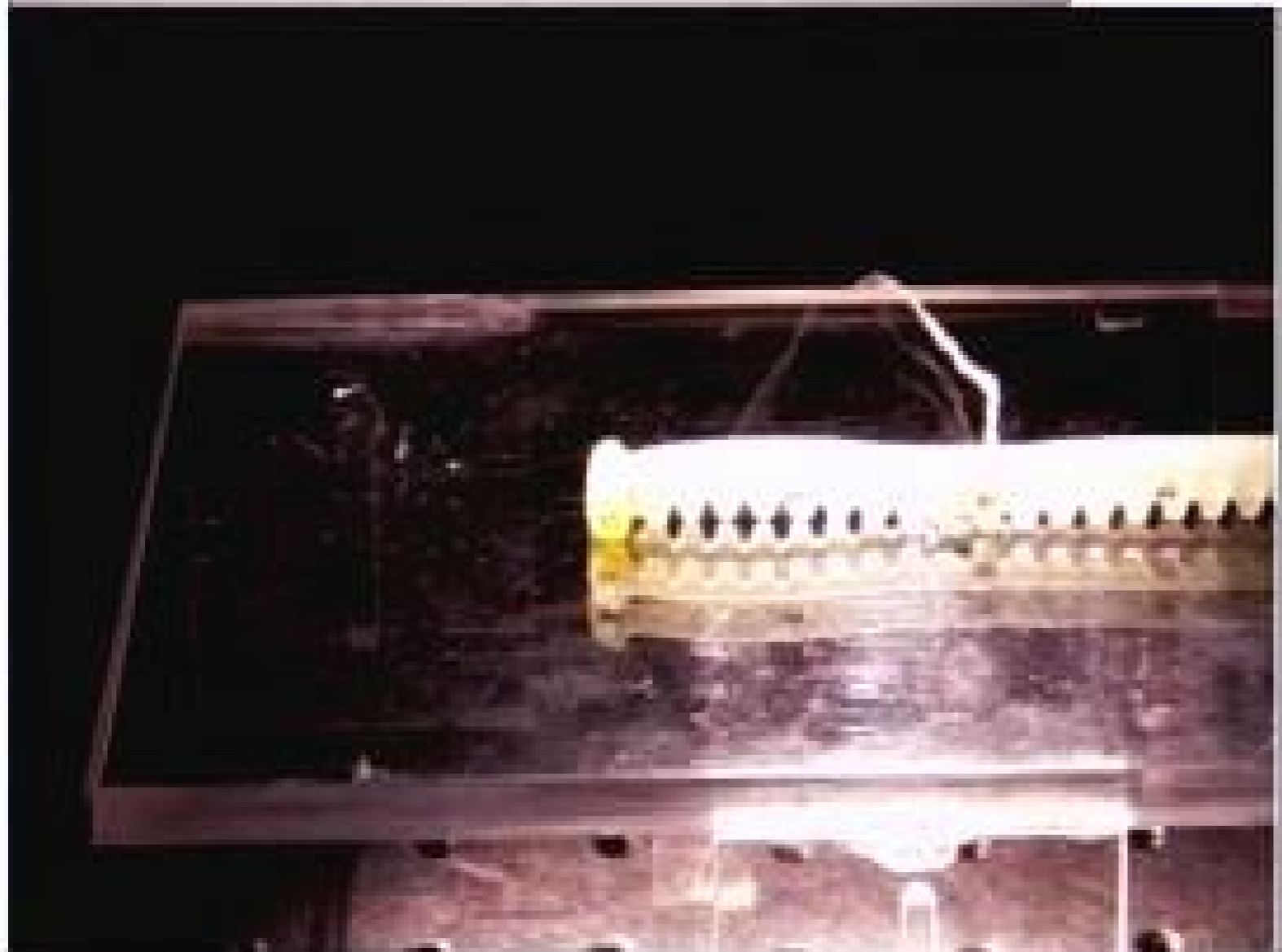
Kohei Nakajima (UZH)



Inching and rolling: GoQBot (Barry Trimmer's caterpillar robots)



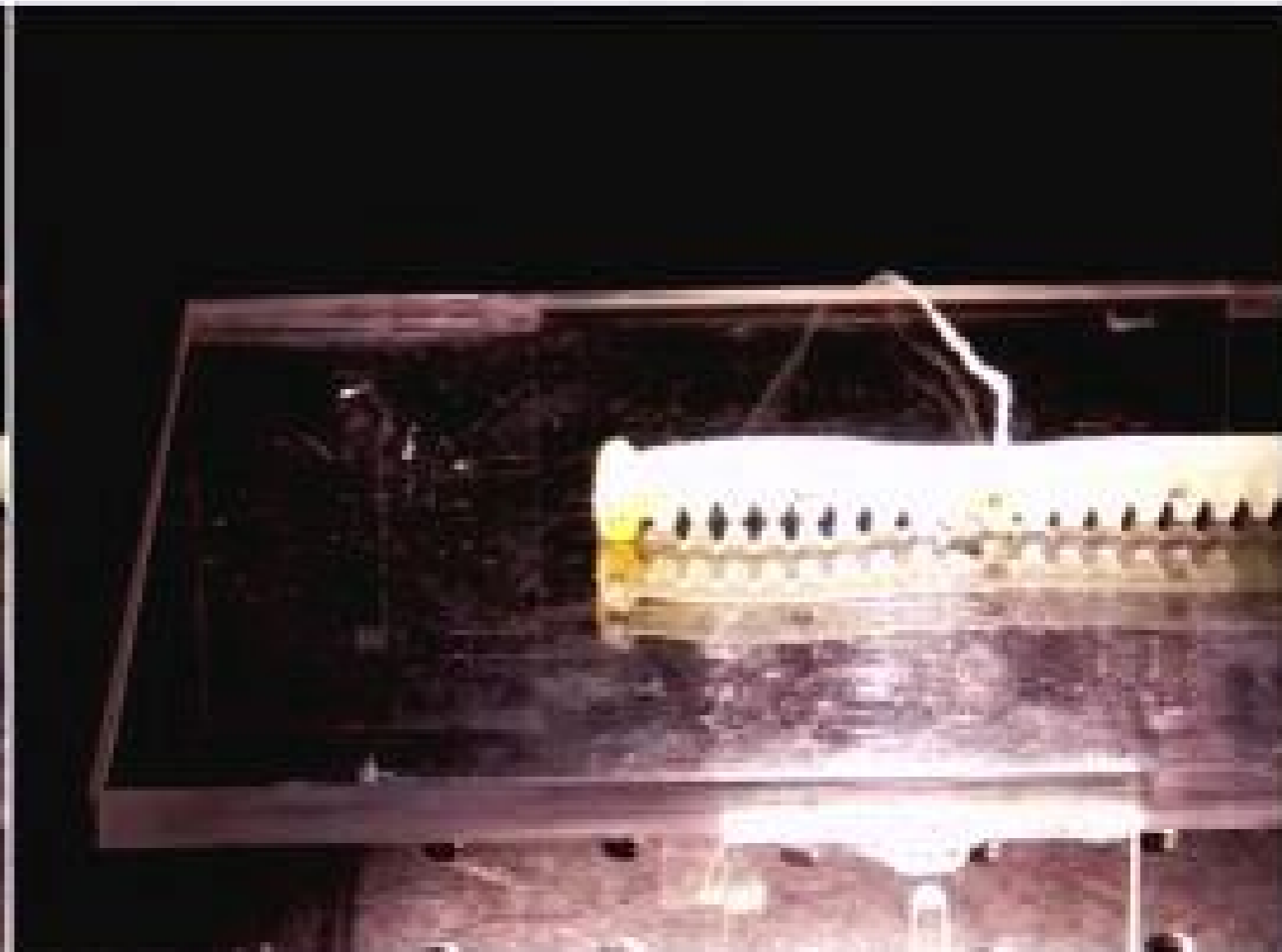
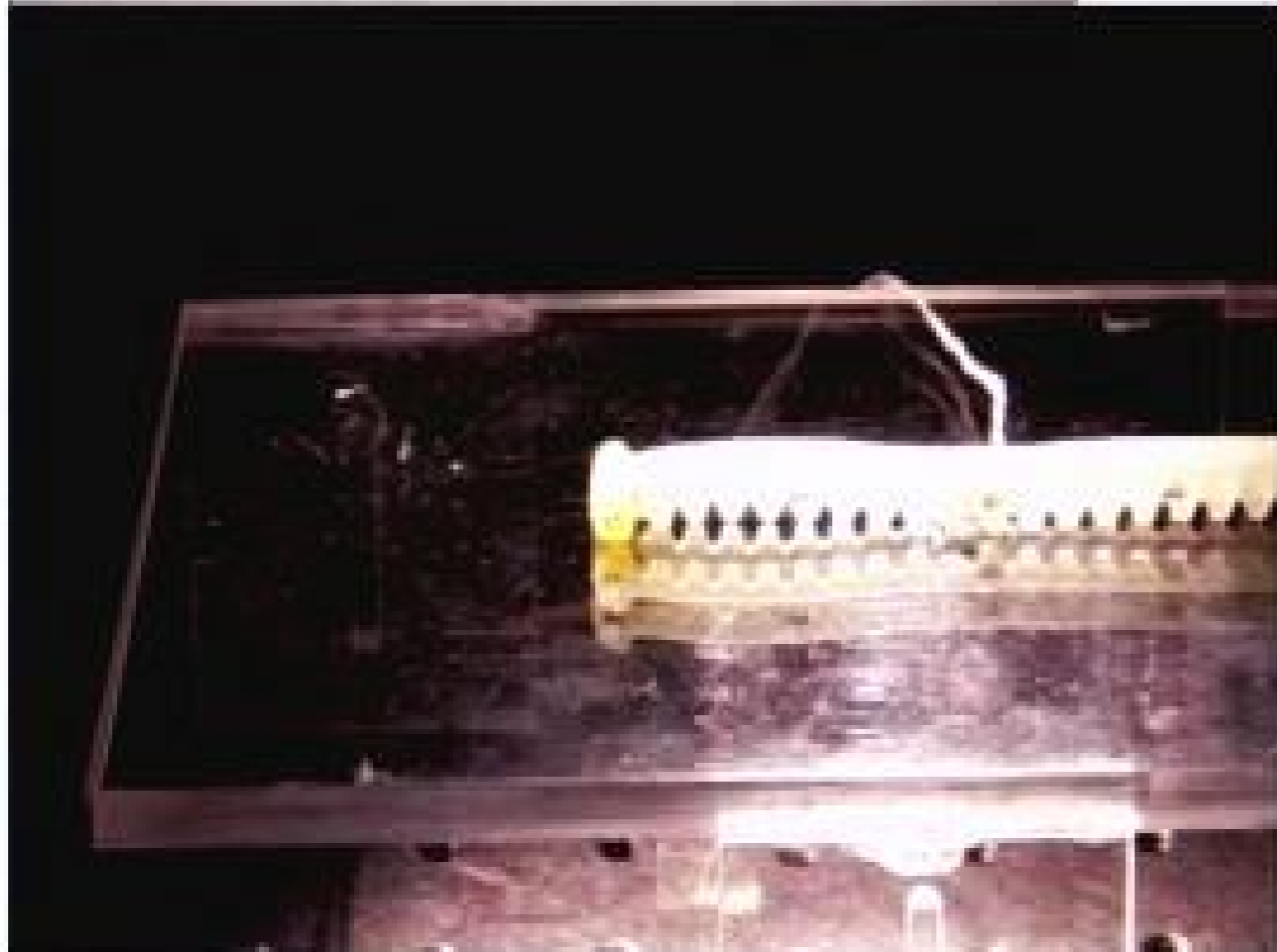
design and construction:
Barry Trimmer, Tuft's University, Boston



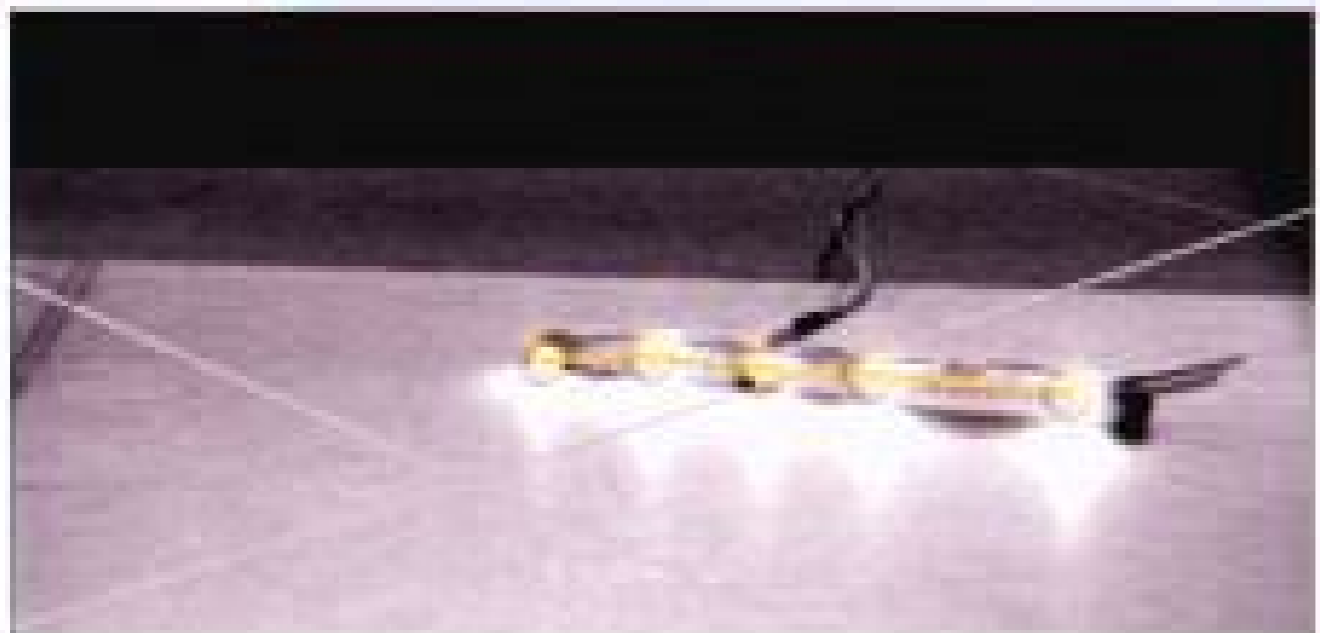
Inching and rolling: GoQBot (Barry Trimmer's caterpillar robots)



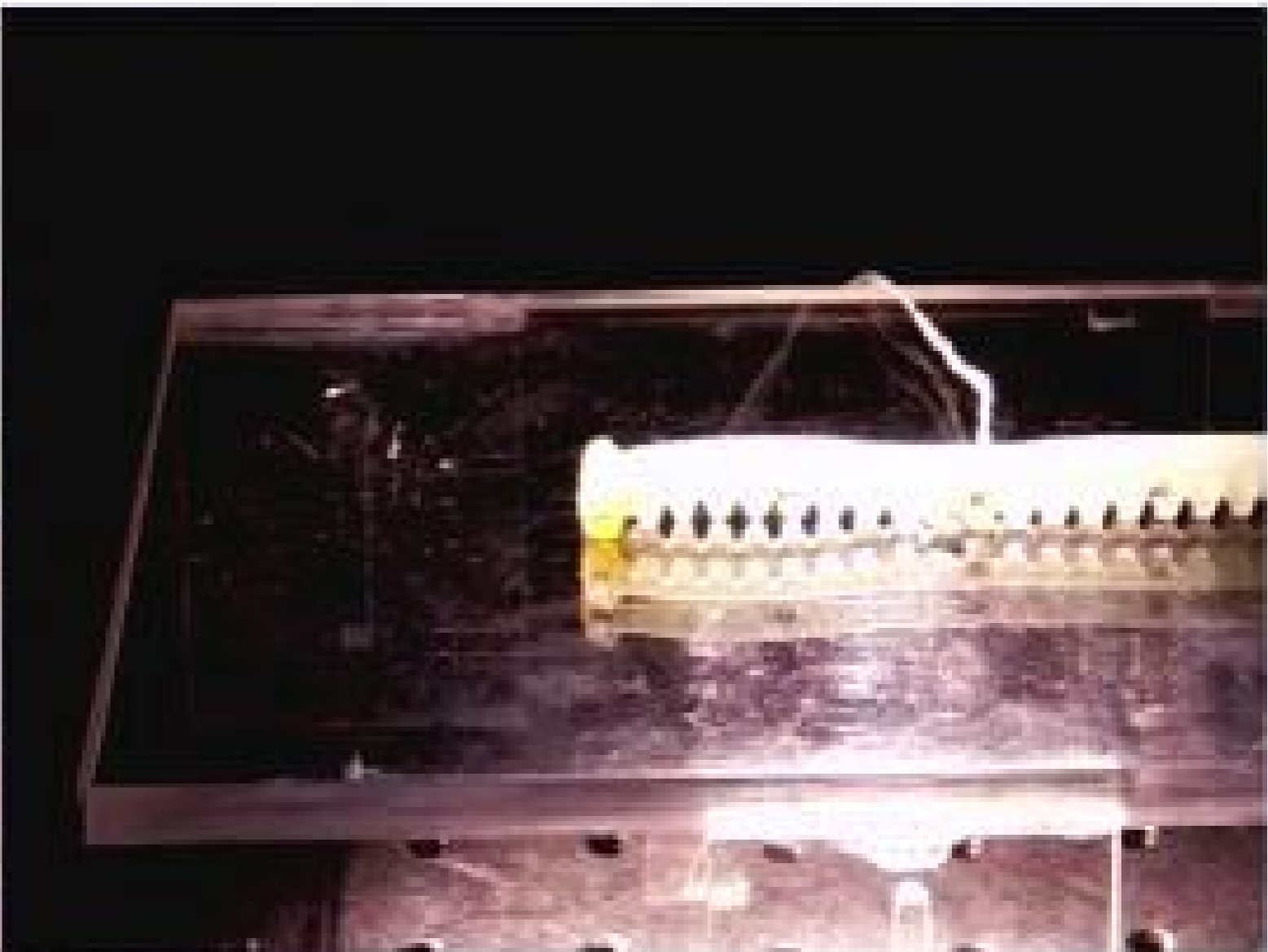
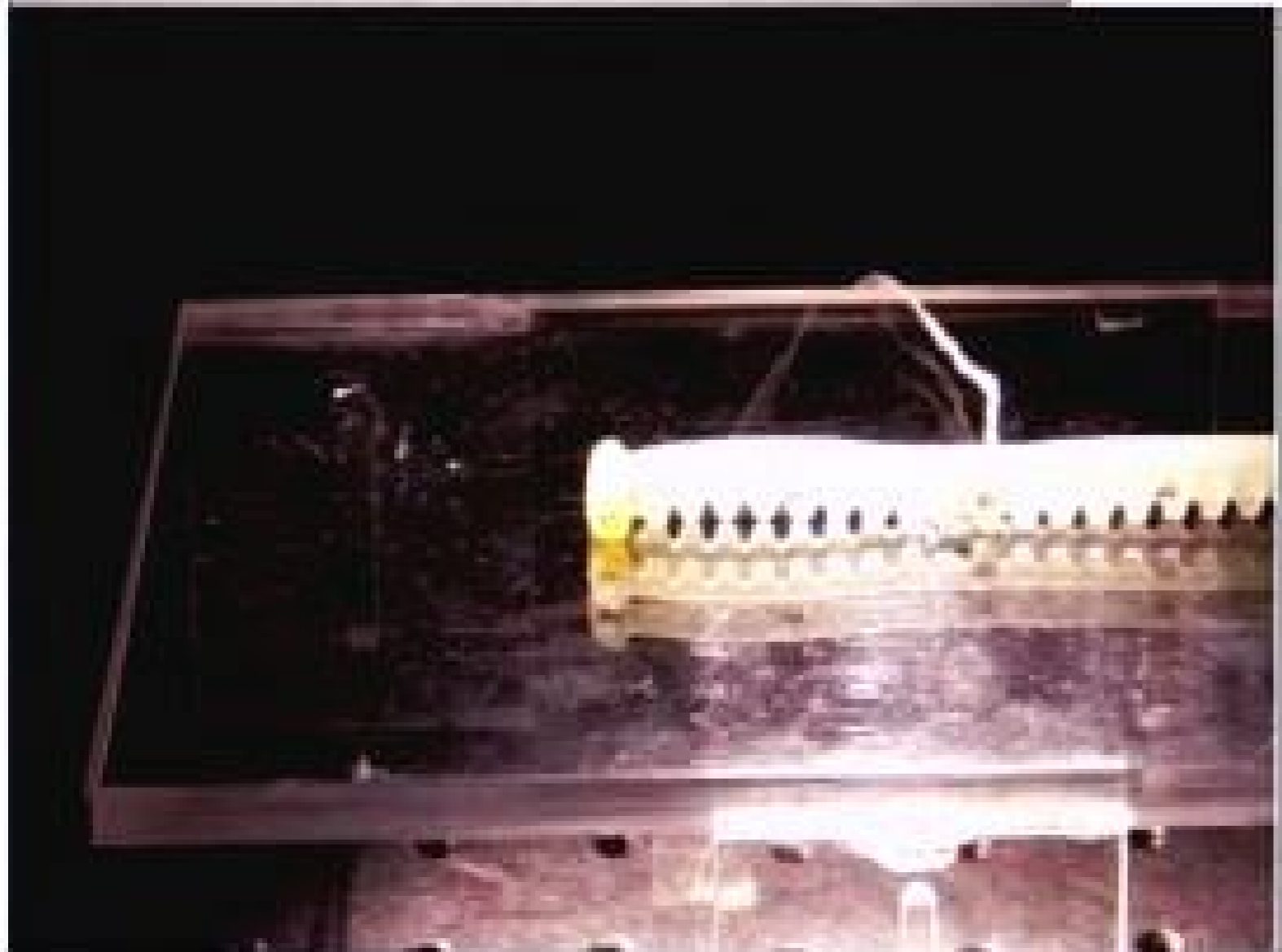
design and construction:
Barry Trimmer, Tuft's University, Boston



