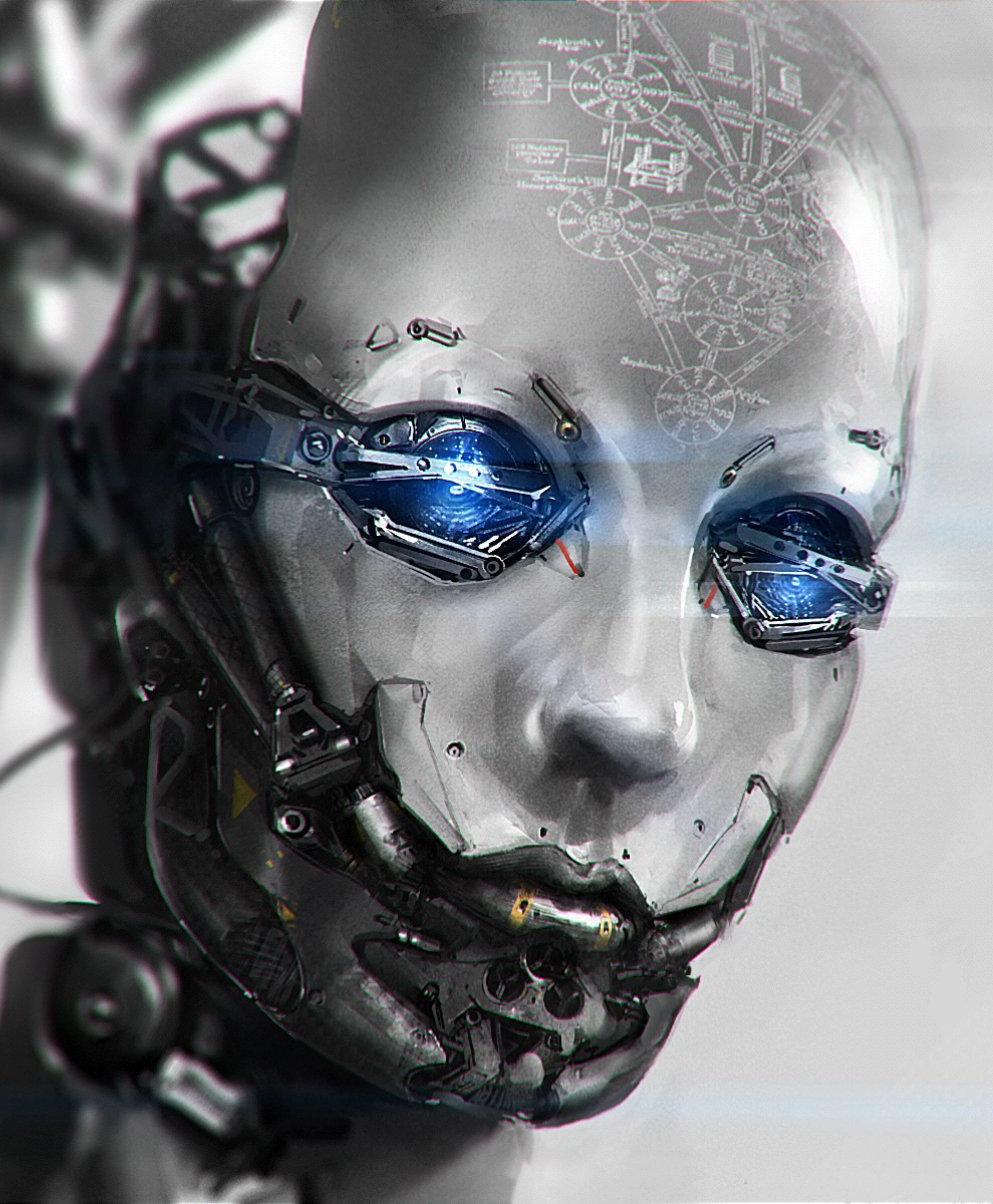
IDEAS

AUTODESK®



"In a properly automated and educated world, then, machines may prove to be the true humanizing influence. It may be that machines will do the work that makes life possible and that human beings will do all the other things that make life pleasant and worthwhile."

- Isaac Asimov


HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS
IDEAS
THE INNOVATION + DESIGN SUMMIT
ROBOTICS
Robots, Robots Everywhere!

IDEAS_09

On June 25th and 26th 2014, thirty leaders met at Autodesk's IDEAS Innovation+Design Summit to discuss the future of robotics. The participants – an energized group of researchers, makers, designers, programmers, economists, engineers, and entrepreneurs – explored a wide range of topics during this two day workshop.

From robot-assisted surgery to large-scale, automated construction projects, and from space exploration to the state of investment in robotics companies, the participants tackled the technologies, tools and trends as well as the economic, industrial and social implications of a world in which robots and humans work side-by-side.

The participants – an energized group of researchers, makers, designers, programmers, economists, engineers, and entrepreneurs – brought many ideas about how robots will be used to design and make just about anything in the future, the challenges the industry faces, and what technology companies may do to address the opportunities.

This visual report contains a breakdown of the key ideas and insights presented during the Summit and brief descriptions each presenter and their presentations.

For more information about IDEAS, contact ideas@autodesk.com.

The IDEAS Team

The Big Idea

Robots, machines capable of automatically carrying out complex tasks, are transforming the way we design and make things. Not only have they reshaped how cars, airplanes and consumer electronics are manufactured, they are augmenting the surgeon’s scalpel, directing self-driving cars and on the verge of transforming the services industries.

As robots grow in sophistication and accessibility, and as market opportunities broaden, a central question emerges for technology companies:

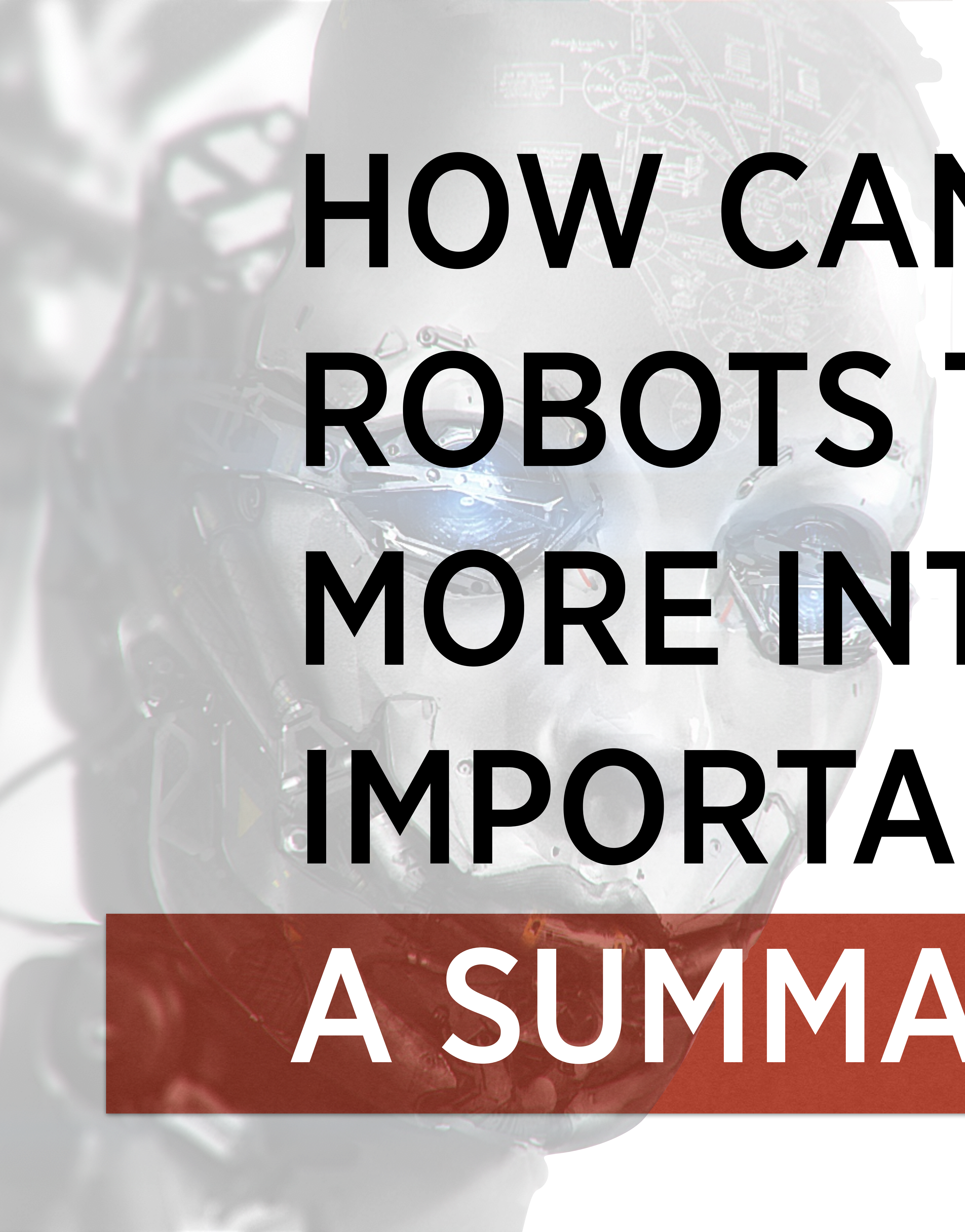
How can we direct robots to do more interesting and important things?

This question is filled with implications. How will robots be designed and programmed? What do we want robots to do for us? Who will be using and benefiting from robots? And what exactly *is* a robot anyway?

IDEAS_09 begins to unpack and answer these questions. Though not definitive, they point towards a new world with fresh opportunities. Without a doubt, robots will play larger roles in the way we design and make things.

IDEAS_09 PARTICIPANTS

Roger	**Chen**	O'Reilly AlphaTech Ventures	Associate
Scott	**Cohen**	New Lab	Co-Founder and Partner
Maurice	**Conti**	Autodesk	Director, Strategic Innovation
Simon	**DiMaio**	Intuitive Surgical	Senior Manager, Research and Advanced Systems
Renee	**DiResta**	O'Reilly AlphaTech Ventures	Principal
Terry	**Fong**	NASA Ames Research Center	Director, Intelligent Robotics Group
Marc	**Freese**	Coppelia Robotics	CEO and Development Director
Tim	**Geurtjens**	Joris Laarman Lab	Technical Director
Mike	**Geyer**	Autodesk	Sr. Manager, Marketing & Business Development
Ken	**Goldberg**	UC Berkeley	Professor
Saul	**Griffith**	OtherLab	Founder
Trevor	**Haldenby**	The Mission Business	Co-Founder and Futurist
Mark	**Hatch**	Techshop	CEO and Co-Founder
Mitchell	**Joachim**	TerreFORM One	Co-Founder and Director of Research
Brian David	**Johnson**	Intel	Futurist
Andra	**Keay**	Silicon Valley Robotics	Managing Director
Jonathan	**Knowles**	Autodesk	Director, Strategic Initiatives
Jeff	**Kowalski**	Autodesk	SVP, Chief Technology Officer
Jeff	**Kramer**	MTD Products	Lead Robotics Engineer
Tessa	**Lau**	Savioke	Chief Robot Whisperer
Byron	**Laviolette**	The Mission Business	Co-Founder and Story Architect
Russell	**Loveridge**	NCCR Digital Fabrication	Managing Director
Tasha	**McCauley**	Fellow Robots	Co-Founder and CEO
Alex	**McDowell**	5D Institute	Founder and Creative Director
Franck	**Messmer**	Autodesk / Delcam	Principal Robotics Software Engineer
Mads	**Paulin**	Autodesk	Software Architect
Nadya	**Peek**	MIT Center for Bits and Atoms	Research Assistant
Jon	**Pittman**	Autodesk	VP Corporate Strategy
EJ	**Sabathia**	Moon Express	Mechanical Design Engineer
Nathan	**Shedroff**	CCA	Program Chair, Design MBA
Alvise	**Simondetti**	Arup	Global Leader, Virtual Design
Chad	**Sweet**	Qualcomm	Director of Software Engineering
Diego	**Tamburini**	Autodesk	Manufacturing Industry Strategist
David	**Thomasson**	Autodesk	Design Engineer, Applied Innovation
Patti	**Vrobel**	Autodesk	Director of Engineering
Tom	**Wujec**	Autodesk	Fellow
Laurie	**Yoler**	Qualcomm Labs	SVP Business Development



HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

A SUMMARY OF IDEAS

What Obstacles limit Robotics?

INDUSTRY CHALLENGES

- **Blind:** Low resolution sensors and perceptual processing means that Robots can't see or hear very well.
- **Stupid:** Robots lack physical and emotional intelligence.
- **Fat:** Robots are physically large.
- **Weak:** Robots have a relatively low lifting capability.
- **Slow:** Robots are relatively slow.
- **Difficult:** Robots are hard to program.
- **Unsafe:** Robots can kill people.
- **Unyeilding:** Robots are not flexible in their work.
- **High Maintenance:** Robots need continual attention.
- **Expensive:** Robots have a high capital cost and even higher maintenance cost.

INDUSTRY OPPORTUNITIES

- **Perceptive:** Inexpensive sensors and more integrated programming will equip robots with better perception.
- **Intelligent:** Emergent algorithms and group behaviour will augment robot intelligence, responding to human emotion.
- **Slim:** New materials and form factors will drive miniaturization.
- **Strong:** Fluid actuators will increase strength and precision.
- **Fast:** Increased processors will increase responsiveness.
- **Easy:** New paradigms will simplify programming.
- **Safe:** Intelligence and soft bodies will make robots safer.
- **Flexible:** Machine learning will make robots smarter.
- **Self-Maintaining:** Robots will fix themselves.
- **Cheap:** Robeconomics will drive the cost of robots down.

How Might we Address Robotics?

INDUSTRY CHALLENGES

- **Mechanical Approach:** Much of robotics uses an approach predicated on solid machines, extending the concept of a smart locomotive engine. This metaphor has inherent limitations and biases.
- **Human Centric:** Many robotic designs aim to mimic the human form and actions.
- **Engineering Approach:** Many robot designs are built from only an optimization mindset.

INDUSTRY OPPORTUNITIES

- **Biological Approach:** We can use cues from biology to better program robots, building on our understanding of how do animals and humans learn?
- **Alternative Biological Forms:** Robots can be designed to mimic a wide range of biological forms.
- **Innovation Approach:** Robots can be designed in response to a problem as well as search for applications.

Who will create, program and use robots?

INDUSTRY CHALLENGES

- **Professionals:** Robots must be programmed by high cost professionals, typically at $200k year.
- **Affluent:** Robots are accessible to highly capitalized organizations in mechanized industries.
- **Skills for Designing, Building and Using:** There are limited curricula for designers to create robots.
- **Male:** There is a bias for robots to be designed, programmed, manipulated by men.

INDUSTRY OPPORTUNITIES

- **Ease of Use:** Simpler user-interfaces, more intelligent design and better tools will enable non-specialists to program robots.
- **Democratized:** Educational tools will enable a wider range of people to understand and use robots.
- New Skills: There is an opportunity to develop new skills to work with, design and construct robots. This can occur at all levels from grade school to hobbits to professional.
- **New Education and Mindsets:** Understanding the breadth of capabilities diverse teams bring to solutions improves the net outcome.

HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

What are the means of manipulation?

INDUSTRY CHALLENGES

- **Low-Level Software:** Of the 30 major robot suppliers, each has its own low level language and it not interchangeable with others.
- **Mid-Level Software:** There is no middleware or platform for application robot behaviour.
- **High-Level Software:** There are few robotic tools that direct complex decision-making and emotional or empathetic computing.
- **Low Robot Accuracy:** Robots currently are imprecise in their movements.
- **Robot Hostile Environments:** Most physical environments are not friendly to robots.

INDUSTRY OPPORTUNITIES

- **Low-Level Software:** Is there a possibility to open the API of manufacturers to improve the coordination and precision of manipulation.
- **Mid-Level Software:** Create a middleware solution of behavioural applications. This app store would allow different robots to embody higher-order sensing-understanding-acting behaviours from cleaning to serving to building.
- **High-Level Software:** Complex decision-making, personality and higher order emotional computation will make robots much more accepted and useful many industries, especially the service industry. Cloud computing and swarming behaviour are rick with possbility.
- **Robot Friendly Environments:** There is a potential to design robot / environmental systems to create more comprehensive solutions. What changes to the environment will make them easier to control.

What exactly is a robot?

INDUSTRY CHALLENGES

- **Unclear Mental Models:** There are different conceptions of what a robot is. Many roboticists have almost religious debates on the topic.
- **Appropriate Taxonomies:** Many robots are designed with inappropriate form factors.

INDUSTRY OPPORTUNITIES

- **Develop a Shared Definition and Taxonomy of Robots:** Create a community where better definitions and definitions of robots are described, with appropriate tools to design them.
- **Explore New Robotic Taxonomies:** Metaphor of what a robots. Form factor of what a robot shapes.
  - **Shapes:** Usually in biological form include human (bipedal), quadraped, arm, hand, snake, fish, bird, car, …
  - **Function**: Helper, Worker, Companion, …
  - **Size**: Small, medium, large …

What actions can robots perform?

INDUSTRY CHALLENGES

- **Low Level Work:** Robots can do the work of Repetitive, dangerous or unpleasant.
- **Mid-Level Skills:** Manufacturing.
- **High Level Work:** Augment Higher level skills Surgery

INDUSTRY OPPORTUNITIES

- **Address Low Level Work:** Robots can be designed to perform dangerous and unpleasant work of all types.
- **Address Mid-Level Work:** Robots can be designed to perform the work of manufacturing.
- **Address High-Level Work:** Robots can continue to enhance specialize skills and capabilities, from surgical to aerospace to mining.
- **Impossible and Unimaginable Work:** Robots have the potential to do work which is currently well-beyond the capabilities of human beings because of size, speed or tolerance of extreme environments.

What is the impact of the robot revolution?

INDUSTRY CHALLENGES

- **Poor General Performance Robots:** While specific functions (manufacturing, vacuum cleaning) are effective, general purpose robots perform poorly.
- **Limited to Solo Devices:** Most robots are designed to operate by themselves taking little advantage of social, mobile, cloud-based technologies.

INDUSTRY OPPORTUNITIES

- **Good General Performance Robots:** With the development of app stores, cloud based interchange learning, there is the possibility to create better quality general purpose robots.
- **Networked Devices.**: The future of robotics seems to lie in a combination of harnessing big data, improved computing power, and inclusion of robots into the internet of things.

How will Robotics affect industry and society?

INDUSTRY CHALLENGES

- **Human Labor:** As robots do and make more things, they will displace human labour creating a new class of unemployed.
- **Limited Applications:** Currently, robots do relatively few things in non-technical industries.

INDUSTRY OPPORTUNITIES

- **Training:** As robots perform better, there are new opportunities for labour to retool and program these devices.
- **Broad Robotic Applications:** As robots grow in sophistication, they will increase the range and scope of their work
  - Sharing information
  - Learning through building
  - Tangible learning
  - Watching the elderly
  - Farming
  - Gardening
  - Music
  - Culture
  - Learning from Failure
  - Exploring (where no human has gone before)

What tools and processes are emerging?

INDUSTRY CHALLENGES

- **Robots are crude and have limited impact:** Though powerful in the world of manufacturing, Robots are still emergent.

INDUSTRY OPPORTUNITIES

- **Do more Positive Things:** How might robots do things that will benefit humanity, children, the world of work and pleasure?
- **Will Robots do Negative Things:** The potential for robotic harm also exists. Will be have robots as armies? Robots as slaves? Robots in Satanic Mills? How might robots be used in the 3rd world?

THE KEY QUESTIONS …	SOME PRELIMINARY ANSWERS …
HOW What Tools and Processes are used to build robots and robotic systems? *Identify methodologies for designing robots as well as designing with them.*	• Robot creation is a complex undertaking with few dedicated tools • Because of the diversity of robots, no single design methodology exists. • Most robots are controlled by primitive low-level scripting tools.
CAN What are the extremes of possibilities? *Explore who will use robots and where they will be used.*	• Robots are evolving to be more social, mobile and cloud-based • They have the opportunity to become more autonomous • The diversity of robots is increasing rapidly into many markets
WE Who will use and create robots? *Explore the access to these next generation tools.*	• Manufacturers have been using robotics successfully for decades • Robotic investment is addressing eight key growing markets • Access to robotics is becoming democratized but has gender
DIRECT What are the means of manipulation? *Determine how software will manage the behavior of robots*	• Sensors are becoming better and less expensive • Actuators and manipulators will require less • Simulators
ROBOTS What is a robot? Mechanical? Biological? Digital? *Establish the ecosystem of robots, large and small, simple and complex.*	• Robots have five parts: Brain, Power, Manipulators, Actuators, Sensors • Robots take various Form Factors: Human, Arm, new are emerging • Taxonomy of Robots is massive with endless permutations
TO DO MORE INTERESTING AND IMPORTANT THINGS What kinds of activities? What is the impact of the robot revolution? *Identify their future uses and benefits.*	• Robots will Augment Human Performance especially in medicine • Do things not interesting for Humans • Internet of Things
MORE EFFECTIVELY What will grow the industry? Address the Industry Challenges? *Distinguish blocks and drivers that shape the industry.*	• Stupid, Weak, Unemotional • Make programming easier. • Make the hardware more accessible.

IDEAS_09 RECEPTION


IDEAS
THE INNOVATION
+ DESIGN SERIES
Laurie
Yoler
Qualcomm
USA
Renee
DiResta
OATV
USA


+ DESIGN SERIES


IDEAS


IDEAS


IDEAS


IDEAS


Mark
Hatch


IDEAS


IDEAS


THE INNOVATION
+ DESIGN SERIES


IDEAS


IDEAS
THE INNOVATION


IDEAS
THE INNOVATION + DESIGN SERIES
AUTODESK

IDEAS_09 PRESENTATIONS

01_Tom Wujec

Autodesk Fellow

"How can we direct robots to do more interesting things?"

Key Questions about Robots

Tom Wujec opened the IDEAS presentations by allowing one robot in particular - Siri's male counterpart - to speak for itself, playfully introducing in rhyme all of the ways in which robots have already made themselves at home in the seas, skies, and even in our homes.

He proceeded through a word-by-word breakdown of the summit's core question, challenging participants to reflect on all assumptions embedded within our current thinking about robots, and to explore how we might want to change or evolve that thinking in the future.


IDEAS
THE INNOVATION
+ DESIGN SUMMIT
ROBOTICS


Robots, Robots Everywhere!


On the Ground
and In the Air
Robots, Robots, Everywhere.


Up in space,
Beneath the seas,
Robots make discoveries.


Tractor Robots
Plant and Sow.


Robots even milk a cow!


Under couches, over rugs,
Vacuum robots have no plugs.


Robot dogs roll over, bark.
Can we take them to the park?

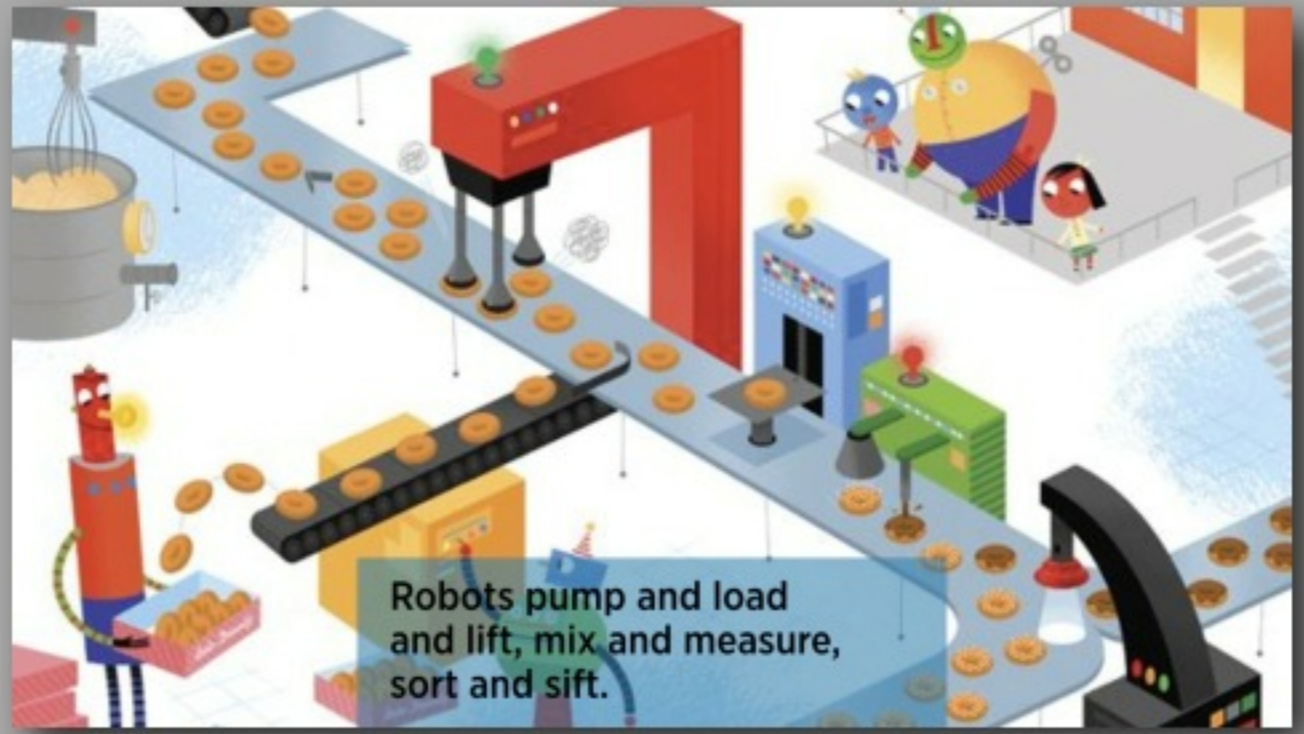

Robots spin and race
and run.

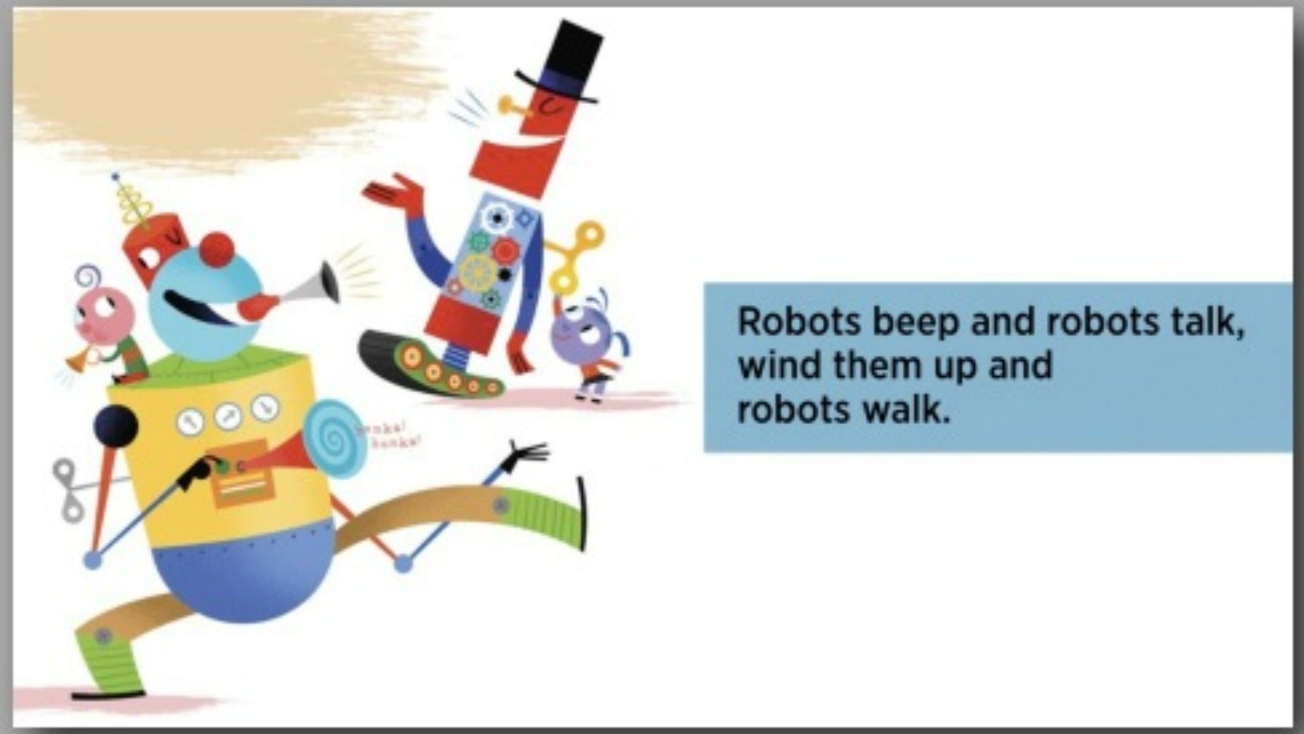

Robots. Robots.
I want one.


Robots weld and paint
and blast. Robots build cars
really fast.


Working robots
drill and grind.

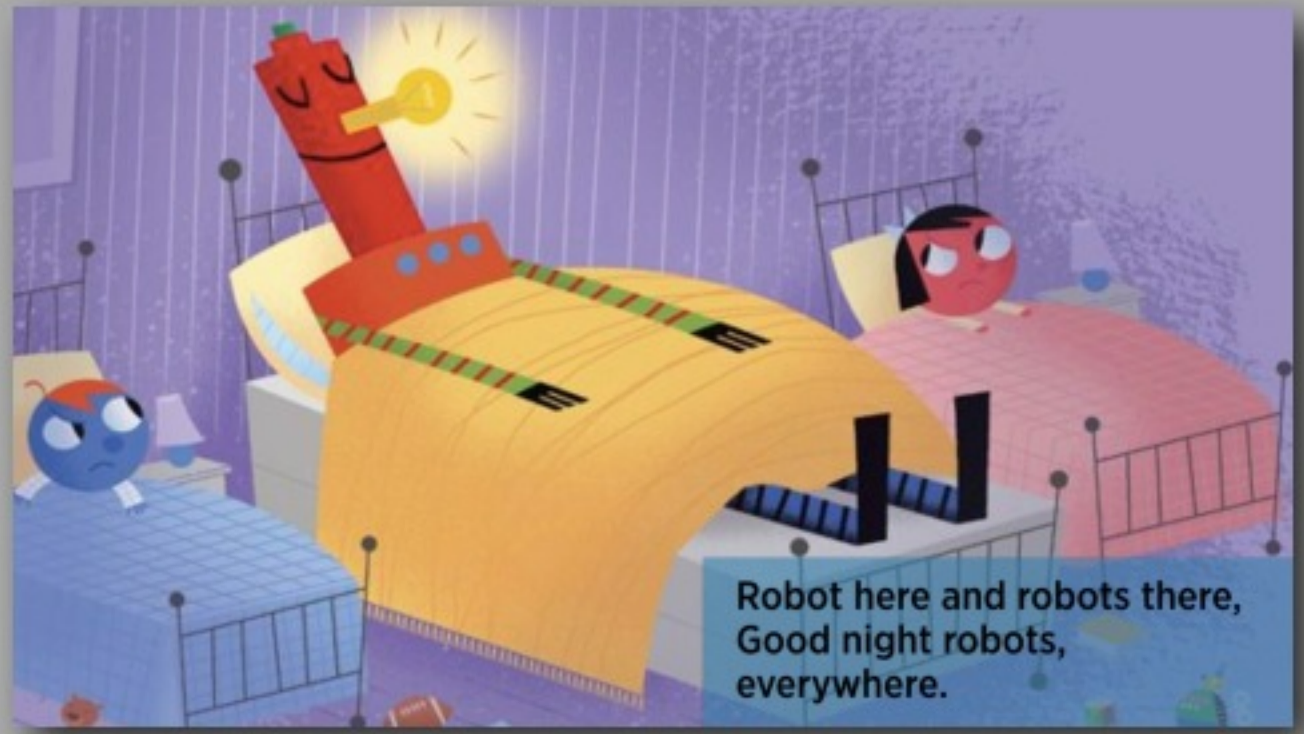

Rescue robots
Seek and find.