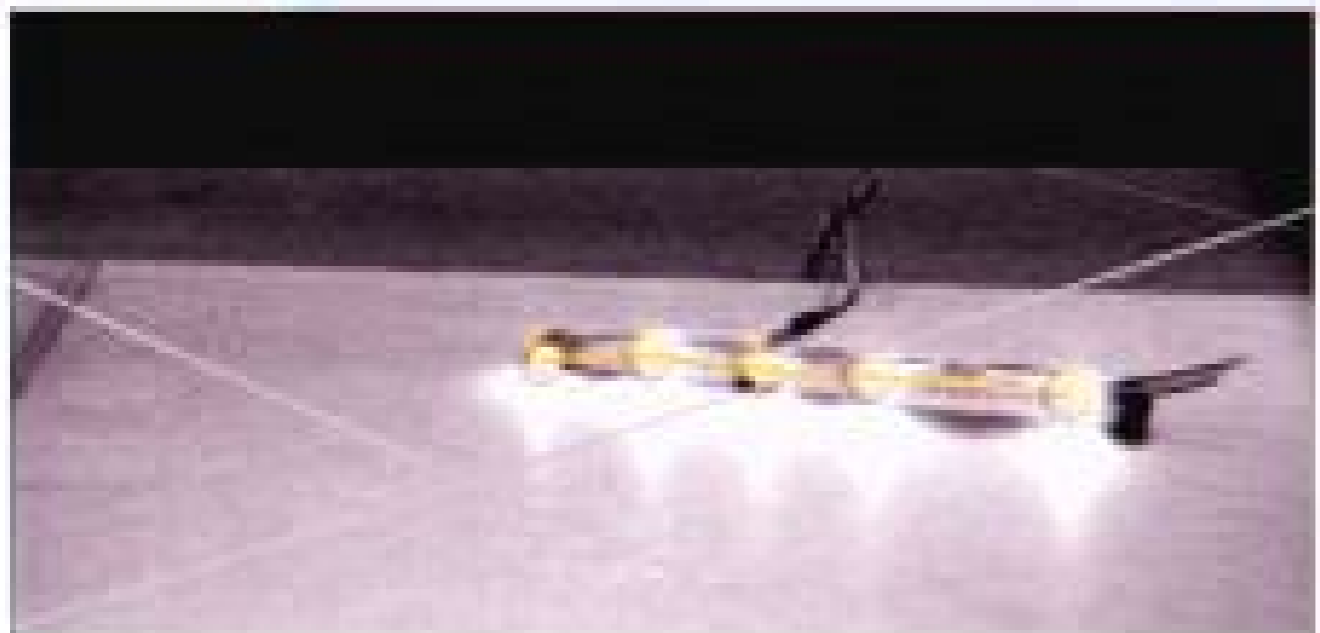
Inching and rolling: GoQBot (Barry Trimmer's caterpillar robots)



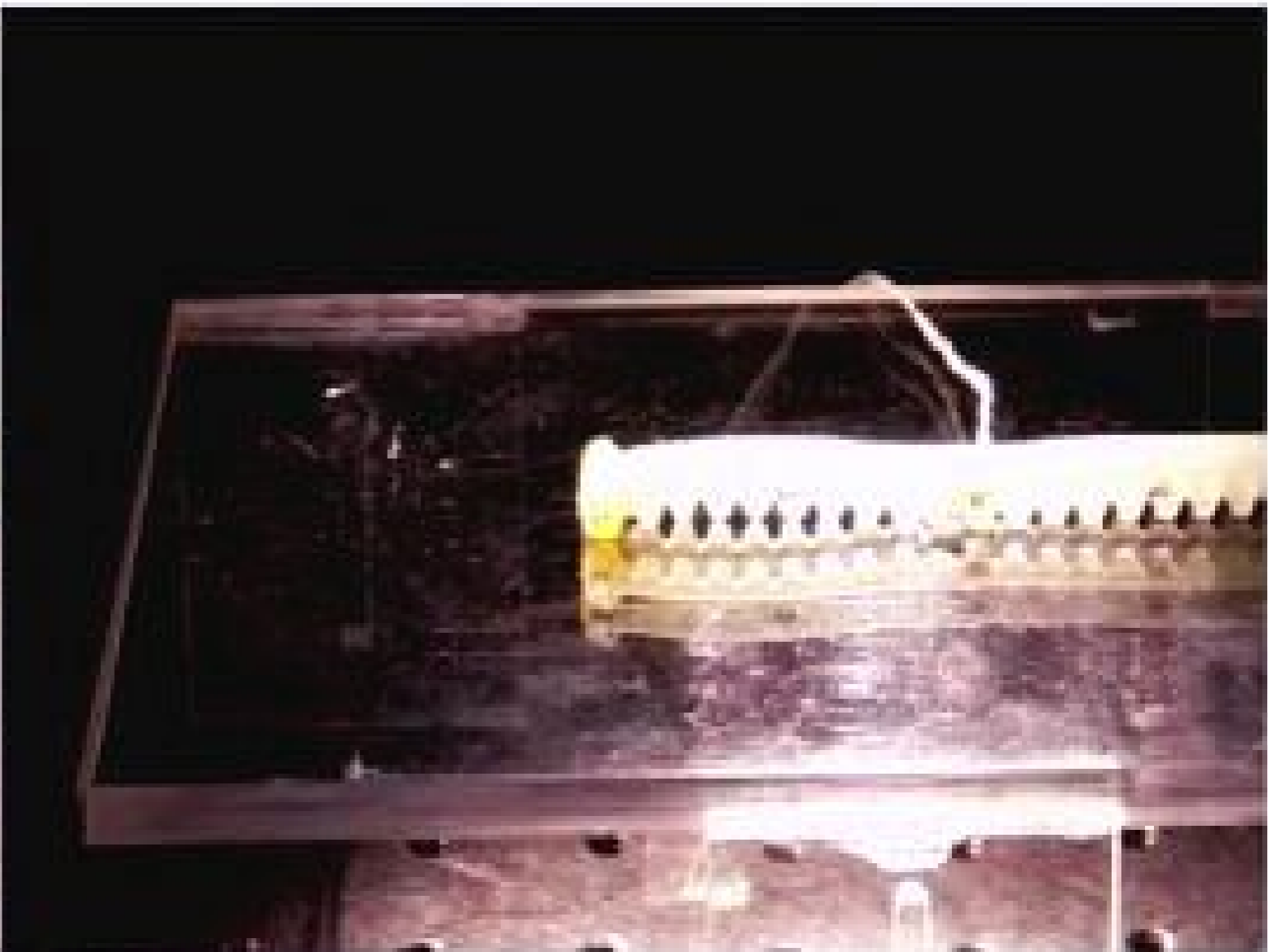
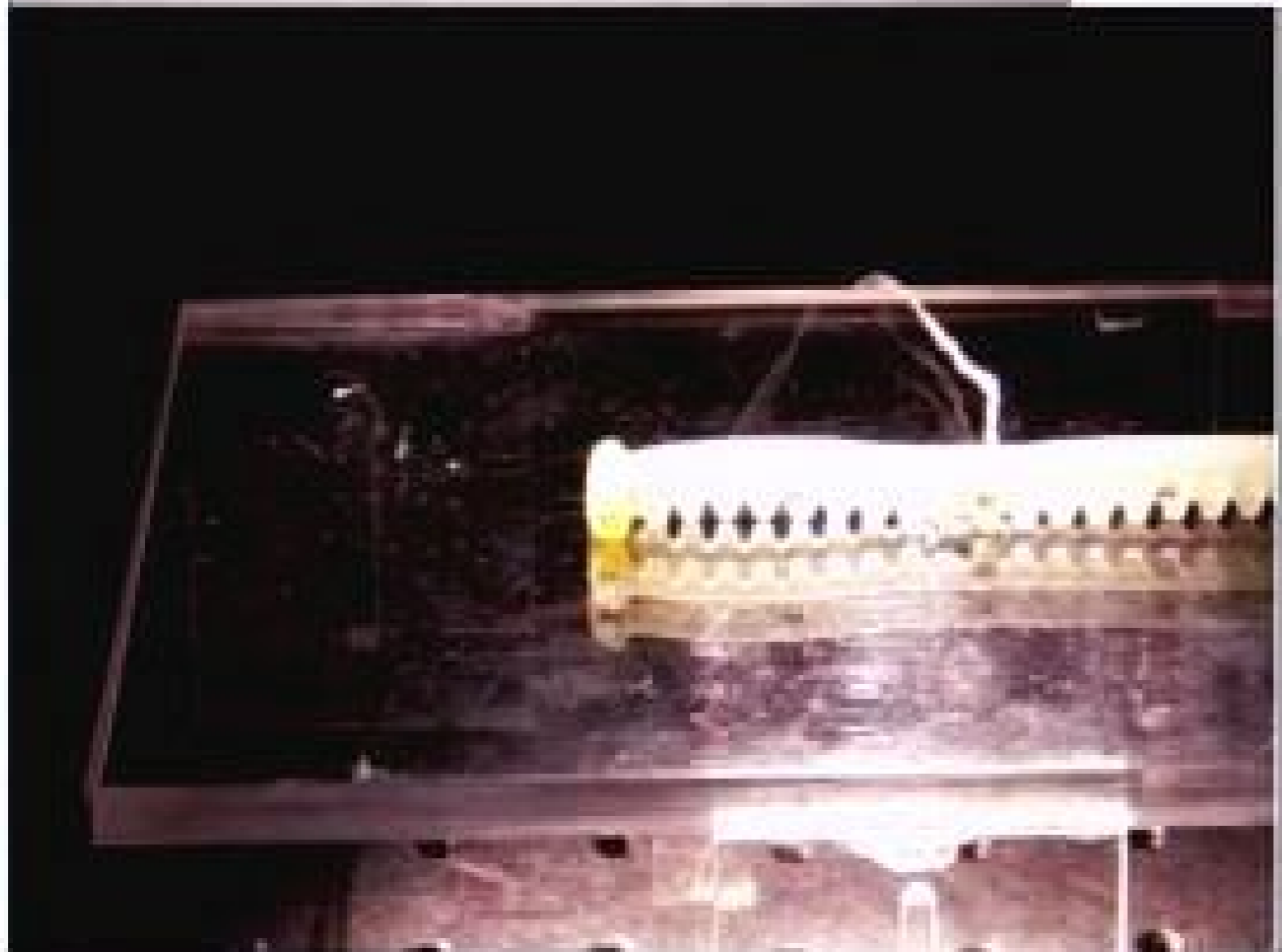
design and construction:
Barry Trimmer, Tuft's University, Boston



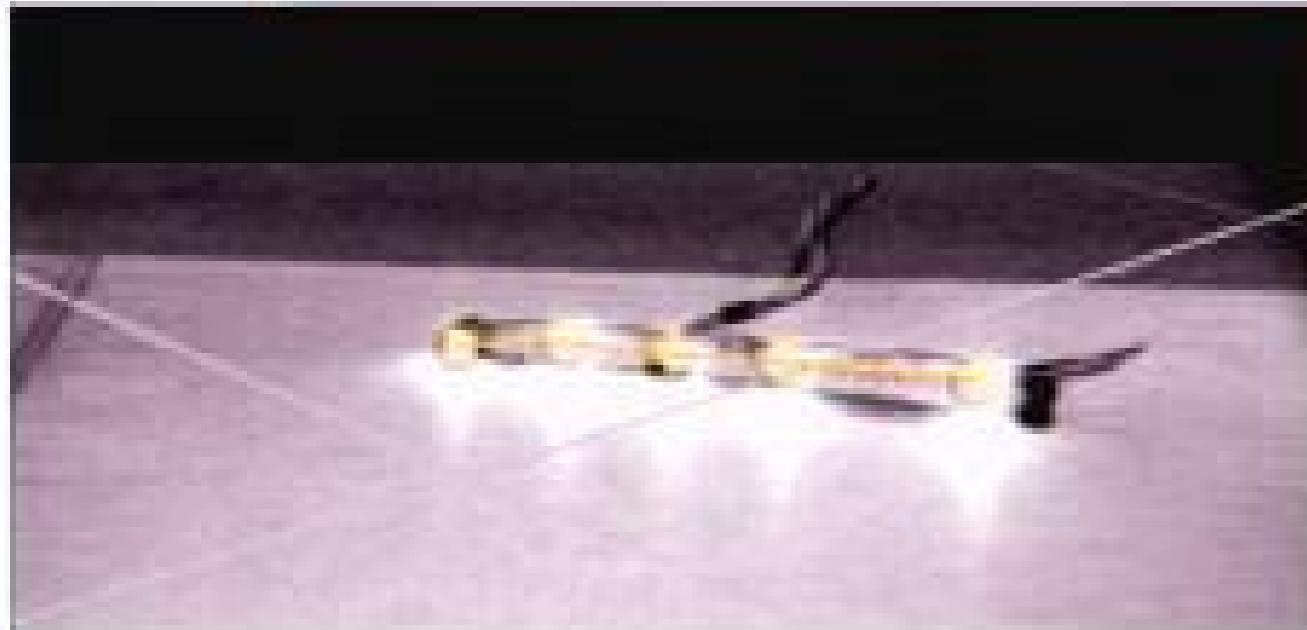
Inching and rolling: GoQBot (Barry Trimmer's caterpillar robots)



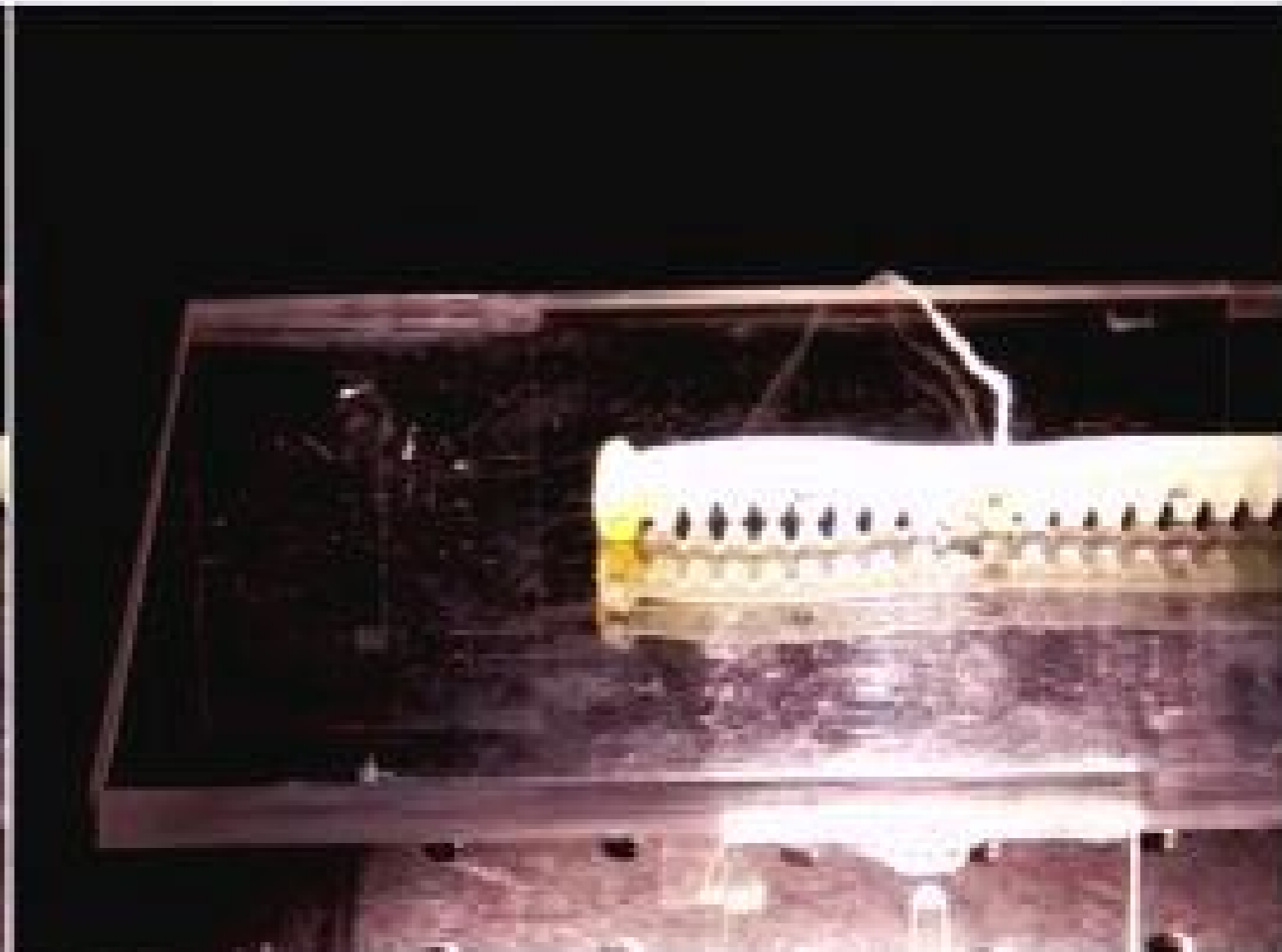
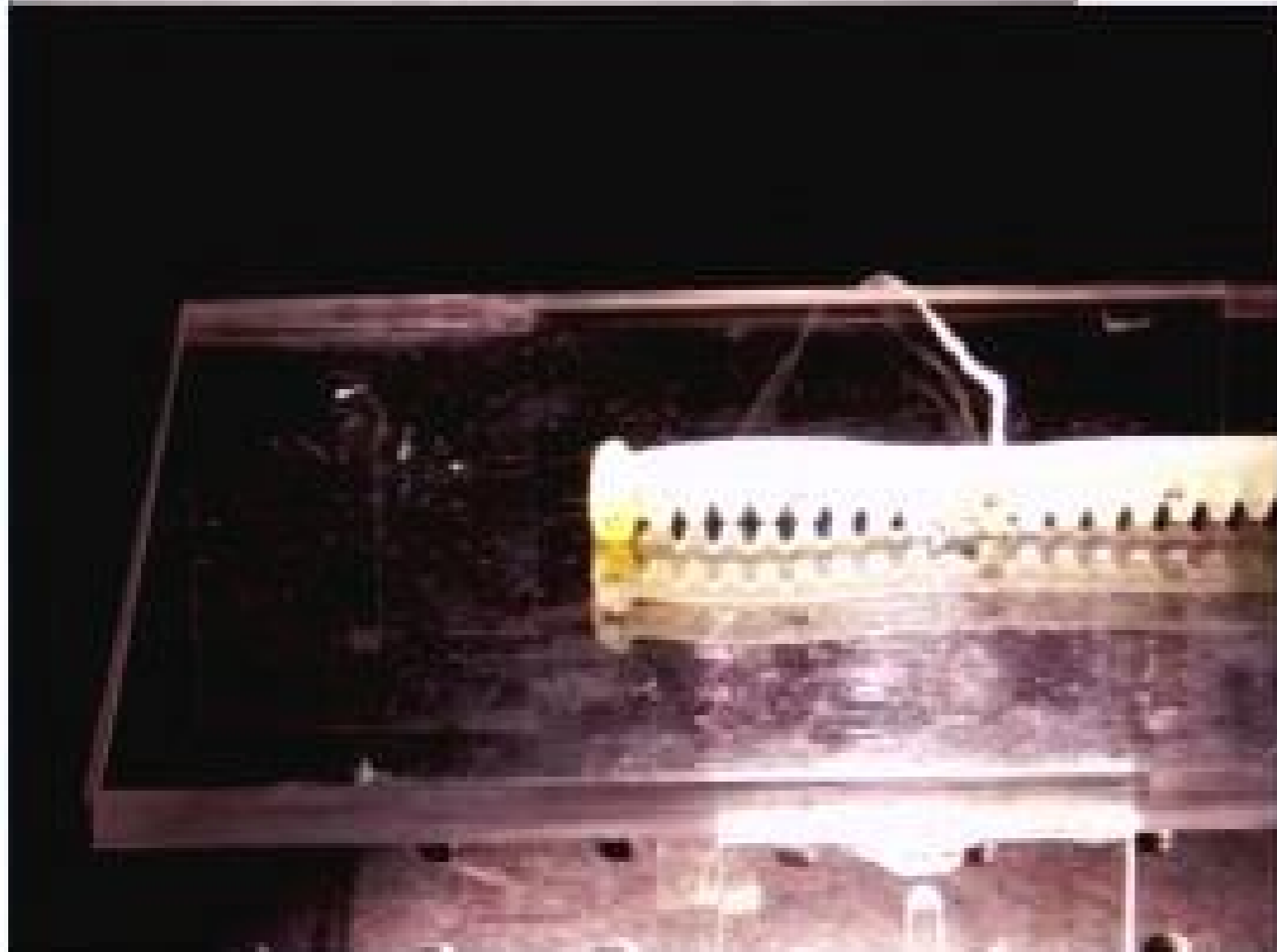
design and construction:
Barry Trimmer, Tuft's University, Boston