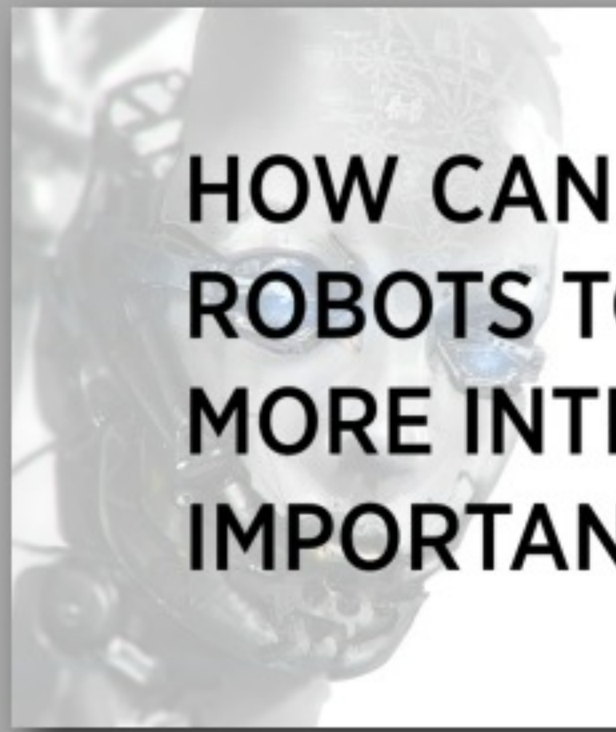

Robots pump and load
and lift, mix and measure,
sort and sift.


Robots beep and robots talk,
wind them up and
robots walk.


Robots made like you and me.


Robot playmates,
wait and see...


Robot here and robots there,
Good night robots,
everywhere.



HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

What tools and processes are emerging?

HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

What are the extreme possibilities?

HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

Who will use Robots?

HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

What are the means of manipulation?

HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

What, actually, do we mean by the word Robot?

HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

How can we think of the actions of Robots?

HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

What kinds of activities will robots do?

HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

What will establish breakthroughs?

What will the impact of the Robot Revolution be?

WELCOME AND INTRODUCTION

Jonathan Knowles
Director of Strategic Initiatives at Autodesk, welcomed the participants to IDEAS.

Tom Wujec
Autodesk Fellow, acted as the facilitator, leading the group through the discussions.


OPEN SOURCE vs. PROPRIETARY
DO ROBOTS MAKE US MORE, LESS, OR NEITHER EMPATHETIC TO EACH OTHER?
PORTABLE SITE-SPECIFIC AUTOMATION
How do we design educational

02_Renee DiResta

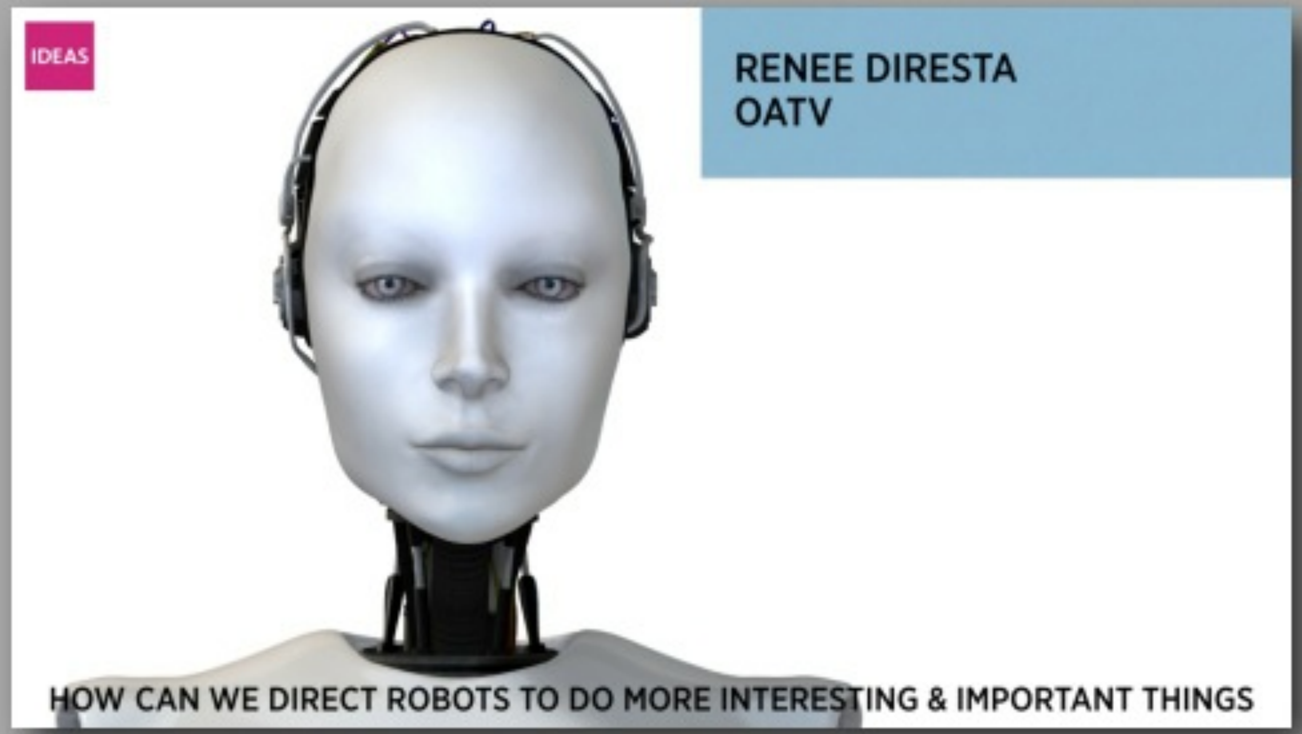
O'Reilly AlphaTech Ventures

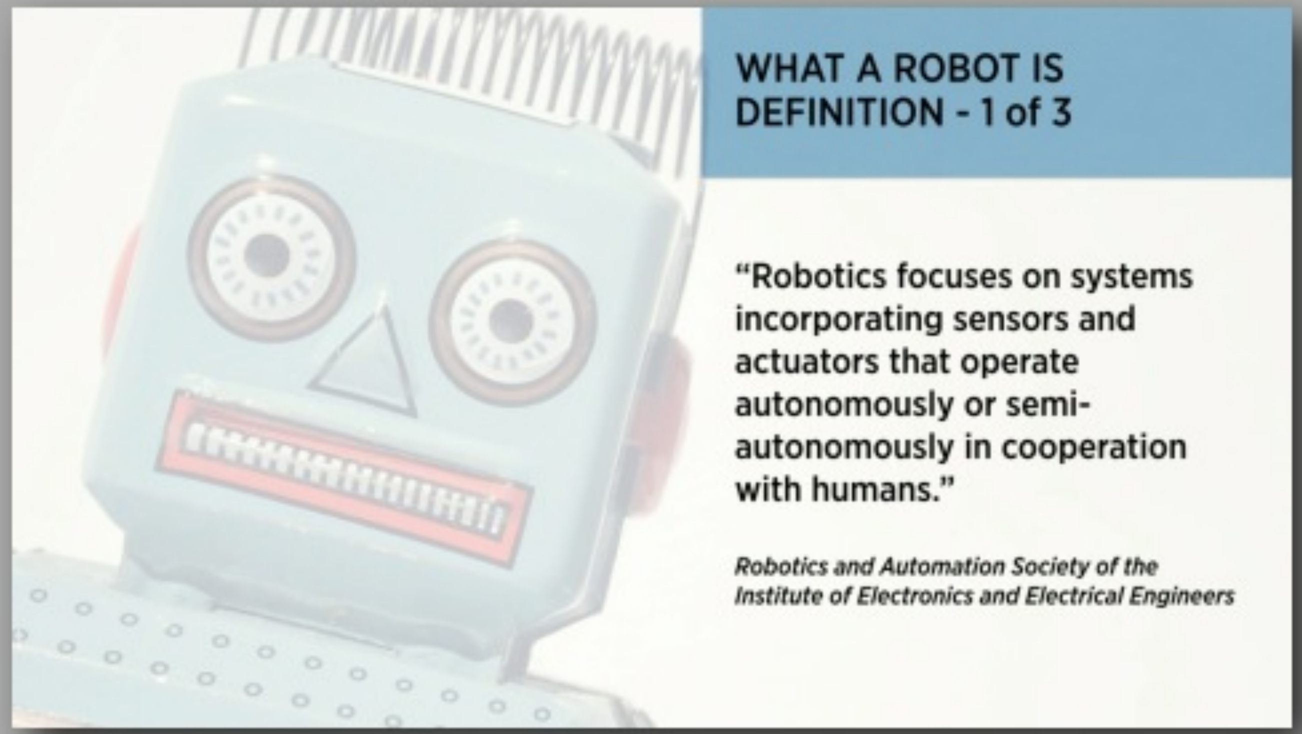
"I'm interested in hardware."

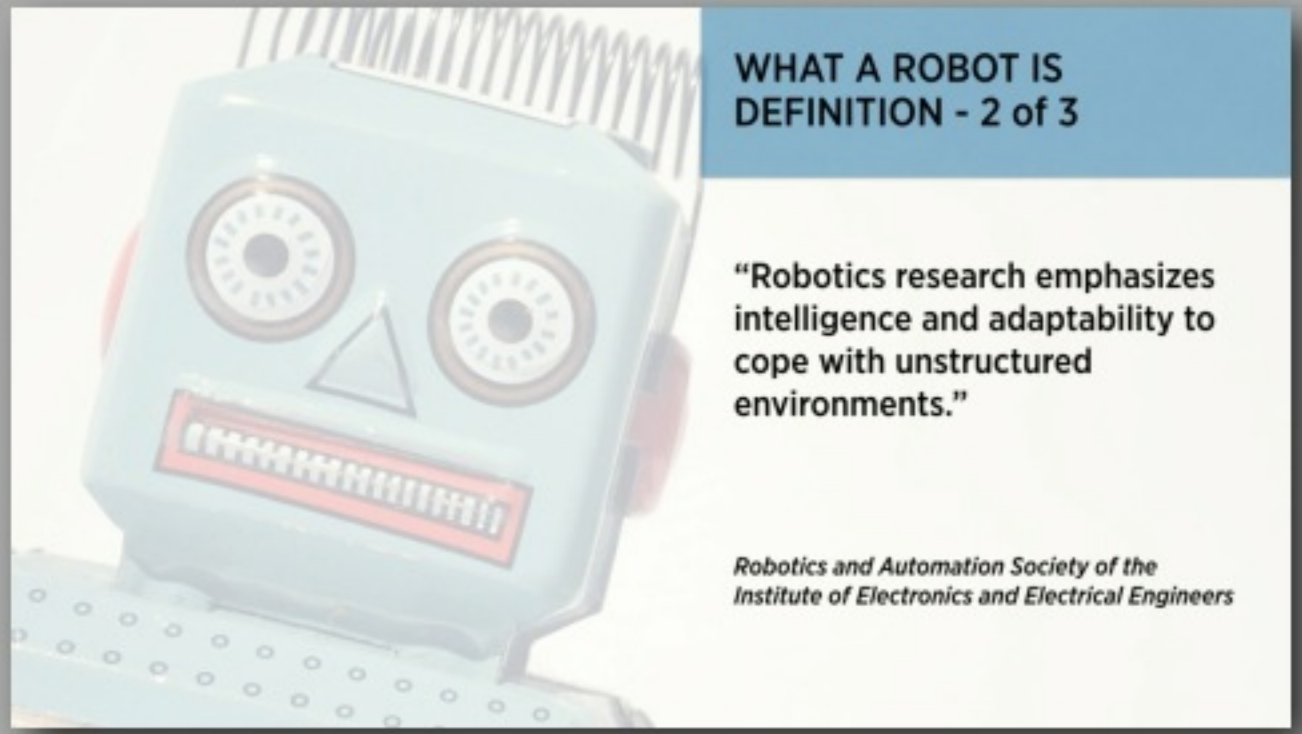
The Economics of Robotics

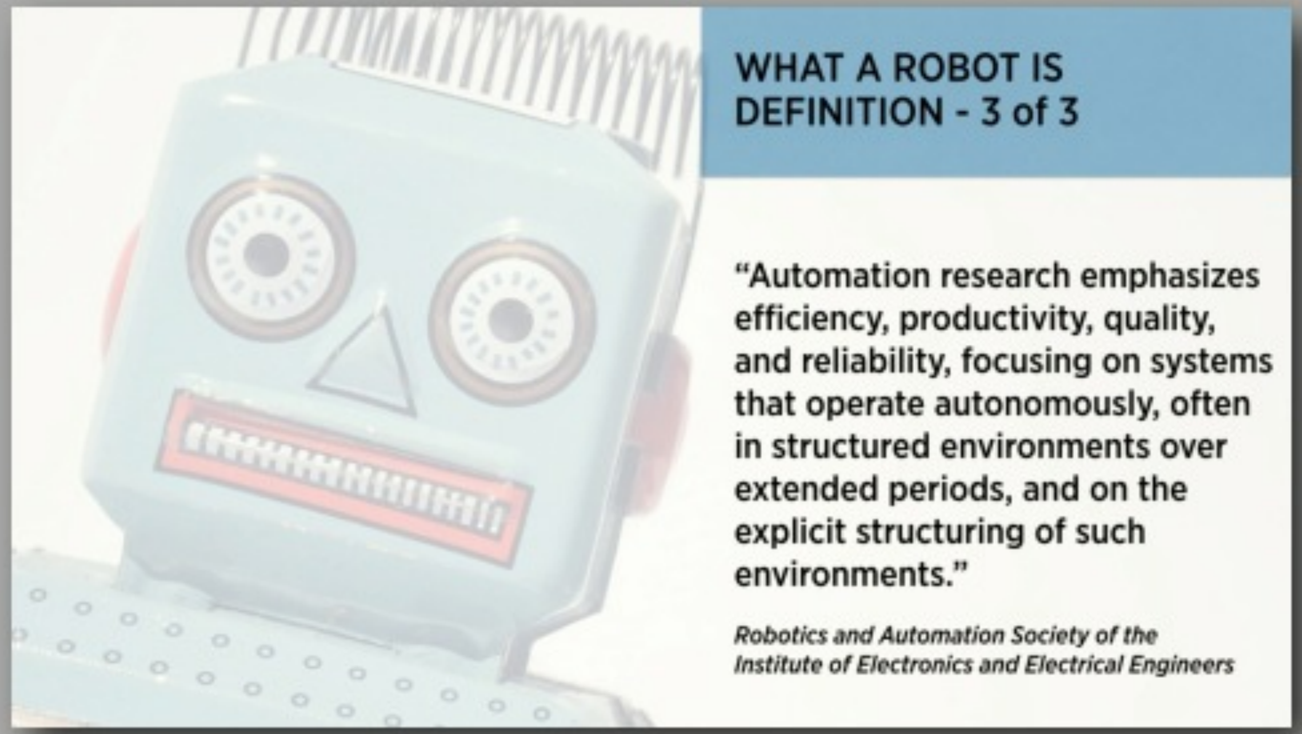
Seen from the perspective of the potential investor, this presentation defined what a 'robot' is and offered a timeline of modern robotics, tracing an evolutionary path from 2002's Roomba to 2014's Festo Robotic Kangaroo (that recharges its batteries through its own hops).

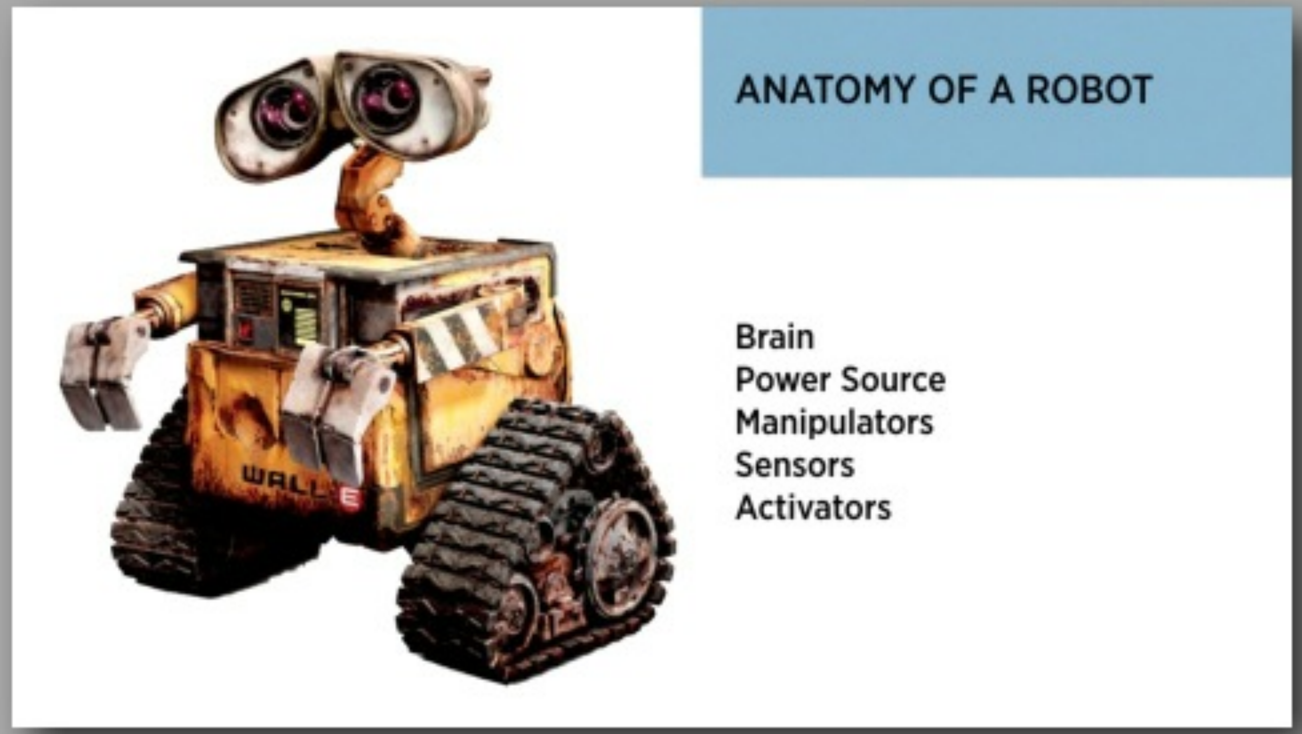
Approximately 350 companies define the modern robotics space, existing across fields as diverse as consumer systems, surgical solutions, interactive haptic systems, industrial robotic systems, biotech/pharma solutions, inventory management, robotic components and unmanned vehicles.

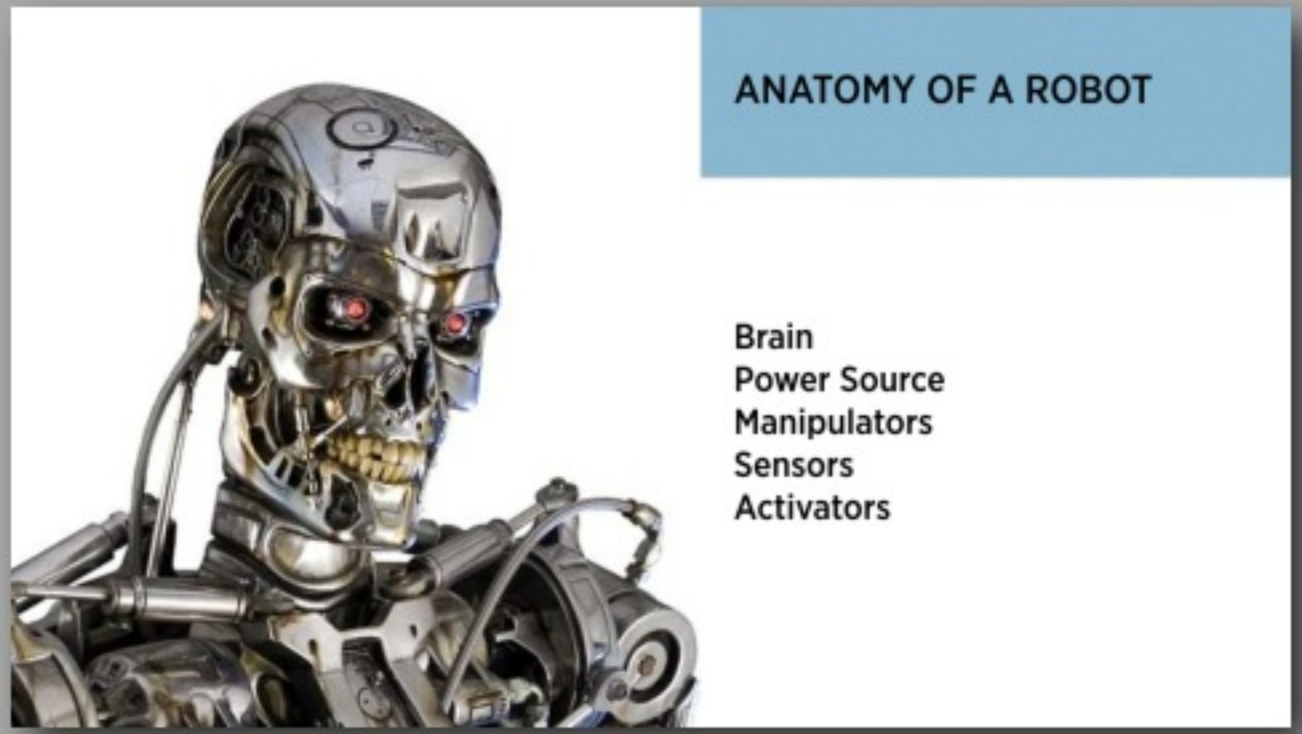

IDEAS
RENEE DIRESTA
OATV
HOW CAN WE DIRECT ROBOTS TO DO MORE INTERESTING & IMPORTANT THINGS

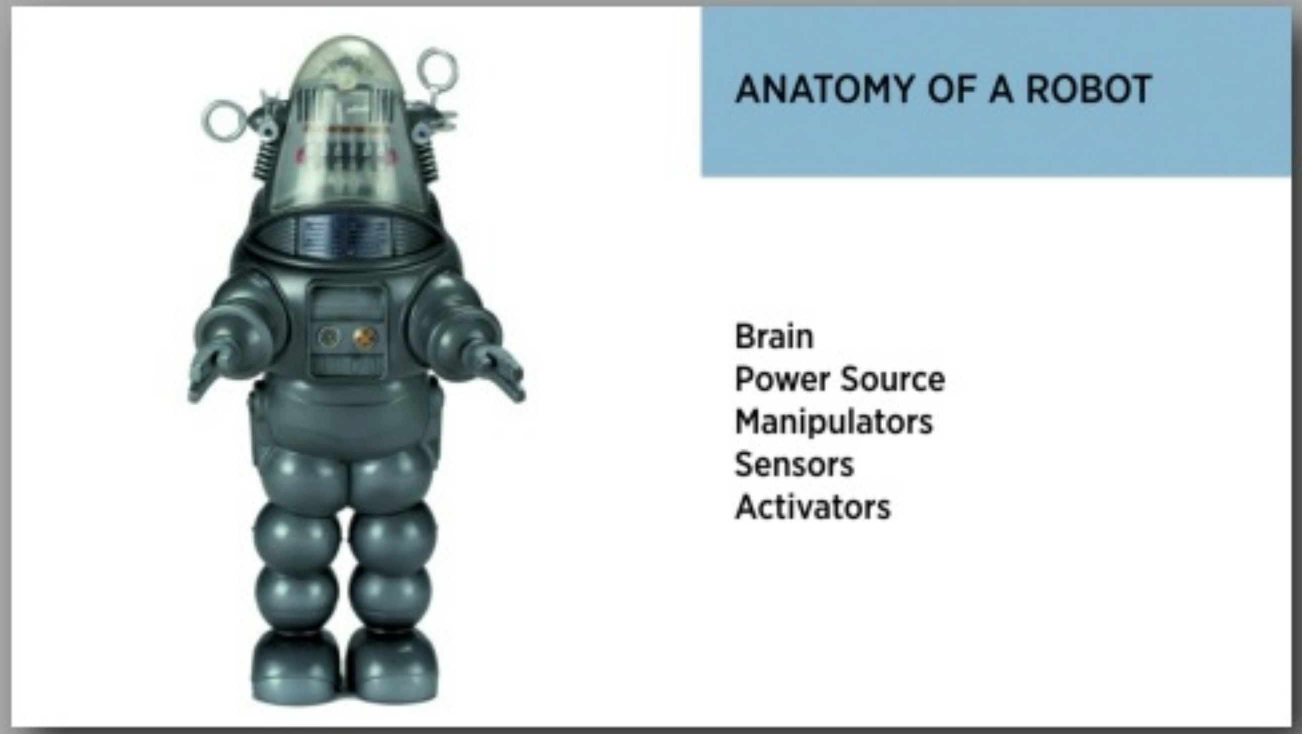

WHAT A ROBOT IS
DEFINITION - 1 of 3
"Robotics focuses on systems incorporating sensors and actuators that operate autonomously or semi-autonomously in cooperation with humans."
Robotics and Automation Society of the Institute of Electronics and Electrical Engineers

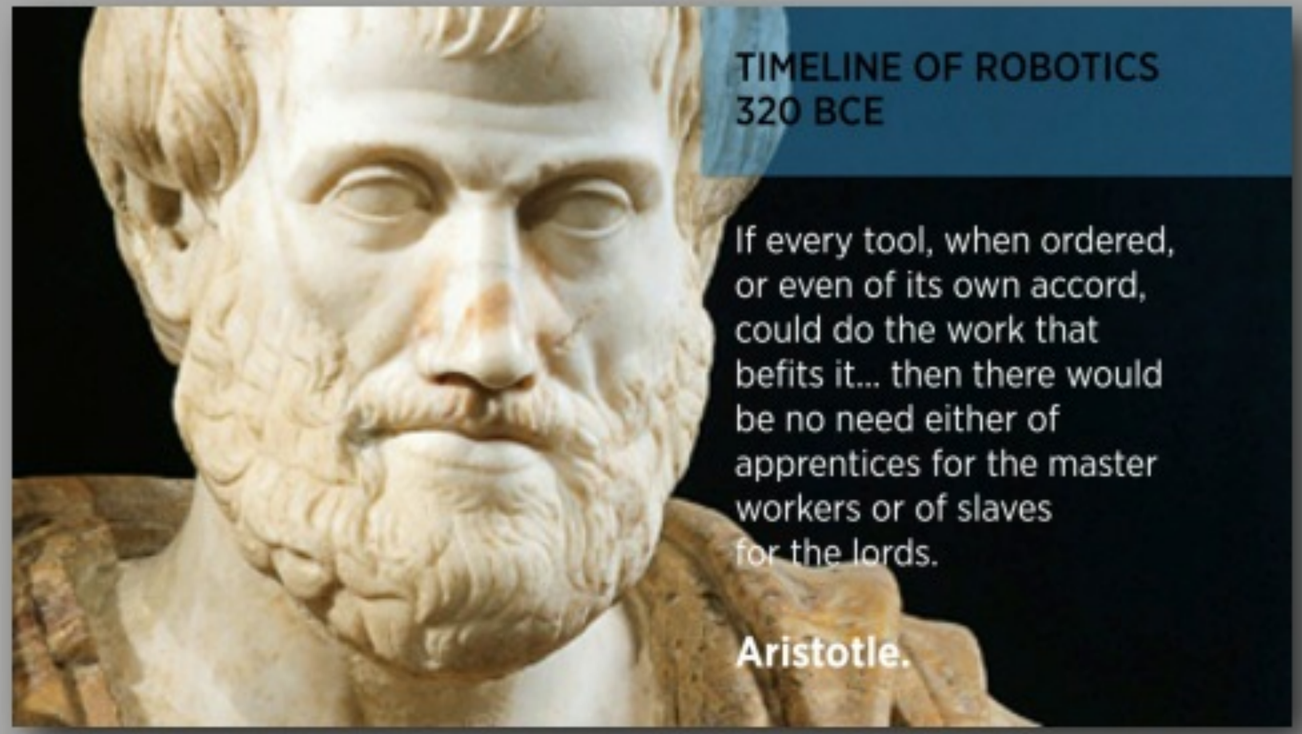

WHAT A ROBOT IS
DEFINITION - 2 of 3
"Robotics research emphasizes intelligence and adaptability to cope with unstructured environments."
Robotics and Automation Society of the Institute of Electronics and Electrical Engineers

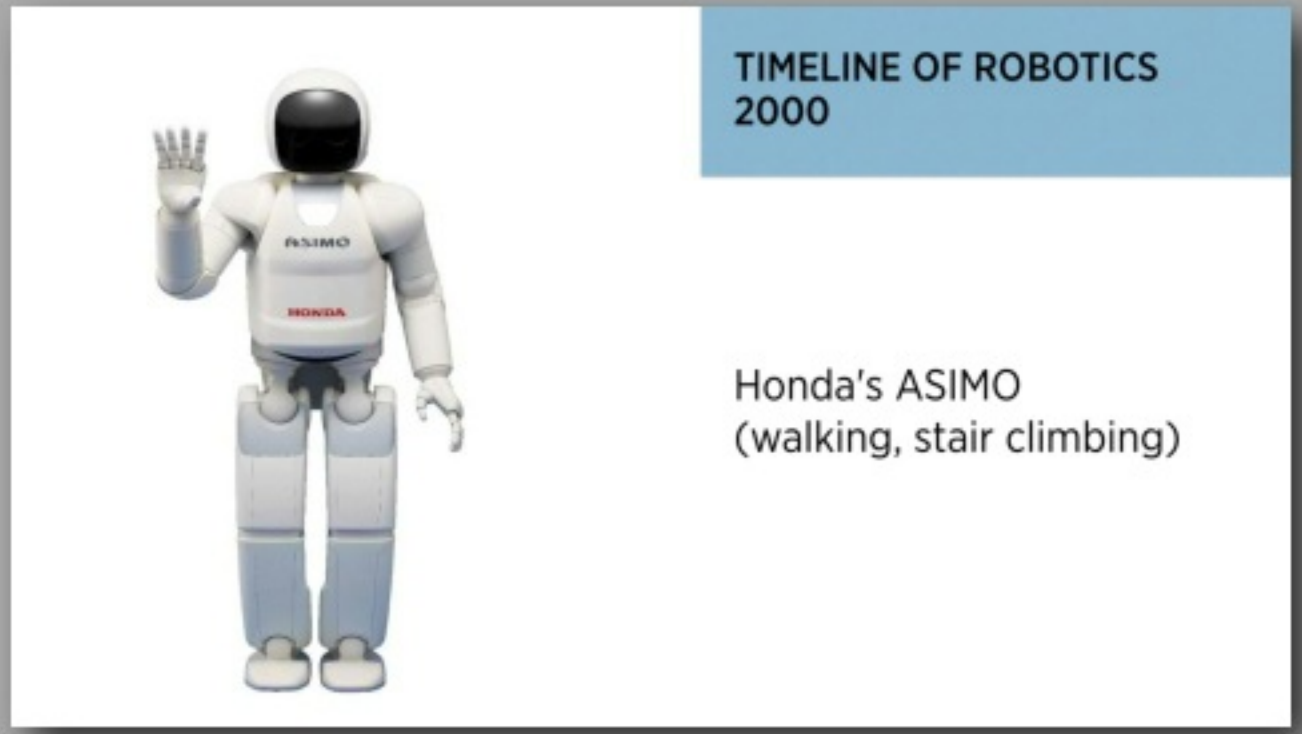

WHAT A ROBOT IS
DEFINITION - 3 of 3
"Automation research emphasizes efficiency, productivity, quality, and reliability, focusing on systems that operate autonomously, often in structured environments over extended periods, and on the explicit structuring of such environments."
Robotics and Automation Society of the Institute of Electronics and Electrical Engineers


ANATOMY OF A ROBOT
Brain
Power Source
Manipulators
Sensors
Activators


ANATOMY OF A ROBOT
Brain
Power Source
Manipulators
Sensors
Activators


ANATOMY OF A ROBOT
Brain
Power Source
Manipulators
Sensors
Activators


TIMELINE OF ROBOTICS
320 BCE
If every tool, when ordered, or even of its own accord, could do the work that befits it... then there would be no need either of apprentices for the master workers or of slaves for the lords.
Aristotle.


TIMELINE OF ROBOTICS
2000
Honda's ASIMO
(walking, stair climbing)

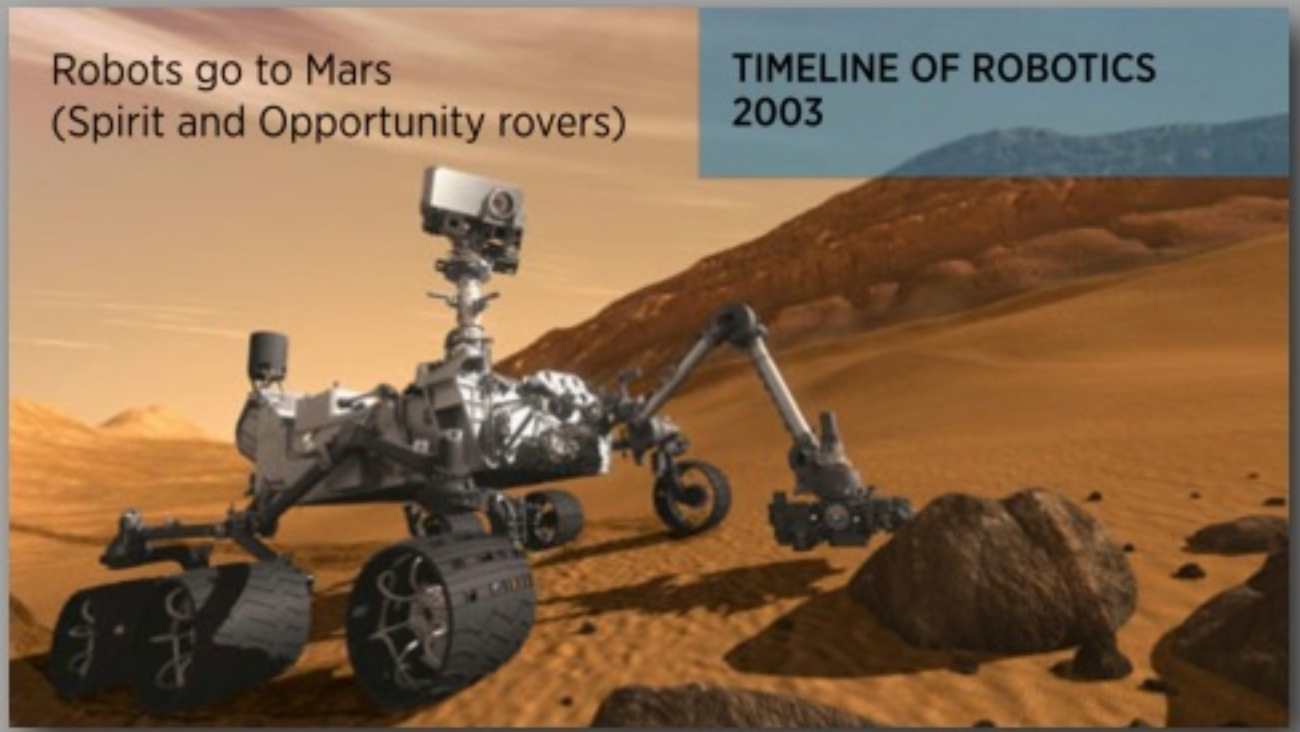
TIMELINE OF ROBOTICS 2001

PackBots by iRobot
(disaster response)

TIMELINE OF ROBOTICS 2002

Roomba
(personal robotics)

TIMELINE OF ROBOTICS 2003



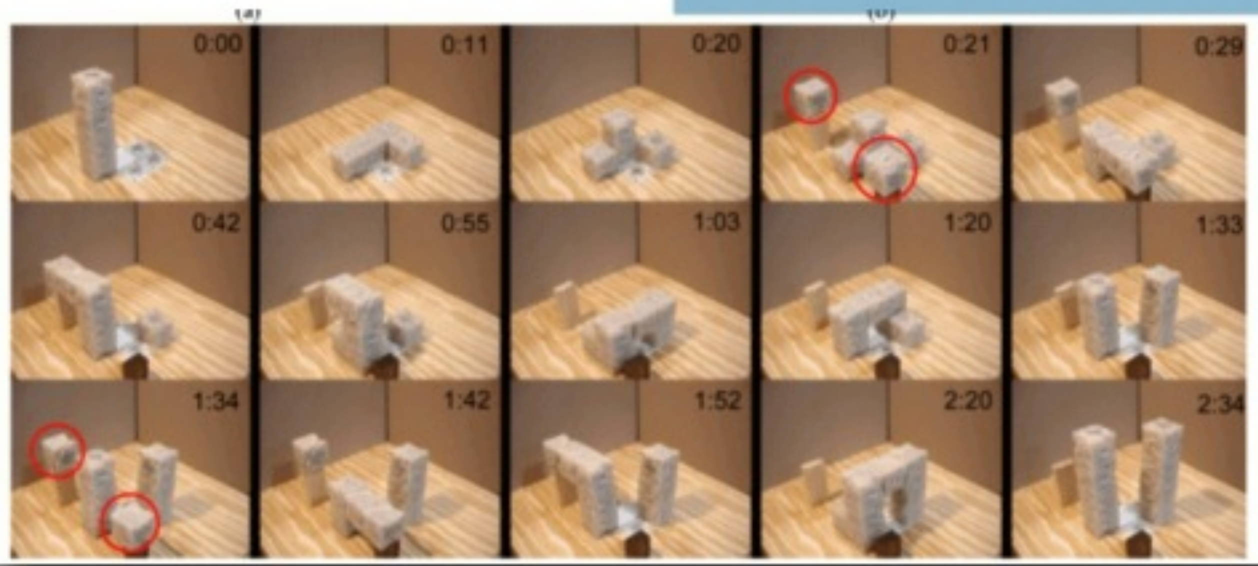
Robots go to Mars
(Spirit and Opportunity rovers)

TIMELINE OF ROBOTICS 2004

DARPA Grand Challenge
for robotic/self-driving cars.
Most successful lasts 7 minutes.

TIMELINE OF ROBOTICS 2005

Cornell's self-replicating
robots (led to self-assembling)



TIMELINE OF ROBOTICS 2006

Robot arm performed
an unassisted surgical
procedure on a patient's heart

TIMELINE OF ROBOTICS 2007

i-LIMB
(bionic prosthetic hand)

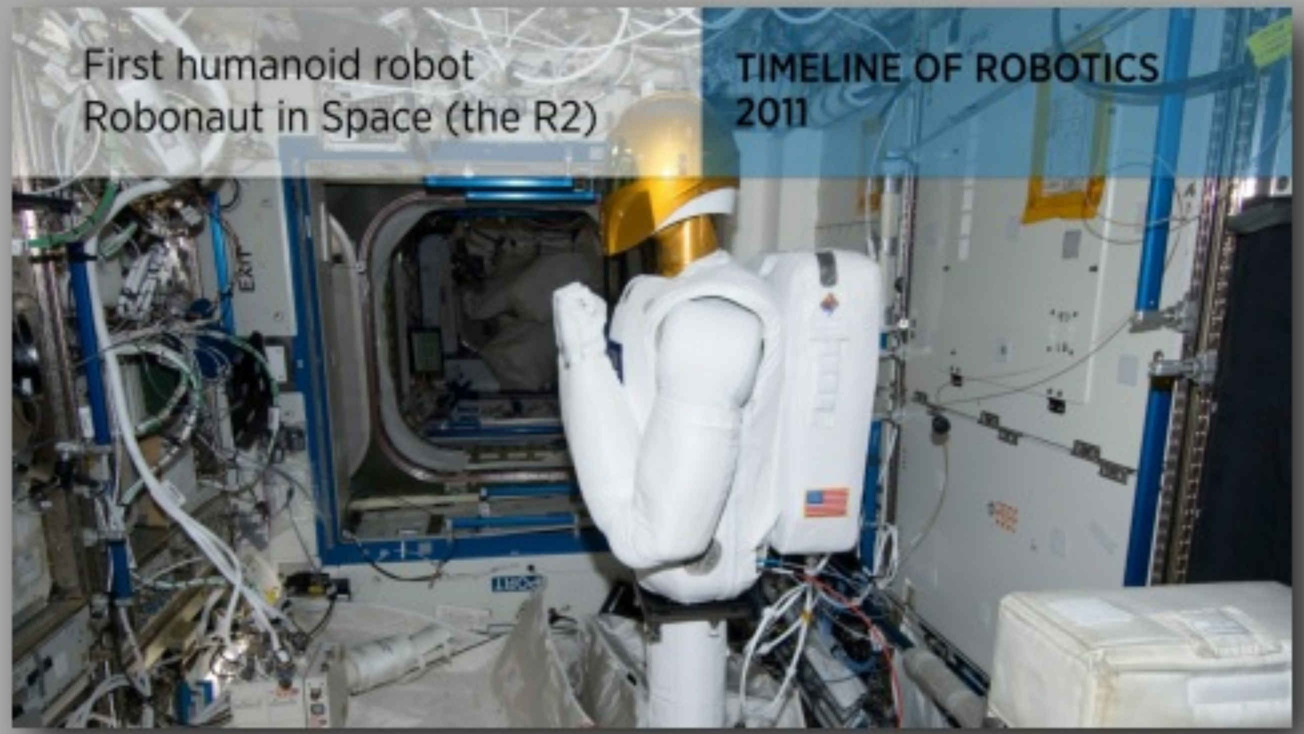
TIMELINE OF ROBOTICS 2008

FANUC launches M-2000iA
the world's largest and
strongest six-axis robot

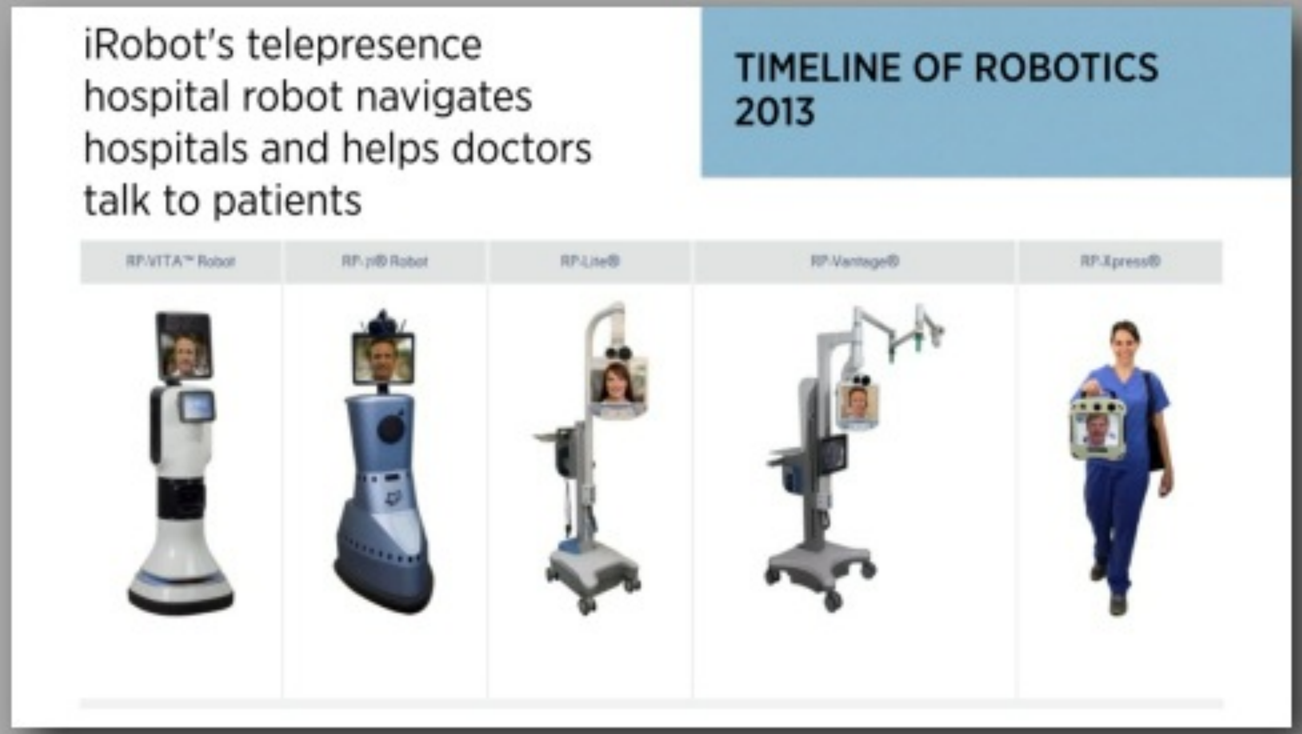
TIMELINE OF ROBOTICS 2009

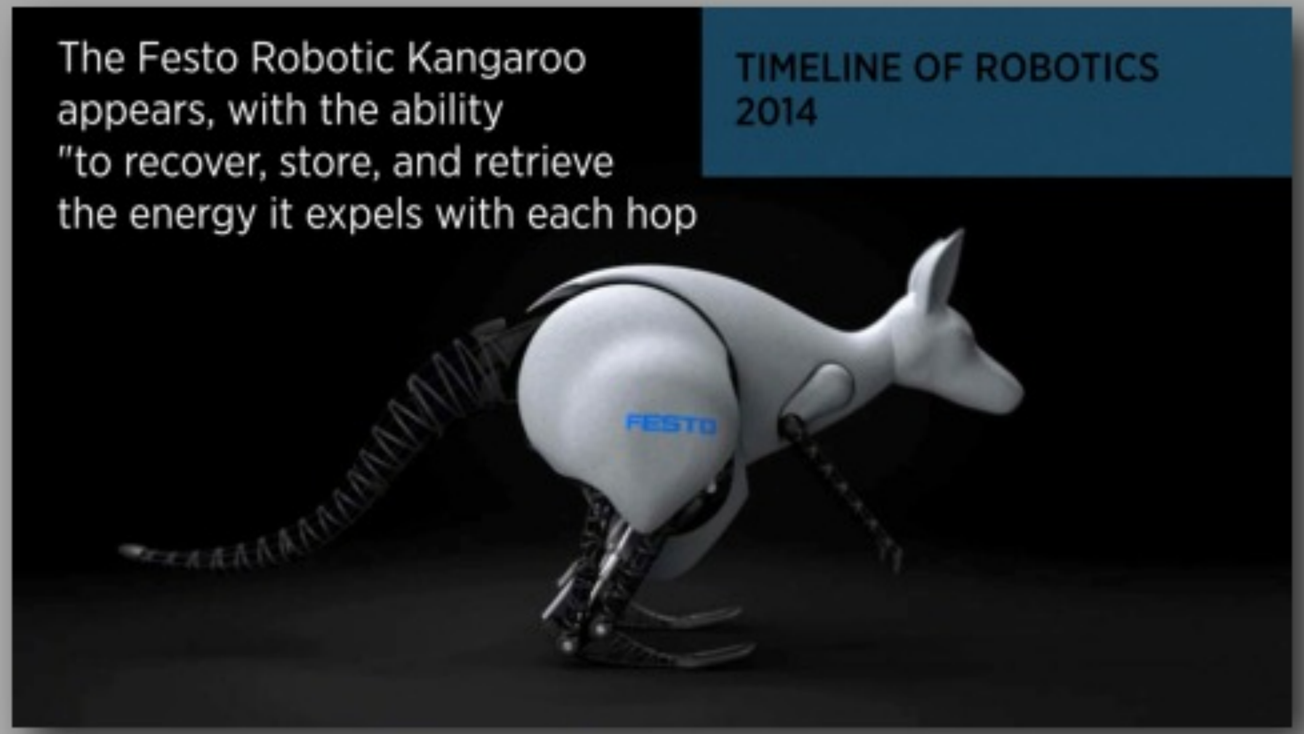
Yaskawa Motoman
improved DX100
control system
fully synchronized
control of 8 robots


TIMELINE OF ROBOTICS
2010
Bionic legs by Rex


First humanoid robot
Robonaut in Space (the R2)
TIMELINE OF ROBOTICS
2011

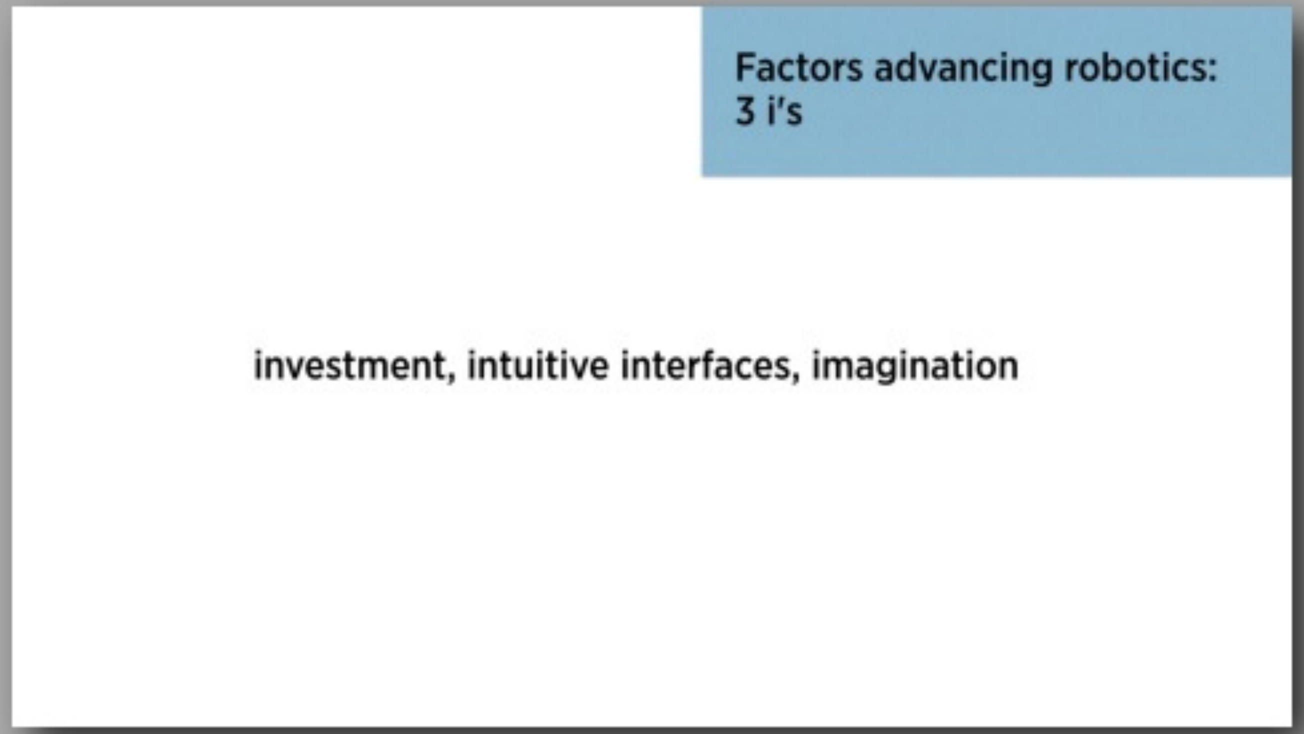

Nevada issues Google first license for self-driving car
TIMELINE OF ROBOTICS
2012
The Nevada Department
of Motor Vehicles
issues a license
for a robotic car


iRobot's telepresence
hospital robot navigates
hospitals and helps doctors
talk to patients
TIMELINE OF ROBOTICS
2013


The Festo Robotic Kangaroo
appears, with the ability
"to recover, store, and retrieve
the energy it expels with each hop
TIMELINE OF ROBOTICS
2014
FESTO


Quid
8 CLUSTERS COMPRISING 350+ COMPANIES DEFINE THE OVERALL ROBOTICS SPACE
Consumer systems
Surgical solutions
Interactive haptic systems
Industrial robotic systems
Biotech and pharma solutions
Inventory management
Robotic components
Unmanned vehicles


Quid
8 CLUSTERS COMPRISING 350+ COMPANIES DEFINE THE OVERALL ROBOTICS SPACE
Liquid Robotics Inc.
Sion Power Corporation
3D Robotics Inc.
Tegra Medical, LLC
Valence Technology Inc.
Premier Tech Ltd.
Segway Inc.
RedZone Robotics, Inc.
Rocket Software, Inc.
Orbotix, Inc.
Anki, Inc.
OraMetrix, Inc.
Mevion Medical Systems, Inc
Endosense SA
ChemoCentryx, Inc.
Biotix Holdings, Inc.
Consumer systems
Surgical solutions
Interactive haptic systems
Industrial robotic systems
Biotech and pharma solutions
Inventory management
Robotic components
Unmanned vehicles


Factors advancing robotics:
3 i's
investment, intuitive interfaces, imagination

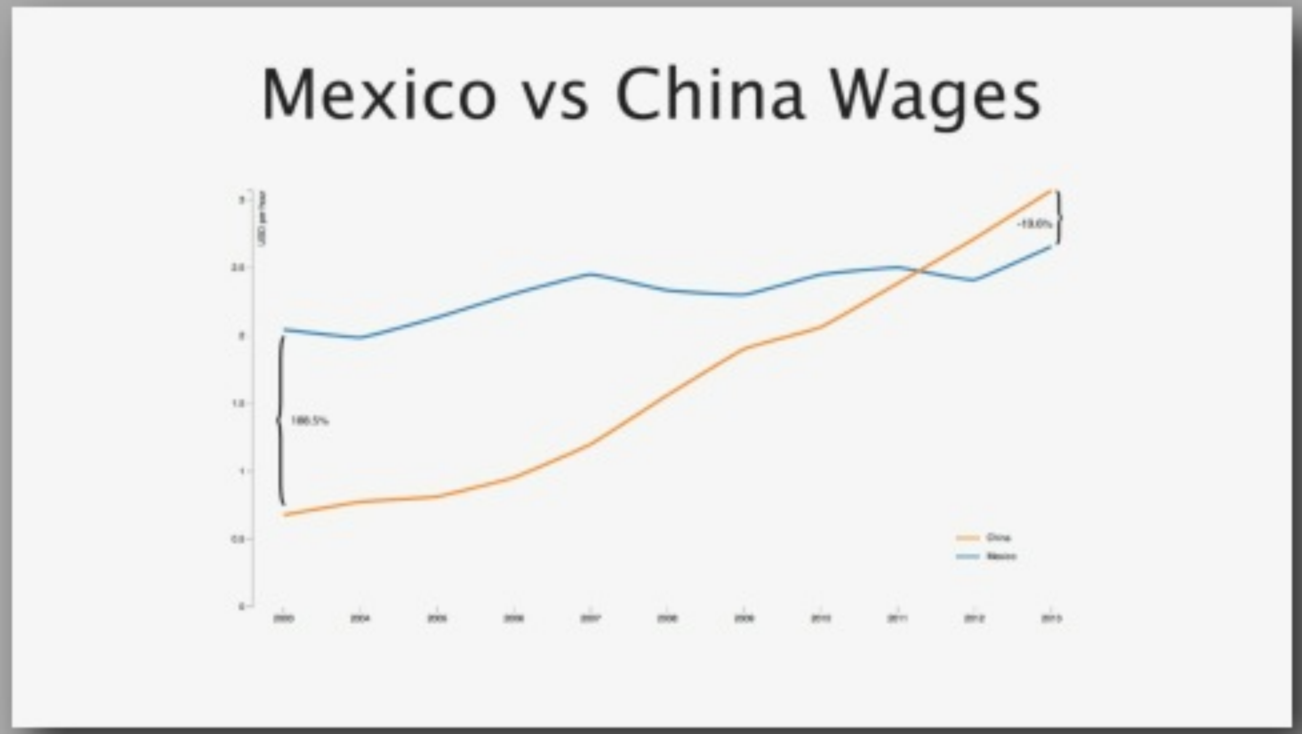

Factors advancing robotics:
INVESTMENT
$154.83M
+4.15%
24
-4%
6
$37.94M
Q2'12
Q2'12

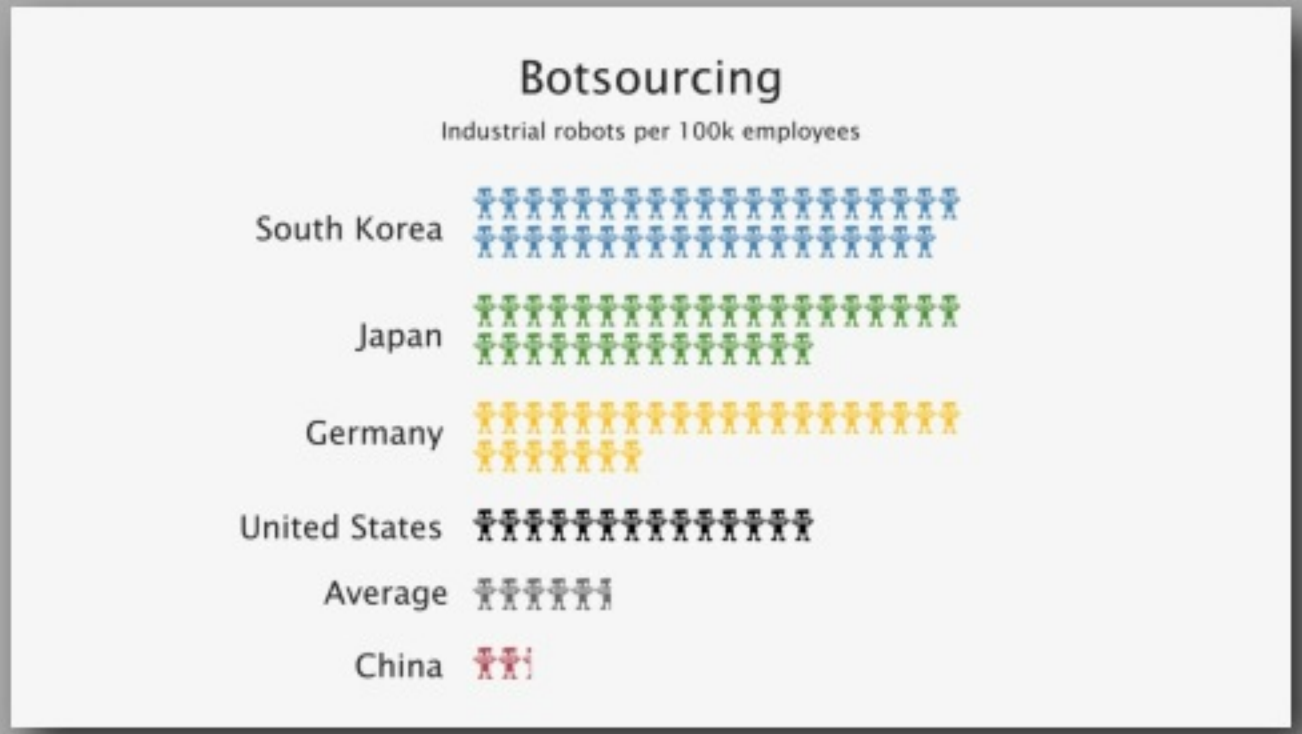

Factors advancing robotics:
INVESTMENT
Data as of: 06/23/2014
Month End as of: 05/31/2014

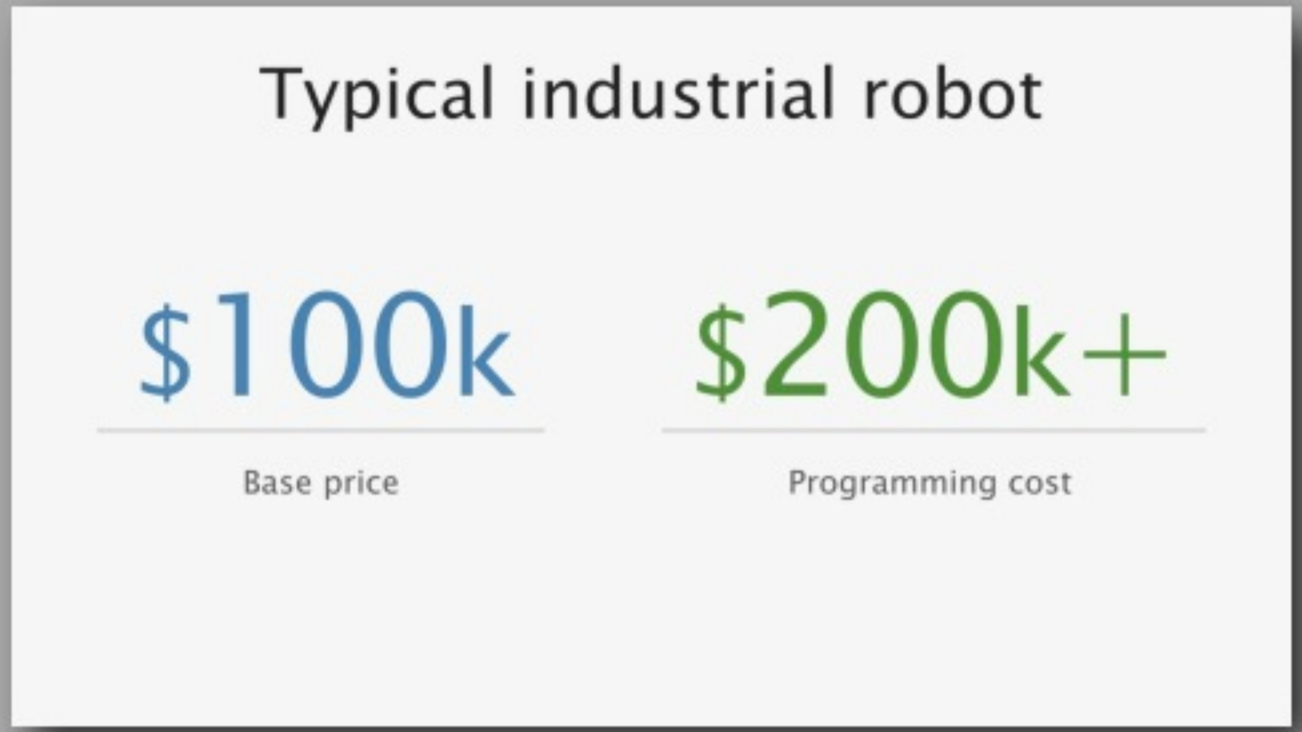

Factors advancing robotics:
INTERFACES
Baxter (B2B)
Roomba (B2C)


Factors advancing robotics:
IMAGINATION

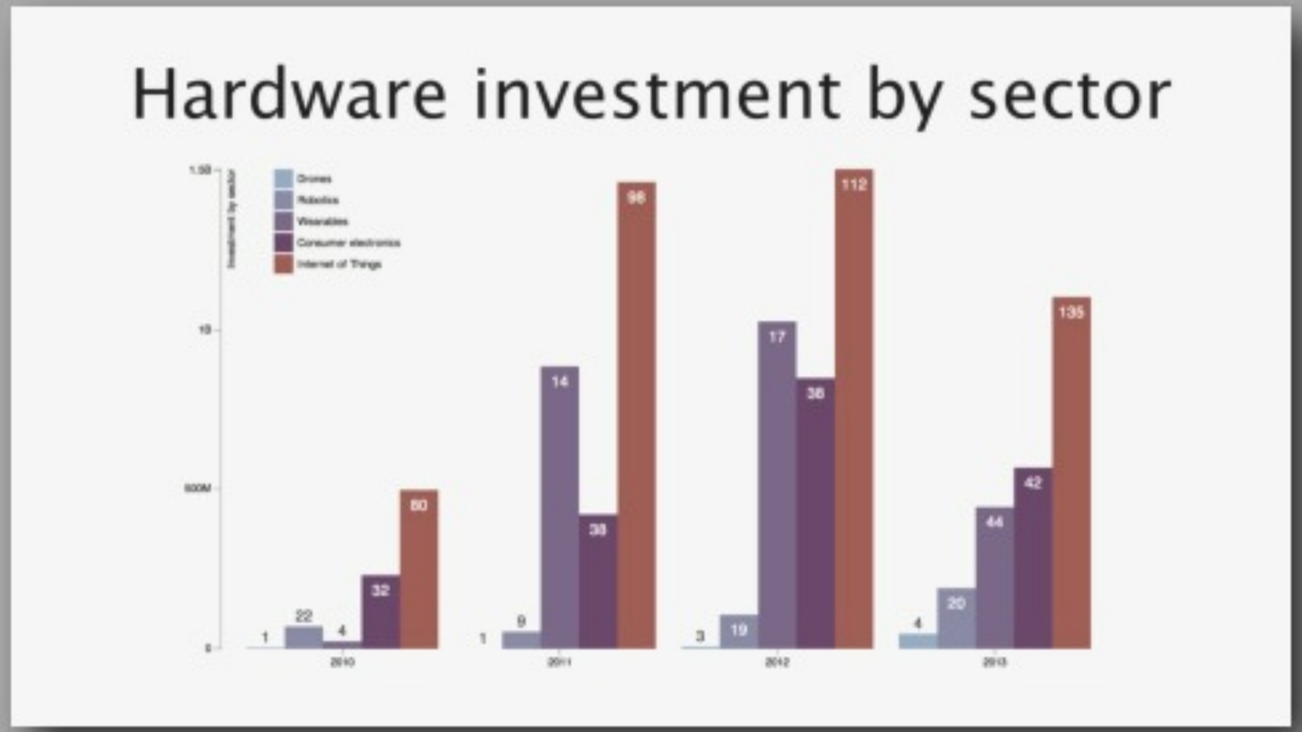

Offshoring
Reshoring
Nearshoring
MADE IN SOUTH AFRICA
MADE IN CZECH REPUBLIC
INDIA
MADE IN RUSSIA
MADE IN CHINA
MADE IN MALAYSIA
MADE IN PHILIPPINES
MADE IN INDIA
MADE IN SOUTH AFRICA


Mexico vs China Wages


Botsourcing
Industrial robots per 100k employees
South Korea
Japan
Germany
United States
Average
China


Typical industrial robot
$100k
Base price
$200k+
Programming cost


Base price
Baxter
$25k
rethink robotics
UR5
$34k
UNIVERSAL ROBOTS
UBR-1
$50k
Unbounded Robotics


Hardware investment by sector


Acquisitions
IRIS
ipi
redwood robotics


THE SECOND MACHINE AGE
WORK, PROGRESS, AND PROSPERITY IN A TIME OF BRILLIANT TECHNOLOGIES
ERIK BRYNJOLFSSON
ANDREW McAFEE
A Bunch of Data about the US Economy and Workforce
Andrew McAfee, MIT
amcafee@mit.edu
@amcafee


The Great Decoupling
US Productivity, Real GDP per capita, Employment and Income: 1947-2012
Labor Productivity
Real GDP per Capita US
Private Employment
Median Family Income
© Andrew McAfee, 2014

02_Roger Chen

O'Reilly AlphaTech Ventures

“I’m interested in machine intelligence.”