Inching and rolling: GoQBot (Barry Trimmer's caterpillar robots)



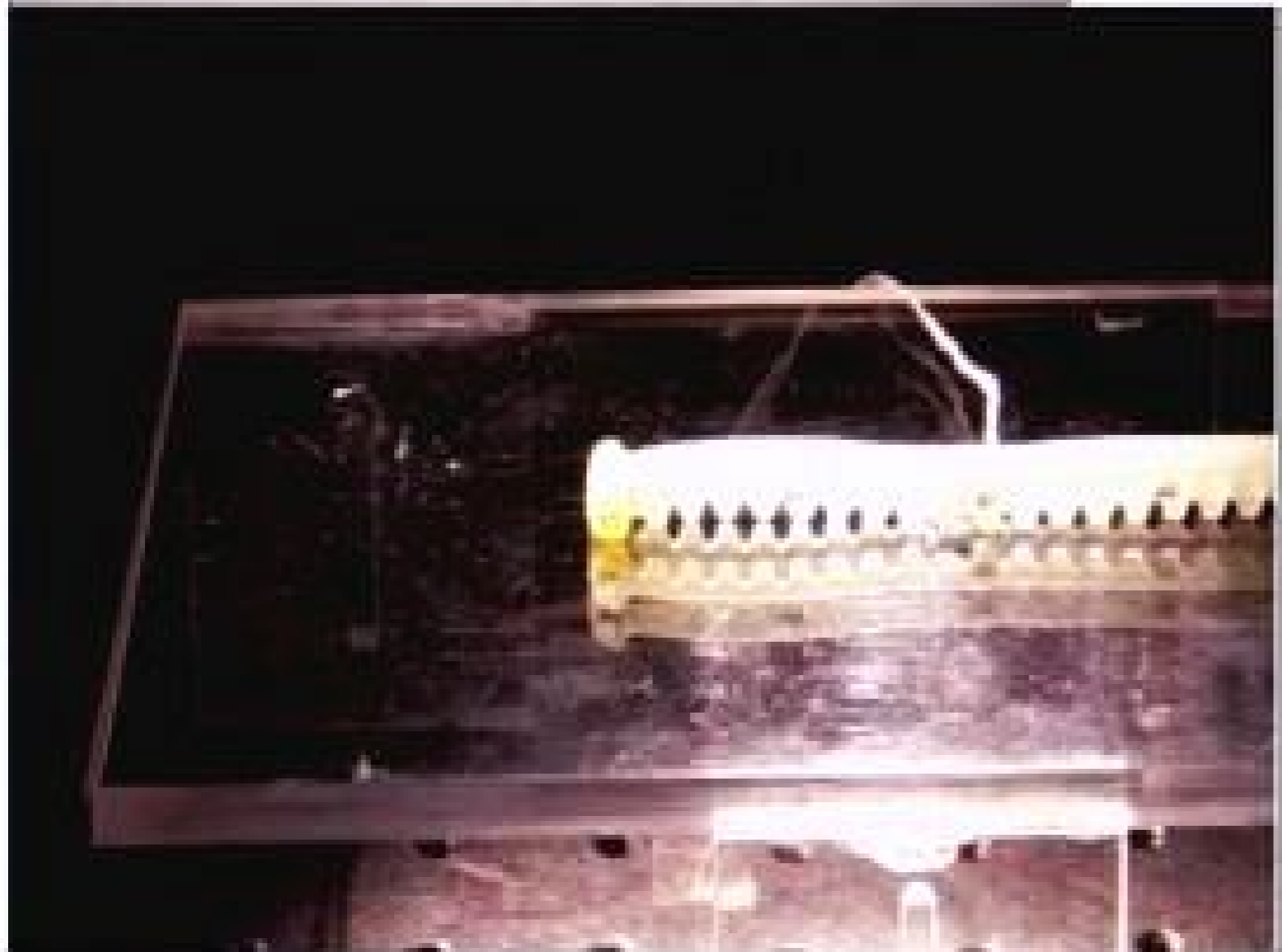
design and construction:
Barry Trimmer, Tuft's University, Boston



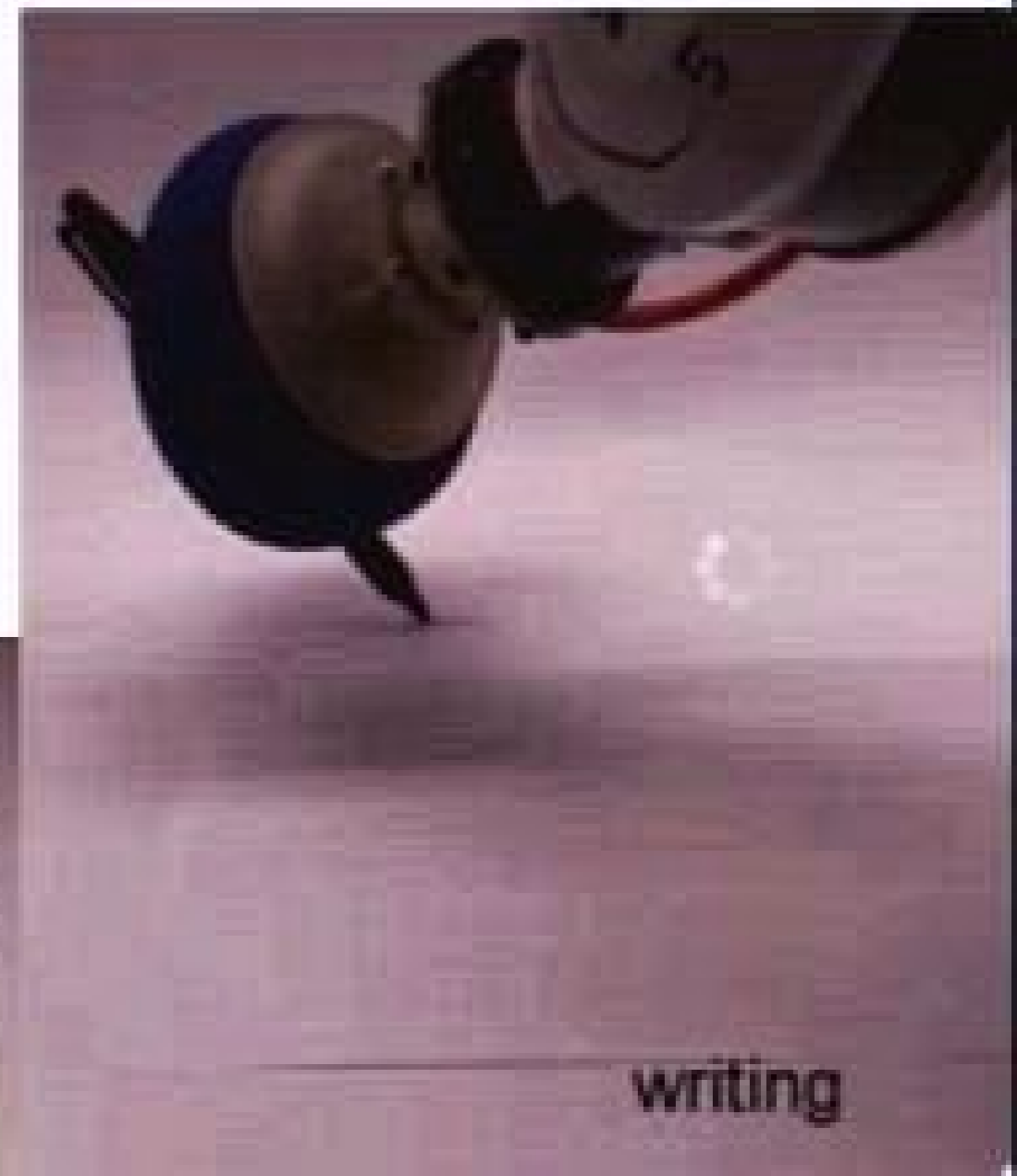
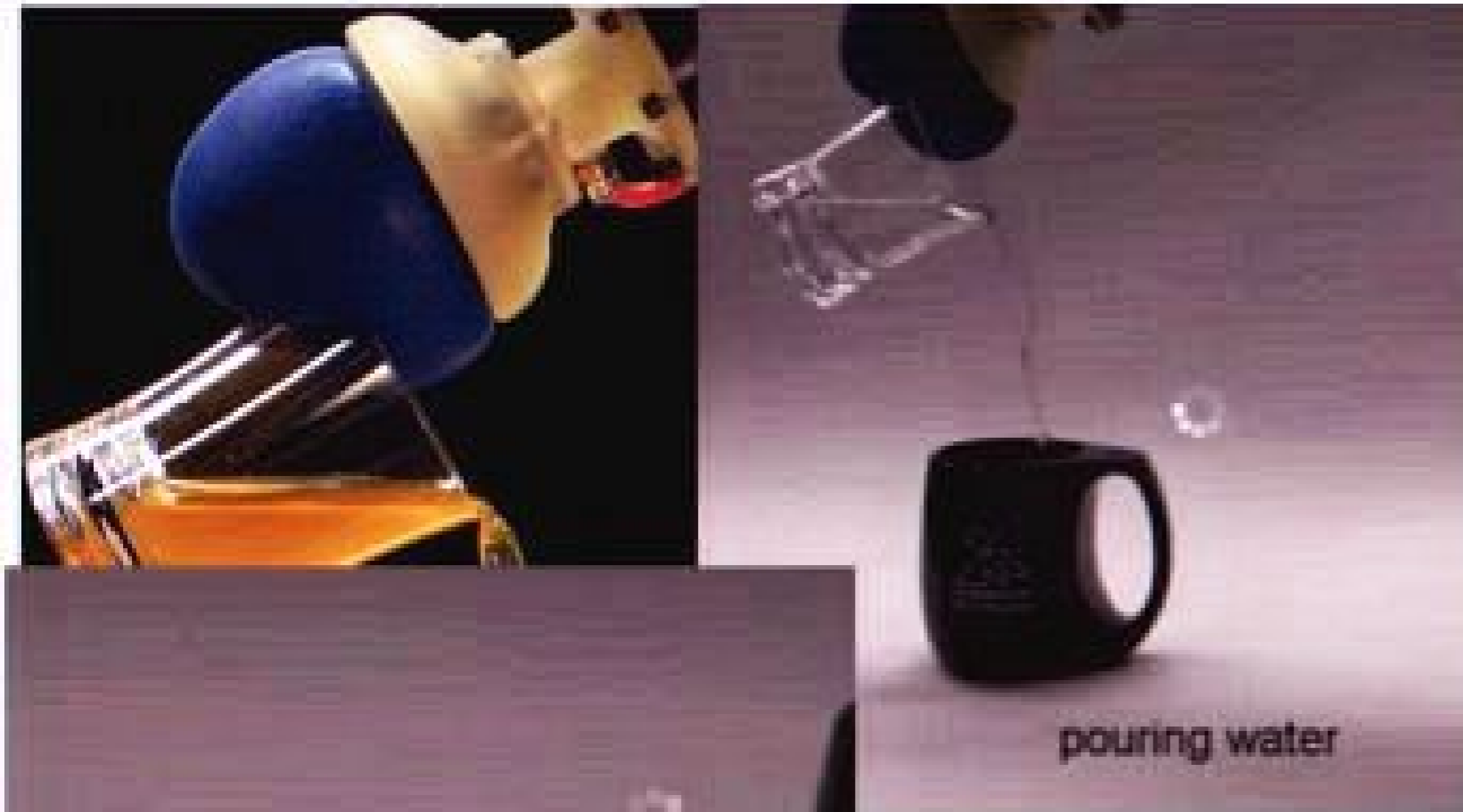
Inching and rolling: GoQBot (Barry Trimmer's caterpillar robots)



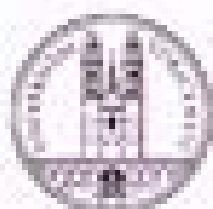
design and construction:
Barry Trimmer, Tuft's University, Boston



Jaeger/Lipson “coffee balloon gripper”



Jaeger/Lipson “coffee balloon gripper”



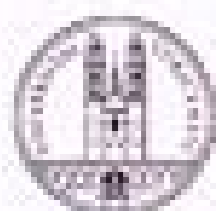
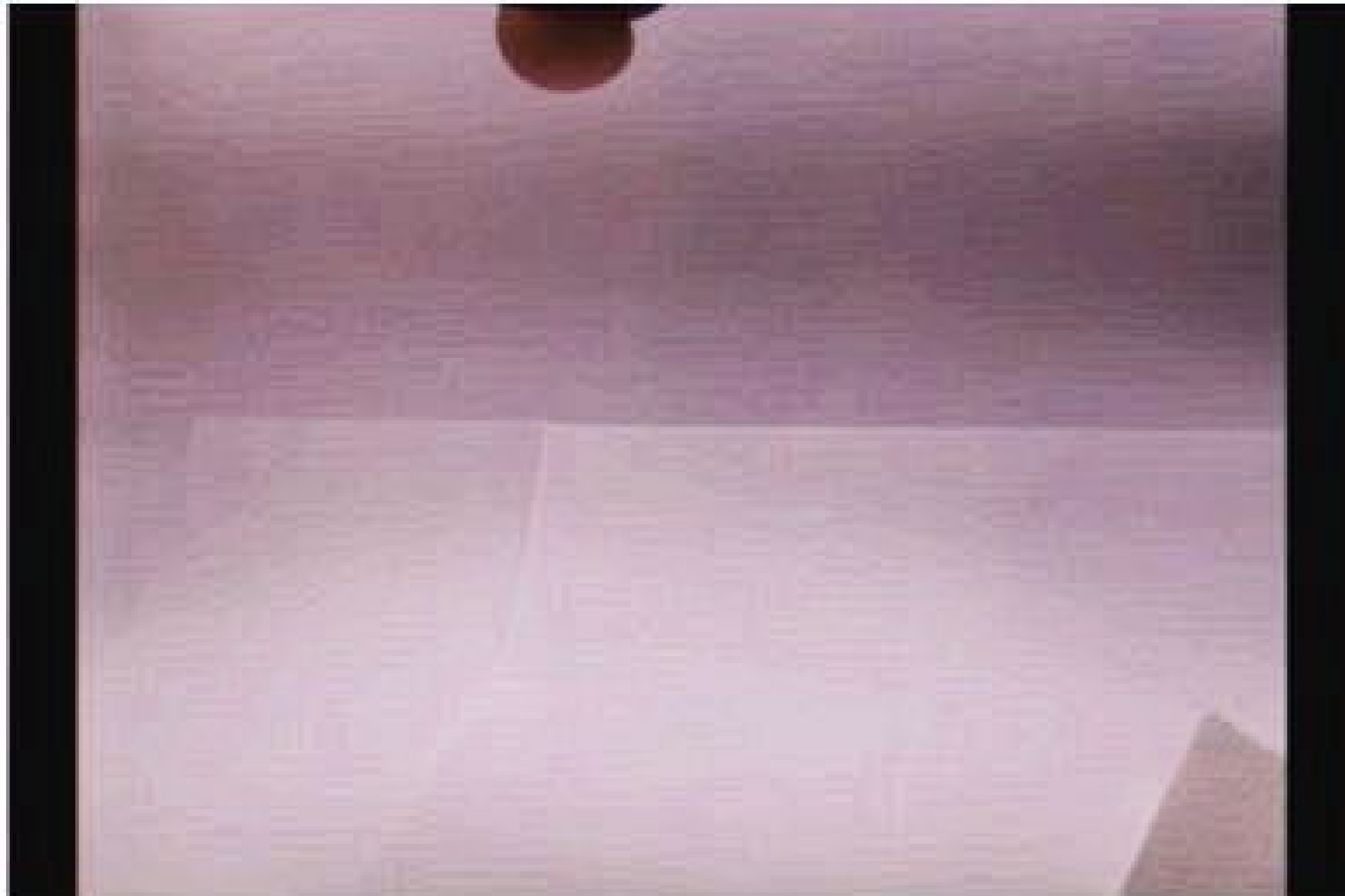
Jaeger/Lipson "coffee balloon gripper"



Jaeger/Lipson “coffee balloon gripper”



Jaeger/Lipson “coffee balloon gripper”



Orchestration of grasping



morphological computation
**exploiting morphology
and materials for control**

Orchestration of grasping



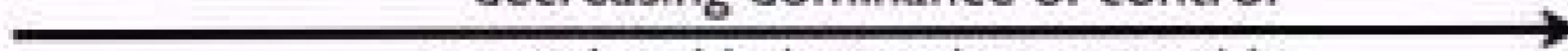
morphological computation
exploiting morphology
and materials for control

Expansion of design space: trading spaces and trade-offs

- **morphologies (physical structure, distribution of sensors, actuators)**
- **many materials; changeable characteristics (e.g. stiffness, length, shape, sensor distribution)**
- **must understand “trading space”: morphology - computation/control**
- **trade-offs: morphology/materials - flexibility (but changeable properties)**

Morphology and computation: “trading spaces”

increasing dominance of morphology and materials
decreasing dominance of control



control and behavior less separable
increasing dependence on environment
increased reliance on self-organization

morphological
computation

informational
computation

control dominant

morphology and materials dominant
“guided self-organization”



pure algorithm

computer (running algorithm)

industrial robot (centralized control)

Asimo (and similar robots)

ECCE (compliant, tendon-driven)

Octopus (soft, continuous)

“Robot Frog” (variable compliance)

Cornell Ranger (exploiting morphology)

Jaeger-Lipson coffee-balloons

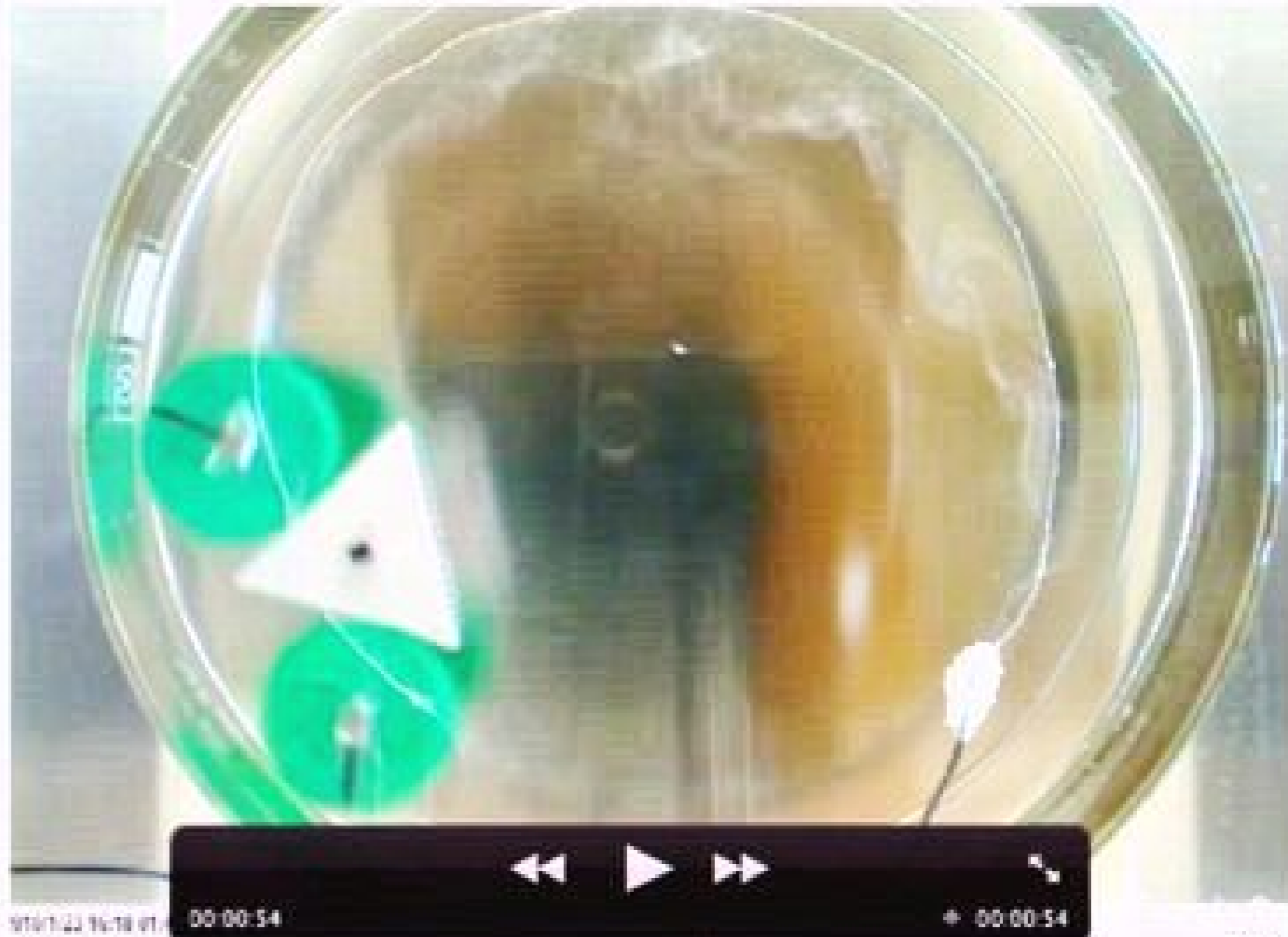
cells molecules “Tribology”

control dominant

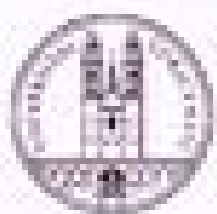
morphology and materials dominant

Morphological Computation: self-assembly and emergent functionality

“The self-assembled, emergent bicycle”