What is Robotics?

Questioning whether robotics should be defined by hardware or software, Roger made a case for the main purpose of robots should be to free up mind space, reducing cognitive load and allowing humans to think at higher levels of interaction.

Recognizing that robotics will displace some labor in the near future, the real concern is how humans will survive the frequency and velocity of the technology shocks that will come from the proliferation of robots in the work force.

What is robotics?

Extending bits to atoms

Impact on labor

Collateral opportunities

There's plenty of room at the top.

04_Tessa Lau

Savioke

"As a self-styled robot whisperer, I am interested in usable human-robot interaction."

Human / Robot Interaction

Tessa delivered a wide-ranging presentation that focused on human/robot interactions in terms of scope and scale and raised several wicked challenges preventing robots to enter into mainstream business.

These include understanding the particular tasks we want robots to do for (or with) us, how these tasks differ on the individual user or environment and whether or not robots should be programmed with learning or programmed to learn. She believes there is opportunity is for a library of robotic behaviors, establishing a common or standard set of human/robot interactions.

Designing usable service robots

Tessa Lau
Savioke Inc.

My background

"Enabling rapid prototyping for the world"

End user programming

Designing robot apps

Assistive robotics

Making

Vision: robots helping people

Vision: robots helping people

Vision: robots helping people

Vision: robots helping people

Why do people want robots?

Non-roboticists have a million ideas of what they want robots to do for them in their homes

However, everyone has a different idea!

Folding laundry

Finding lost keys

Picking up toys

Cooking meals

Doing dishes

And putting them away

In a variety of cabinets

With a variety of handles

Even without handles

Why no robots yet?

Service robots must be easy to use
... for a wide variety of tasks
... in a variety of home environments
... by non-technical people

Solving all 3 at once is the true challenge!

Why no robots yet?

Service robots must be easy to use
~~... for a wide variety of tasks~~
... in a variety of home environments
... by non-technical people

Why no robots yet?

Service robots must be easy to use
... for a wide variety of tasks
~~... in a variety of home environments~~
... by non-technical people

Why no robots yet?

Service robots must be easy to use
... for a wide variety of tasks
... in a variety of home environments
~~... by non-technical people~~

Robot use is programming

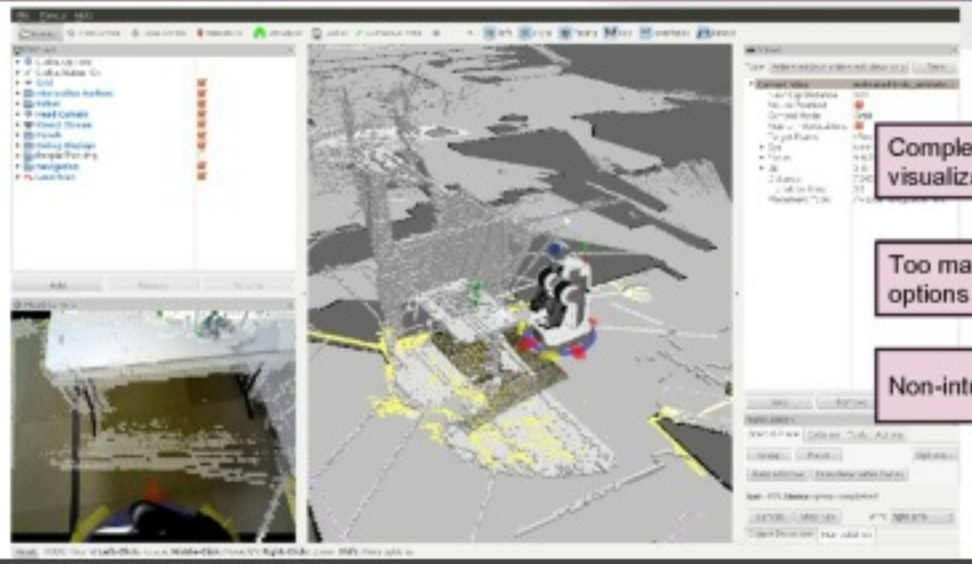
"The purpose of programming is to find a sequence of instructions that will [cause the computer to] automate performing a specific task or solve a given problem."

[Computer programming, Wikipedia]

Characterizing difficulty

- Do you have direct contact with the robot/task?
- Does the task/environment change each time?
- How difficult is it to specify the goal?
- How much autonomy is involved?

Designing robot behavior today



Complex concepts and visualizations

Too many configurable options and parameters

Non-intuitive 3D controls

Concurrency & uncertainty

Many manipulation tasks require coordinated motion across multiple joints

And the world will change when you're not looking!

Commonsense reasoning

Moving around in the world requires a lot of common sense

"keep to the right"
"bring me a coffee"

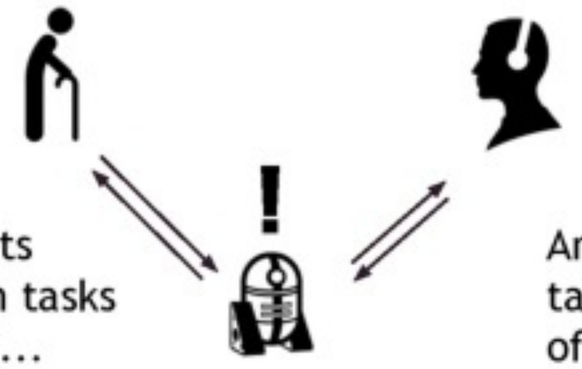
How might we ...

Define the behaviors of physical things so that they can be catalogued and composed?

Etsy MakerBot Thingiverse pinshape

How might we ...

Share autonomy?



To give robots autonomy on tasks they do well...

And let humans take over in case of errors?

How might we ...

Leverage new devices to interact with the 3D world around us?

savioke

Autonomous robots for the services industry










05_Brian David Johnson

Intel

The 21st Century Robot Project

Joining via telepresence, Brian introduced Jimmy, an open source robot, created to challenge assumptions around modern robotics needing to be big, complicated and controlled by large corporations or educational institutions.

Developed out of a new robot manifesto, Jimmy embodies the principles that robots should be easy to build and simple to understand, should be social (able to act and interact with other robots, humans and technology), should be constantly iterated upon and available to the general public.

Jimmy

The 21st Century Robot

Brian David Johnson
@IntelFuturist

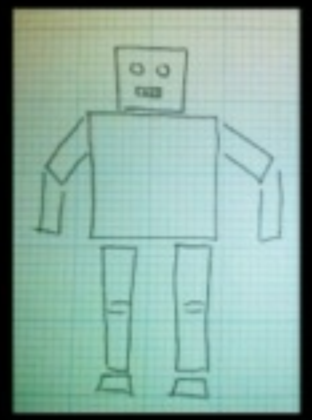
Who am I?

Age 13

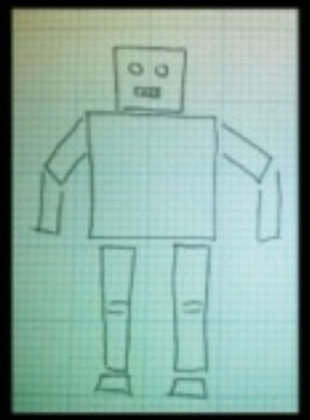
Nerd.

A Thought Experiment

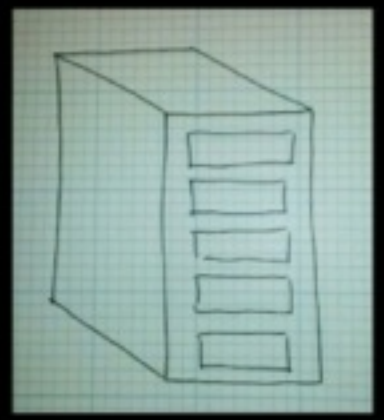
Robots Then…



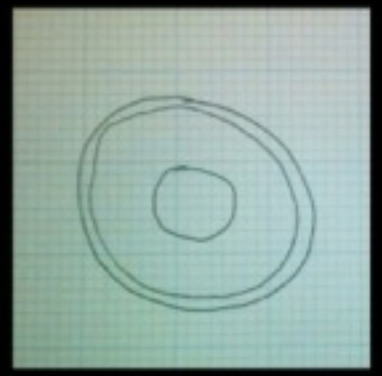
Robots Then…



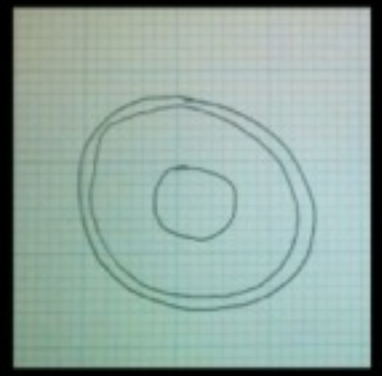
=



Robots a Little Later…



Robots a Little Later…



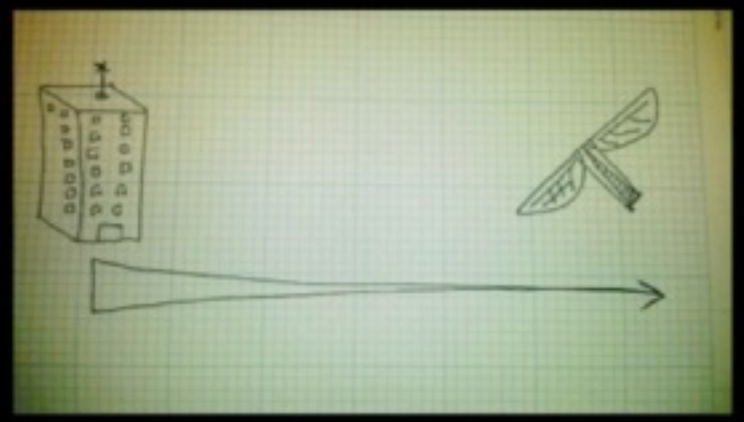
=

A 21st Century Robot?

?

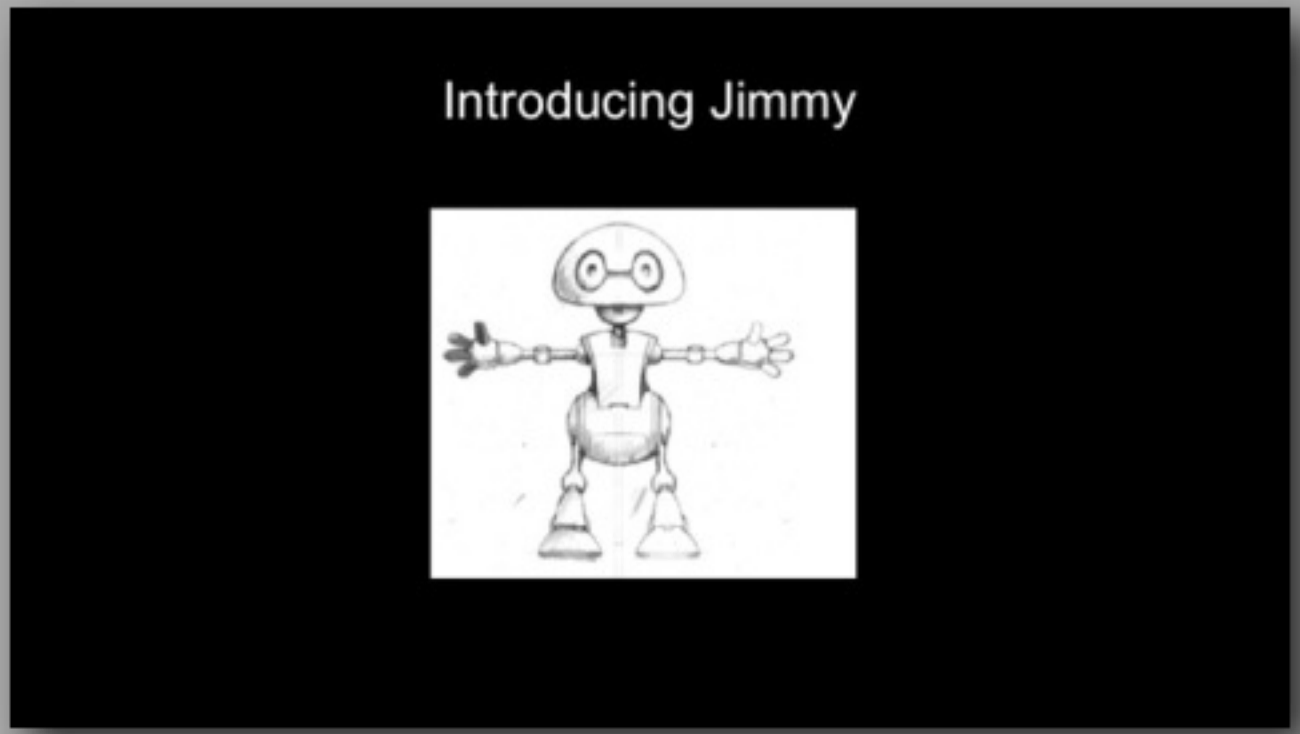
=

These are not the droids you're looking for*

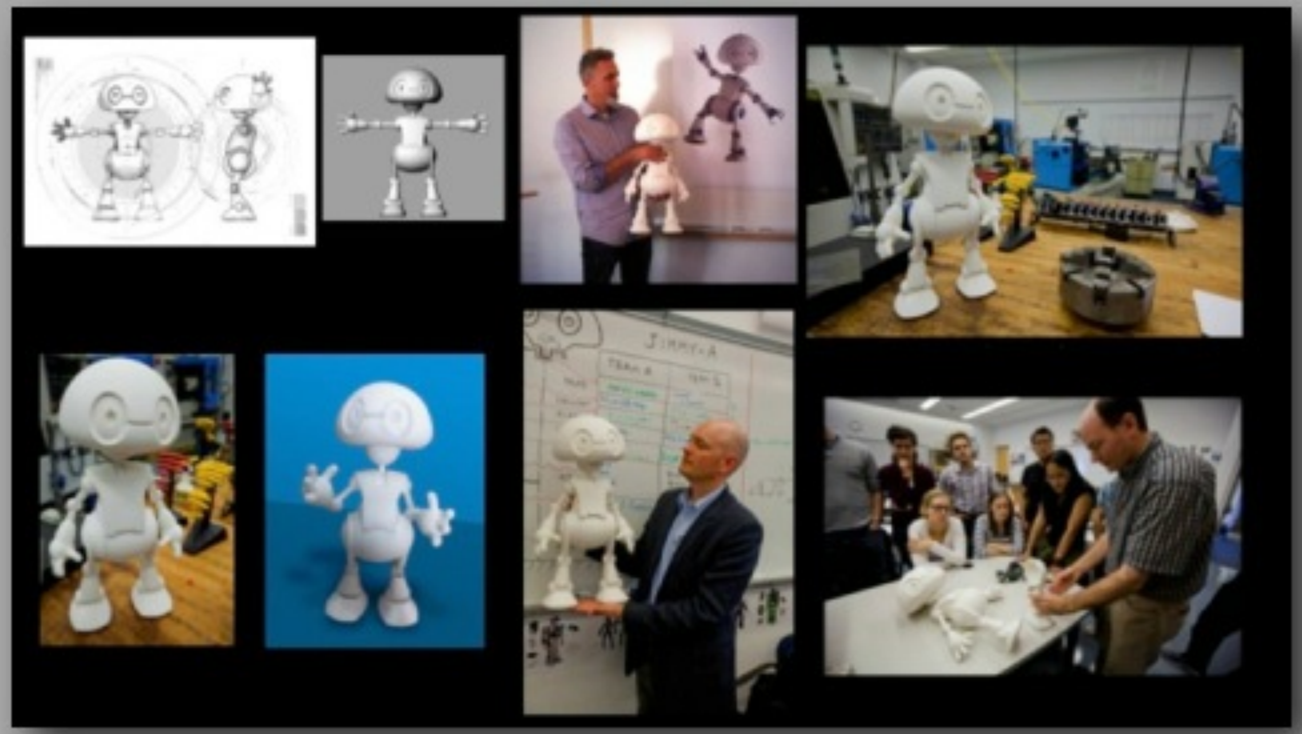


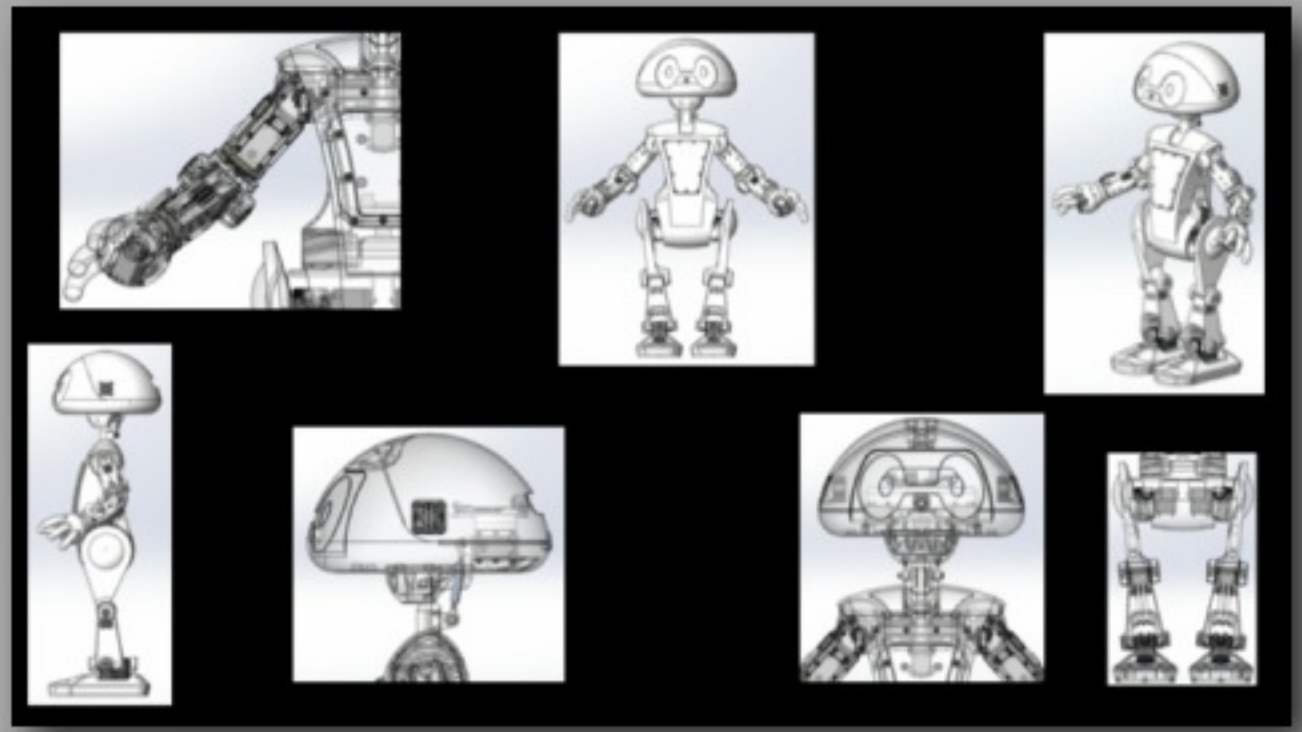
*Illustrations not to scale


A New Kind of Robot
21st CENTURY ROBOT
MANIFESTO
A ROBOT IS:
IMAGINED FIRST
EASY TO BUILD
COMPLETELY OPEN SOURCE
FIERCELY SOCIAL
INTENTIONALLY ITERATIVE
FILLED WITH HUMANITY AND DREAMS
THINKING FOR HER/HIM/ITSELF


Introducing Jimmy

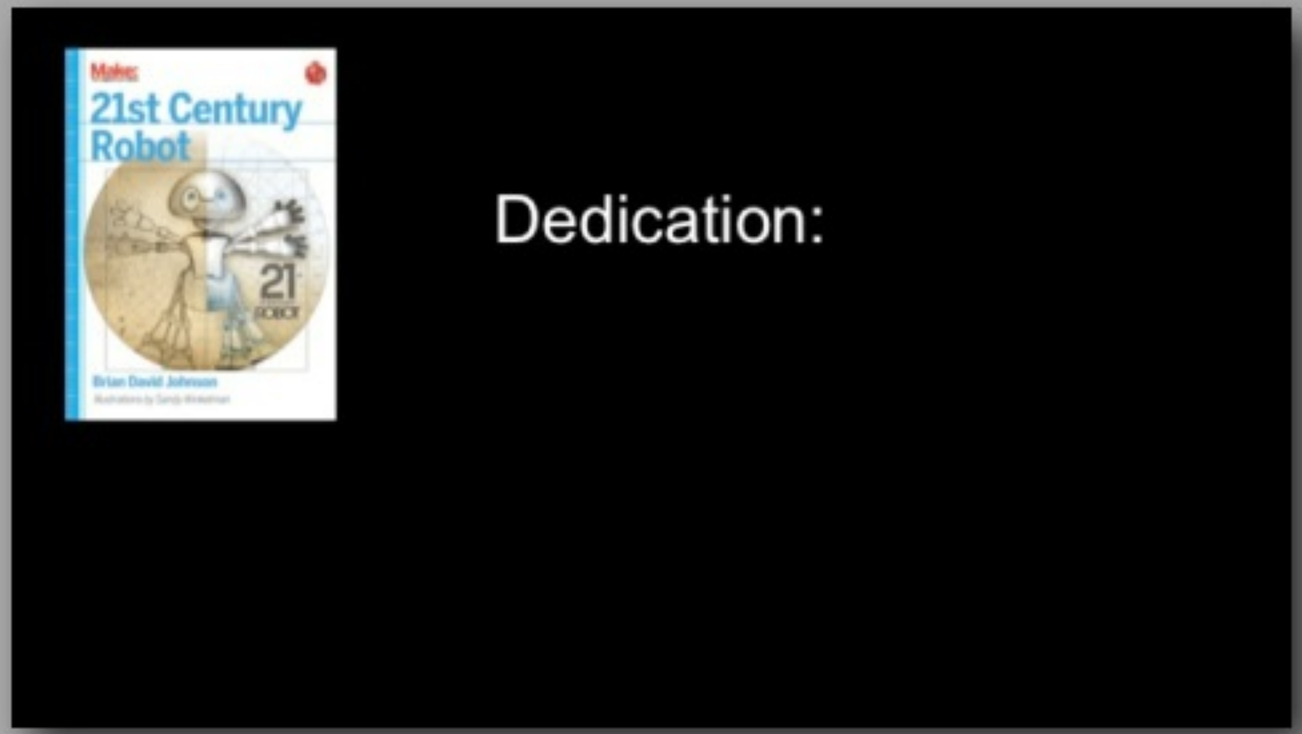

A New Kind of Robot
every robot
has a name



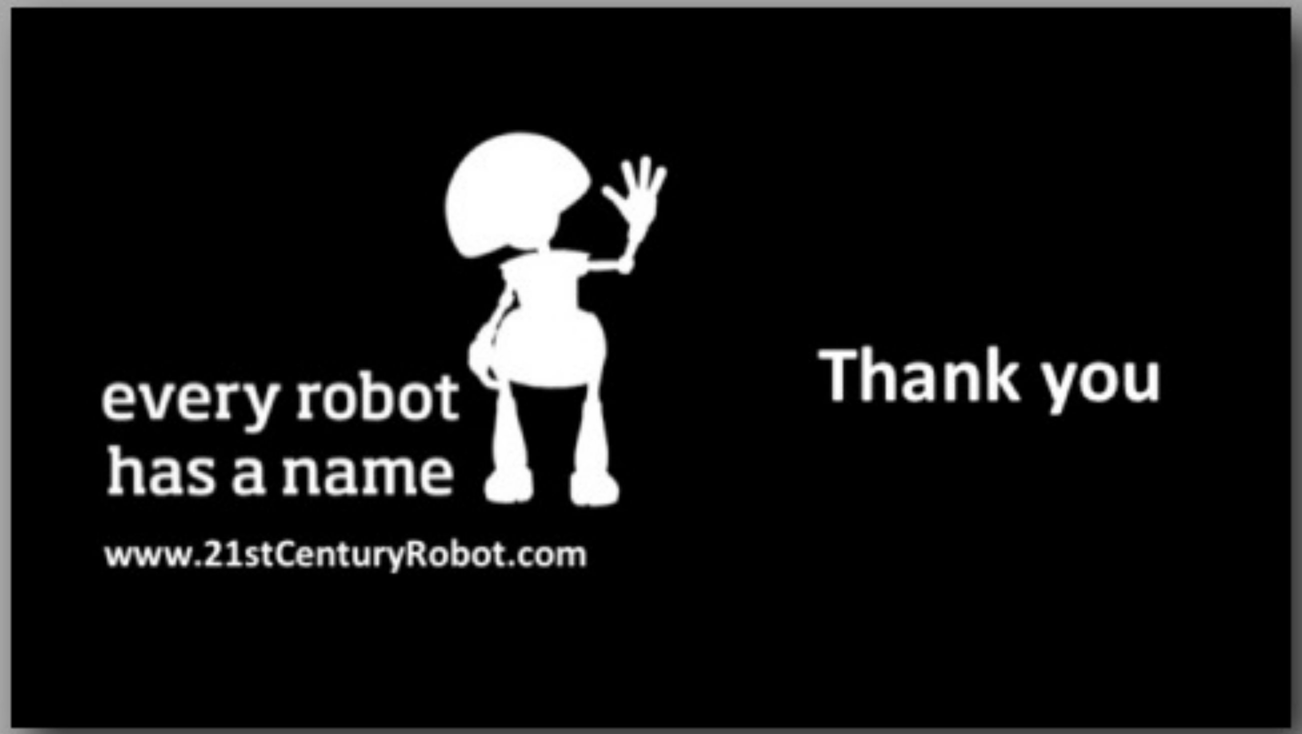



Introducing Jimmy
http://www.youtube.com/watch?v=YCd4glKBCxM&feature=youtu.be


Introducing Jimmy
Fall 2014


21st Century Robot
Dedication:


21st Century Robot
Dedication:
To anyone born after 2014…


every robot has a name
www.21stCenturyRobot.com
Thank you

06_Saul Griffith

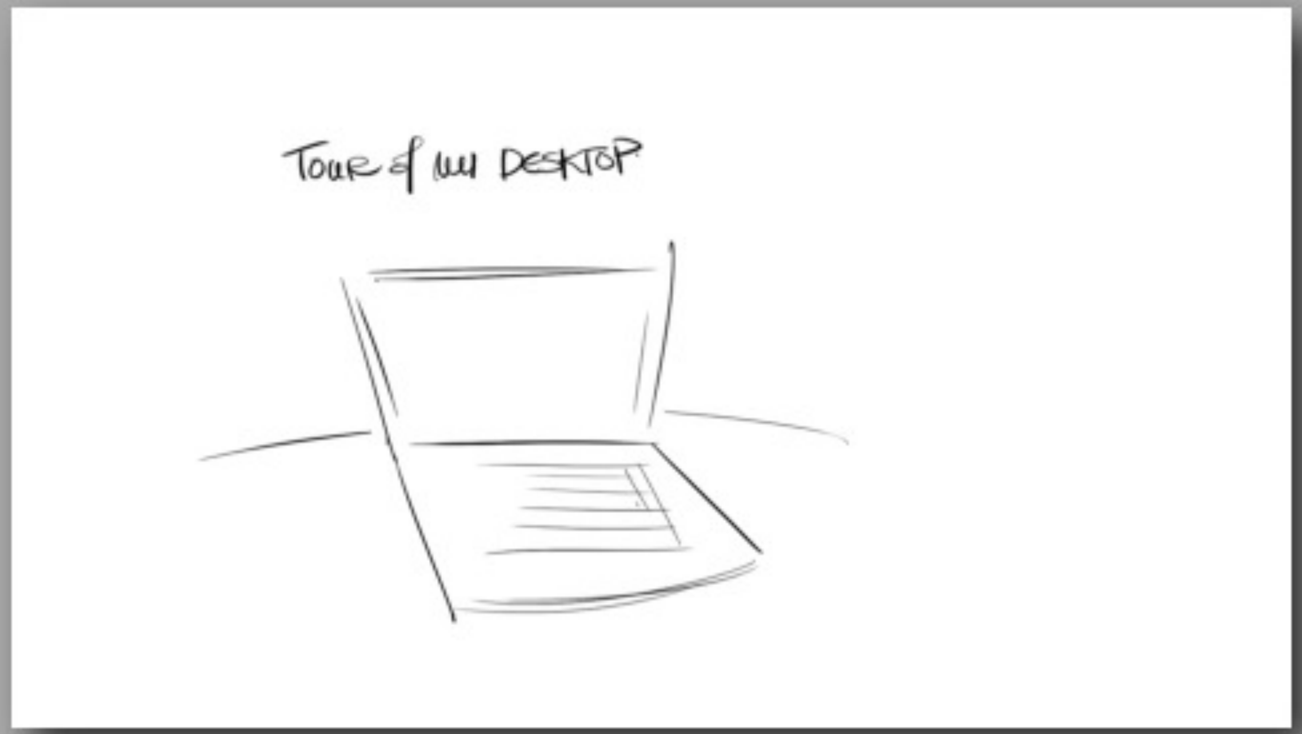
OtherLab

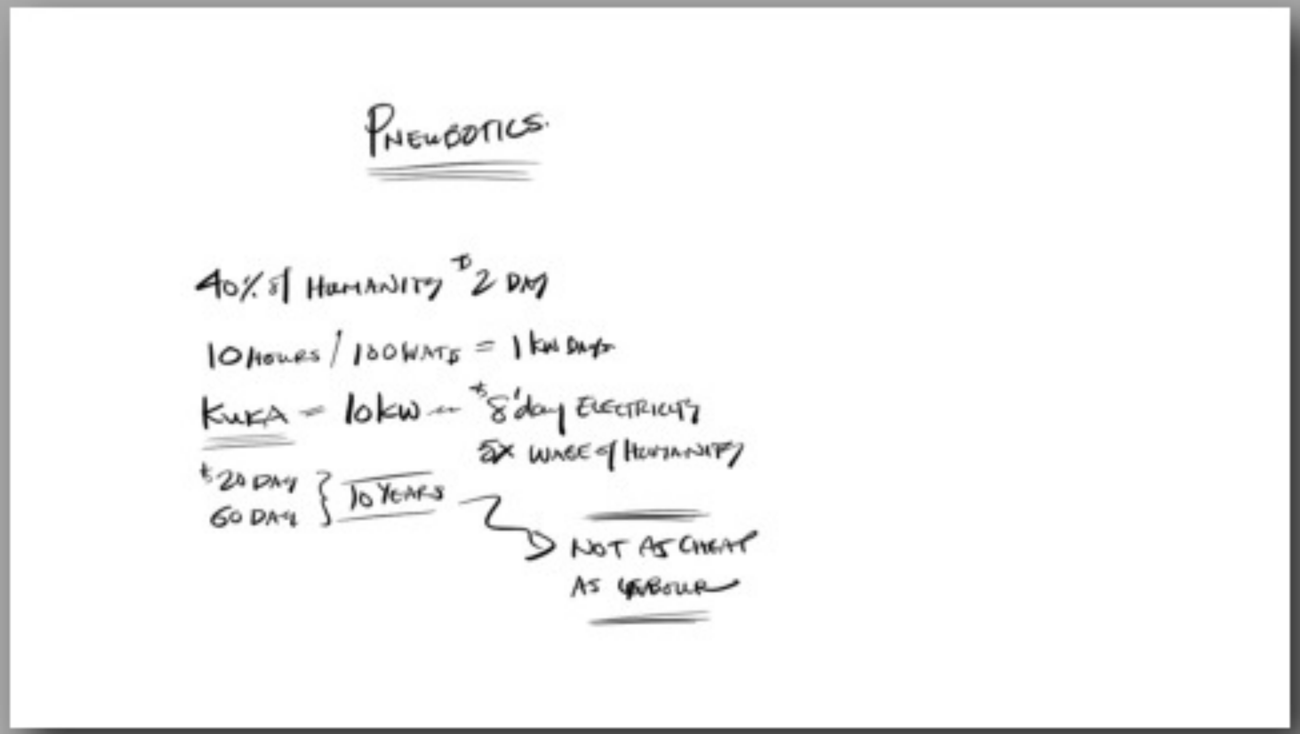
*"Robots are blind, stupid, fat, weak,
slow, difficult, and unyielding."*

Moving from Solid to Soft

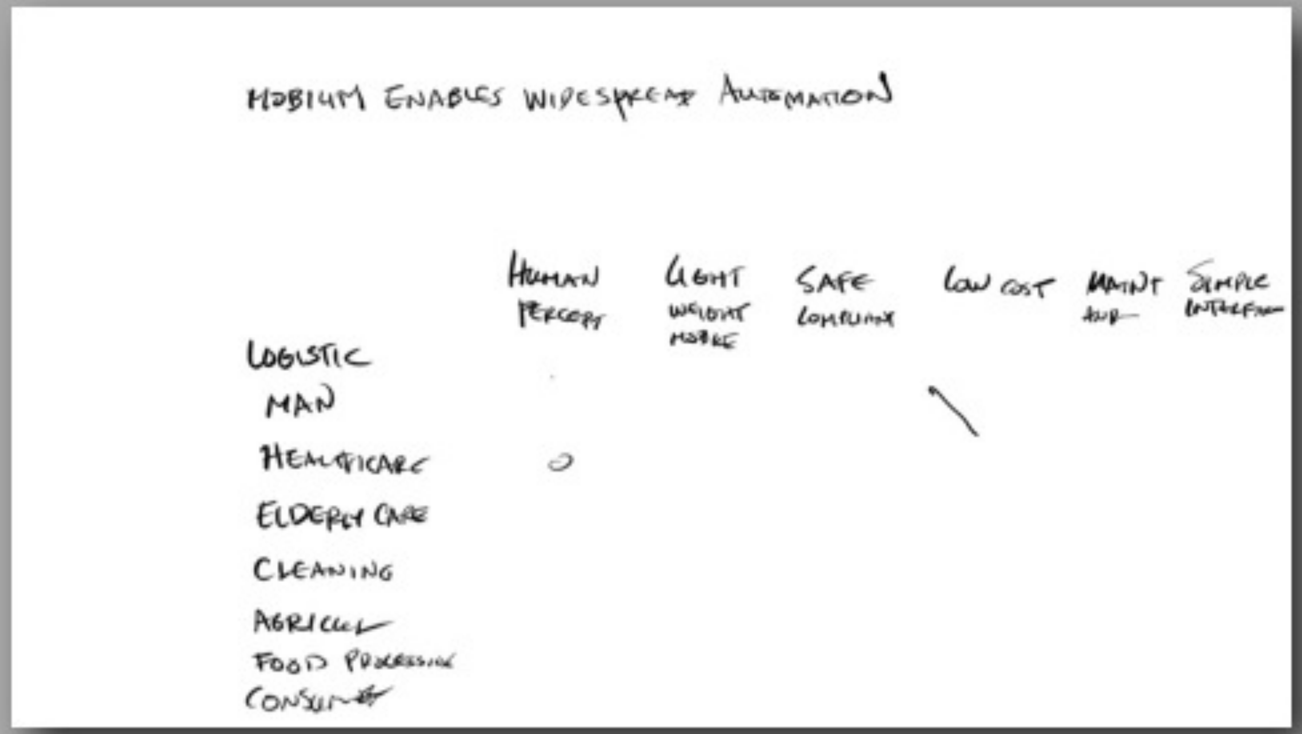
Deeply critical of the promise of robotics as a cure all for modern industry's desire to become more efficient, Saul identified robots as "blind, stupid, fat, weak, slow, difficult and unyielding."

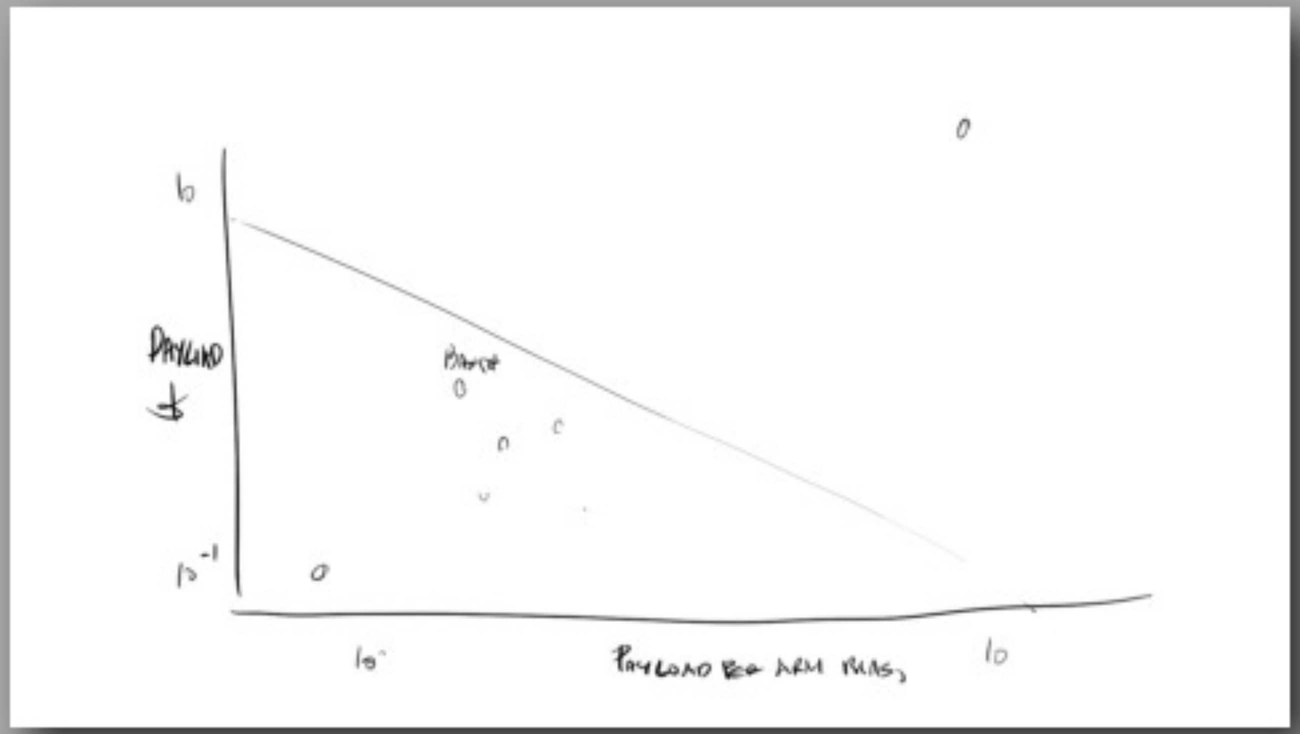
Saul shoed how these shortcomings could be addressed by Pneubots, soft skinned robots powered by compressed air and based around how human body controls its muscles. Pneubots solve two major issues that plague modern robotics – that robots are deeply energy inefficient when compared to a human worker and that the weight of the robot itself often limits their mobility and increases the risk to the humans who interact with them.

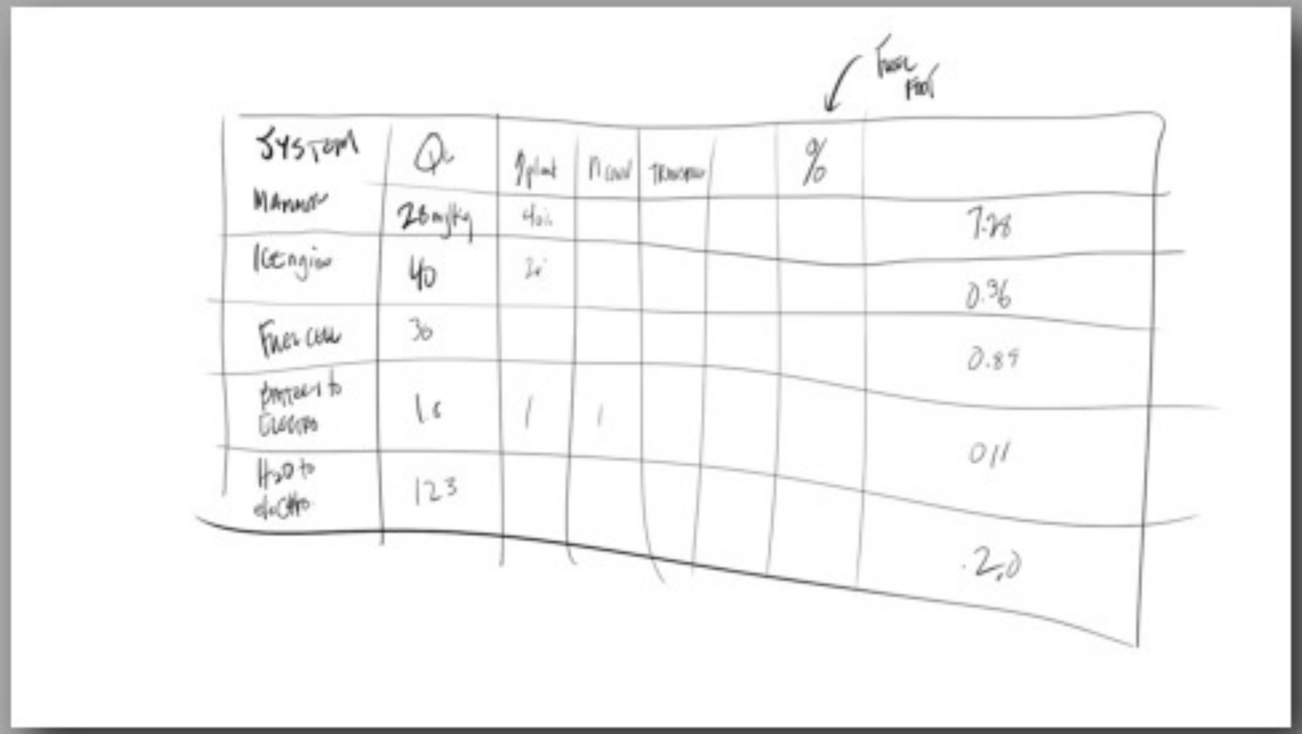

TOUR OF MY DESKTOP

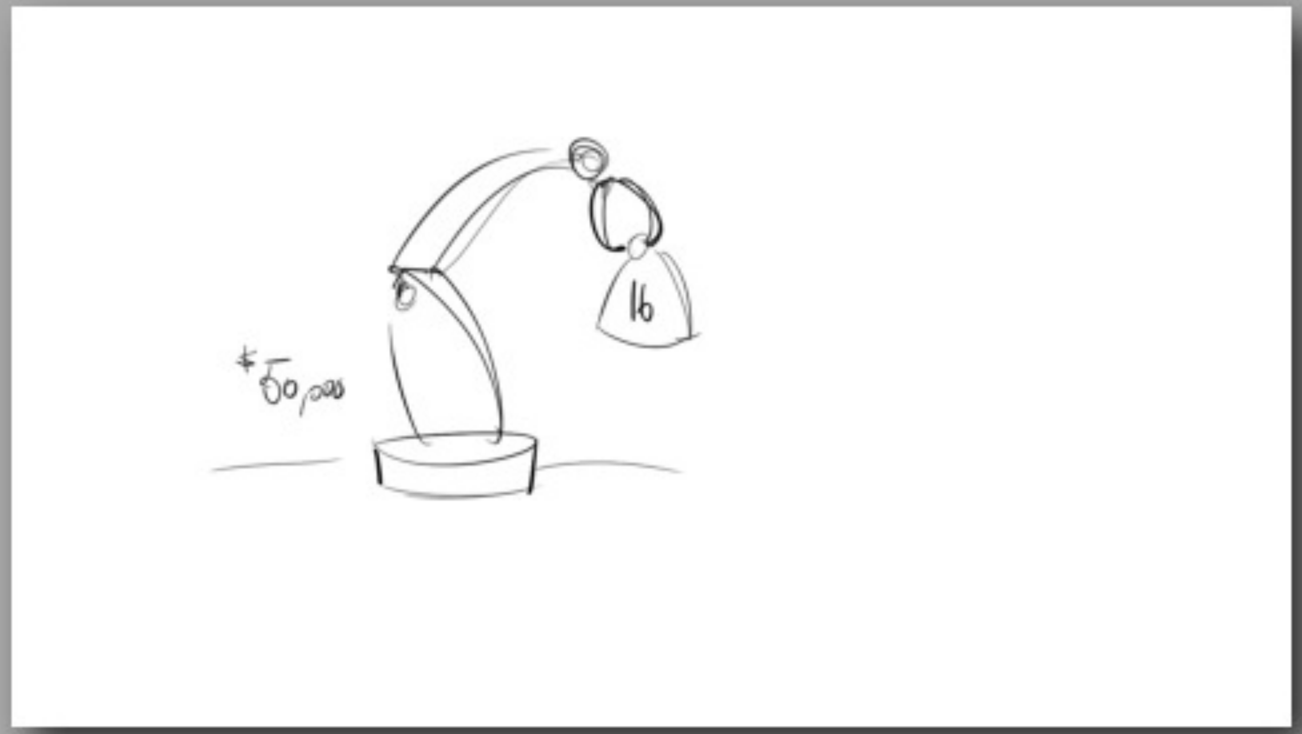

PNEUBOTICS
40% of HUMANITY $2 DAY
10 HOURS / 100WATTS = 1 kW DAY
KUKA = 10kW = $8/day ELECTRICITY
5X WAGE of HUMANITY
$20 DAY
60 DAY
10 YEARS
NOT AS CHEAP
AS LABOUR

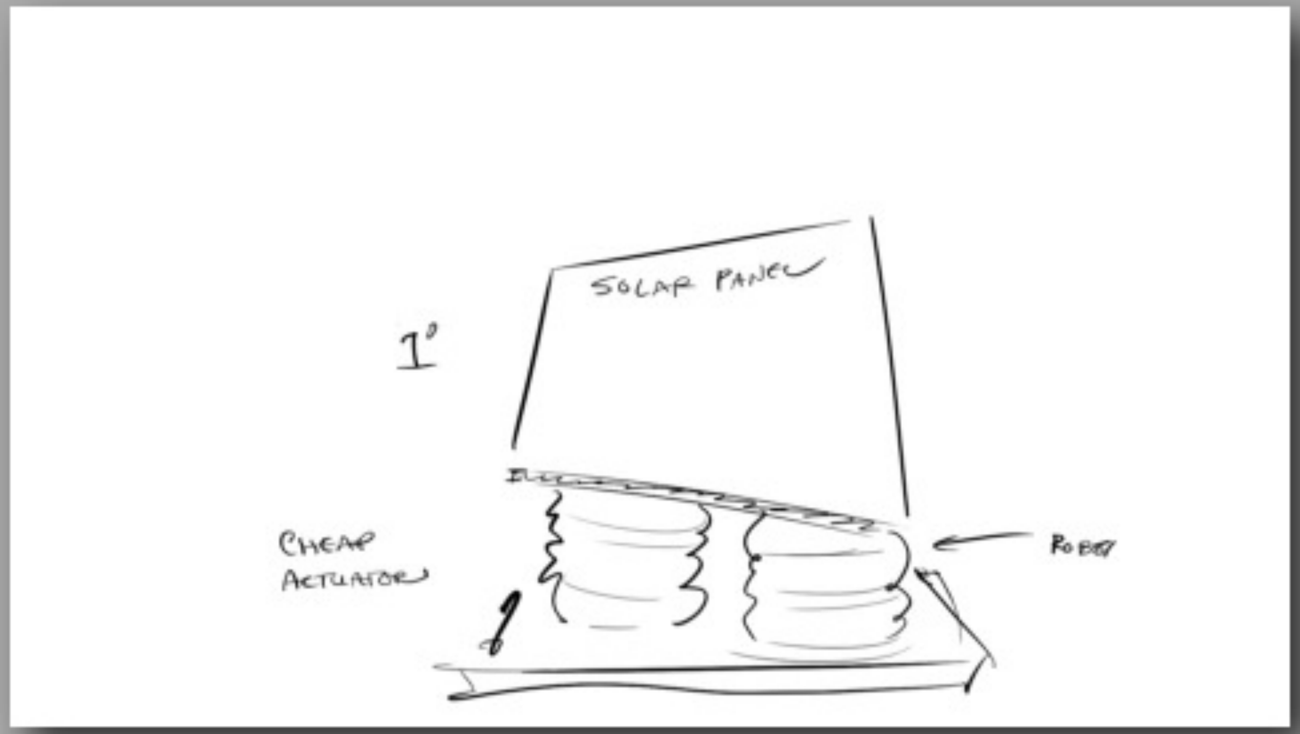

ROBOTS
BLIND
STUPID
FAT
WEAK
SLOW
DIFFICULT
UNYIELDING

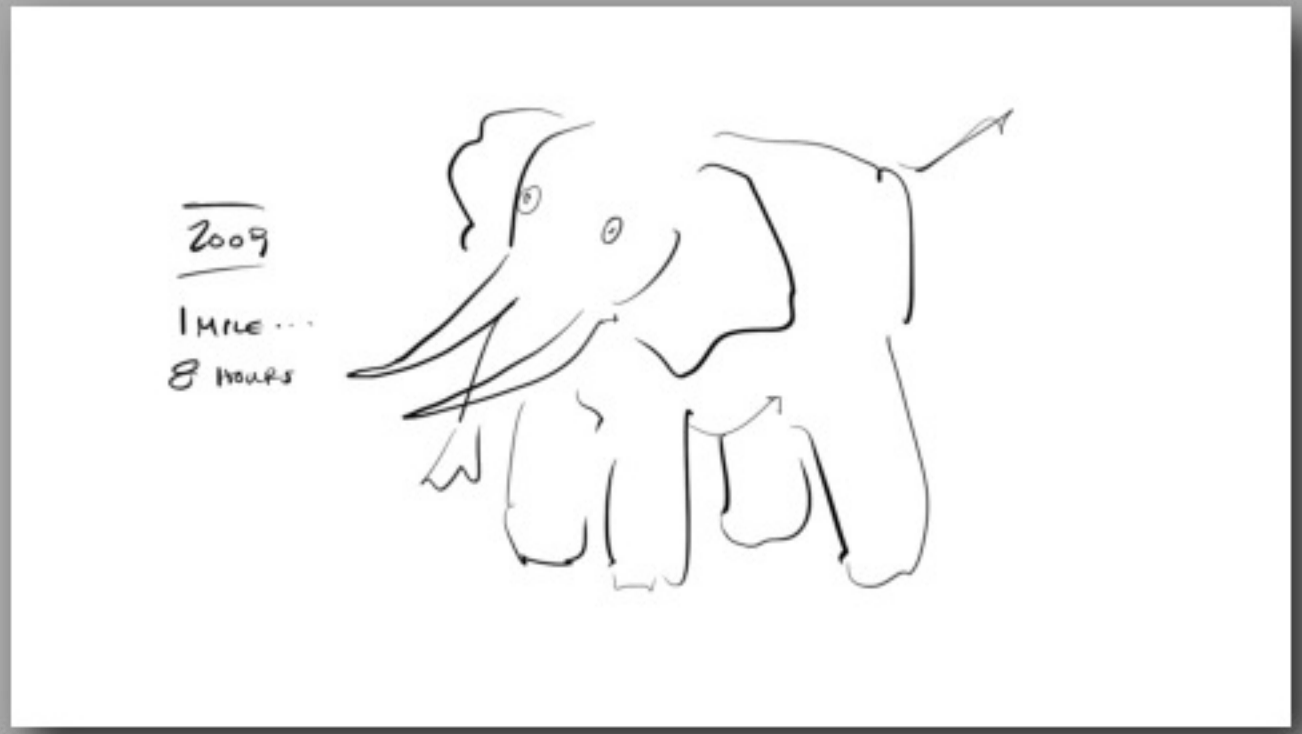

MOBIUM ENABLES WIDESPREAD AUTOMATION
HUMAN PERCEPT
LIGHT WEIGHT MOBILE
SAFE COMPLIANT
LOW COST
SIMPLE INTERFACE
LOGISTIC
MAN
HEALTHCARE
ELDERLY CARE
CLEANING
FOOD PROCESSING