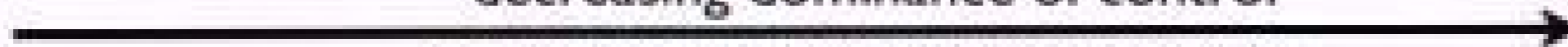
Design and
construction:
Shuhei Miyashita



University of
Zurich ^{UNIZH}

Morphology and computation: “trading spaces”

increasing dominance of morphology and materials
decreasing dominance of control



control and behavior less separable
increasing dependence on environment
increased reliance on self-organization

morphological
computation

informational
computation

control dominant

*morphology and materials dominant
“guided self-organization”*



pure algorithm

computer (running algorithm)

industrial robot (centralized control)

Asimo (and similar robots)

ECCE (compliant, tendon-driven)

Octopus (soft, continuous)

“Robot Frog” (variable compliance)

Cornell Ranger (exploiting morphology)

Jaeger-Lipson coffee-balloons

cells molecules “Tribology”

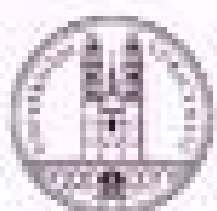
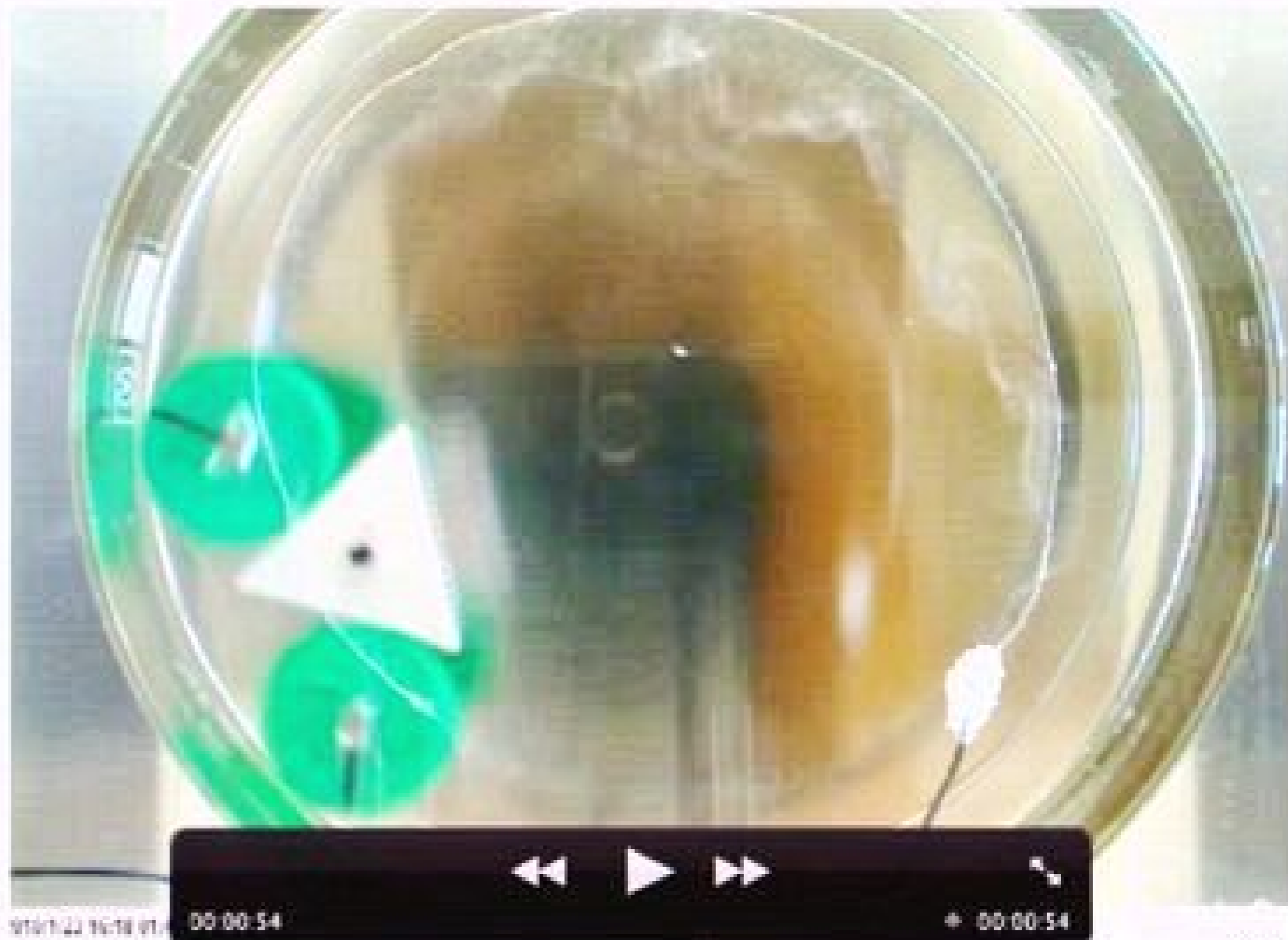
control dominant

morphology and materials dominant

Morphological Computation: self-assembly and emergent functionality

“The self-assembled, emergent bicycle”

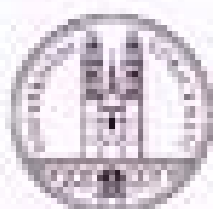
Design and
construction:
Shuhei Miyashita



Morphological Computation: self-assembly and emergent functionality

“The self-assembled, emergent bicylce”

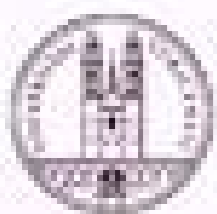
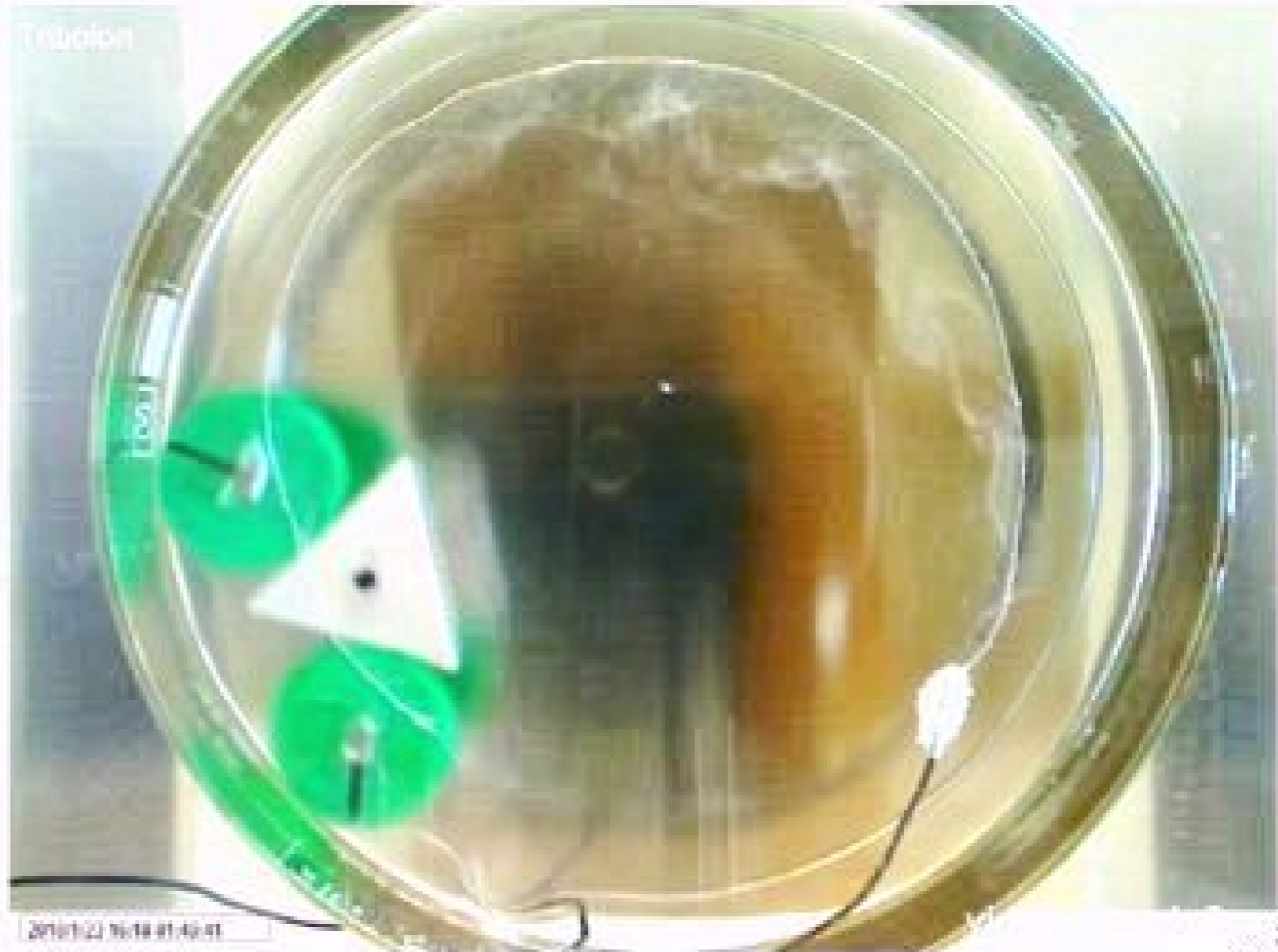
Design and
construction:
Shuhei Miyashita
(previously AI Lab,
now MIT)



Morphological Computation: self-assembly and emergent functionality

“The self-assembled, emergent bicylce”

Design and
construction:
Shuhei Miyashita
(previously AI Lab,
now MIT)

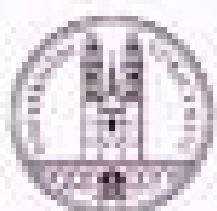


Morphological Computation: self-assembly and emergent functionality

“The self-assembled, emergent bicylce”

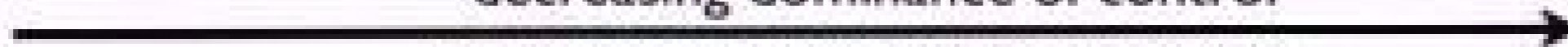
morphological computation:
no control (vibration motor)
only morphology

Design and
construction:
Shuhei Miyashita



Morphology and computation: “trading spaces”

increasing dominance of morphology and materials
decreasing dominance of control



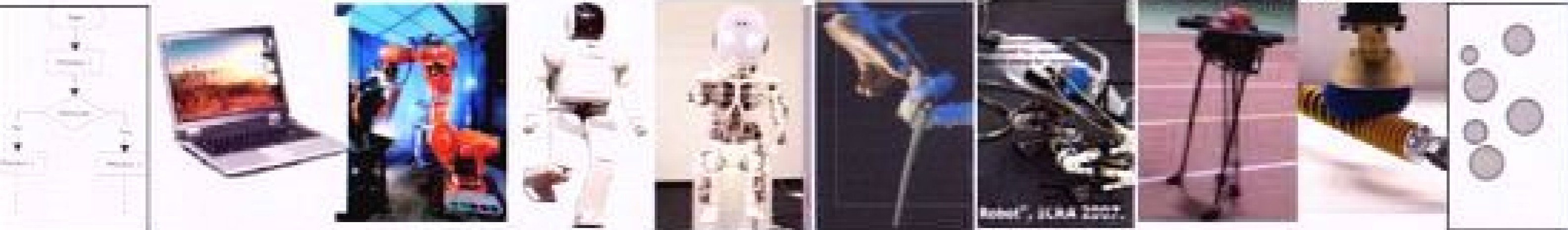
control and behavior less separable
increasing dependence on environment
increased reliance on self-organization

morphological
computation

informational
computation

control dominant

*morphology and materials dominant
“guided self-organization”*



pure
algorithm

computer
(running
algorithm)

industrial
robot
(centralized
control)

Asimo
(and
similar
robots)

ECCE
(compliant,
tendon-
driven)

Octopus
(soft,
continuous)

“Robot
Frog”
(variable
compliance)

Cornell
Ranger
(exploiting
morphology)

Jaeger-
Lipson
coffee-
balloons

cells
molecules
“Tribology”

*control
dominant*

*morphology and
materials dominant*

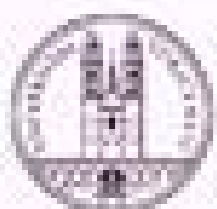
back to the “four messages”

Message 4: Physical dynamics and information structure

Induction of patterns of sensory stimulation through physical interaction with environment

—> raw material for information processing of brain (control)

—> induction of correlations (information structure)



Essence

- **self-structuring of sensory data through — physical — interaction with world**
- **physical process, not computational**
pre-requisite for learning
—> predictions / expectations

Inspiration:

John Dewey, 1896 (!)

Merleau-Ponty, 1963

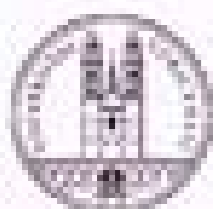
Bajcsy, 1963; Aloimonos, 1990; Ballard, 1991

Sporns, Edelman, and co-workers

Thelen and Smith (developmental studies)

Contents

- introduction and background
- the four messages of embodiment
- the “power of materials”
- **summary and conclusions**
- **the “Roboy” project**



The four messages of embodiment

Message 1: Physical embedding

Understanding brain not enough; morphology materials; embedding

Message 2: Real/Artificial worlds

Fundamental differences industrial and real-world environments

Message 3: Task distribution

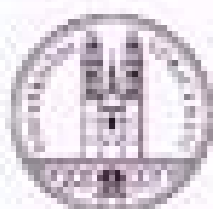
Cooperation - brain, body, environment

Message 4: Physical dynamics and information structure

Induction of information structure; dependence on morphology and control

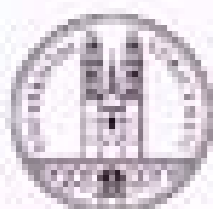
“Soft robotics”

- **central role of materials!**
- **no clear separation between controller and to-be-controlled**
- **new notion of control (morphological computation; “orchestration”)**
- **understanding the “design space”**



Contents

- introduction and background
- the four messages of embodiment
- the “power of materials”
- summary and conclusions
- **the “Roboy” project**



Compliance, “softness”: the next steps

ROBOY

[HOME](#) [ABOUT](#) [SUPPORTER](#) [ONTOUR](#) [MEDIA&NEWS](#) [CONTACT](#)

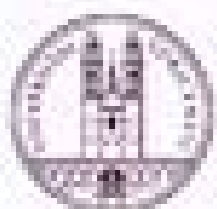


HELLO.
MY NAME IS ROBOY


I am a unique humanoid robot.

© Let me tell you my story

the “Roboy” project



University of
Zurich ^{UNIVERSITÄT ZÜRICH}

robotics  Swiss National
Centre of Competence
in Research

ai lab

The Zurich AI Lab 25th Anniversary 1987 - 2013

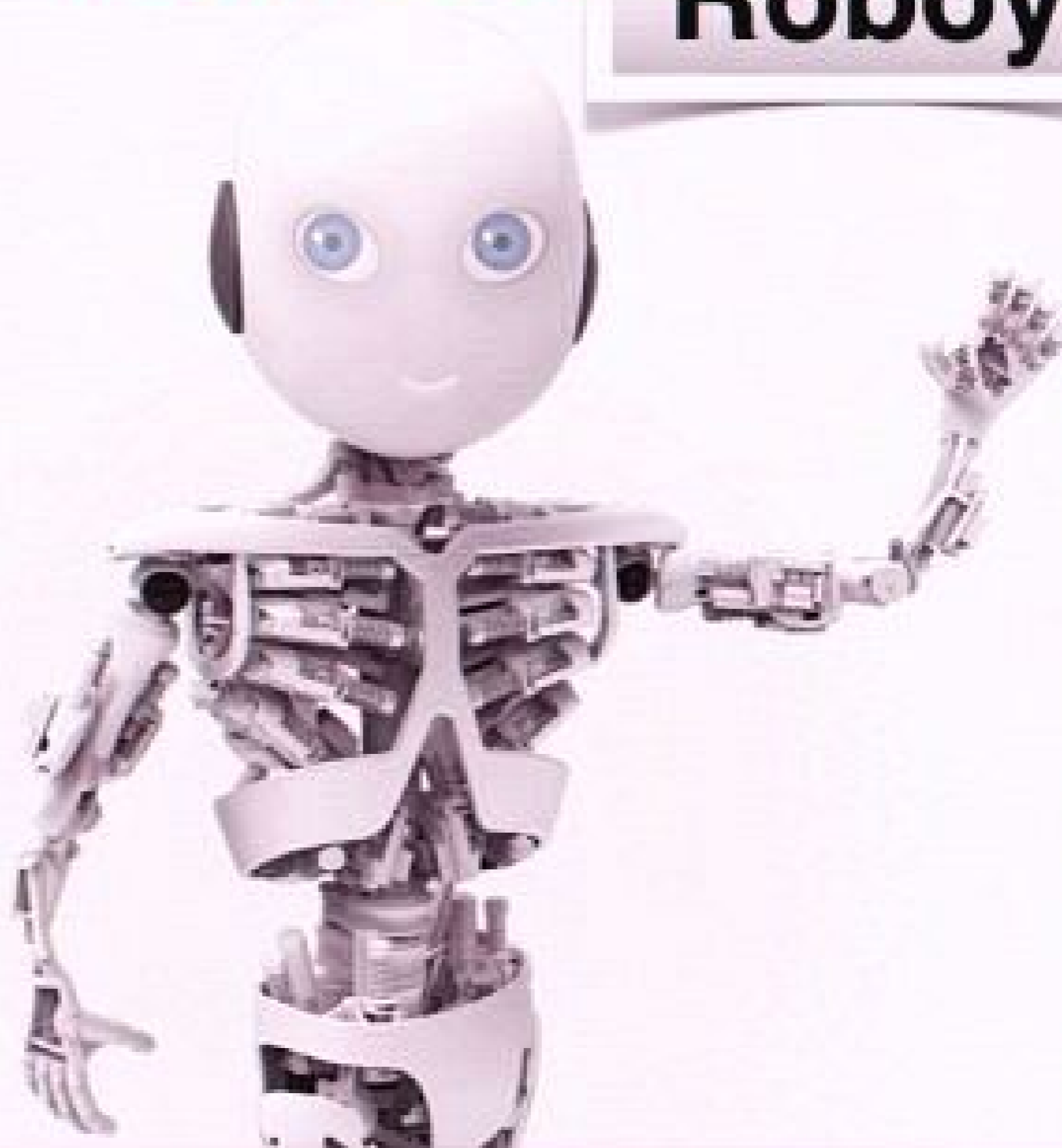
a special "birthday
present"?

Idea:
June 2012 finish by
March 2013

Idea: Pascal Kaufmann

ROBOTS ON TOL

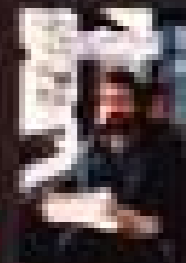
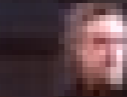
Roboy



nich

kauf
Tickets

ow mit



FOUNDATION OF NI LAB ZÜRICH

At the end of the 1980s, the research group in Artificial Intelligence at the University of Zurich was reorganized into the Artificial Intelligence Laboratory Zurich. The laboratory was founded by Prof. Dr. Rolf Pfeifer and Prof. Dr. Otfried Dieckmann. The laboratory is currently led by Prof. Dr. Rolf Pfeifer. The laboratory is currently led by Prof. Dr. Rolf Pfeifer.

CONNECTIONISM IN PERSPECTIVE, ZÜRICH

Connectionism in perspective, Zurich. This section discusses the development of connectionist models and their application in artificial intelligence. It covers the work of researchers like Rolf Pfeifer and others in the field of neural networks and cognitive modeling.

PARADIGM AT THE UNIVERSITY OF BRUSSELS

Paradigm at the University of Brussels. This section explores the influence of the University of Brussels on the development of artificial intelligence research, particularly in the area of cognitive science and neural networks.

ARISE (OR CONSCIOUSNESS) WORKSHOP ON "THE ARTIFICIAL LIFE ROUTE TO ARTIFICIAL INTELLIGENCE"

Arise (or Consciousness) Workshop. This section details the workshop on artificial life and intelligence, which brought together researchers from various disciplines to discuss the challenges and opportunities of creating artificial life.

PRACTICE AND FUTURE OF AUTONOMOUS AGENTS

Practice and Future of Autonomous Agents. This section focuses on the practical applications and future prospects of autonomous agents in various domains, including robotics, virtual worlds, and intelligent systems.