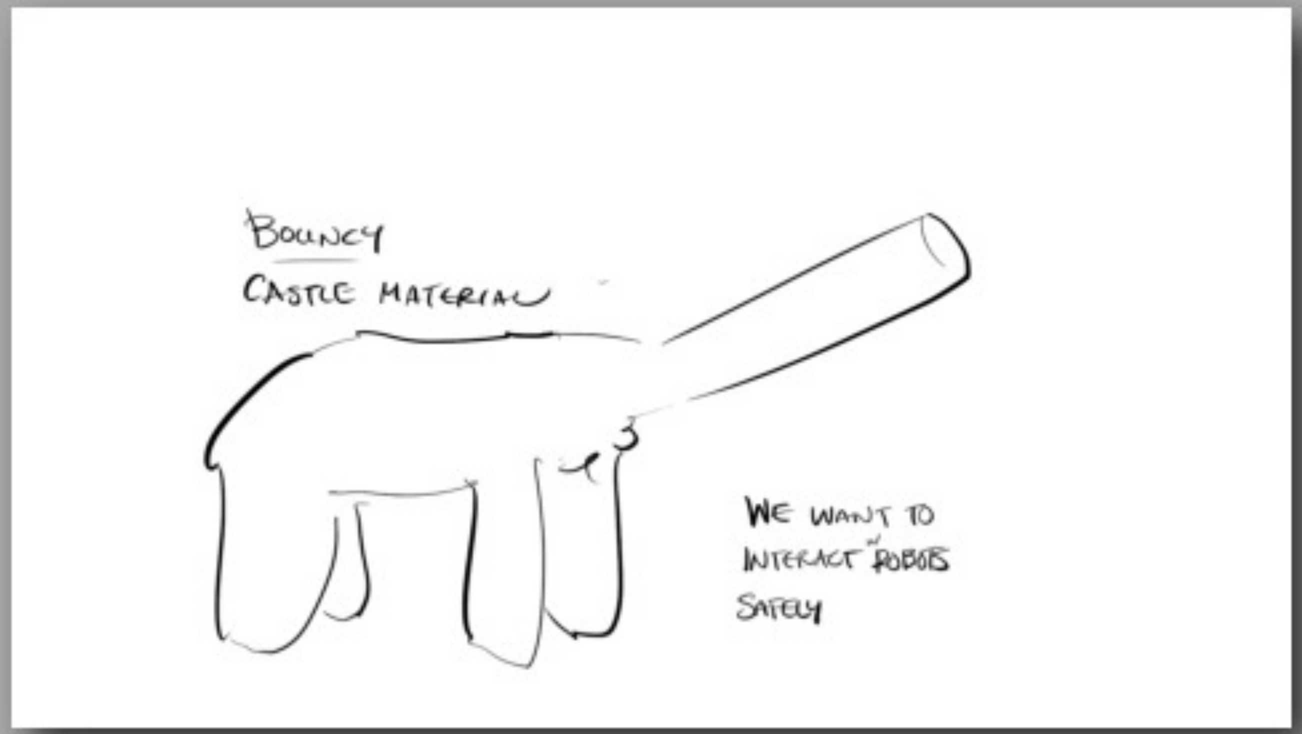

PAYLOAD
$
PAYLOAD PER ARM MASS

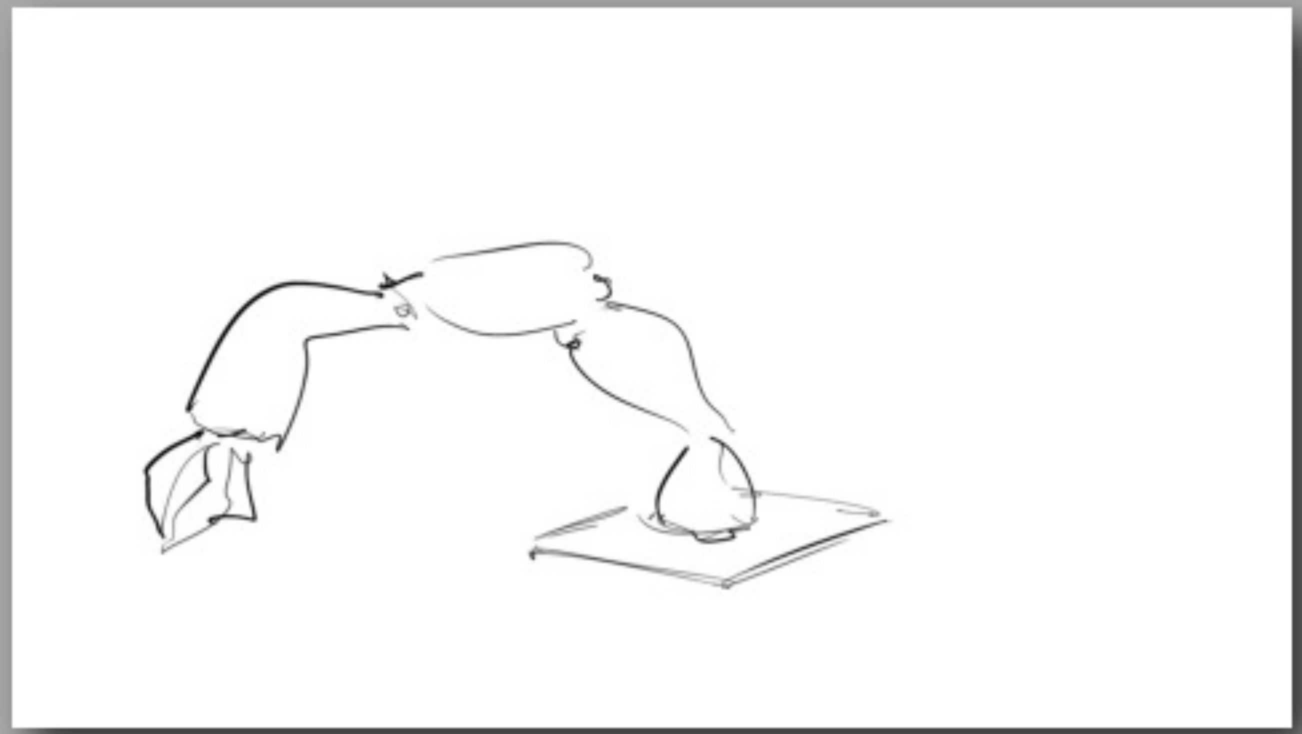

SYSTEM
%


$50,000
16

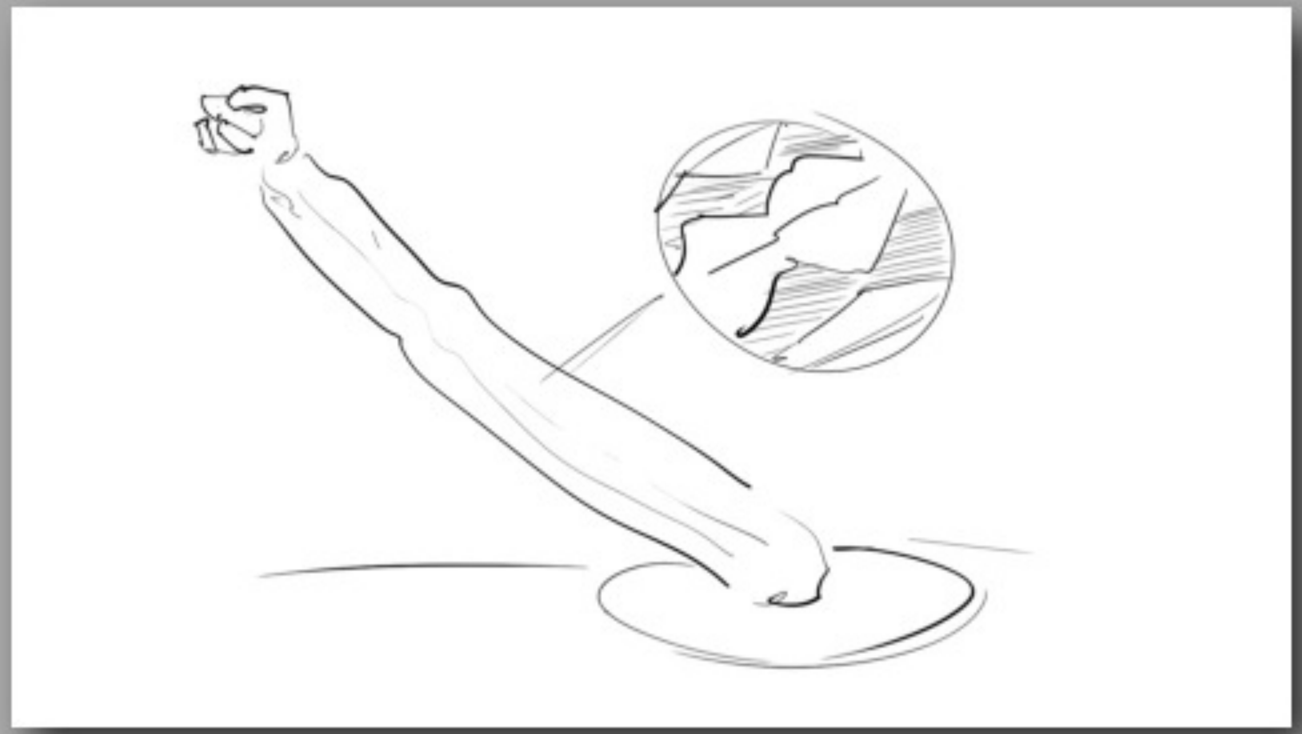

SOLAR PANEL
CHEAP ACTUATOR
ROBOT

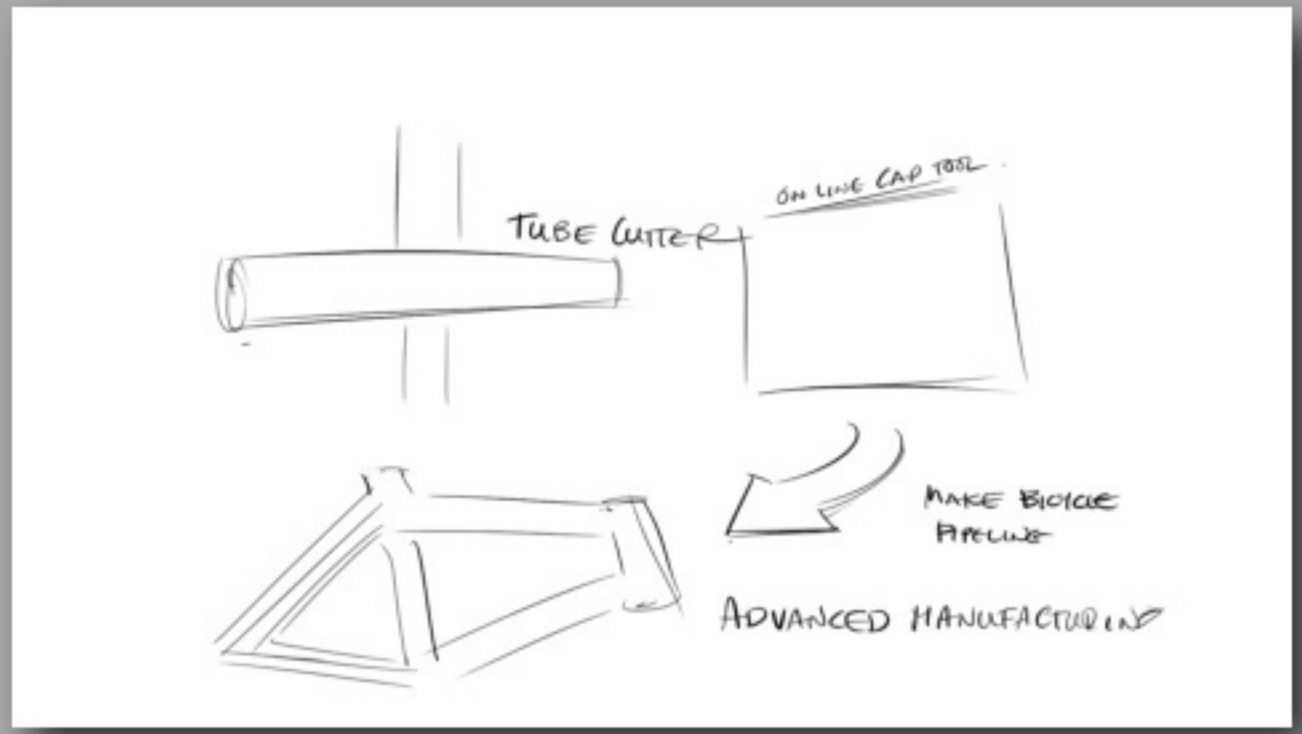

2009
1 MILE...
8 HOURS

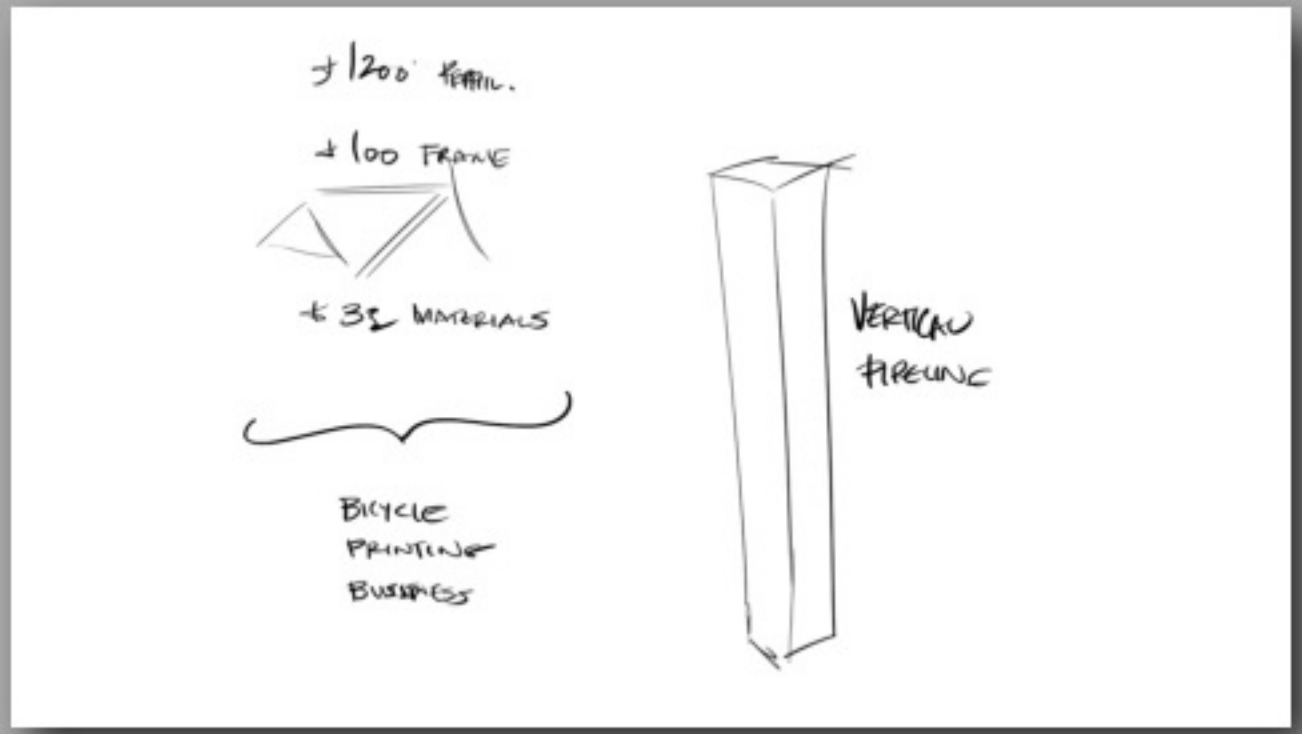

BOUNCY
CASTLE MATERIAL
WE WANT TO
INTERACT ROBOTS
SAFELY




GREY ARM.
$30 FABRIC
$100 SENSORS
A NEW STRATEGY FOR
ROBOT CONTROL




TUBE CUTTER
ON LINE CAP TOOL
MAKE BICYCLE
PIPELINE
ADVANCED MANUFACTURING


$100 FRAME
MATERIALS
BICYCLE
PRINTING
BUSINESS
VERTICAL
PIPELINE

07_Maurice Conti and David Thomasson **Autodesk**

"I for one welcome our robot overlords."

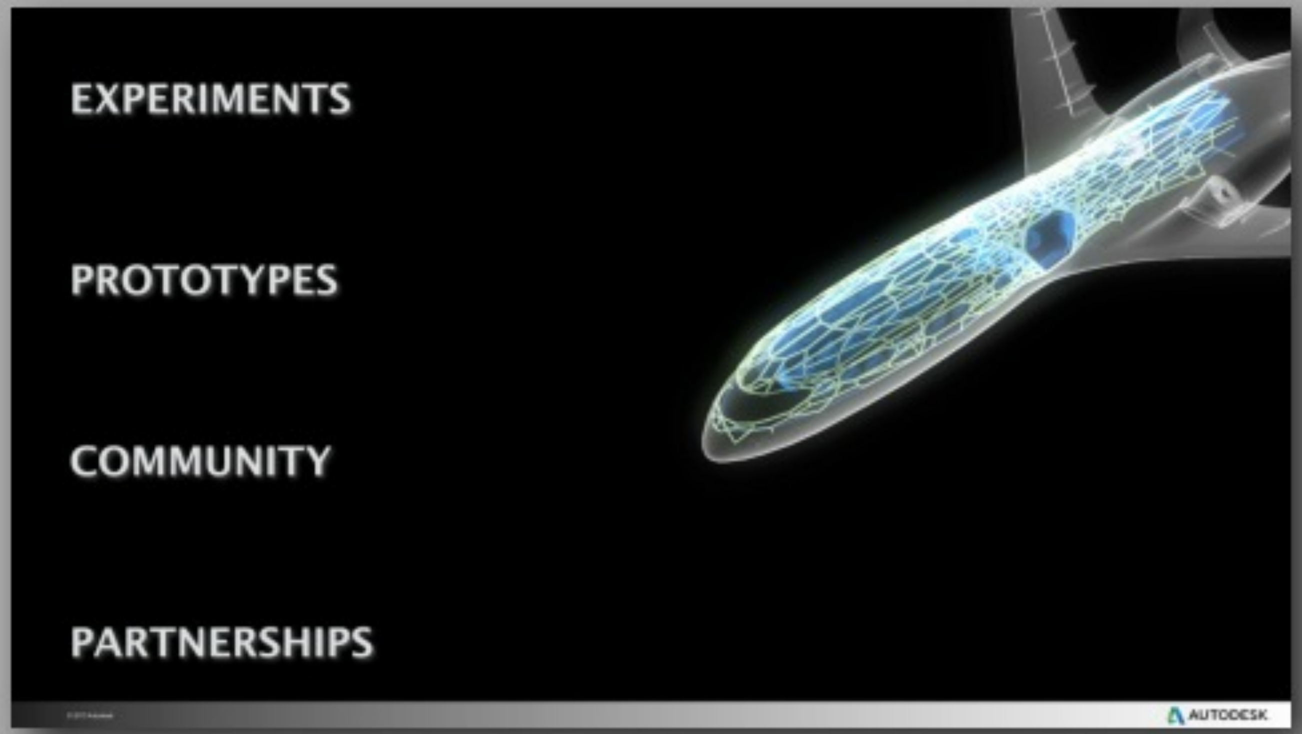
"Creative collaborations between humans and robots."

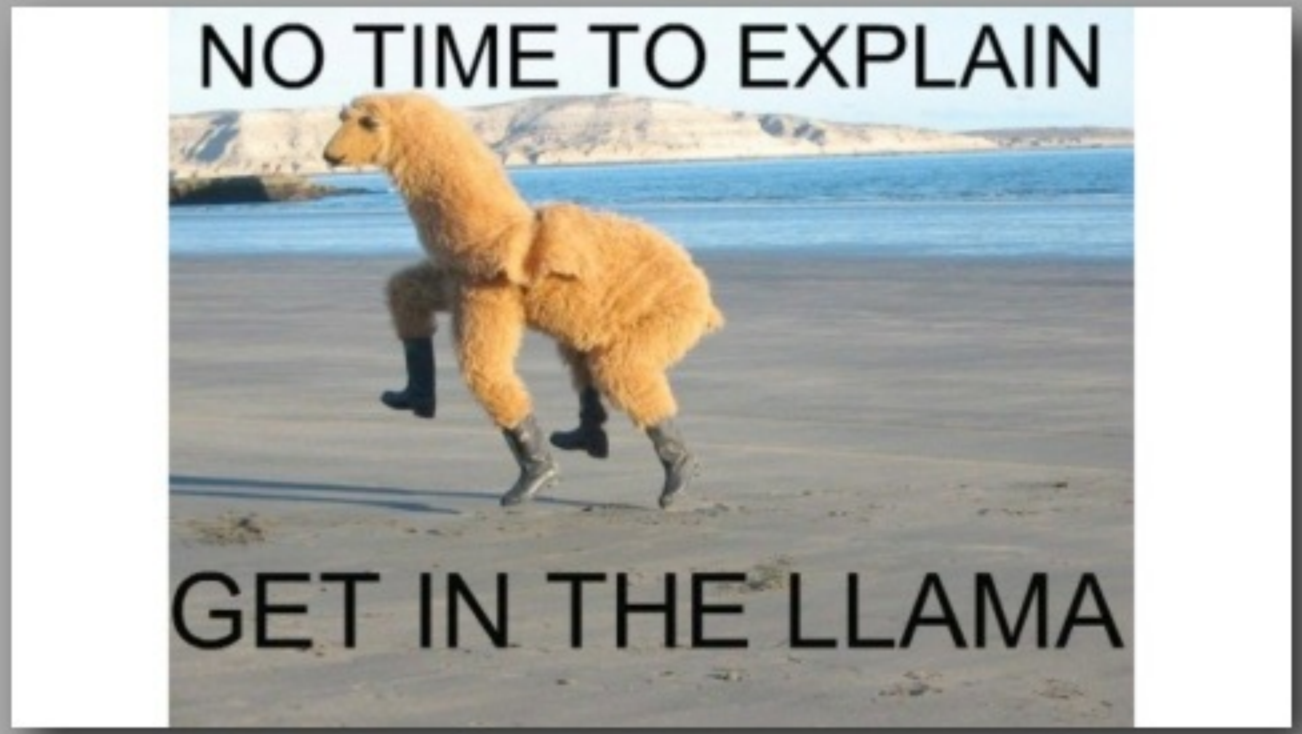
Autodesk and Robotics

Maurice and David are members of Autodesk and presented how the Office of the Chief Technology Officer (OCTO) are fostering research, insight, strategy and innovation into the field of robotics. Creating experiments, prototypes, communities and partnerships, they identified Autodesk as a software company not leading the charge on robotics, but seeking strategic path. This presentation also served to announce the soft launch of Autodesk's Pier 9 robotics lab – a facility devoted to understanding in real time what challenges people experience working in the modern robot landscape so that they can better create software for future customers.

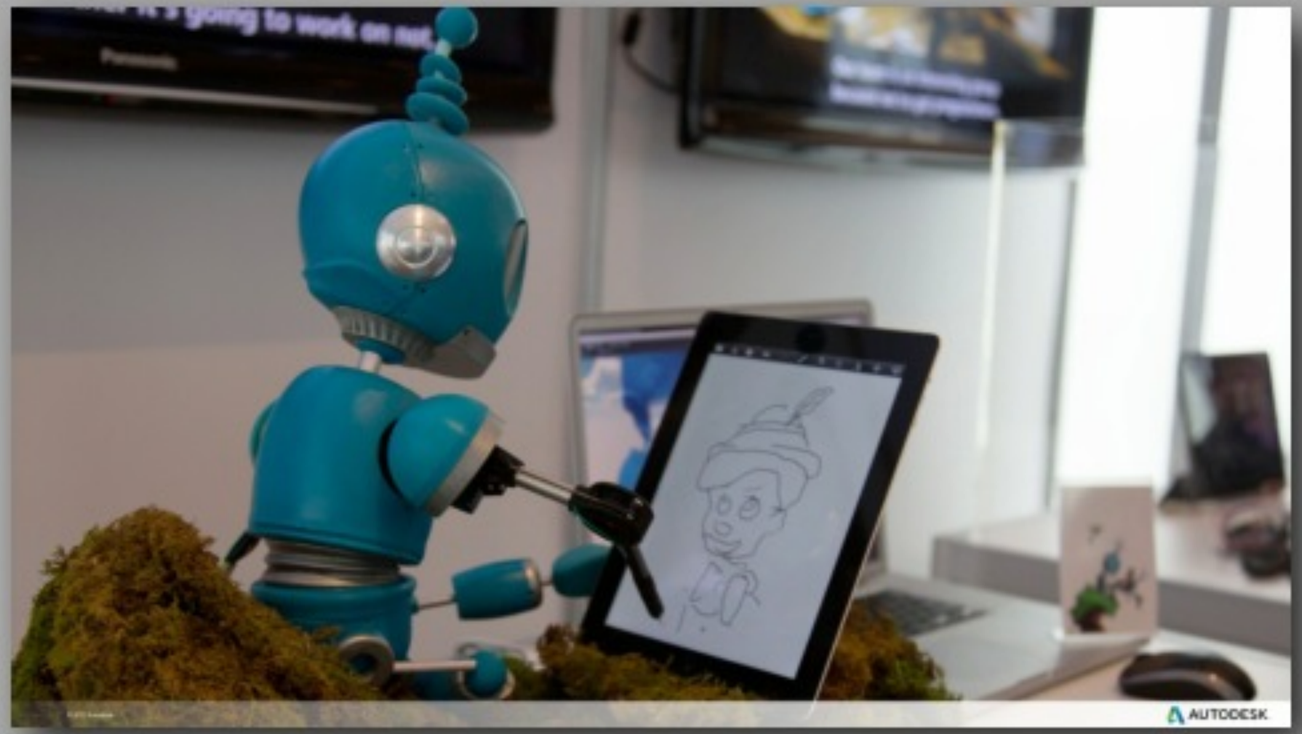

Maurice Conti
Director, Strategic Innovation
Autodesk AI Lab & Maritime R&D
David Thomasson
Design Engineer,
Strategic
Innovation


RESEARCH
INSIGHT
STRATEGY
INNOVATION
OCTO


EXPERIMENTS
PROTOTYPES
COMMUNITY
PARTNERSHIPS
AUTODESK

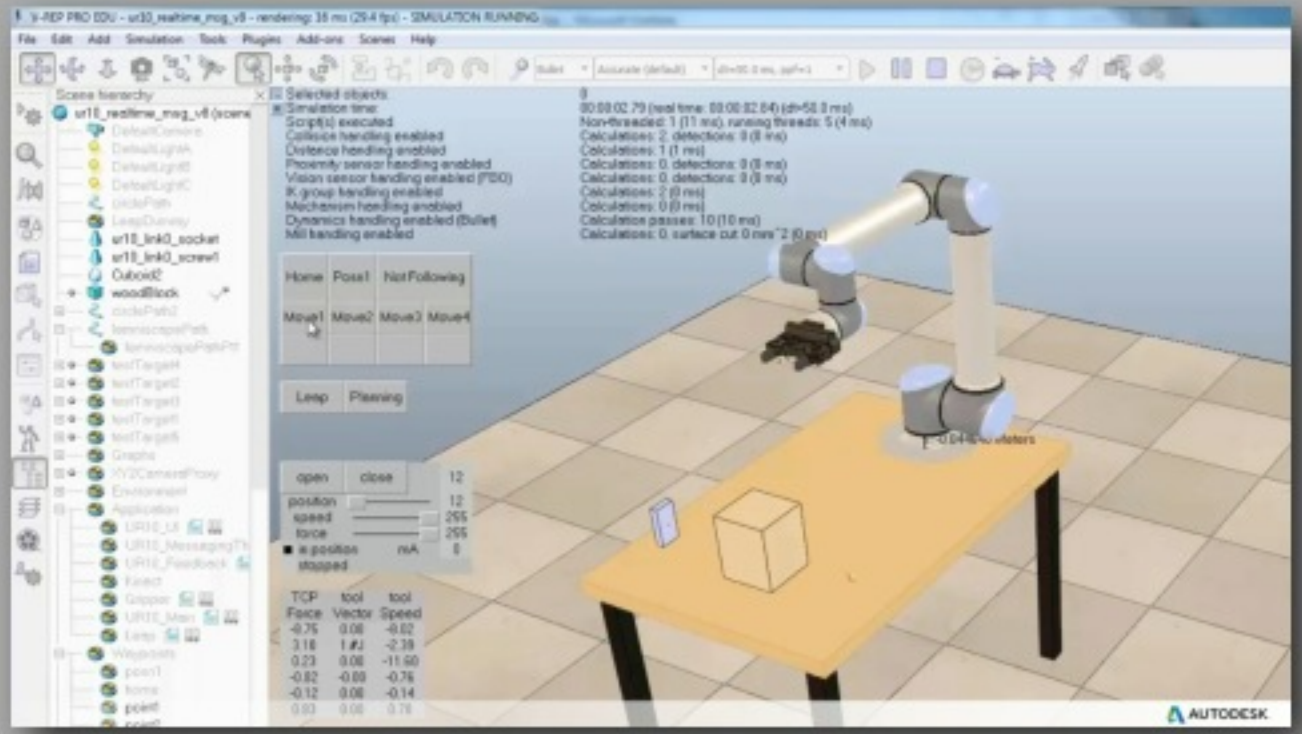

NO TIME TO EXPLAIN
GET IN THE LLAMA

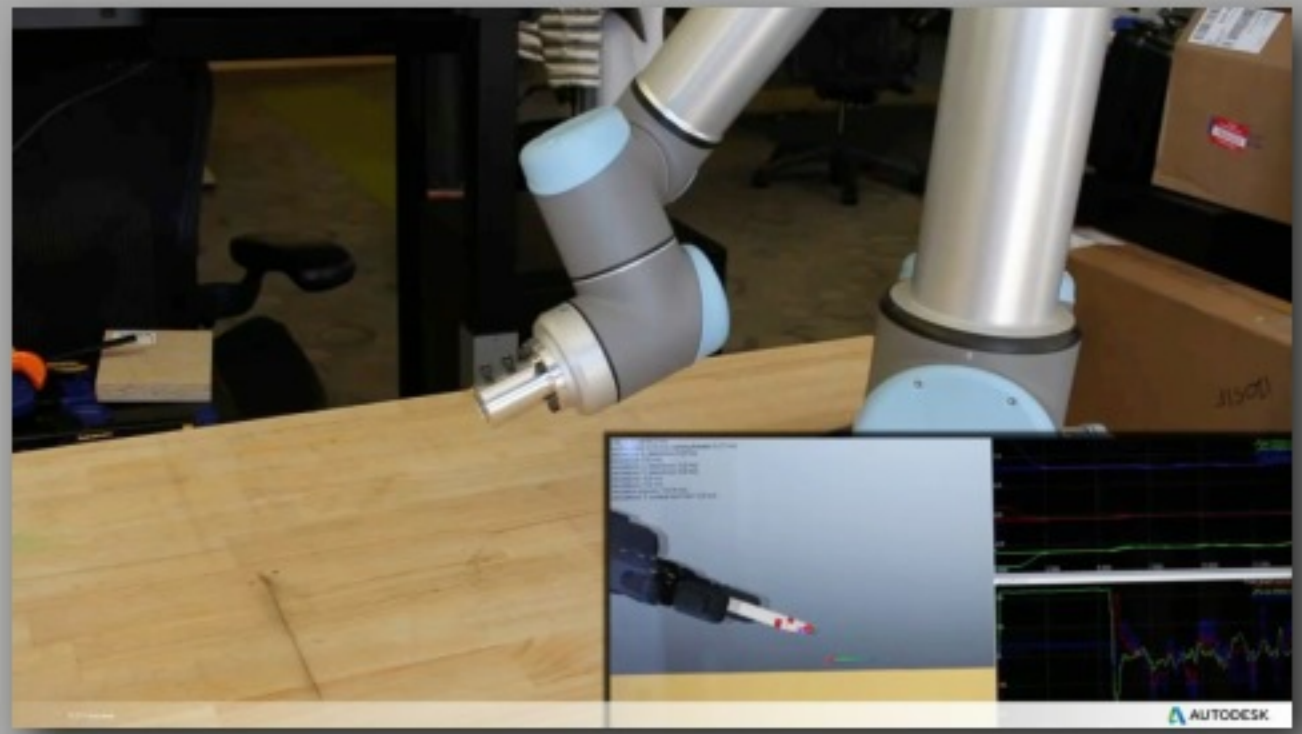

AUTODESK

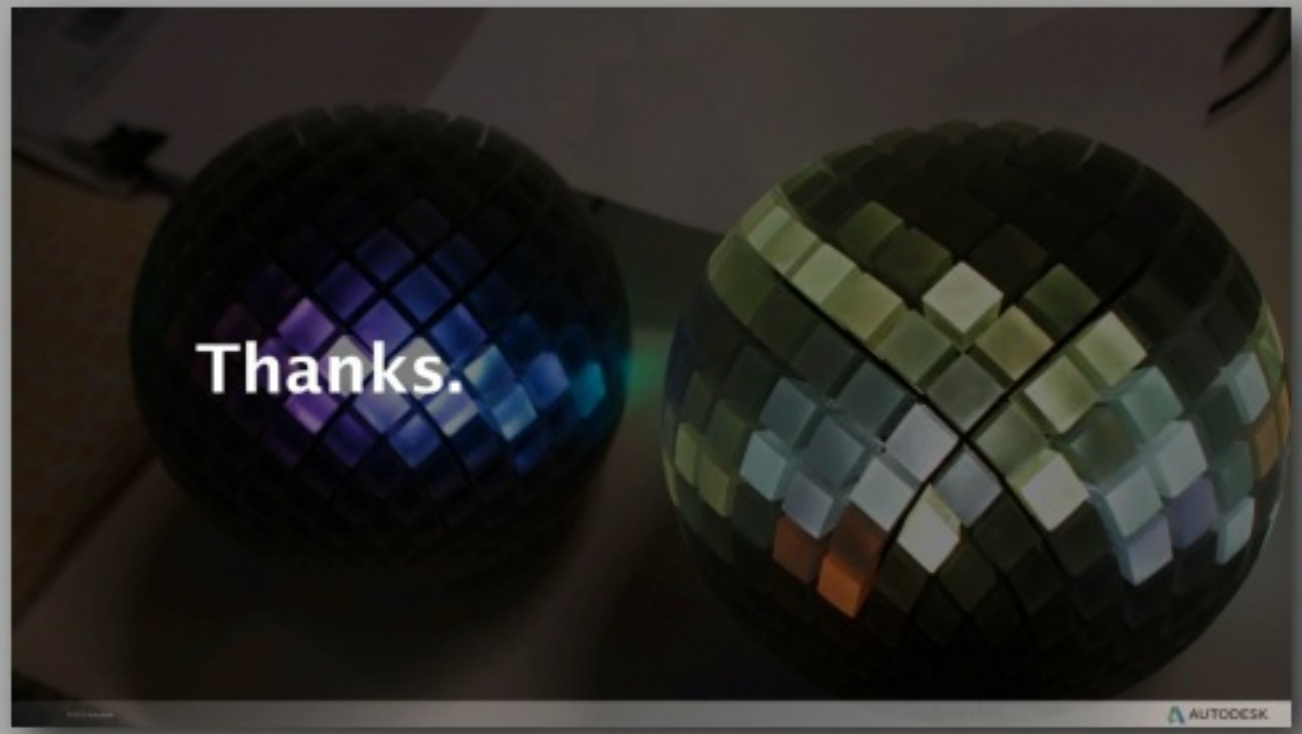

AUTODESK


AUTODESK


AUTODESK


AUTODESK




Thanks.

08_Mitchell Joachim

Terreform ONE

"I'm interested in robots helping to deal with refuse in cities."

Making the Very Large

Multi-disciplinary design thinking can solve large-scale problems. Terreform One imagines their work as public propaganda – based in art and science – exploring waste management and urban construction.

Promoting a paradigm shift from growing rather than building, Joachim suggested that whole ecology design and the use of biocomposite systems will create new processes and practices and bring patience back to human advancement.

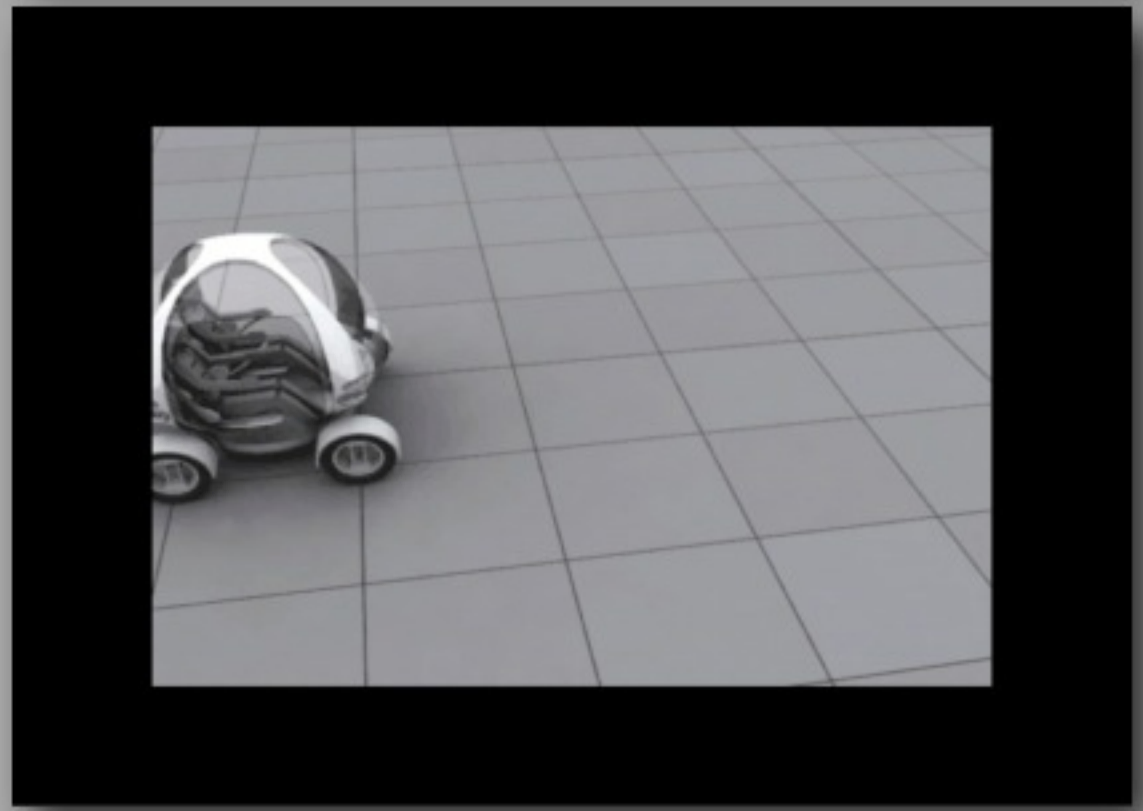

TERREFORM
ONE
Mitchell Joachim


Urbaneering: Governors Hook
TERREFORM ONE


Smart Streets + Vertical Farms
TERREFORM ONE


OVER-DEVELOPMENT
McPEOPLE
McCAR
McMANSION
TERREFORM ONE


Blimp Bumper Bus: On The Fly Mobility
TERREFORM ONE



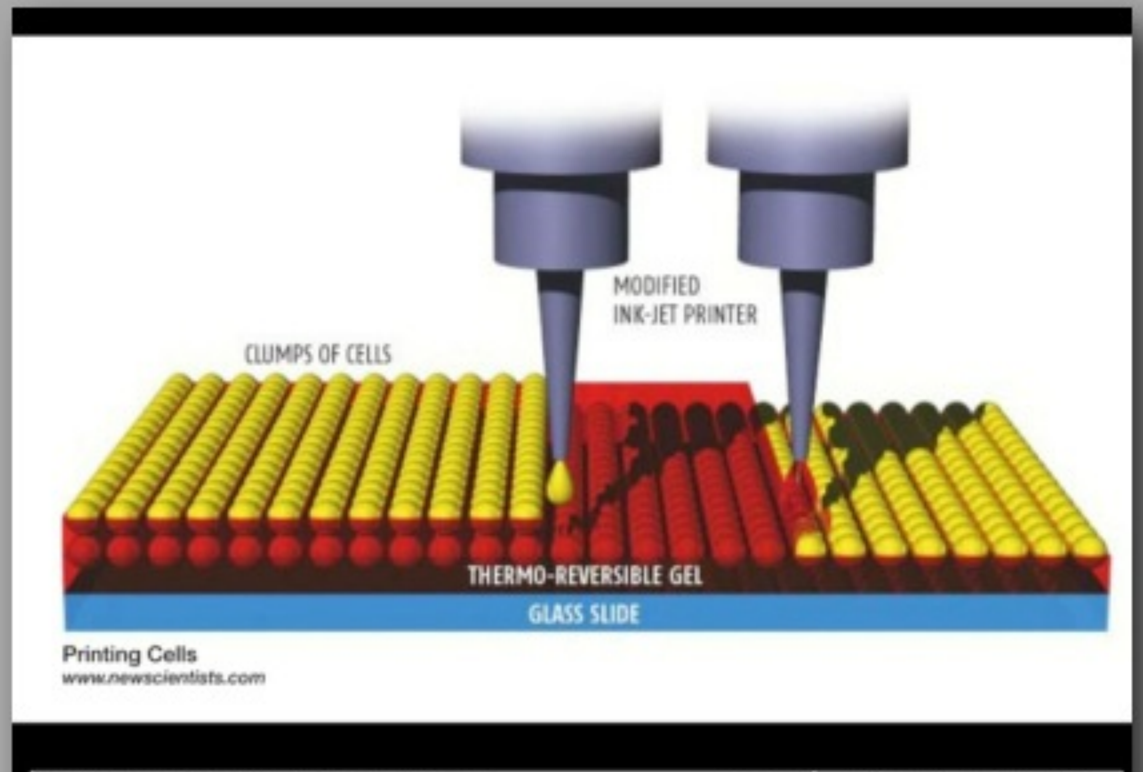

XO LAMB: Concept Car w/ GM + Gehry
TRANS 02
TERREFORM ONE


SMART MOBILITY: Omni Flocking
IDEATION 04
TERREFORM ONE

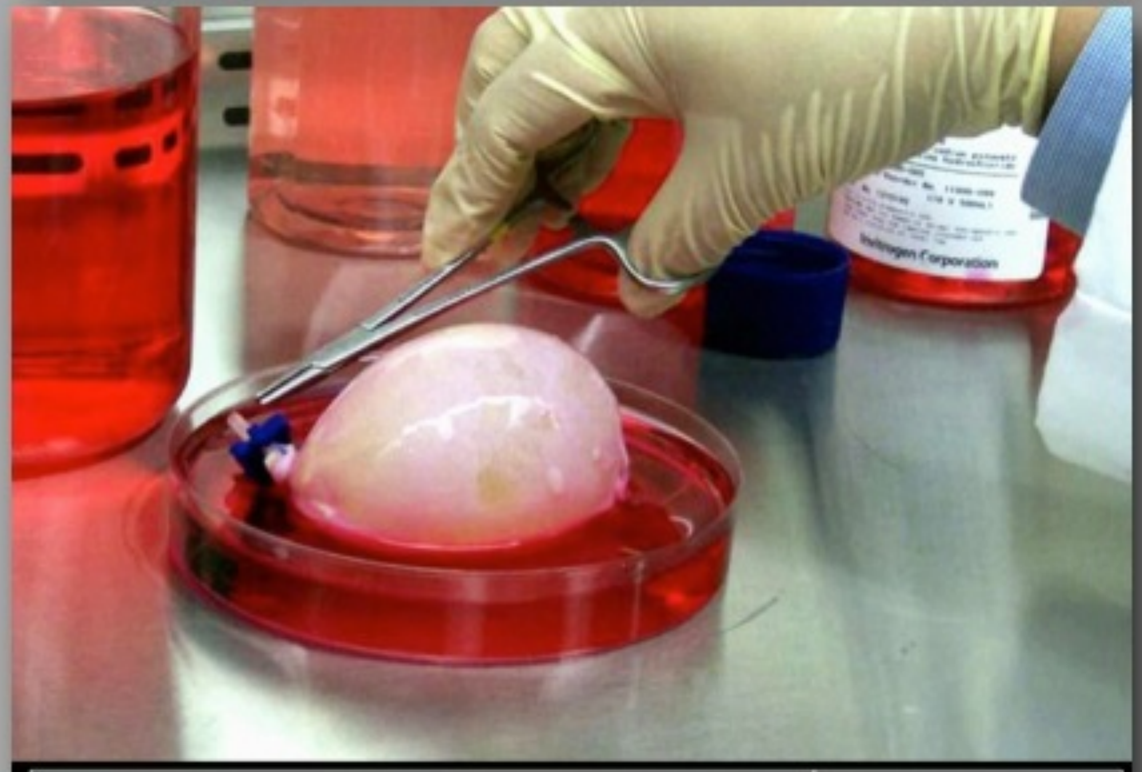

SMART MOBILITY: Charge Station Stack
IDEATION 04
MITCHELL JOACHIM

Hiriko MIT Car TRANS 03 MITCHELL JOACHIM

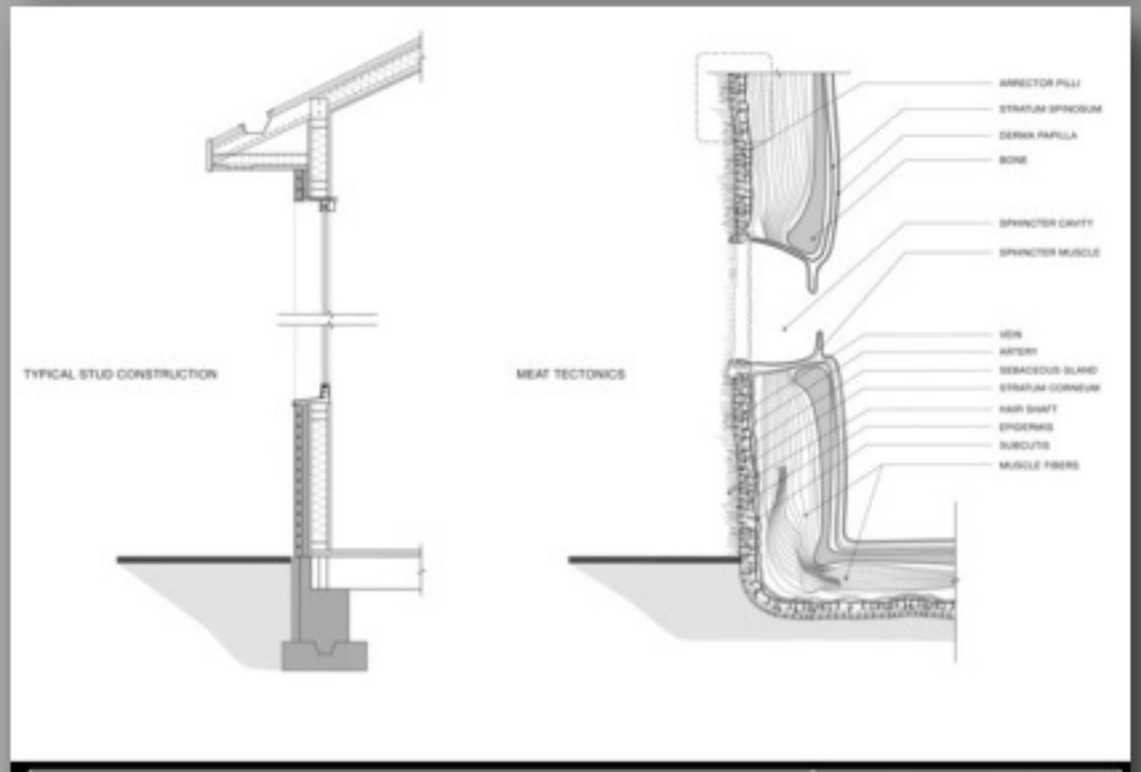
GENSPACE TERREFORM ONE



In Vitro Meat Hab: Victimless Material ECO 02 MITCHELL JOACHIM



In Vitro Meat Hab: Victimless Material ECO 02 MITCHELL JOACHIM

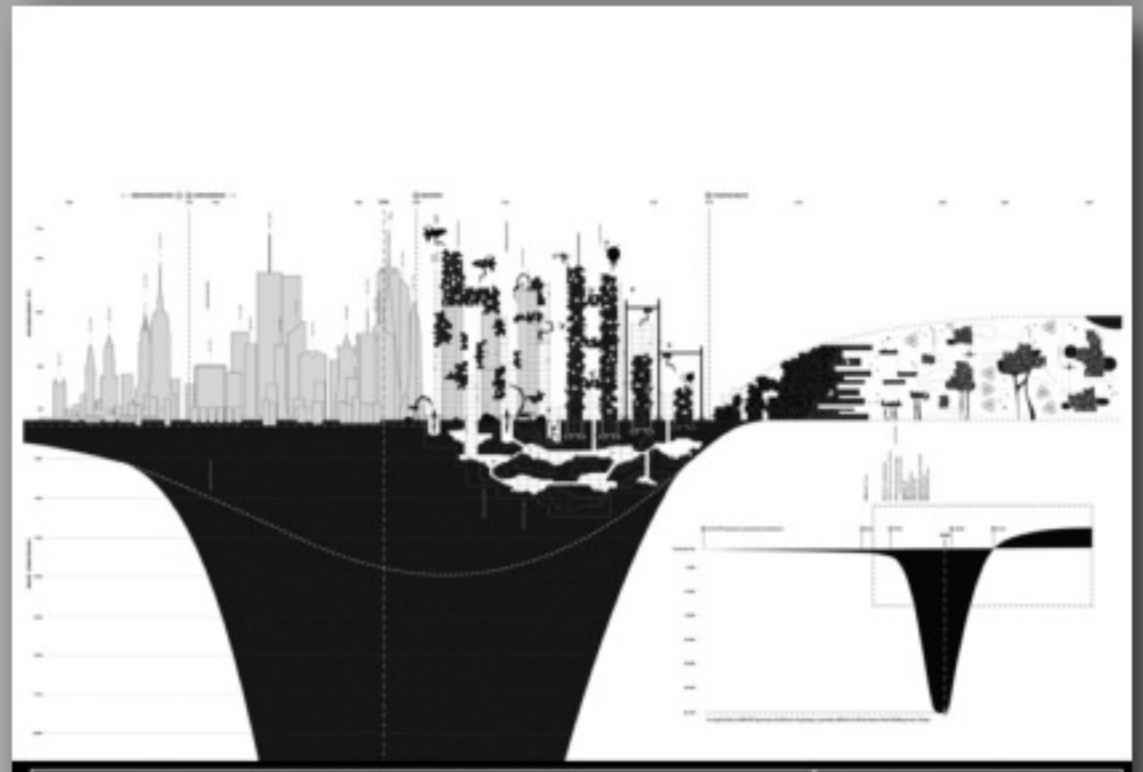


In Vitro Meat Hab: Victimless Material ECO 02 MITCHELL JOACHIM

In Vitro Meat Hab: Victimless Material ECO 02 MITCHELL JOACHIM

In Vitro Meat Hab: Victimless Material ECO 02 MITCHELL JOACHIM

In Vitro Meat Hab: Victimless Material ECO 02 MITCHELL JOACHIM



Rapid Re(f)use: Waste as Source ECO 02 MITCHELL JOACHIM


Rapid Re(f)use: Waste as Source
ECO 02
MITCHELL JOACHIM


EVERY HOUR
New York produces enough waste to fill the Statue of Liberty.
Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE


Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE


Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE


Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE


Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE


Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE

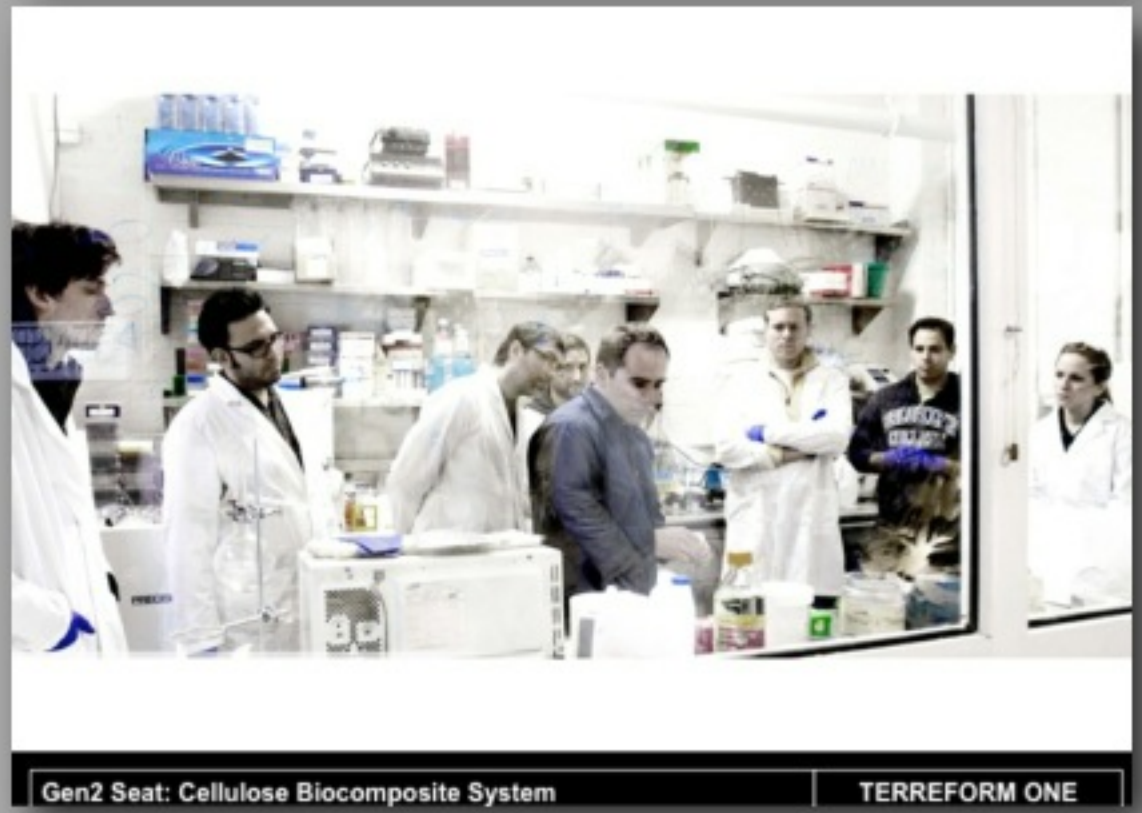

Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE

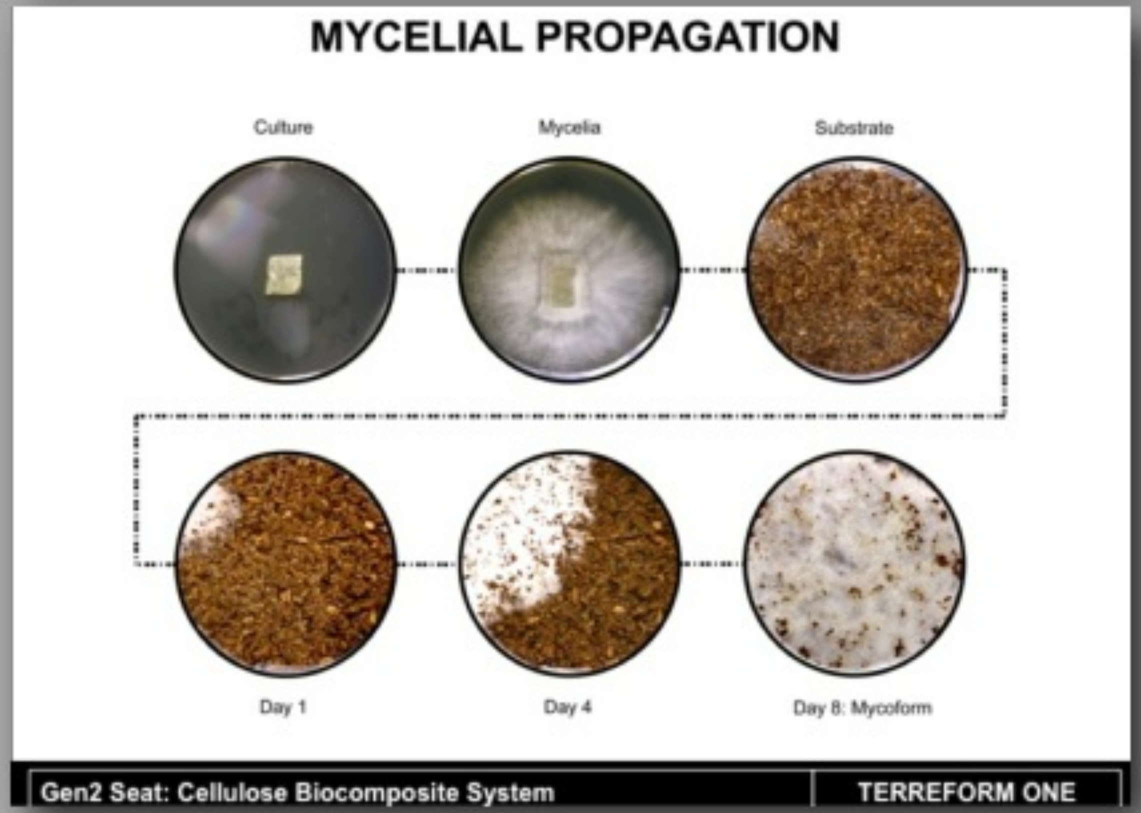

Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE


Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE

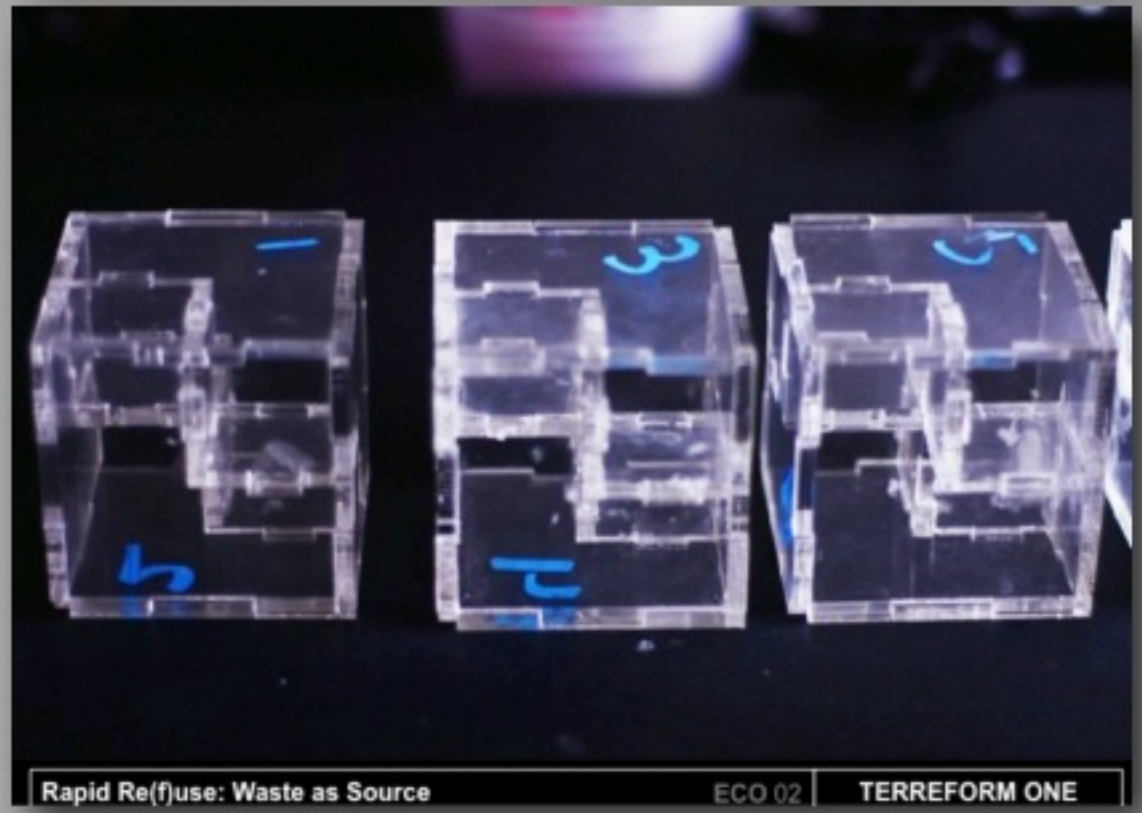

Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE


Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE

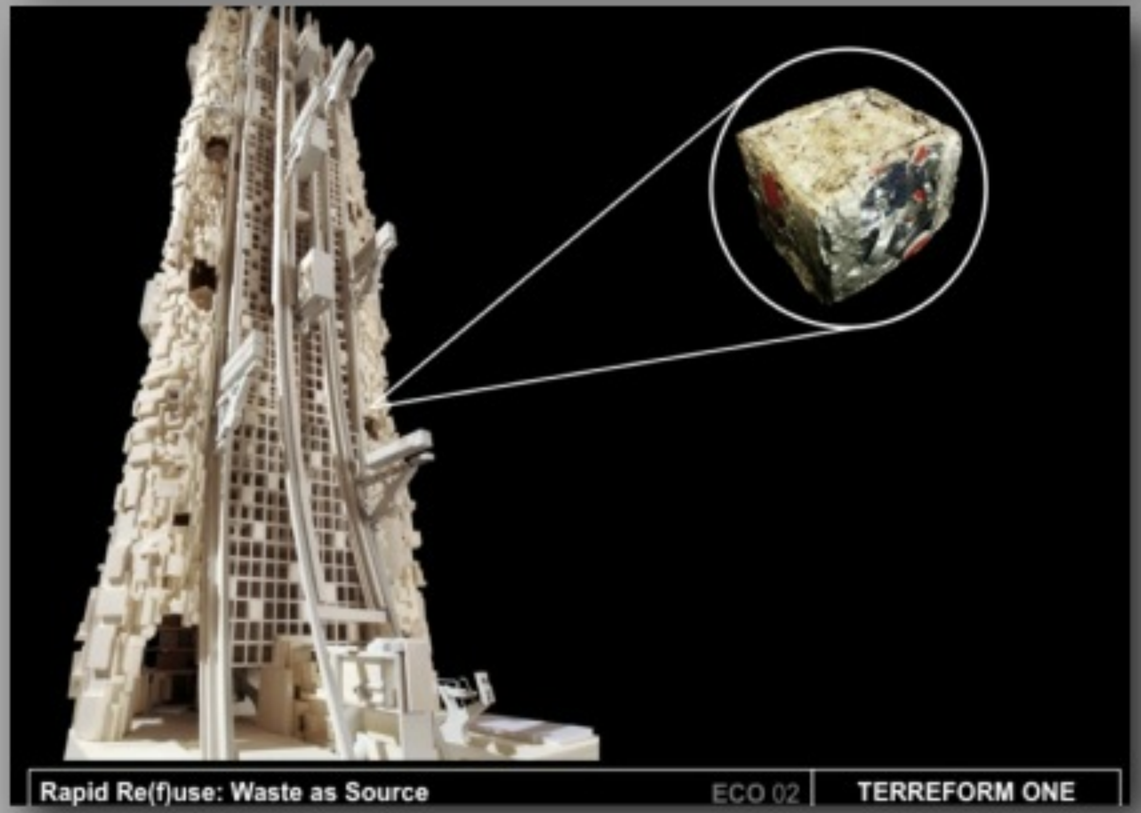

Gen2 Seat: Cellulose Biocomposite System
TERREFORM ONE

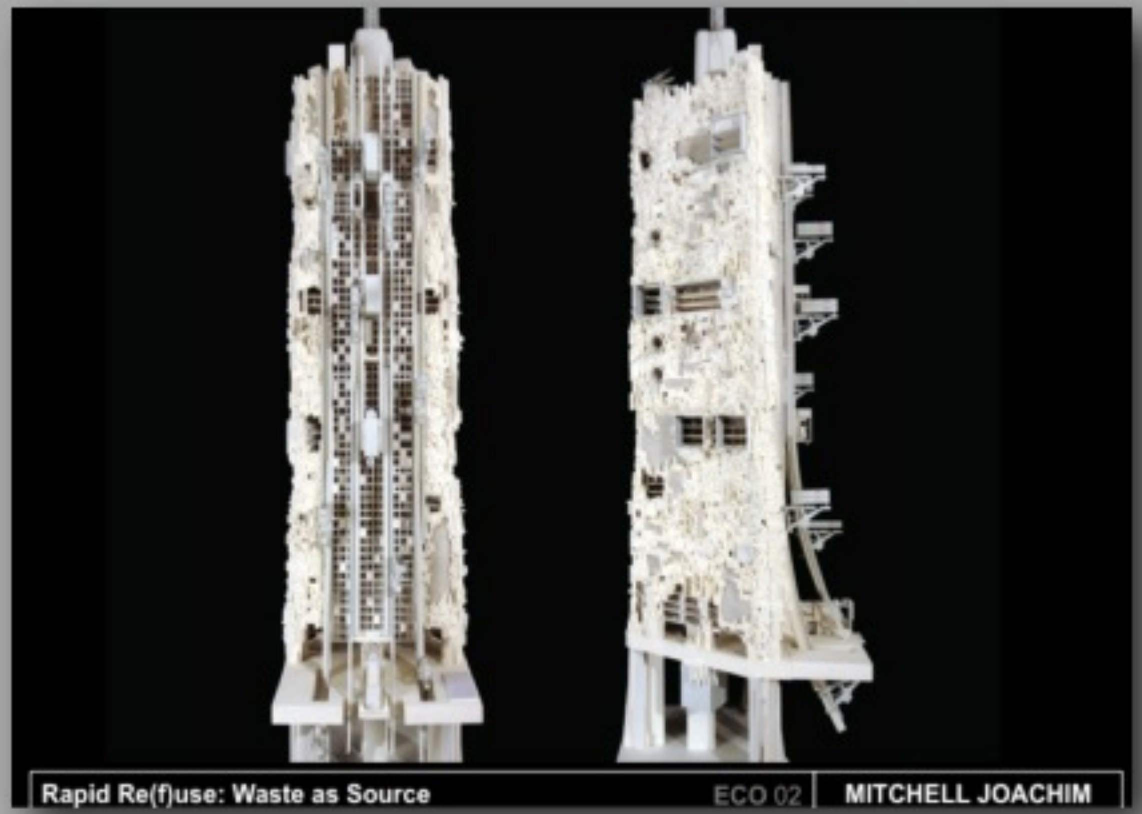

MYCELIAL PROPAGATION
Culture
Mycelia
Substrate
Day 1
Day 4
Day 8: Mycoform
Gen2 Seat: Cellulose Biocomposite System
TERREFORM ONE