THE "GOOT" AT THE MIT

The "Goot" at the MIT. This section discusses the "Goot" project at MIT, which was an early attempt at creating a multi-agent system capable of complex, coordinated behavior.



EXPERIMENTAL SYSTEMS

EMERGING BEHAVIOR

EVOLUTIONARY COMPUTATION

BIOLOGICALLY INSPIRED PARADIGMS

DESIGN PRINCIPLES

1987

88

89

1990

91

92

93

94

1995

96

97

98



ROLF PFEIFER



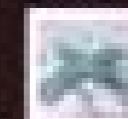
ROLF PFEIFER



ROLF PFEIFER



ROLF PFEIFER



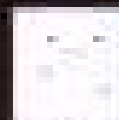
ROLF PFEIFER



ROLF PFEIFER



ROLF PFEIFER



ROLF PFEIFER



ROLF PFEIFER



ROLF PFEIFER



The Zurich AI Lab 25th Anniversary 1987 - 2013

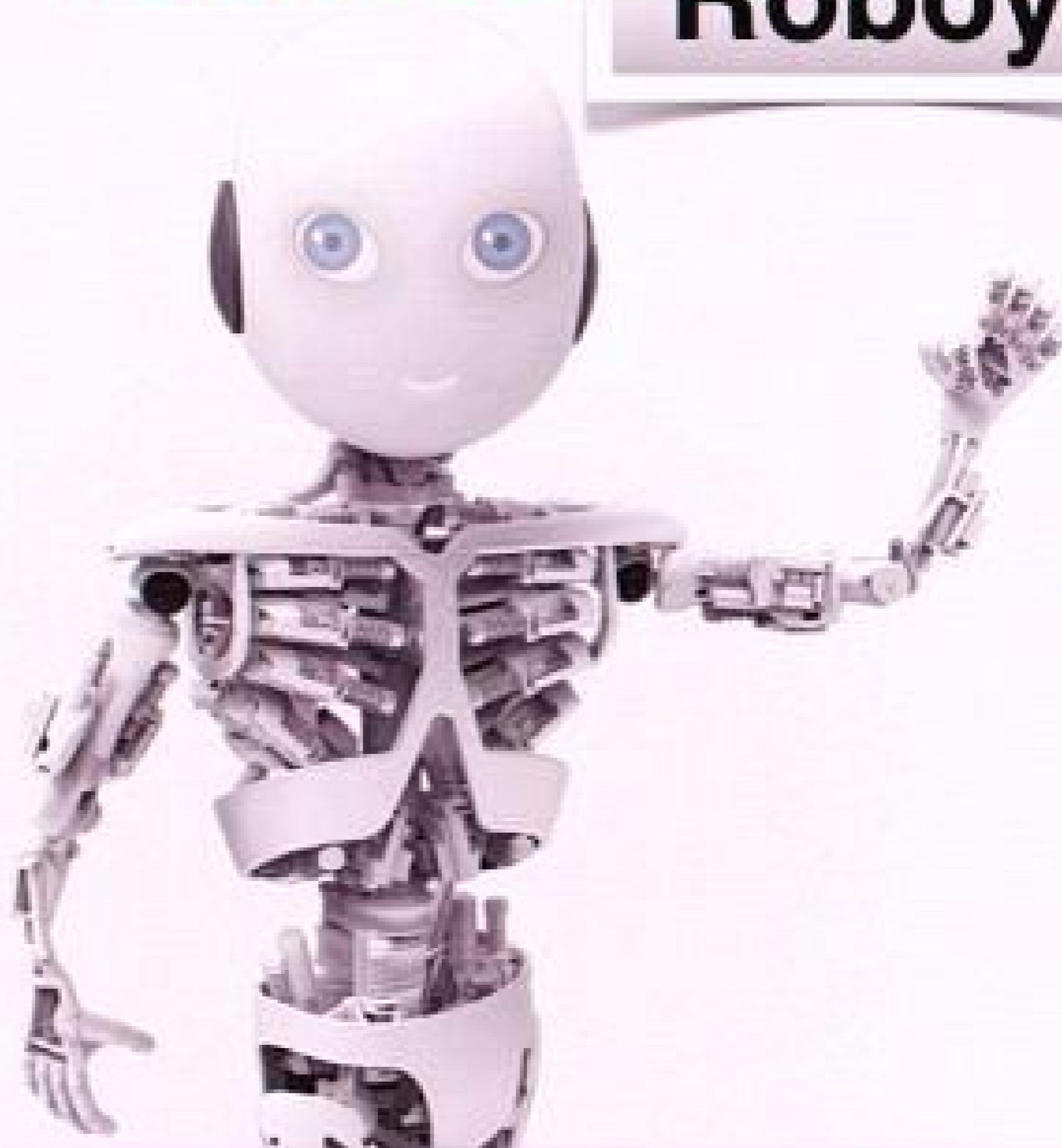
a special "birthday
present"?

Idea:
June 2012 finish by
March 2013

Idea: Pascal Kaufmann

ROBOTS ON TOUR

Roboy



*** Ausverkauf

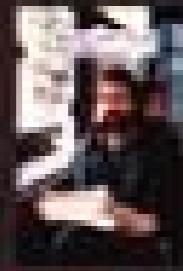
25 Jahre AI |
Roboter aus

sich

nich

kauft
Tickets

er mit



FOUNDATION OF NI LAB ZÜRICH

Prof. Peter Doherty (1928-2018) was a pioneer in the field of artificial intelligence. He was a member of the Turing Institute and the University of Edinburgh. He was also a member of the Royal Society and the Royal Academy of Engineering. He was a leading expert in the field of artificial intelligence and was a member of the Turing Institute and the University of Edinburgh. He was also a member of the Royal Society and the Royal Academy of Engineering.

CONNECTIONISM IN PERSPECTIVE, ZÜRICH

Connectionism in perspective, Zürich. This section discusses the early work on connectionism and its impact on the development of artificial intelligence. It covers the work of researchers like Donald Hebb and the influence of his ideas on the field.

ARBEDE COMBINONNI WORKSHOP ON "THE ARTIFICIAL LIFE ROUTE TO ARTIFICIAL INTELLIGENCE"

Arbede Combinonni Workshop on "The Artificial Life Route to Artificial Intelligence". This workshop was a significant event in the history of artificial intelligence, bringing together researchers from various fields to discuss the potential of artificial life in creating intelligent systems.

PARADIGM AT THE UNIVERSITY OF BRUSSELS

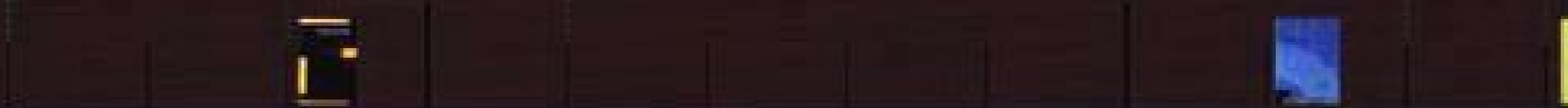
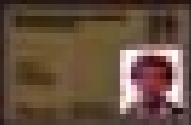
Paradigm at the University of Brussels. This section explores the paradigm shift in artificial intelligence research that occurred at the University of Brussels, focusing on the work of researchers like Jean-Louis Lasseigne and the impact of their work on the field.

PRACTICE AND FUTURE OF AUTONOMOUS AGENTS

Practice and future of autonomous agents. This section discusses the practical applications of autonomous agents and the challenges they face. It also looks at the future of this technology and the potential for it to revolutionize various industries.

THE "GOOT" AT THE MIT

The "Goot" at the MIT. This section discusses the "Goot" project at MIT, which was an early attempt at creating a multi-agent system. It explores the challenges of coordinating multiple agents and the lessons learned from the project.



EXPERT SYSTEMS LEARNING MACHINES EVOLUTIONARY COMPUTATION BIOLOGICALLY INSPIRED METHODS DESIGN PRINCIPLES

1957

58

59

1990

91

92

93

94

1995

96

97

98



MARVIN T. HINES



MRS. GUYRA FERGUSON



ROBOT



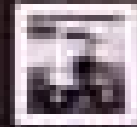
ROBOT



ROBOT



ROBOT



ROBOT



ROBOT



ROBOT



ROBOT





RECORDED ARTIFICIAL INTELLIGENCE, CASTLE INTERNATIONAL

... ..

WORLD SUMMIT OF AI ON MONTE VERDE

... ..



SCIENCE SLURRY PORTRAITS OF TOP RESEARCHERS IN SWITZERLAND

... ..

THE ROBOY COMMISSION FOR CITIZENS, A PET FLAGSHIP PROJECT "MORE THAN MACHINES" 2011-2012

... ..



The "Roboy" project 2012 - 2013

"TOKYO LECTURES" 2008-2009

... ..



BOOK LAUNCH OF "HOW THE BODY SHAPES THE WAY WE THINK"

... ..



THE "THINKING LECTURES" 2008-2012

... ..

FETTS: THE B TECHNOLOGICAL AND EXHIBITION FACTORY

... ..



MOVES TO AACHENSTRASSE

... ..

THE 20TH ANNIVERSARY OF THE AI LAB

... ..



MORPHOLOGICAL COMPUTATION

SOFT ROBOTICS

ROBO PORTFOLIO

04 2005 06 07 08 09 2010 11 12 13 14 2015



ROBABILITY I



ROBABILITY II



ROBABILITY III



ROBABILITY IV



PUPPY



OCTOPUS



WALKER



CONTACT BIRD



SHOULDER



ICARUS



PRELIMINARY WORK



EXPERIMENTAL



EXPERIMENTAL



ROBOY WALK I



ROBOTT



ROBOTT



ROBOTT



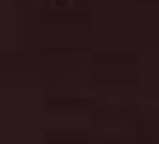
ROBOTT



ROBOTT



ROBOTT



ROBOTT



ROBOTT

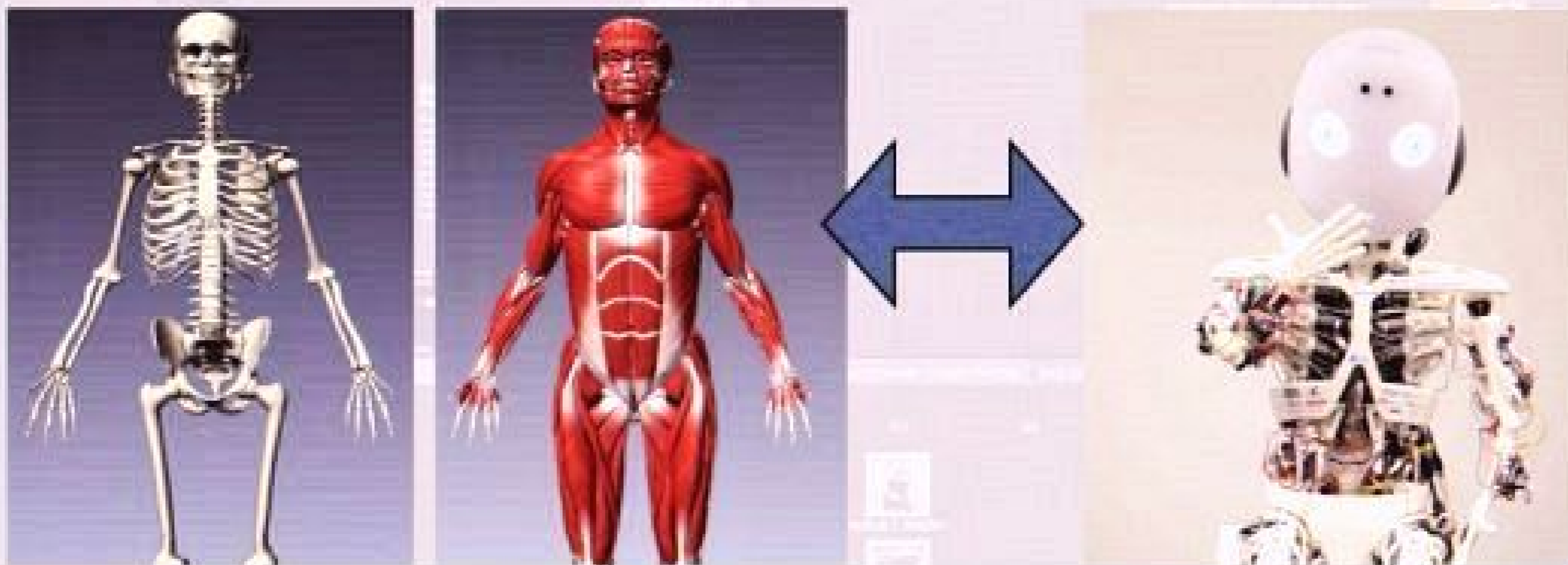


ROBOTT



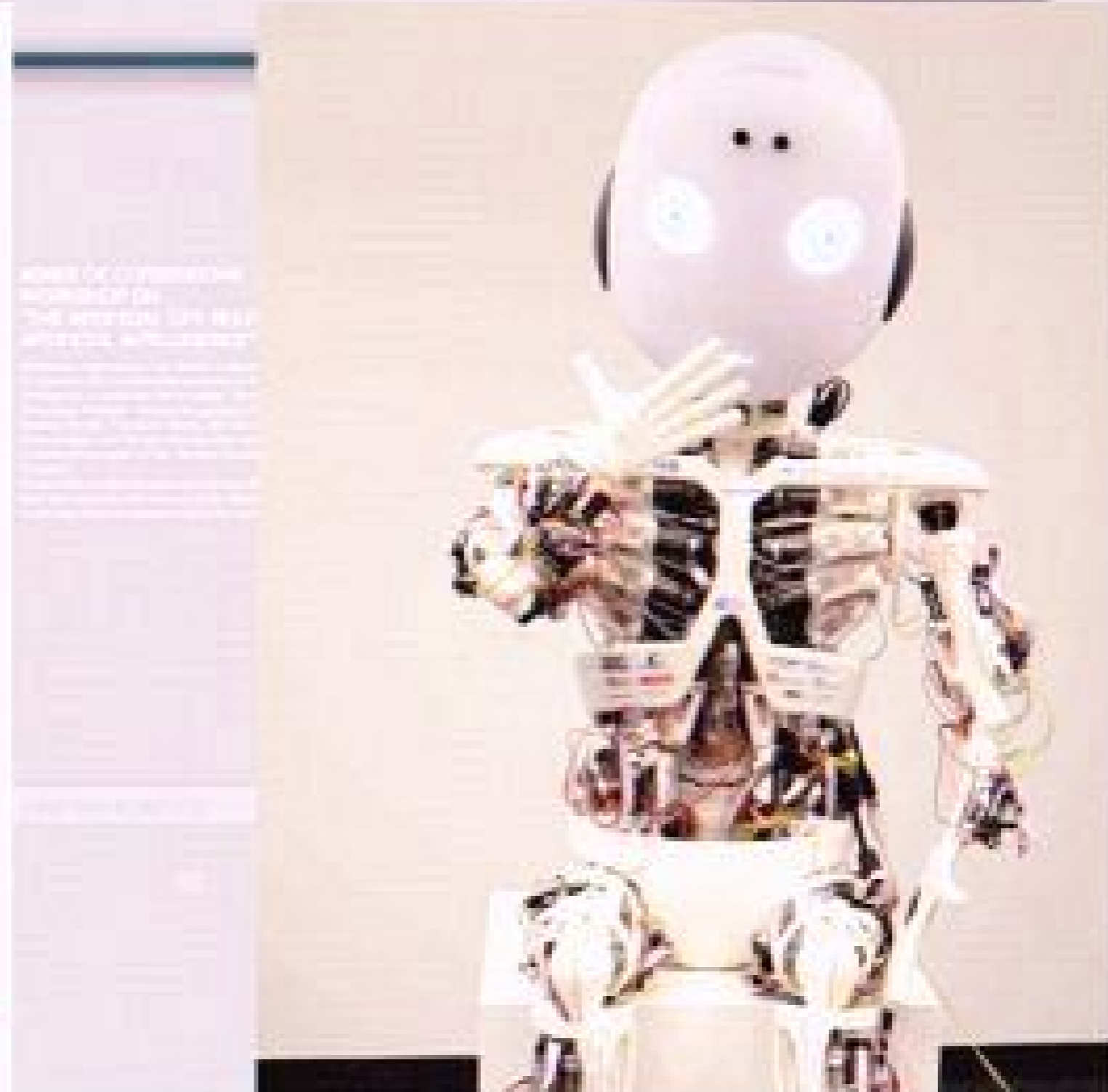
ROBOTT

“Roboy” — the bio-inspired tendon-driven humanoid robot



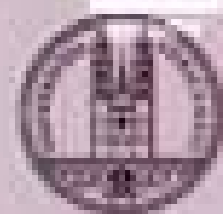
Slogan: “Understanding by building”

“Roboy” — the bio-inspired tendon-driven humanoid robot



Slogan: “Understanding by building”

Roboy's predecessor: ECCE (EU-project)

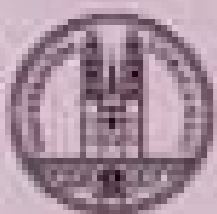


Project goals

- ambassador of new generation of robots
- sharing living space with humans
- evoke positive emotions
- kid-like appearance - cute
- research platform, not (yet) product
- rapid development: 9 months
- open source: creating a community

First design

CUTE??!?

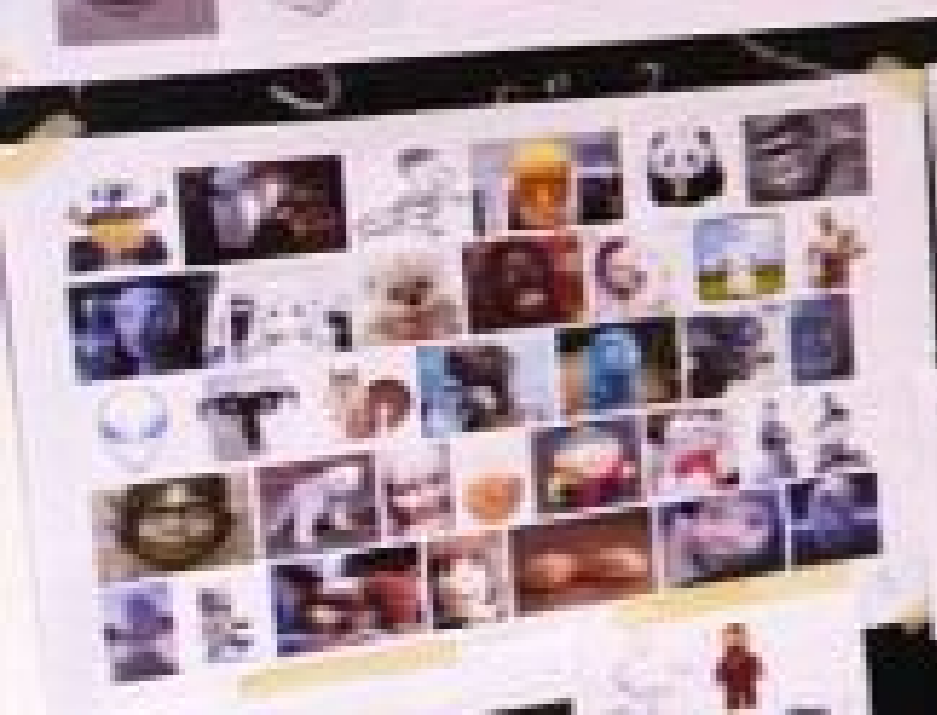
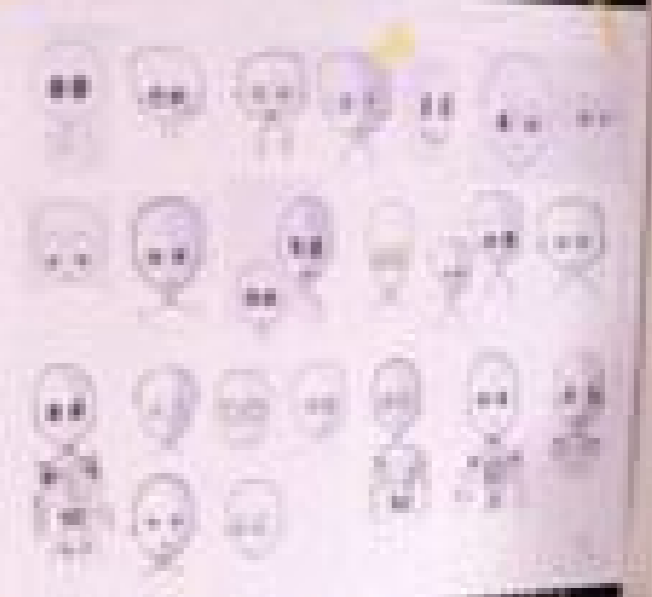
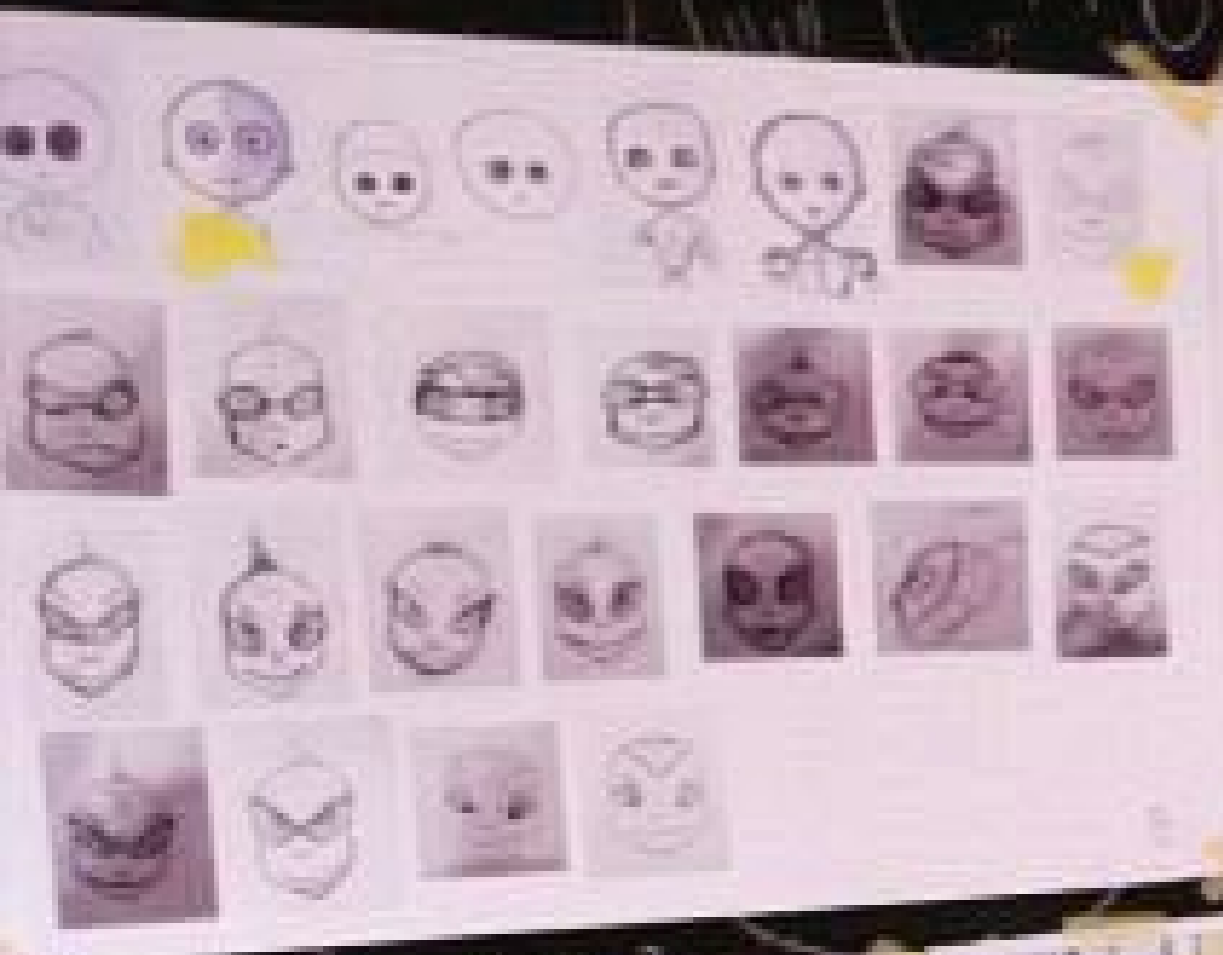


University of
Zurich

robotics



nutzfreundlich?
ist es Emotionen?



Wir danken
erfolgreich
H...



funktionell es?
(user)?



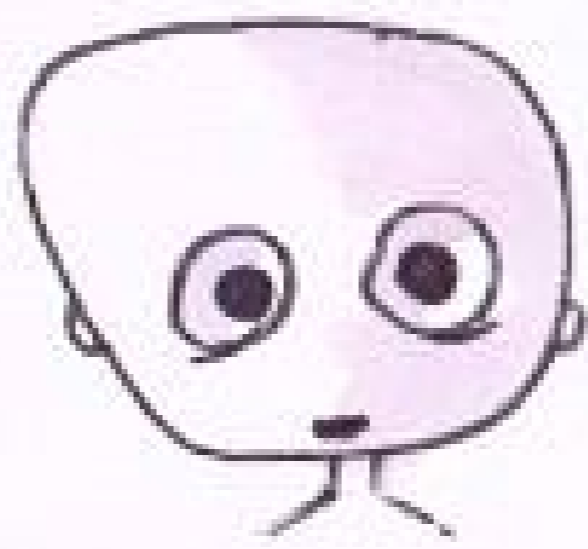
1



2



3



4



5



6



7



8



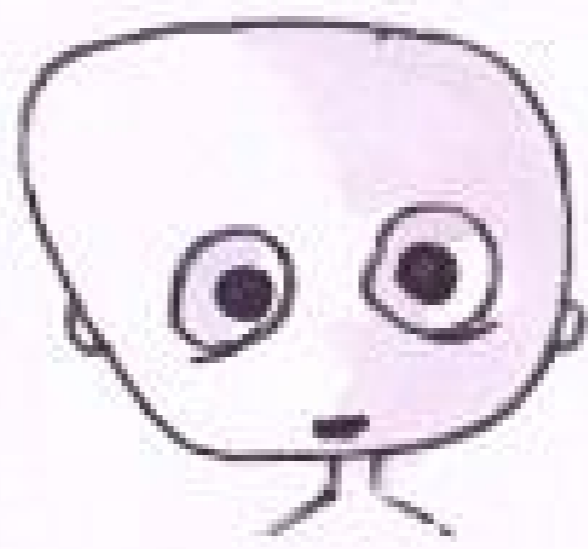
1



2



3



4



5



6



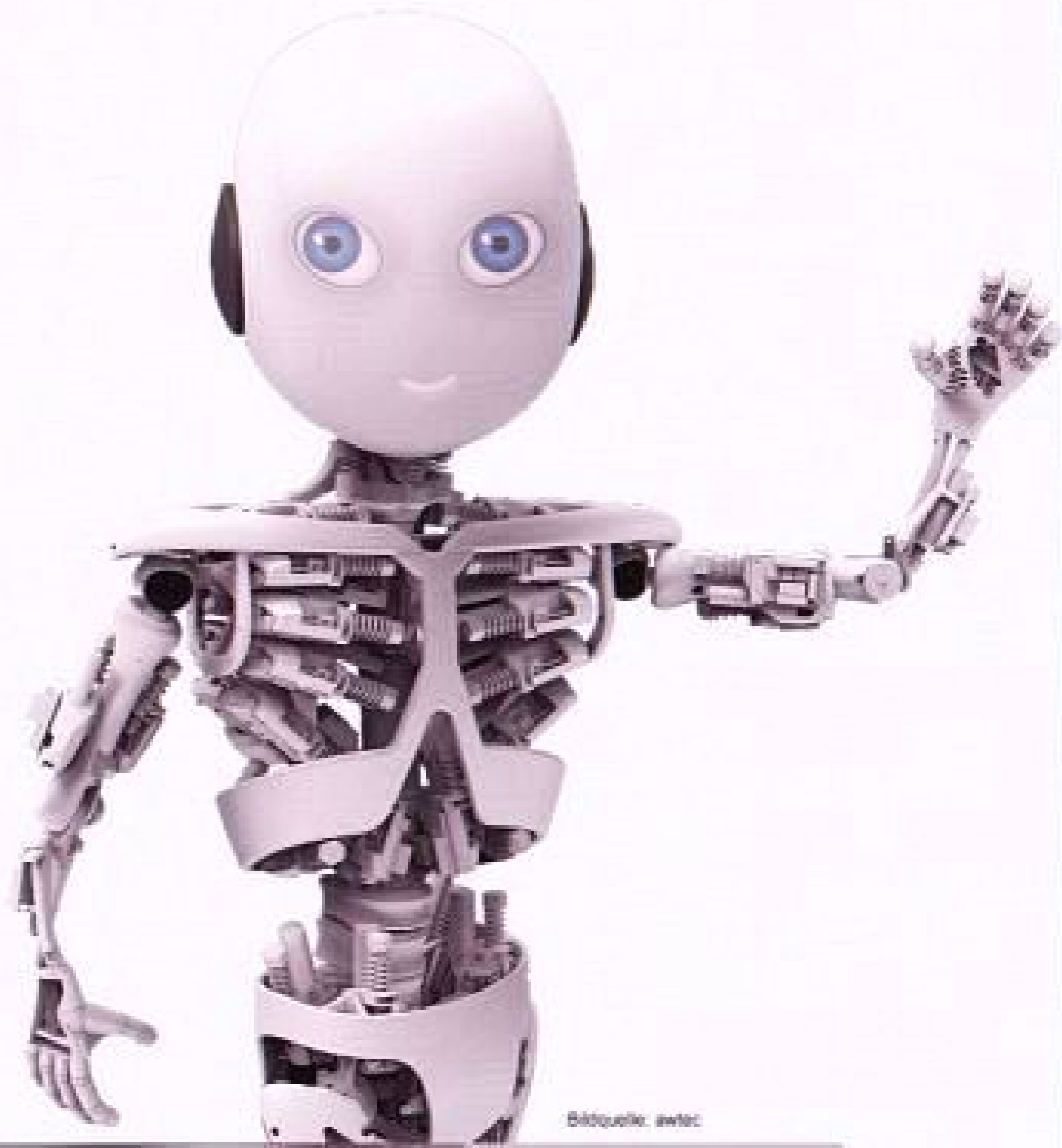
7



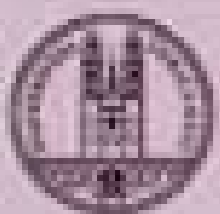
8



Roboy's new look



Bildquelle: swtec



University of
Zurich

Teaser video for crowdfunding November 2012

video: Yves Terrier, Starmind



The Year 2012
Zurich-Oerlikon, Switzerland

Teaser video for crowdfunding November 2012

video: Yves Terrier, Starmind

Make Roboy your friend!

www.roboy.org

Various Youtube videos December 2012



<http://www.youtube.com/watch?v=0LJDCastUn0s&feature=youtu.be>

Various Youtube videos December 2012



<http://www.youtube.com/watch?v=0LJDCatUnTs&feature=youtu.be>

Various Youtube videos December 2012



<http://www.youtube.com/watch?v=0LJDGstUnTs&feature=youtu.be>

Various Youtube videos December 2012



<http://www.youtube.com/watch?v=0LJDCastUnMs&feature=youtu.be>

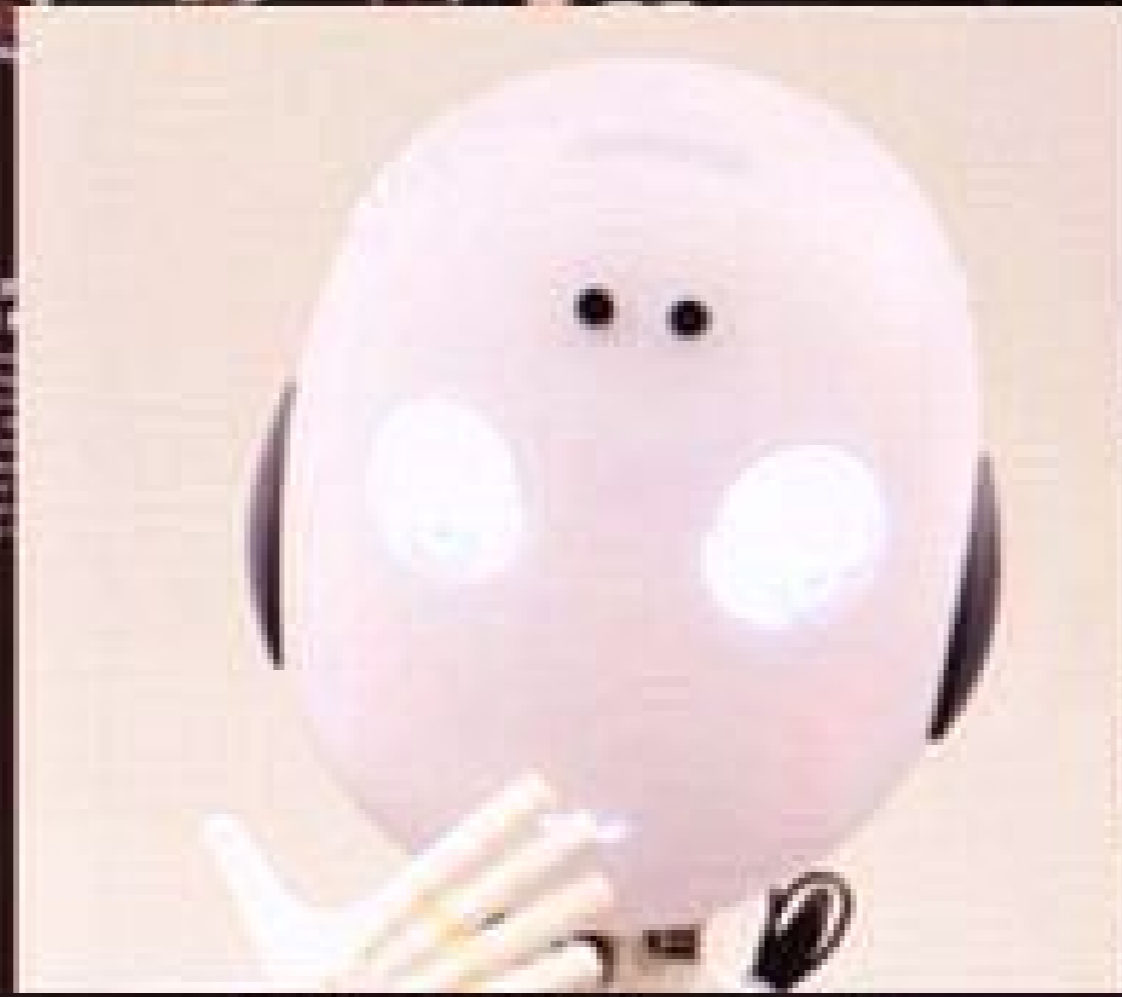
Various Youtube videos December 2012



<http://www.youtube.com/watch?v=0LJDGatUnGs&feature=youtu.be>

Development

head
facial expression



head, facial expression by:
Sedax, Uster

ROBOTS ON TOUR

World Congress and Exhibition of Robots, Humanoids, Cyborgs and more

START BESUCHER ROBOTER PROGRAMM REFERENTEN ORT TICKETS KONTAKT

ENGLISH



9. MÄRZ 2013 | 09.00–20.00 Uhr

PULS 5 | Giessereistrasse 18 | 8005 Zürich

Roboter für Jung und Alt in Zürich –
reservieren Sie sich Ihr Ticket

*** Ausverkauft ***

25 Jahre AI Lab Zürich:

Roboter aus aller Welt für Jung und Alt

AUSVERKAUFT

Robots on Tour ist ausverkauft.
Leider gibt es auch keine Tickets
mehr an der Tageskasse.

Invasion in Zürich – die

ZURICH Die beiden dem Menschen nachempfundenen Roboter versetzten sich am 4. und 6. März in Zürich. Forscher aus aller Welt zeigen, warum sie Menschen menschliche Tugenden geben wollen.

Solange das Konzept der Roboter für die Zukunft der Menschheit ein Thema ist, werden die Roboter der Zukunft die Fähigkeiten der Menschheit zu imitieren. Sie werden die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren. Sie werden die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.

Überflächen

Der Mensch dient als Vorbild

Wie der Mensch als Vorbild für Roboter dient, zeigt dieses Bild. Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.



Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.

...den, abgeschlossen sind. Das hat einen guten Grund: «Die Roboter sind früher schon in der Welt und sie werden sich weiterentwickeln», sagt Prof. Mori. «Sie können sich an ihre Umgebung anpassen, aber werden sie auch lernen? Deshalb haben wir Roboter entwickelt, die nicht nur lernen, sondern auch denken können.»

...schönen, natürlich anmutende. Ihre Mimik wurde auch von der des Kindes (siehe Seite 22) entworfen. Doch viele Schichten in der Haut, welche Transparenz für einen Blick, aber in den Bereichen der menschlichen Haut nachempfunden ist, kann ein Roboter erkennen, was er sehen will. Das ist ein wichtiger Schritt auf dem Weg zu einem Roboter, der nicht nur sehen, sondern auch denken kann.

Androiden kommen

Roboy - ganz natürlich

...Anfangen wird es mit der Entwicklung der Roboter. Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.

Gehirn

Steuern mit Gedankenkraft



Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.

...Anfangen wird es mit der Entwicklung der Roboter. Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.

Heißende Hände

Dem Menschen stets zu Diensten

...Anfangen wird es mit der Entwicklung der Roboter. Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.

...Anfangen wird es mit der Entwicklung der Roboter. Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.



Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.

Emotionen

Maschinen drücken Gefühle aus

...Anfangen wird es mit der Entwicklung der Roboter. Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.

...Anfangen wird es mit der Entwicklung der Roboter. Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.



Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.

Der Gast



Der Gast: Prof. Mori

Humanoide Zukunft?

...Anfangen wird es mit der Entwicklung der Roboter. Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.

«Roboter als Teil der Gesellschaft»

ZURICH Pascal Kaufmann ist einer der Väter des autonomen Roboterlabor RoboLab. Er arbeitet am Labor für Kognitive Intelligenz der ETH Zürich.

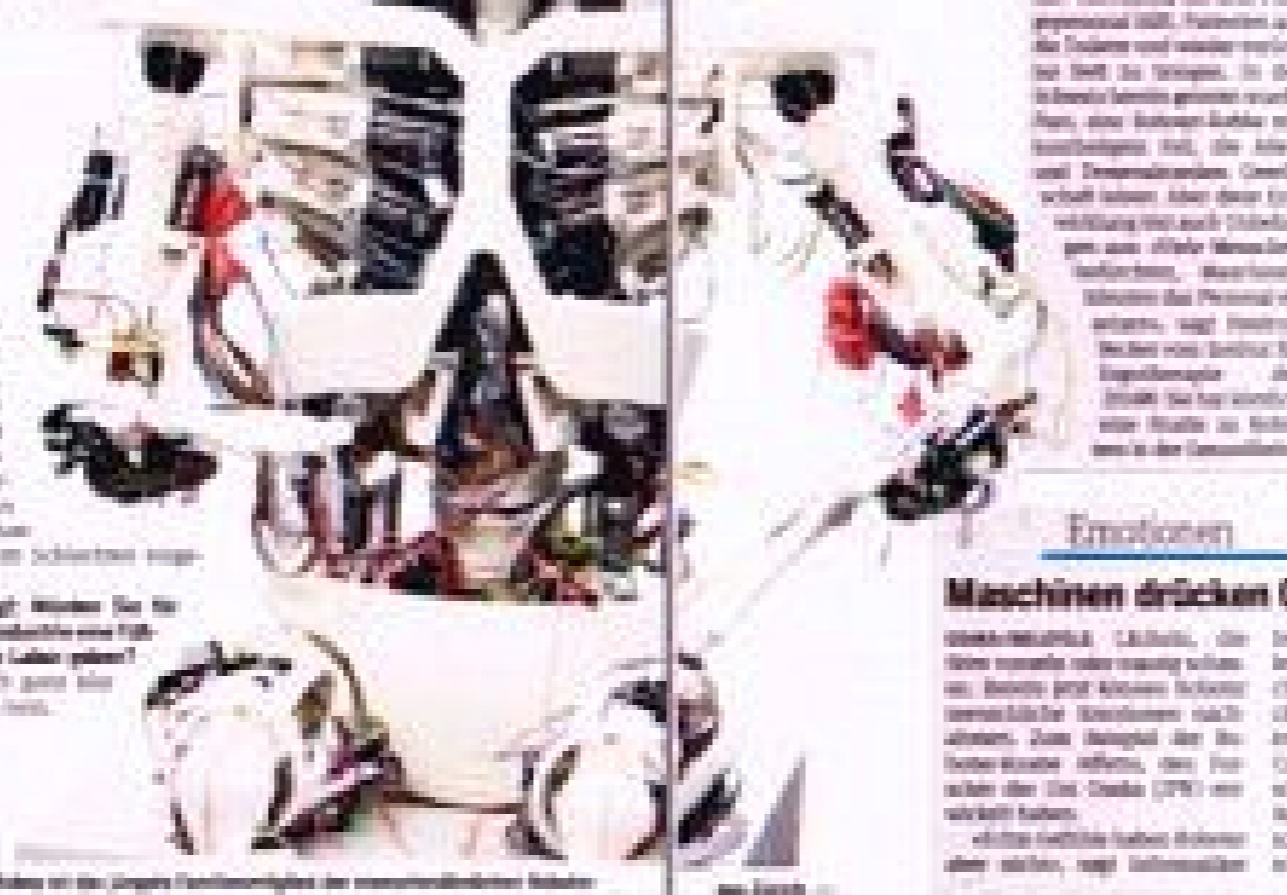
Pascal Kaufmann, warum muss ein Roboter aussehen wie ein Mensch?



Roboterlabor Pascal Kaufmann

...Anfangen wird es mit der Entwicklung der Roboter. Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.

...Anfangen wird es mit der Entwicklung der Roboter. Die Roboter sind so konstruiert, dass sie die Fähigkeiten der Menschheit imitieren, um die Menschheit zu imitieren.



Roboy ist der jüngste Forschungsroboter der autonomen Roboterlabor Zürich.



Pictures: Jaan Spitz

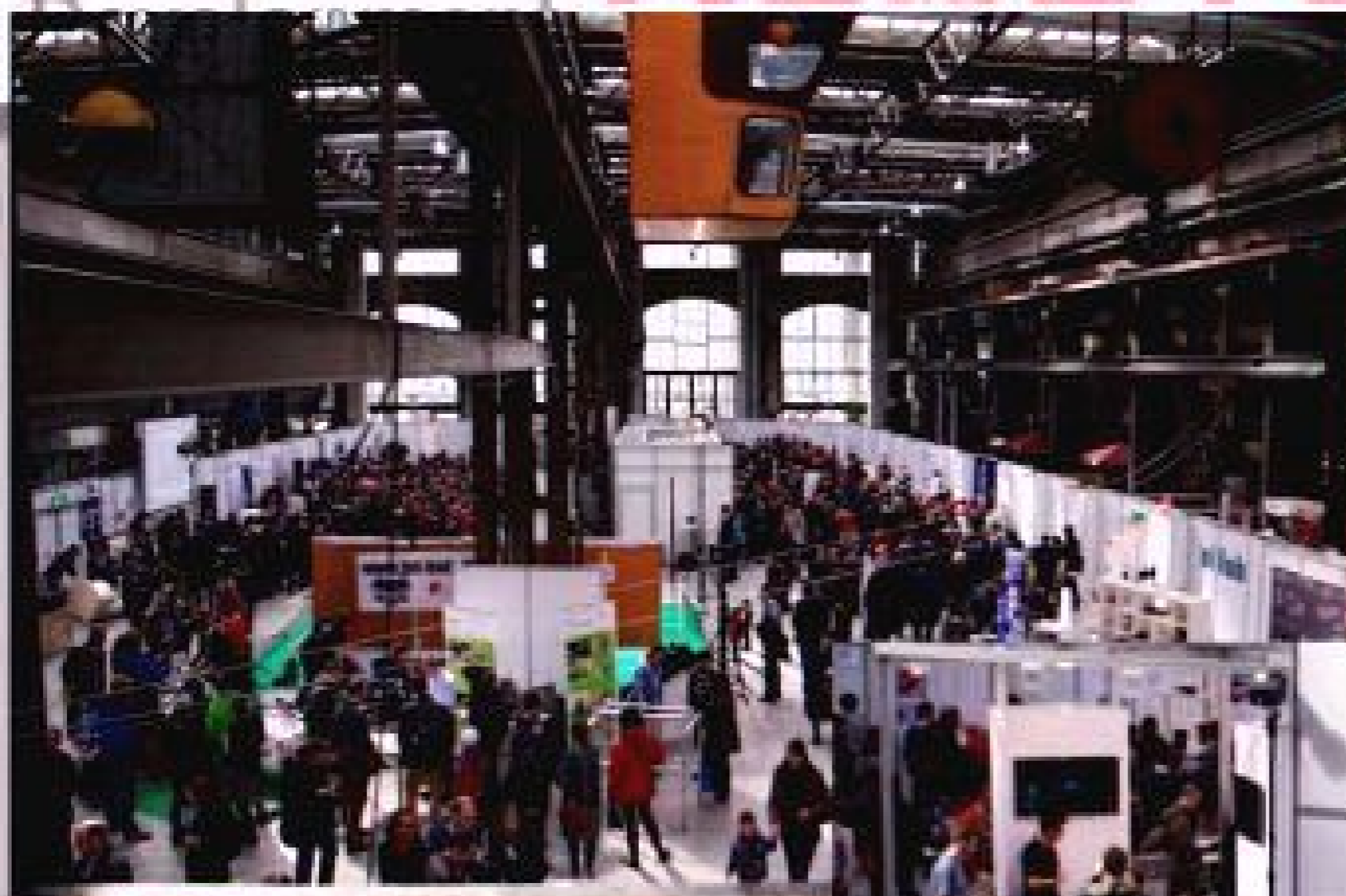
Roboter aus einer Welt für Jung und Alt

ROBOTS

13

orgs and more

ENGLISH

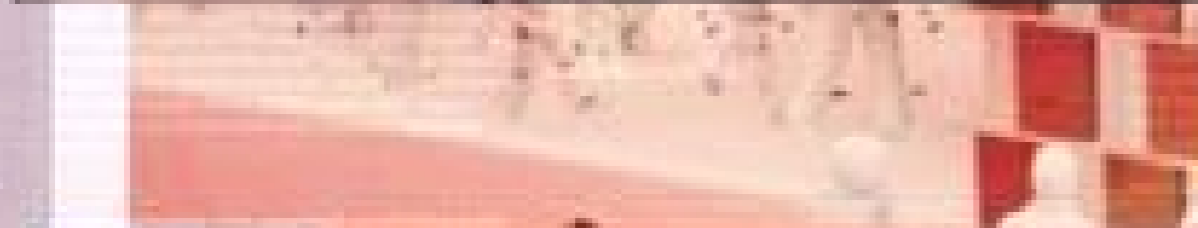


*** Ausverkauft ***

Pictures: Jaan Spitz

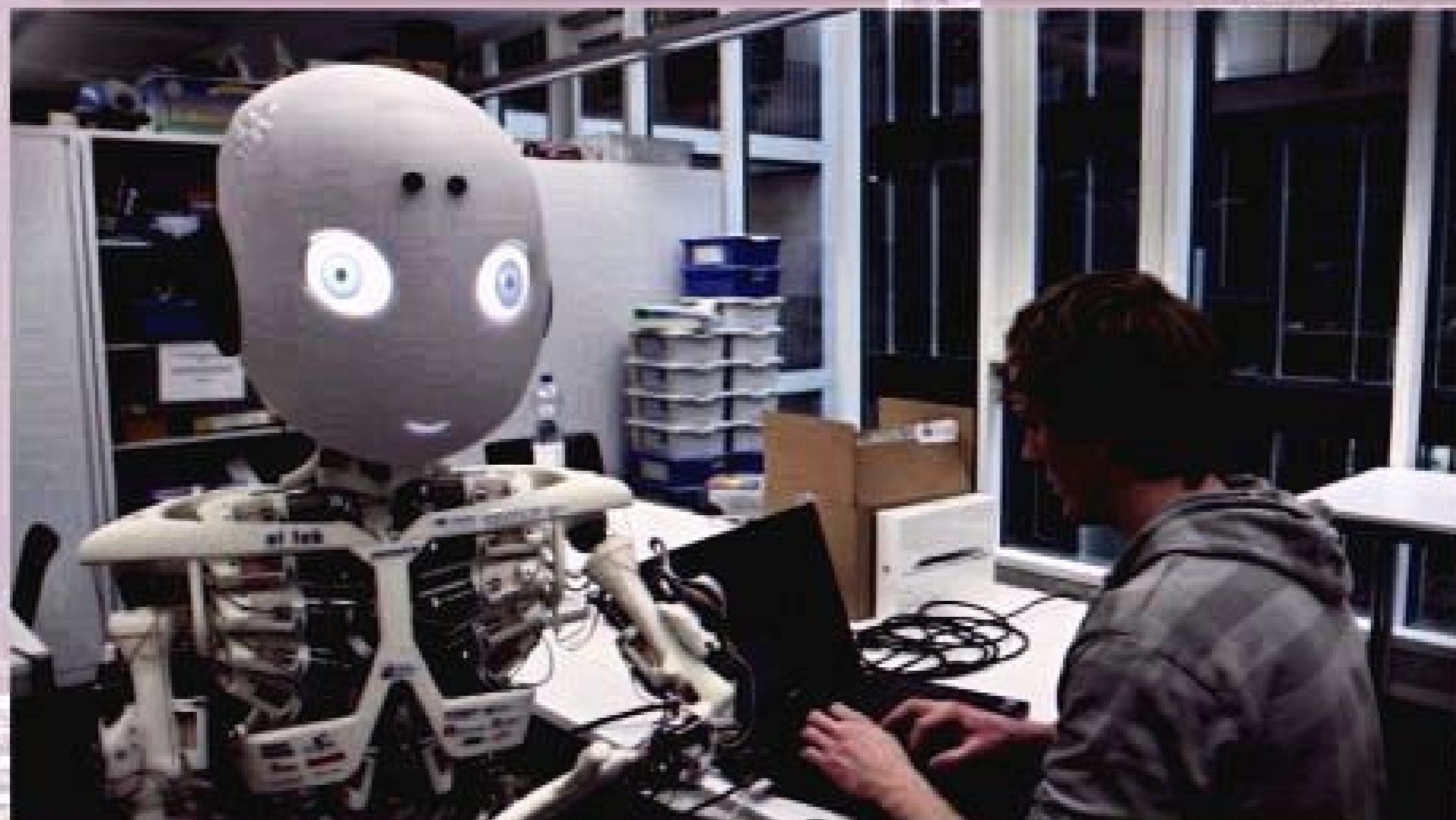


Roboter aus einer Welt für Jung



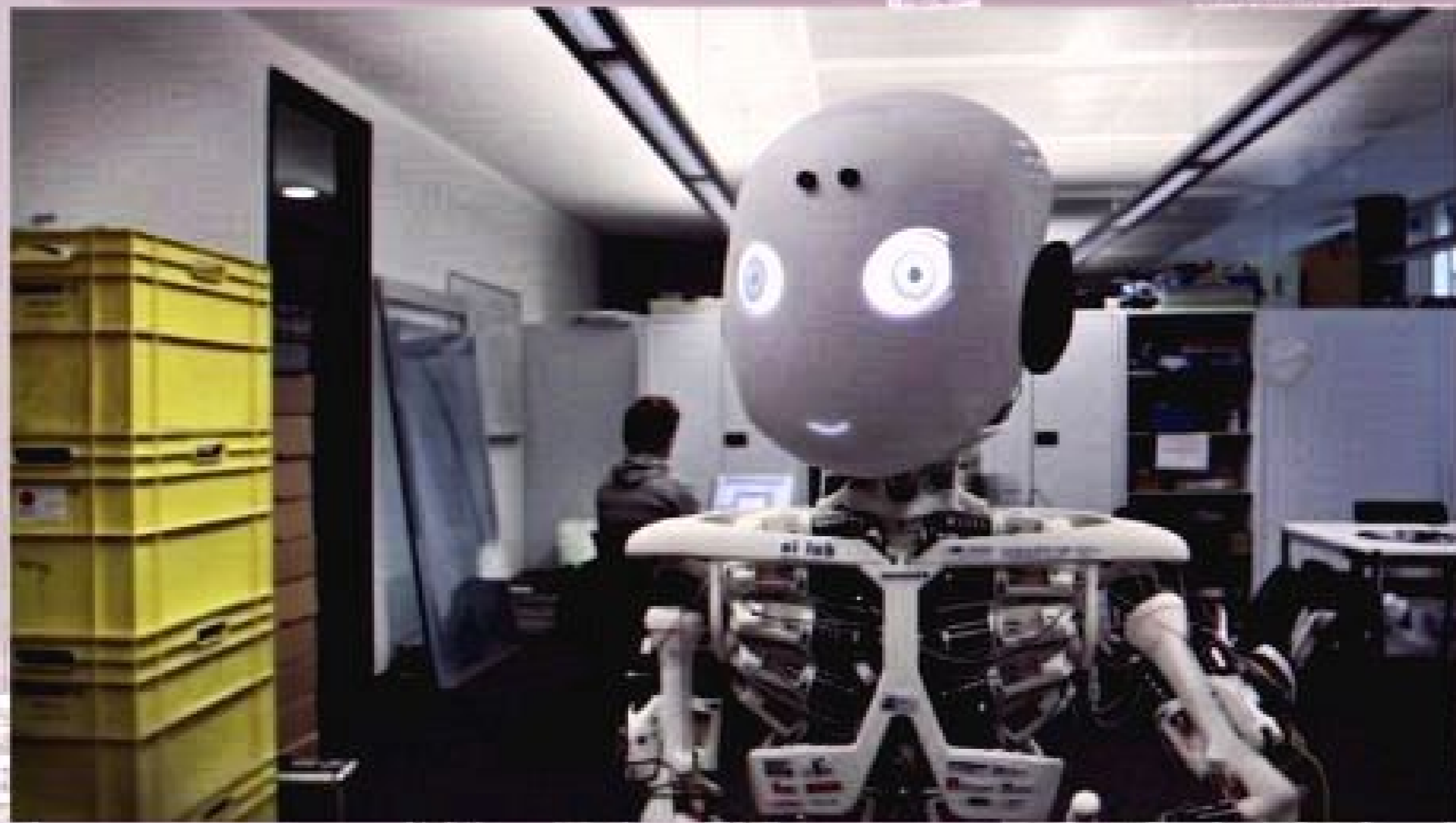
Pictures: Jaan Spitz

Various Youtube videos March 2013



video: ZHdK, Zürcher Hochschule der Künste, March 2013

Various Youtube videos March 2013

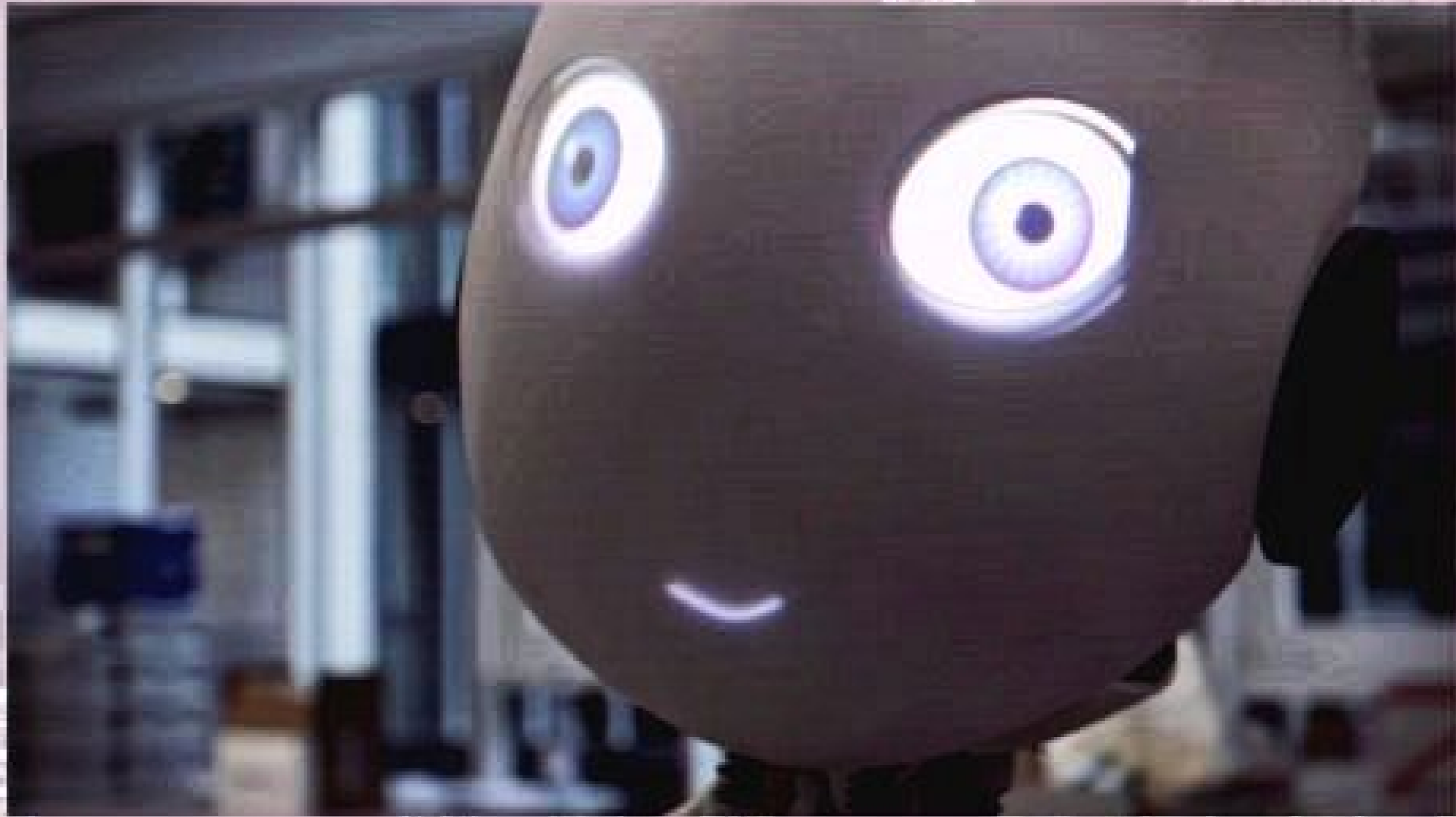


video: ZHdK, Zürcher Hochschule der
Künste, March 2013

 University of

http://www.youtube.com/watch?feature=player_detailpage&v=U6g0iVWuADL8

Various Youtube videos March 2013



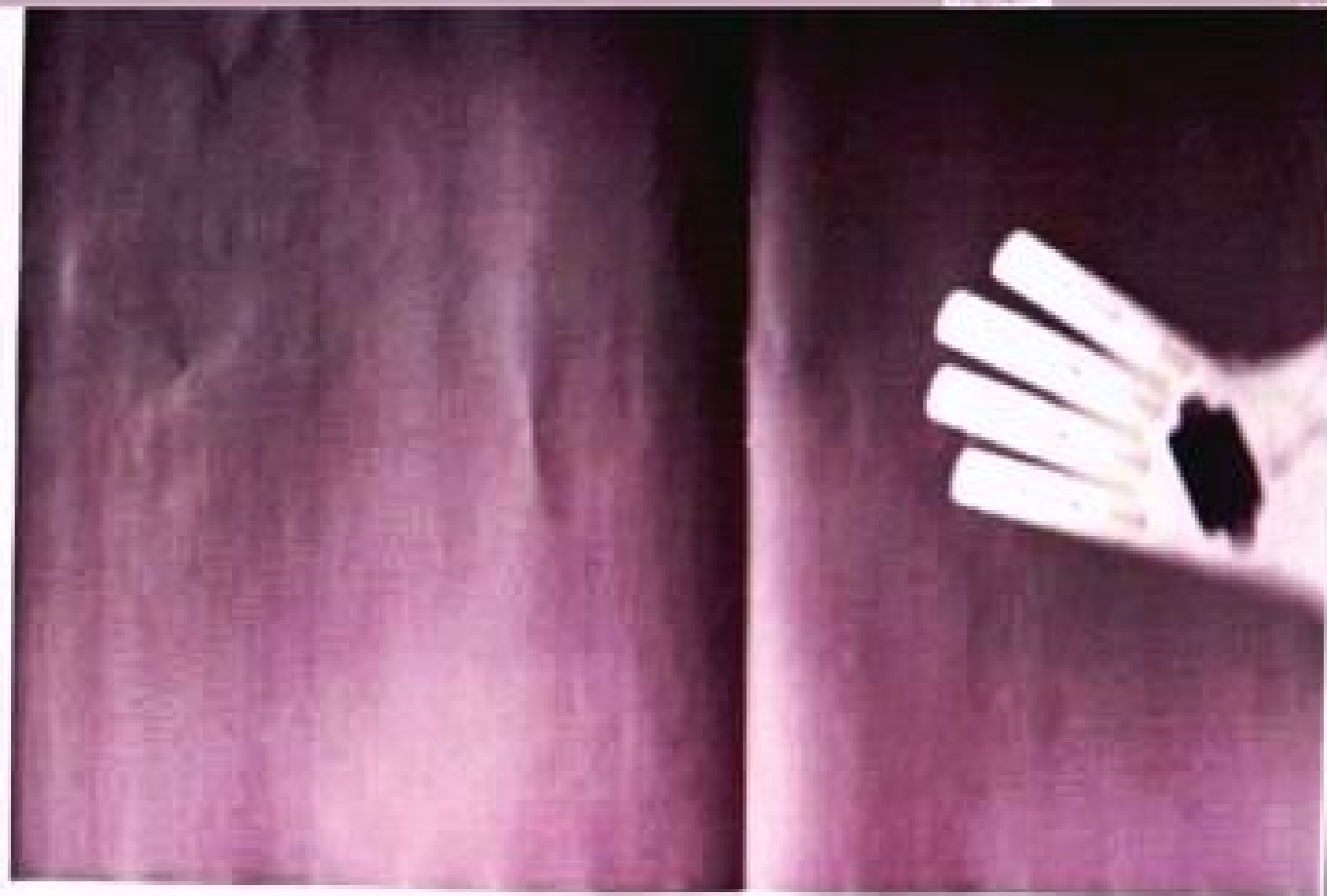
video: ZHdK, Zürcher Hochschule der
Künste, March 2013

Various Youtube videos March 2013



video: ZHdK, Zürcher Hochschule der
Künste, March 2013

Various Youtube videos March 2013



video: ZHdK, Zürcher Hochschule der Künste, March 2013



Media Coverage

BBC, Financial Times, Discovery Channel, Wired, Huffington Post, CNET, Science World Report Reuters, Keystone, National Geographic, ZDF, Bild, Welt, Süddeutsche Zeitung, Berliner Zeitung, 3SAT, Daily Mail, SRF Tagesschau, NZZ, Tages Anzeiger, 20Minuten, ...

Switzerland, Germany, France, Spain, England, Sweden, Italy, Turkey, Irland, Greece, Japan, China, Indien, USA, Canada, Chile, Argentina, Vietnam, Israel, Egypt, Mexico, Korea, Russia, ...

Roboy on Tour

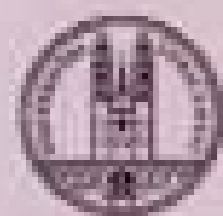
Itinerary:

ICRA (Karlsruhe), Swiss Innovation Fair (Zurich), Munich (TU), Beijing and Shanghai (China), Tokyo (Japan), London (UK) ...



Summary, conclusions

- wonderful experience >
- funding: crucial
- careful: crowdfunding not easy
- media attention: reason?
- tipping points
- discrepancy with funding

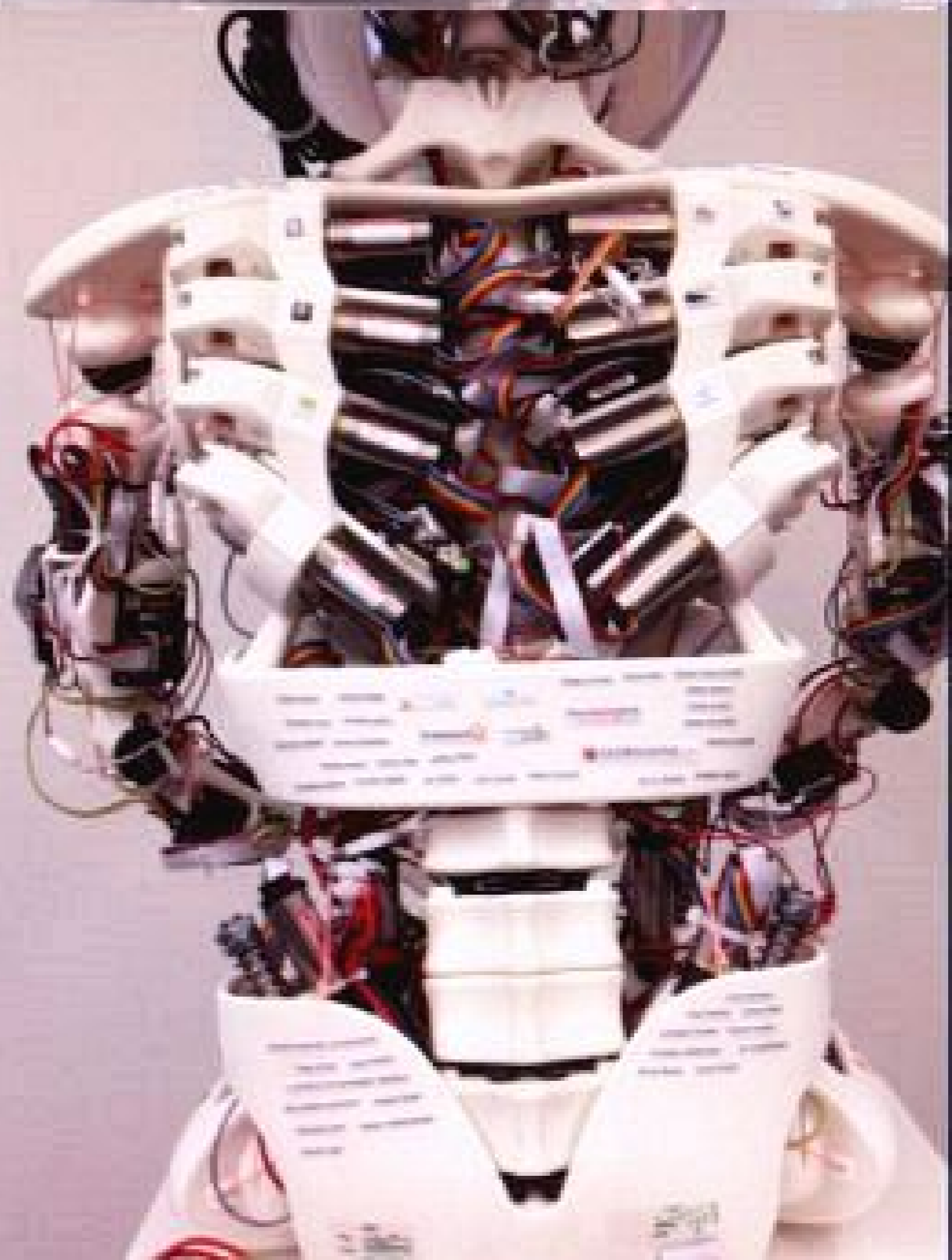
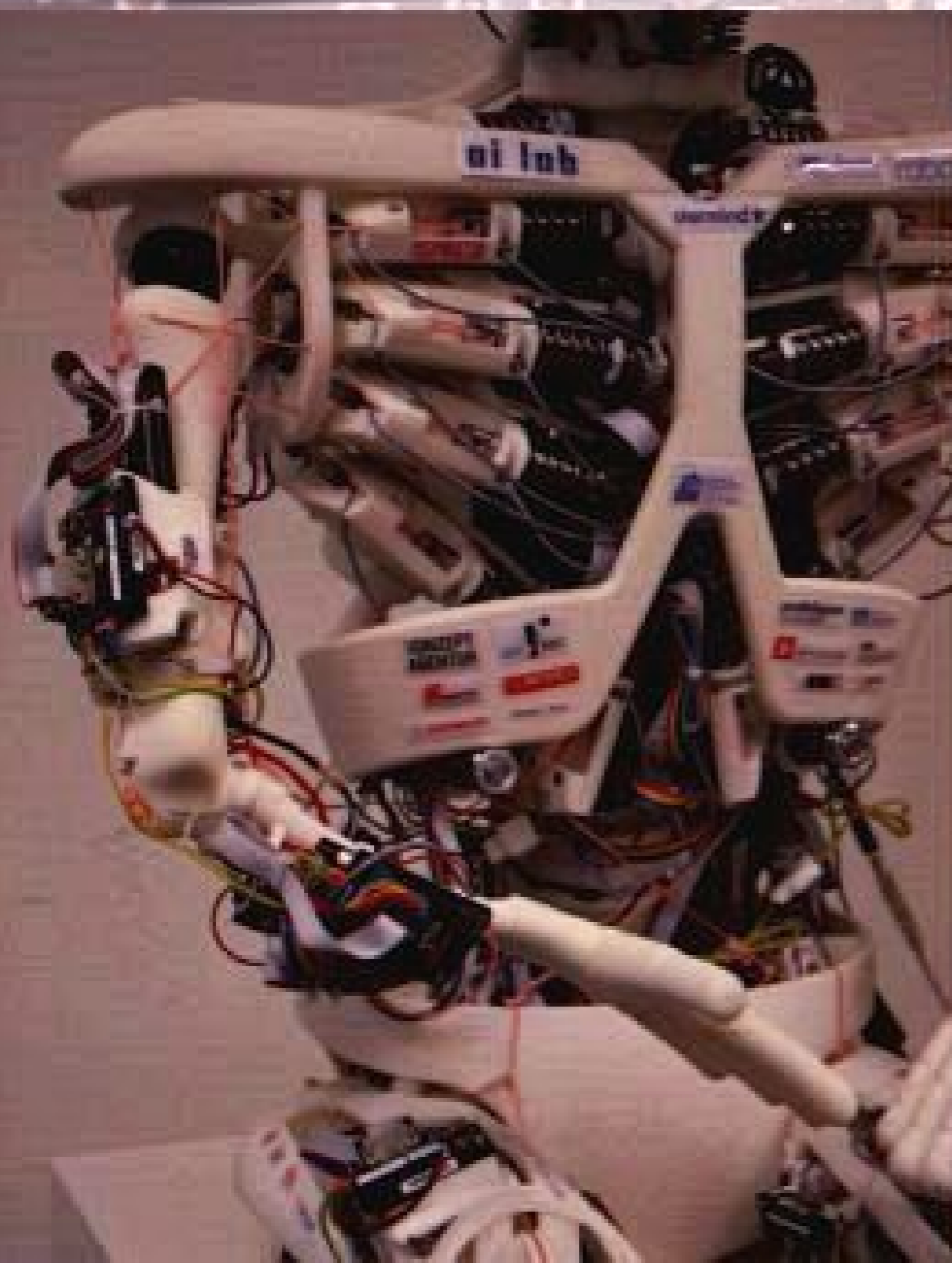


Summary, conclusions

- wonderful experience

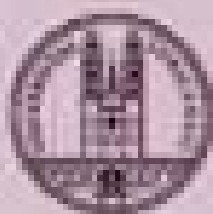
- 40 people
- 15 companies
- 7 universities (UZH, ETH-Z, TUM, U-Tokyo, Simtec-Singapore, ZHaW, ZHdK-Zurich)
- 50 sponsoring companies

Sponsors - Logos on Roboy



Summary, conclusions

- wonderful experience >
- funding: crucial
- careful: crowdfunding not easy
- media attention: reason?
- tipping points
- discrepancy with funding





Cheers!

Holding a hard object!

Your ideas - warmly welcomed!

Cheers!

Holding a hard object!



Like to know more?

WORLD SUMMIT OF AI ON MOBILE DEVICES

Expanding on the previous year's success, the summit will focus on the latest developments in mobile AI, including the challenges of processing data on small devices, the role of edge computing, and the impact of AI on user experience. The event will feature keynote speeches, panel discussions, and hands-on workshops.



BOOK LAUNCH OF 'FROM THE BODY SHAPING THE WAY WE THINK'

This book explores the profound impact of the human body on our cognitive processes and decision-making. It delves into the science of embodied cognition, showing how physical experiences shape the way we think and solve problems.

THE 8TH AWARDS OF THE AI LAB

The AI Lab's annual awards celebrate the most innovative and impactful research in the field of artificial intelligence. This year's winners represent a significant step forward in the development of intelligent systems.

SCIENCE SUMMIT PORTRAITS OF TOP RESEARCHERS IN THIRTEENS AND

This year's Science Summit features a series of portraits of leading researchers in the field of AI and robotics. These profiles highlight their contributions to the field and their vision for the future of the industry.

THE 'SHANGHAI LECTURES' 2014-2015

The Shanghai Lectures series brings together world-class experts to discuss the latest trends and challenges in AI and robotics. The lectures provide a unique opportunity for researchers and industry professionals to learn from the best in the field.

THE 2014 EUROPEAN FUTURE IN PET PLASHER'S PROJECT 'TACKLING TRAFFIC MANAGEMENT' (2011-2013)

This project explored the application of AI and robotics in urban traffic management. It demonstrated how intelligent systems can optimize traffic flow, reduce congestion, and improve overall city efficiency.

PEP'11, THE EUROPEAN FUTURE TECHNOLOGIES CONFERENCE AND EXHIBITION 'SCIENCE BEYOND FACTORY'

PEP'11 was a landmark event that showcased the latest European technologies in AI and robotics. The conference and exhibition provided a platform for researchers and industry leaders to share their work and discuss the future of the field.



DAVID SCHWARZE, THE NEW PROFESSOR AT THE AI LAB

David Schwarze has joined the AI Lab as a new professor, bringing with him extensive experience in AI and robotics. His research focuses on the intersection of machine learning and cognitive science.

ROBOTS-ON-TOUR WITH AWARD-WINNING OF THE AI LAB

The AI Lab's award-winning robots have embarked on a tour, showcasing their capabilities and the research behind them. This tour highlights the practical applications of AI and robotics in various settings.

DIFFERENTIAL COMPUTATION

SOFT ROBOTICS

ROCK ROBOTICS



University of Zurich

robotics

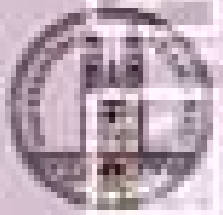
ai lab

Like to know more?

Read THE book!

Like to know more?

WHAT book?!???



University of Zurich

robotics

International Centre of Competence in Research

ai lab

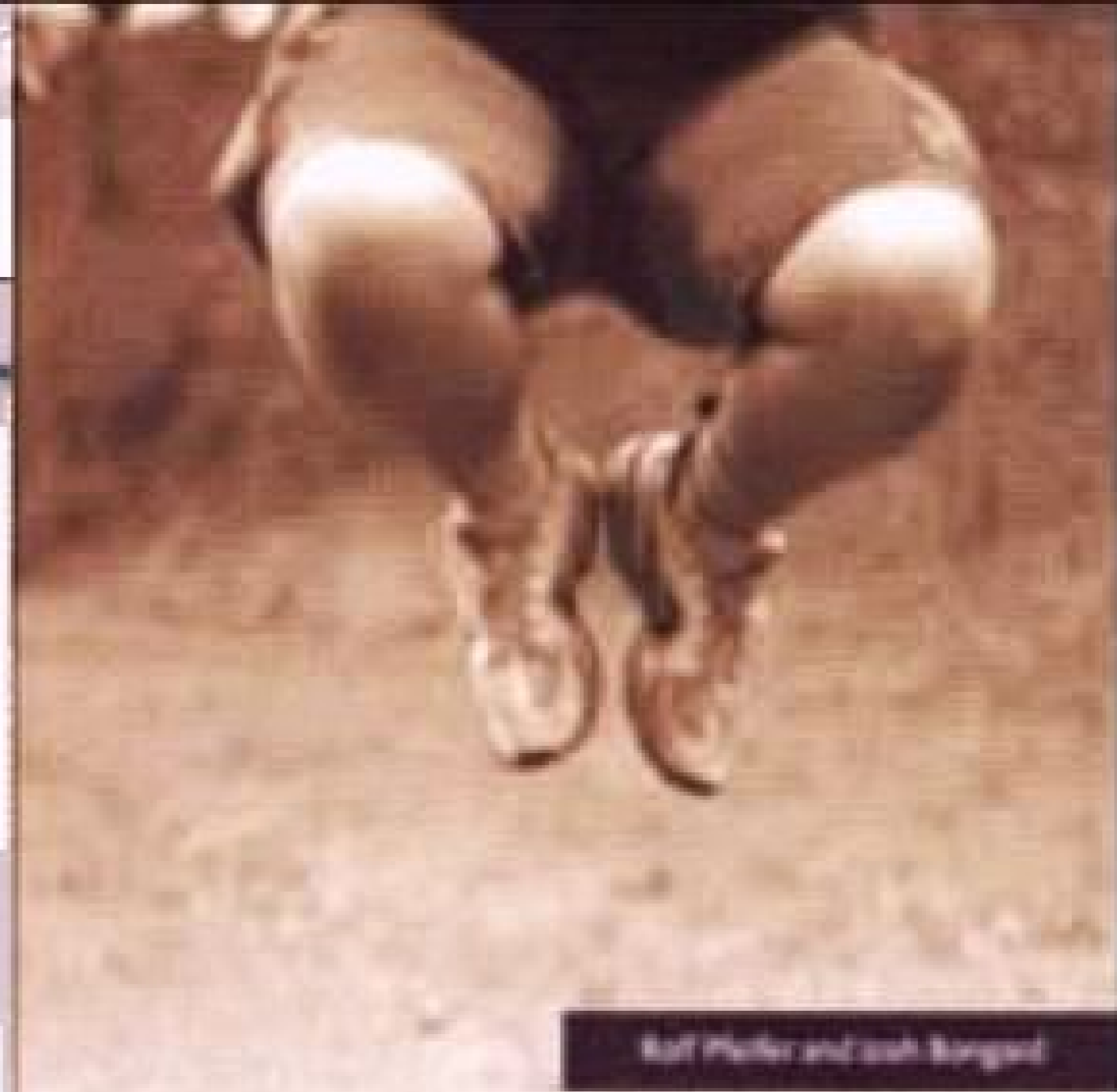
Read:

Rolf Pfeifer and Josh Bongard

How the body shapes the way we think — a new view of intelligence

MIT Press, 2007

Illustrations by Shun Iwasawa



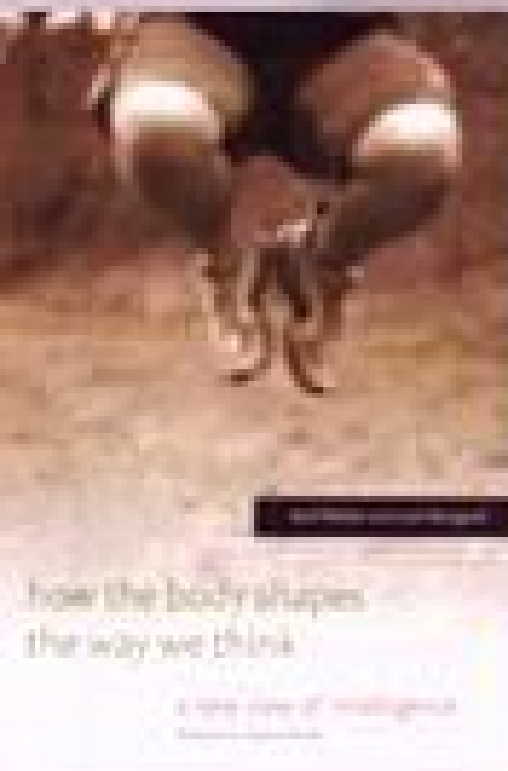
Rolf Pfeifer and Josh Bongard

how the body shapes
the way we think

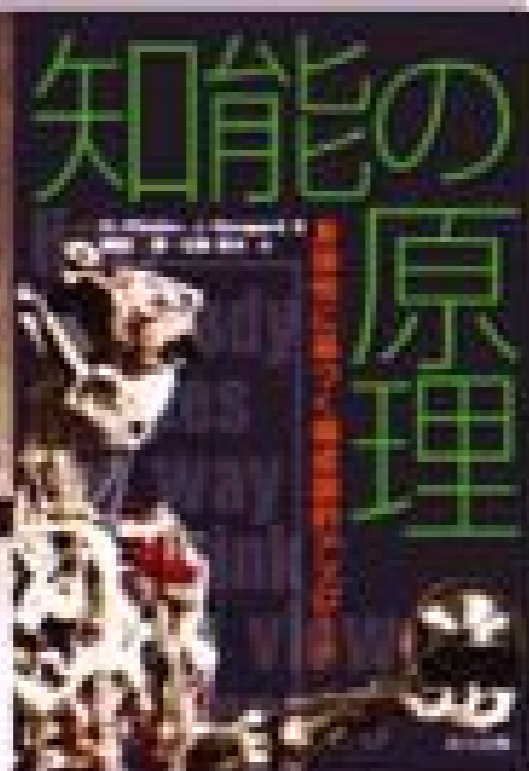
a new view of intelligence

Illustrations by Shun Iwasawa

Read:



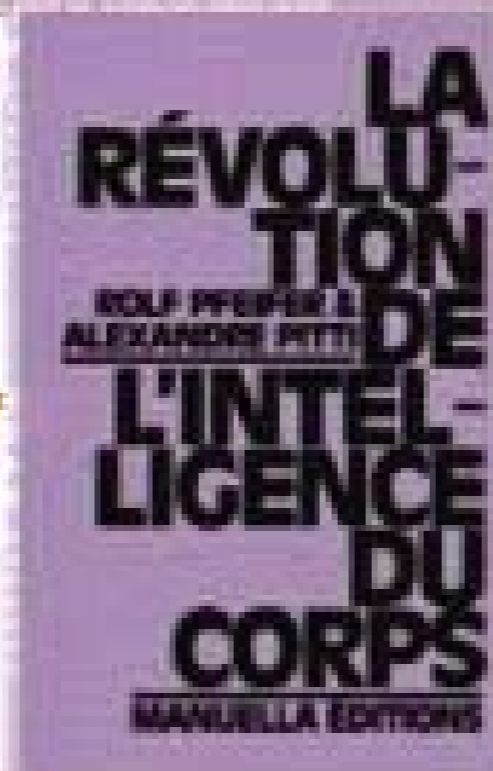
English



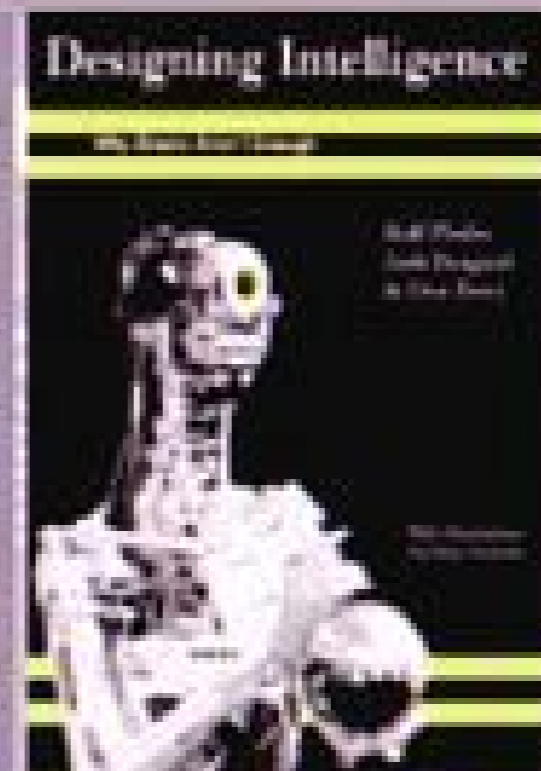
Japanese



Chinese



French



English



Arabic

Better robots — better life



Thank you for your attention!