MYCOFORM
Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE

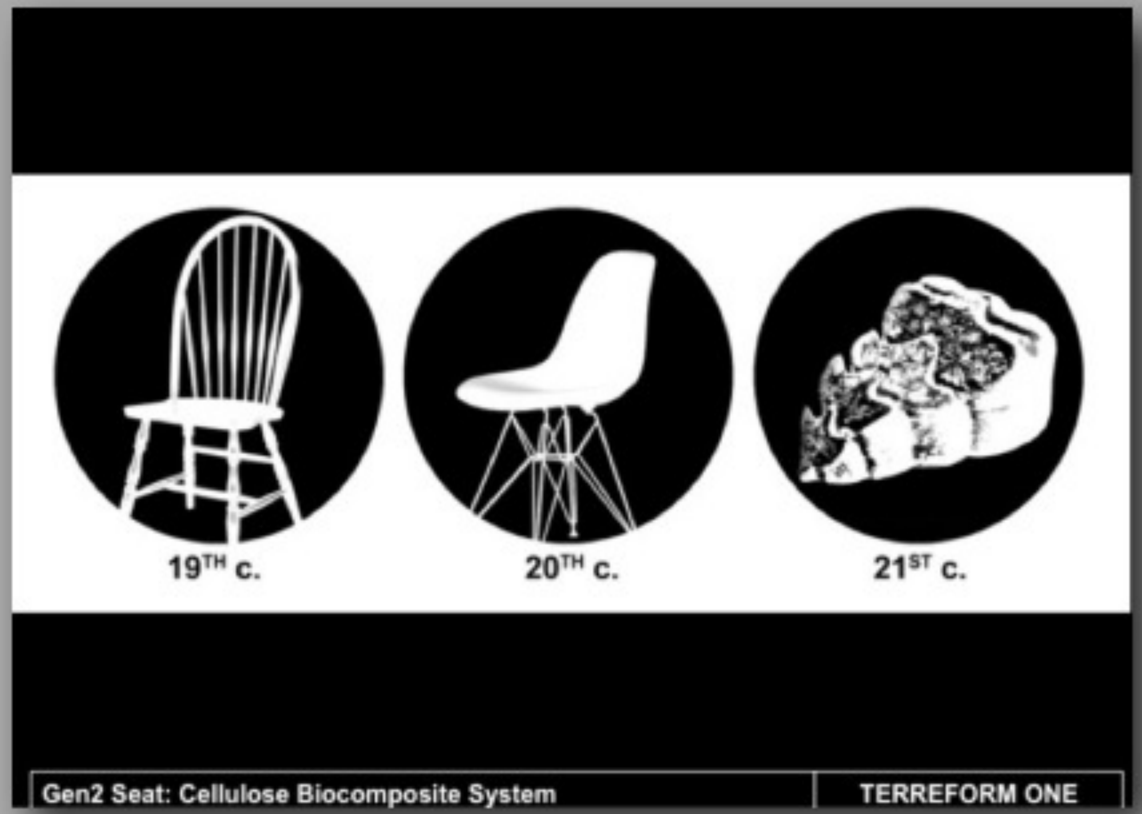

Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE

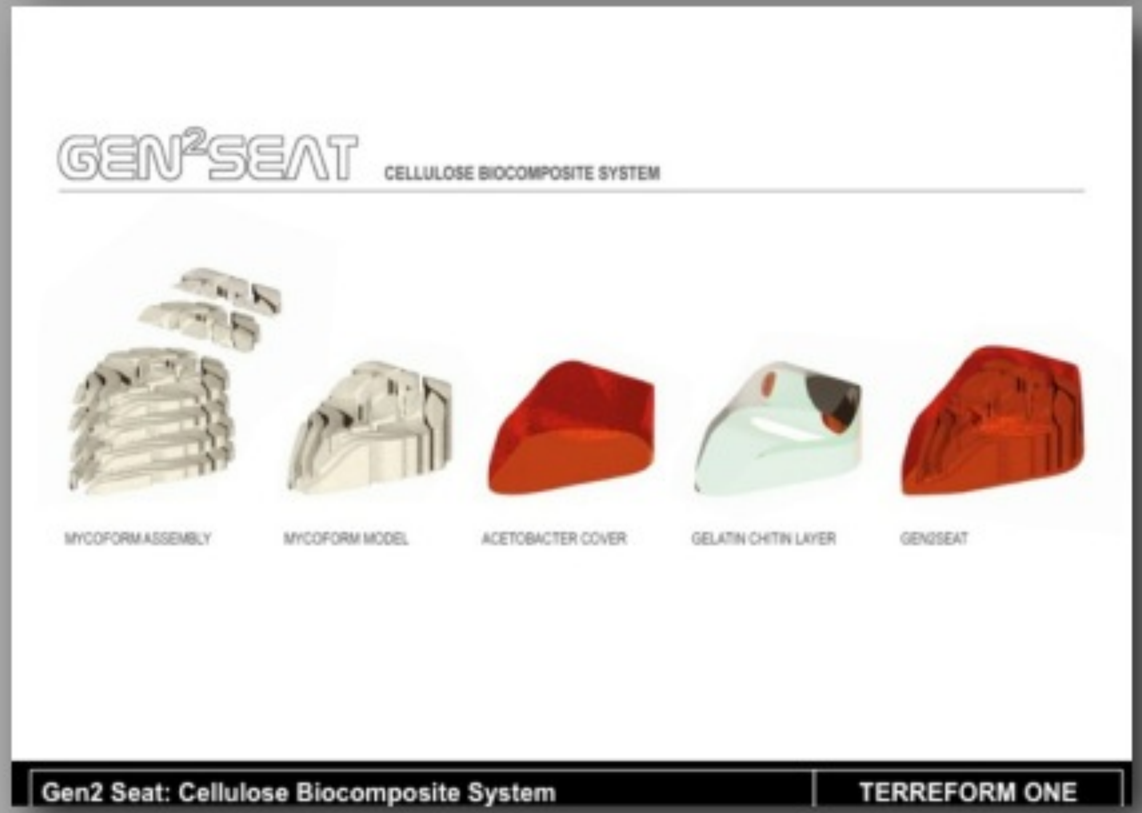

Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE

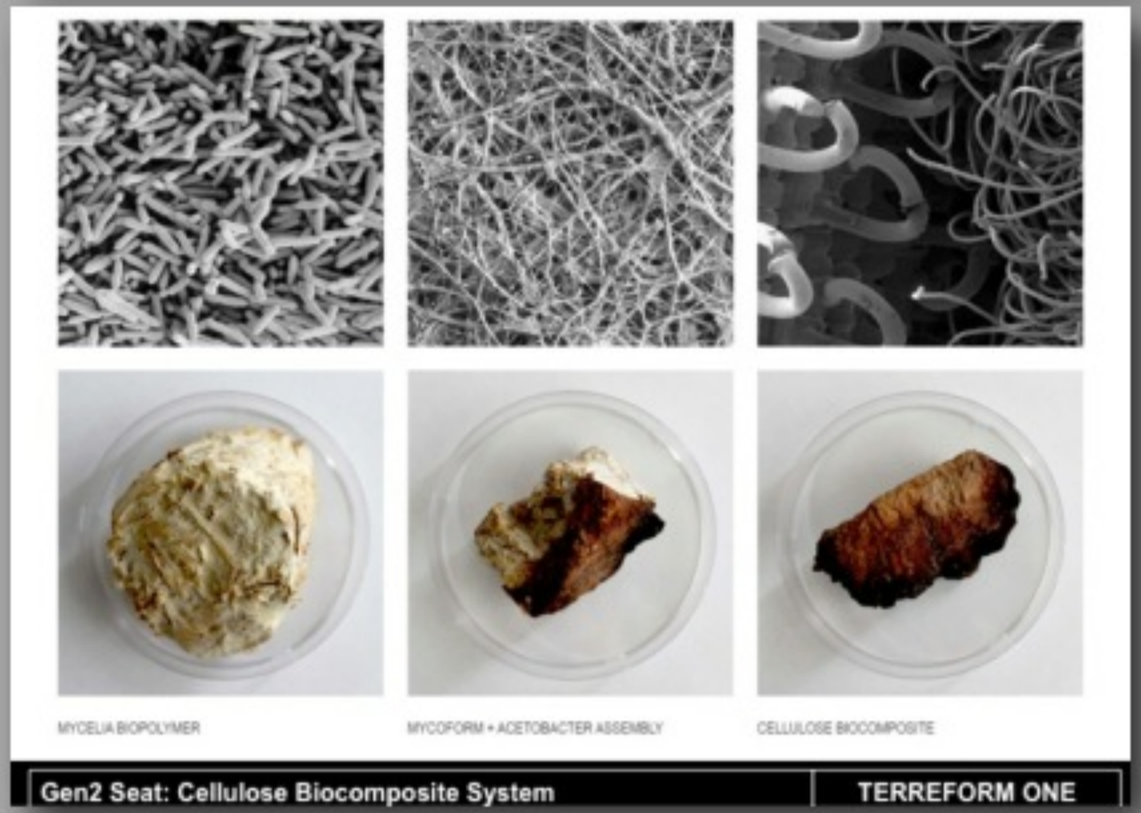

Rapid Re(f)use: Waste as Source
ECO 02
TERREFORM ONE


Rapid Re(f)use: Waste as Source
ECO 02
MITCHELL JOACHIM

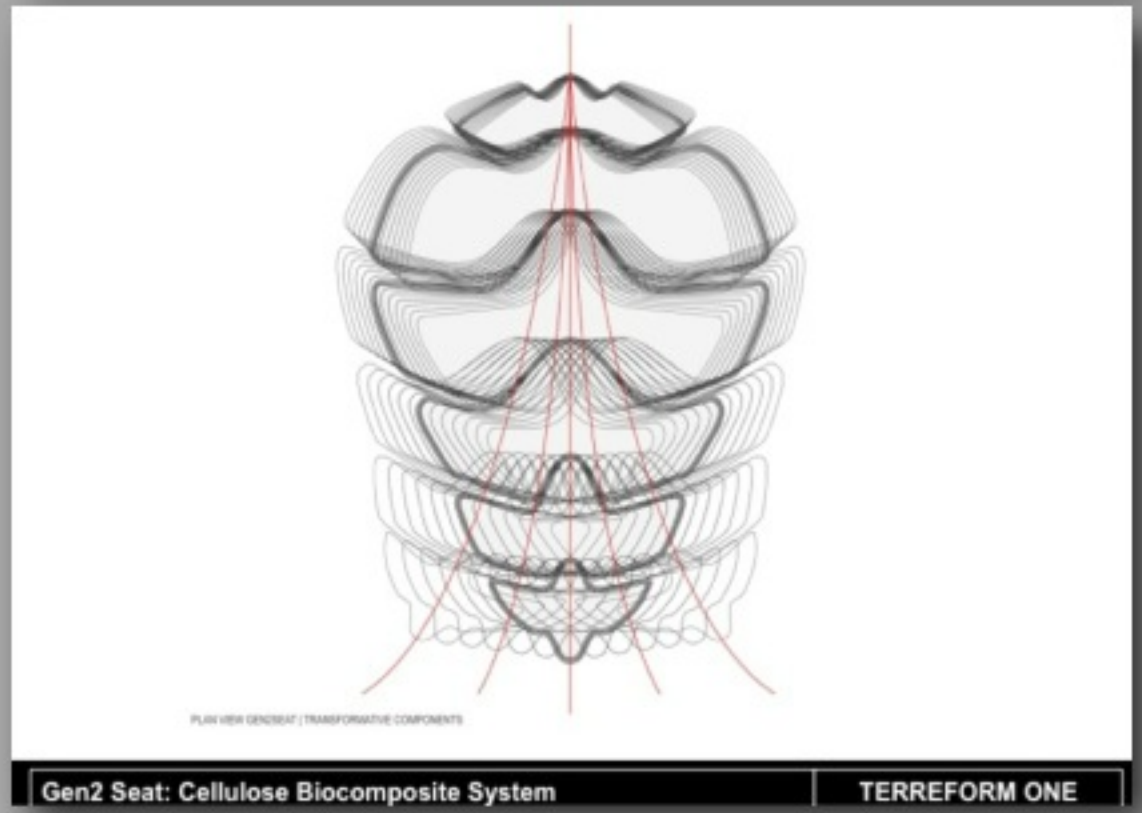

GEN²SEAT
CELLULOSE BIOCOMPOSITE SYSTEM
Terreform ONE + Genspace
TERREFORM ONE


19TH c.
20TH c.
21ST c.
Gen2 Seat: Cellulose Biocomposite System
TERREFORM ONE


GEN²SEAT
CELLULOSE BIOCOMPOSITE SYSTEM
MYCOFORM ASSEMBLY
MYCOFORM MODEL
ACETOBACTER COVER
GELATIN CHITIN LAYER
GEN2SEAT
Gen2 Seat: Cellulose Biocomposite System
TERREFORM ONE


MYCELIA BIOPOLYMER
MYCOFORM + ACETOBACTER ASSEMBLY
CELLULOSE BIOCOMPOSITE
Gen2 Seat: Cellulose Biocomposite System
TERREFORM ONE


Fusion of Cellulose and Chitin with Fungi
TERREFORM ONE


PLAN VIEW GEN2SEAT | TRANSFORMATIVE COMPONENTS
Gen2 Seat: Cellulose Biocomposite System
TERREFORM ONE


Gen2 Seat: Cellulose Biocomposite System
TERREFORM ONE


Gen2 Seat: Cellulose Biocomposite System
TERREFORM ONE


FAB TREE HAB: Whole Ecology Design
ECO 01
TERREFORM ONE

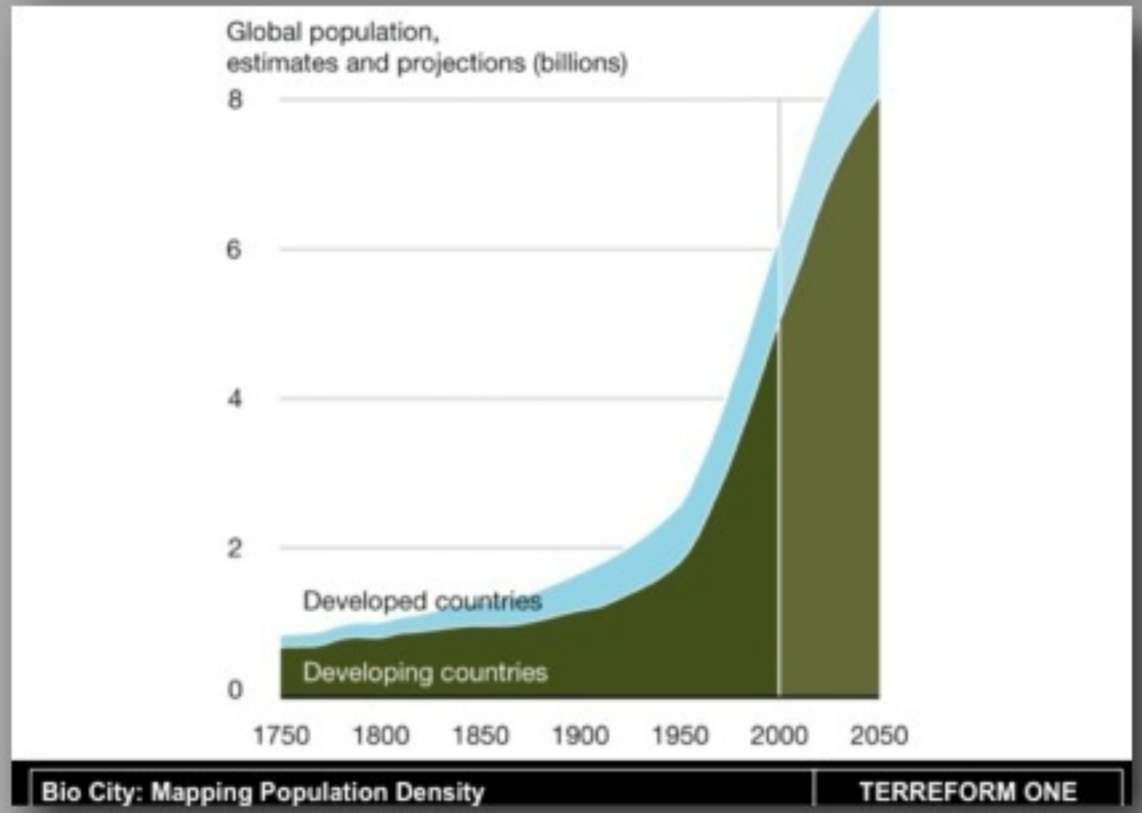

FAB TREE HAB: Whole Ecology Design
ECO 01
TERREFORM ONE

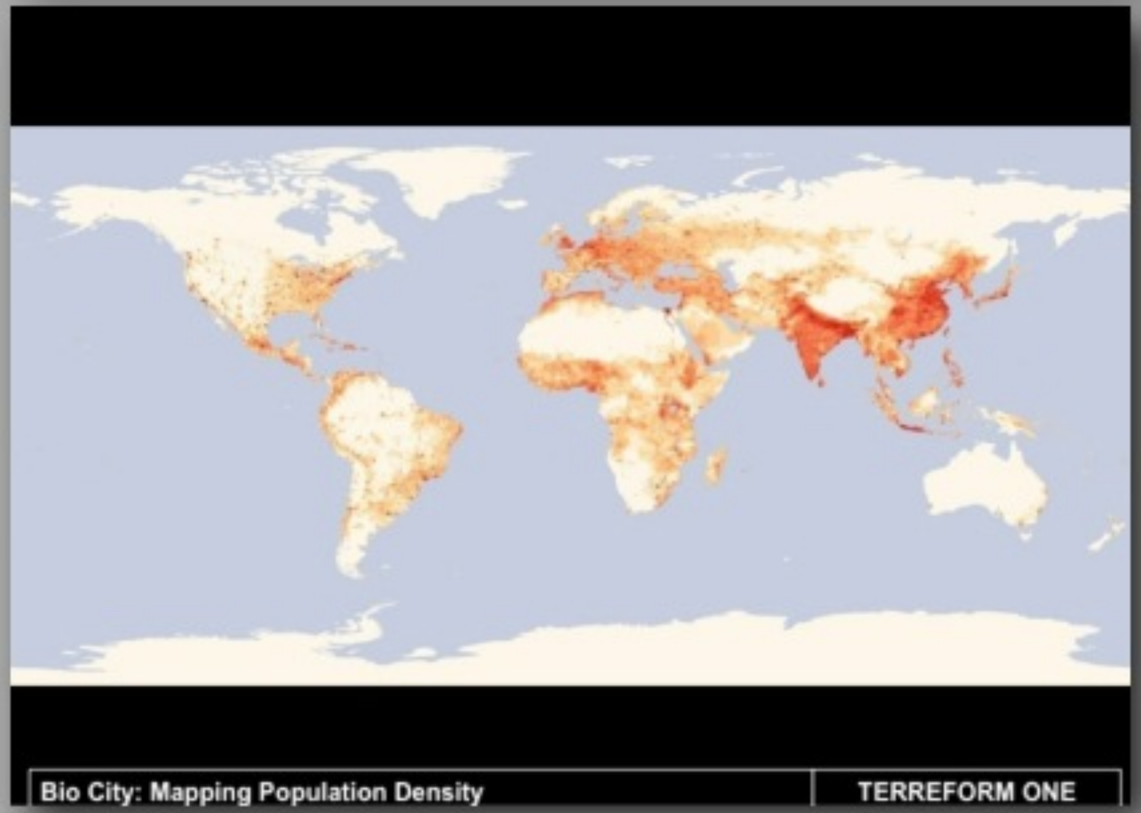

FAB TREE HAB: Whole Ecology Design
ECO 01
TERREFORM ONE


FAB TREE HAB: Whole Ecology Design
ECO 01
TERREFORM ONE

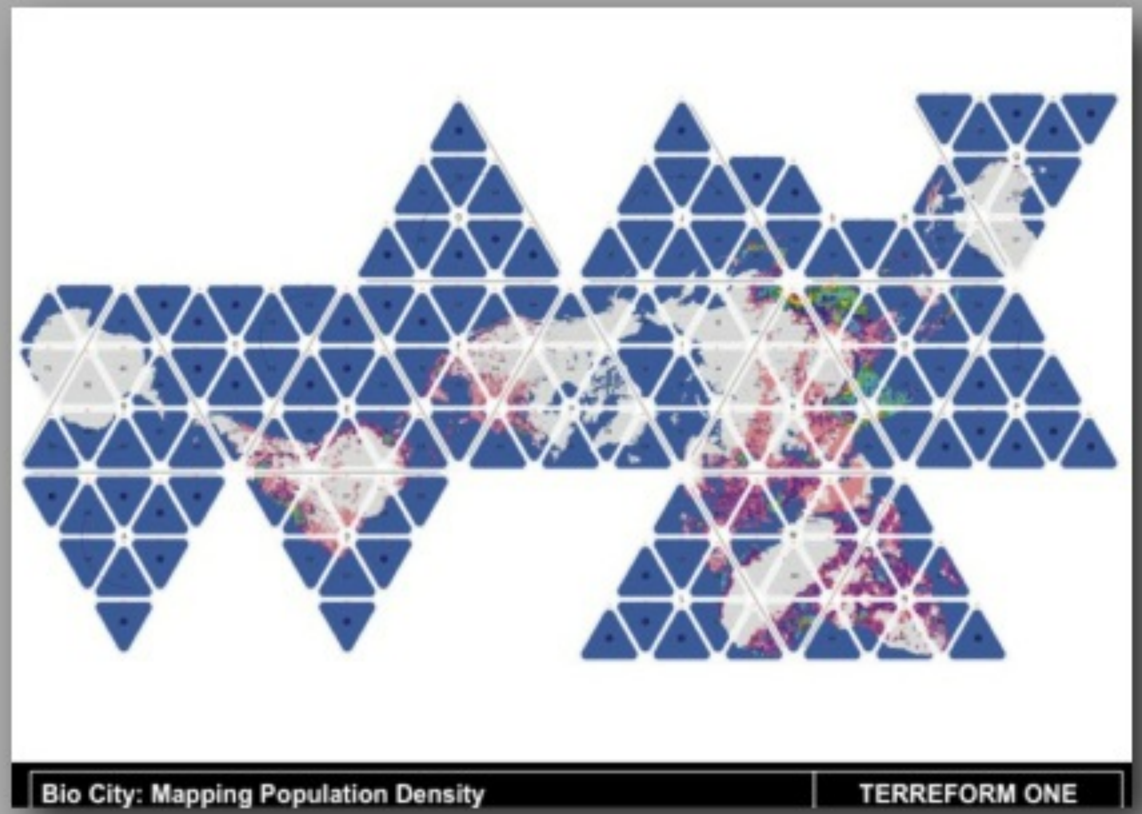

FAB TREE HAB: Whole Ecology Design
ECO 01
TERREFORM ONE

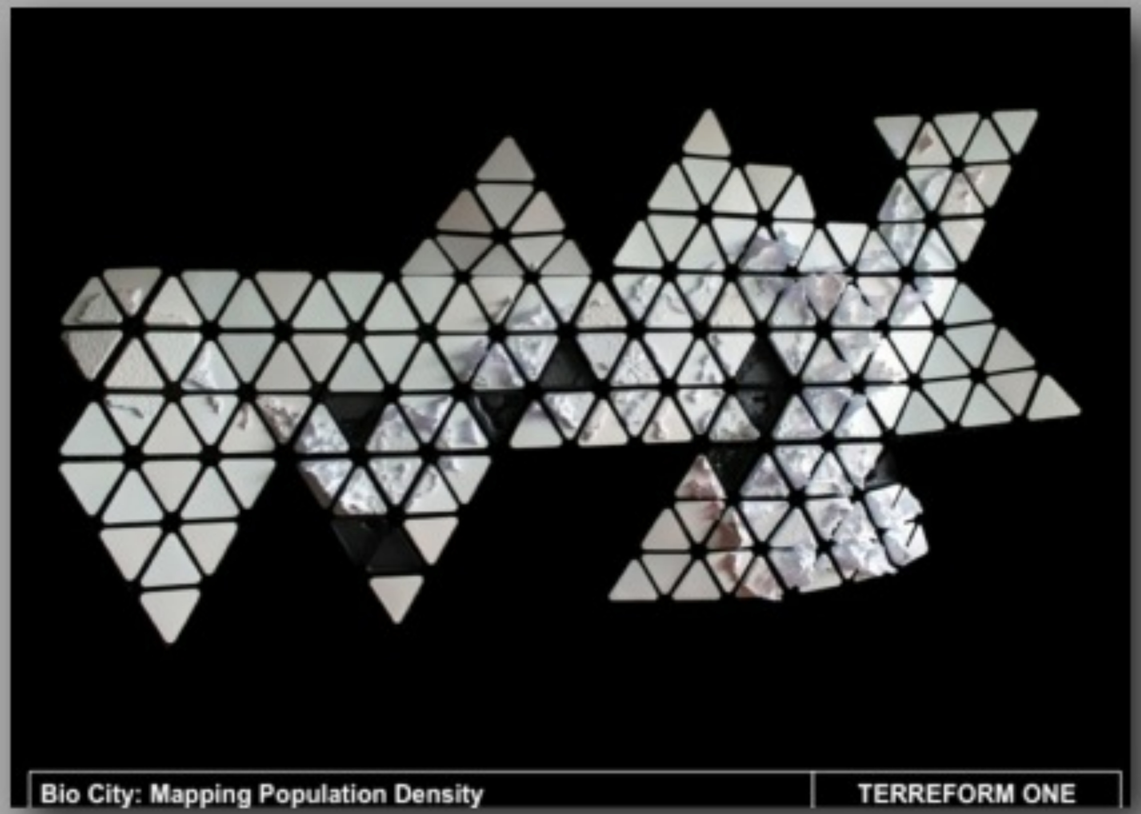

FAB TREE HAB: Whole Ecology Design
ECO 01
TERREFORM ONE

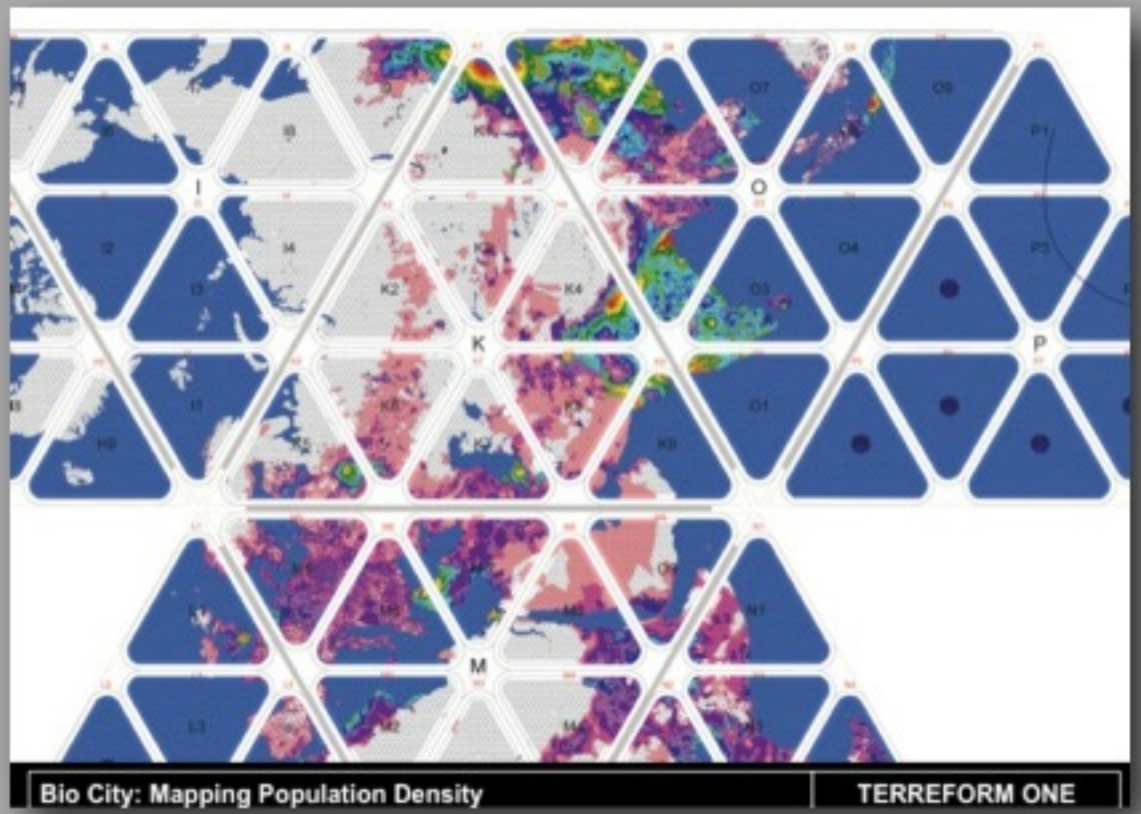

Global population,
estimates and projections (billions)
8
6
4
2
0
Developed countries
Developing countries
1750
1800
1850
1900
1950
2000
2050
Bio City: Mapping Population Density
TERREFORM ONE

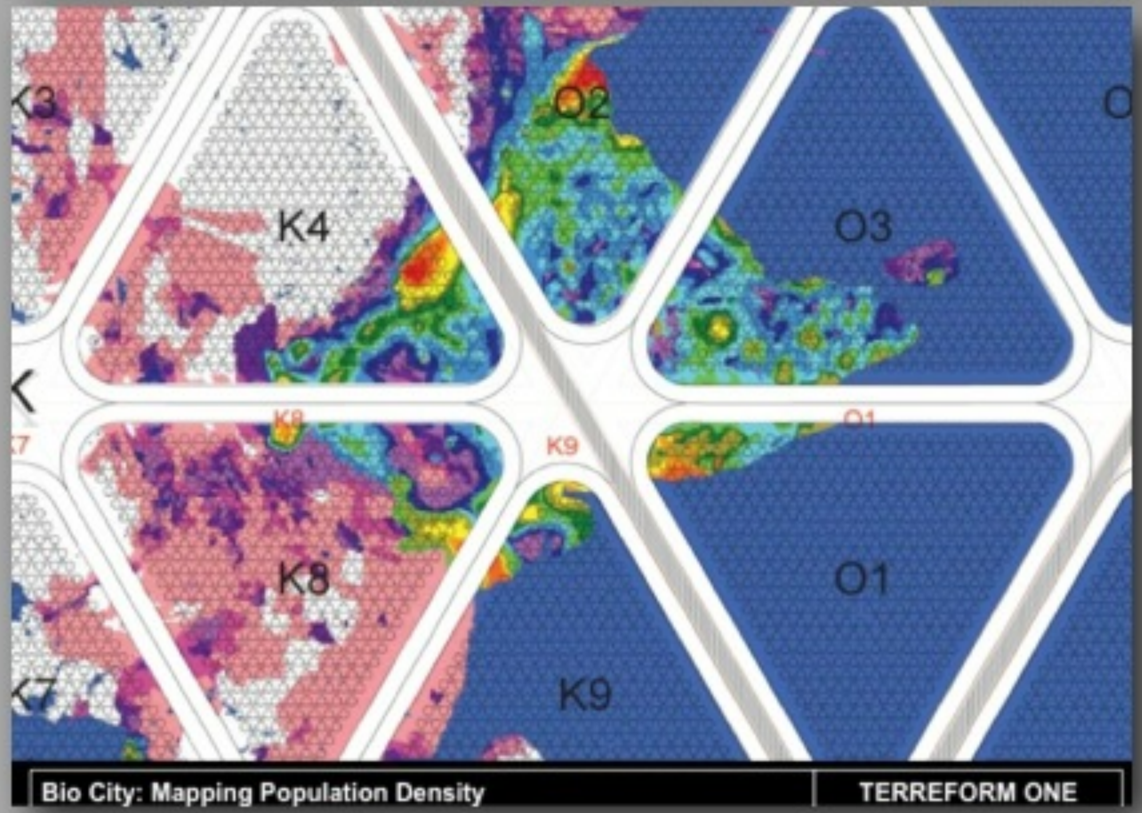

Bio City: Mapping Population Density
TERREFORM ONE


MORE PEOPLE INSIDE THE
CIRCLE THAN OUTSIDE OF IT.
Bio City: Mapping Population Density
TERREFORM ONE

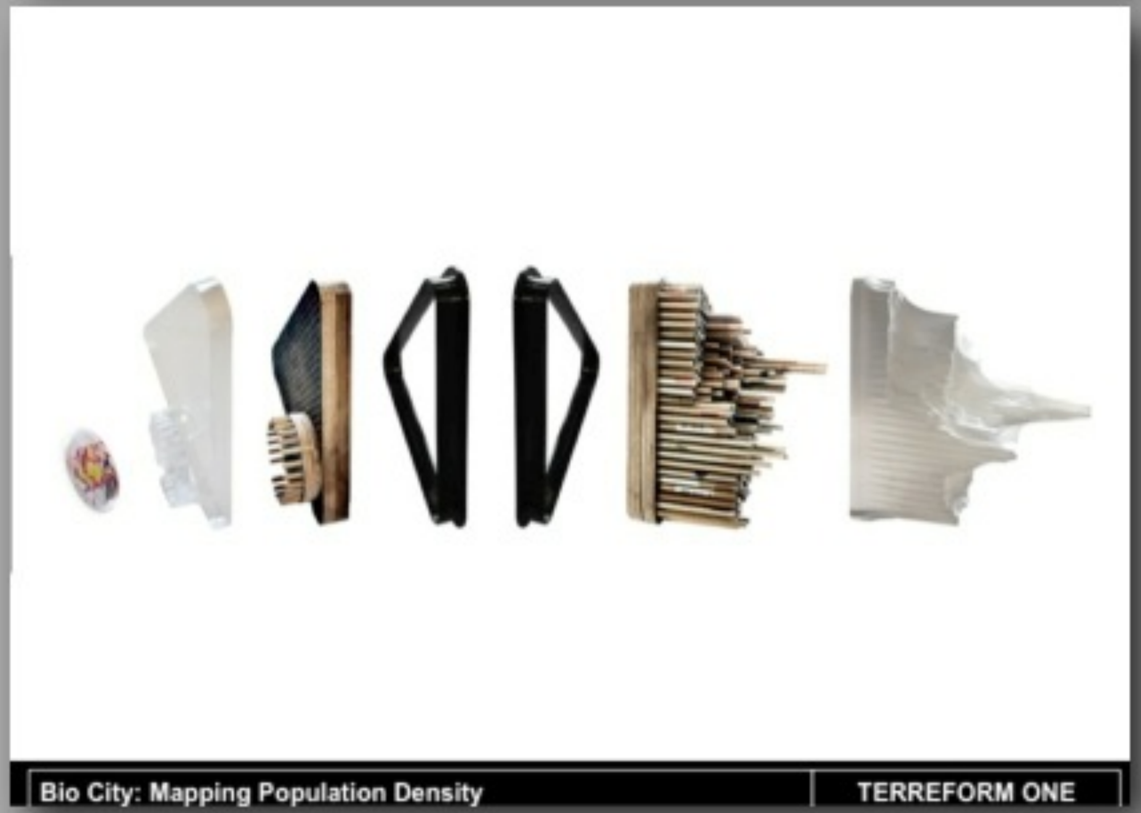

Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE

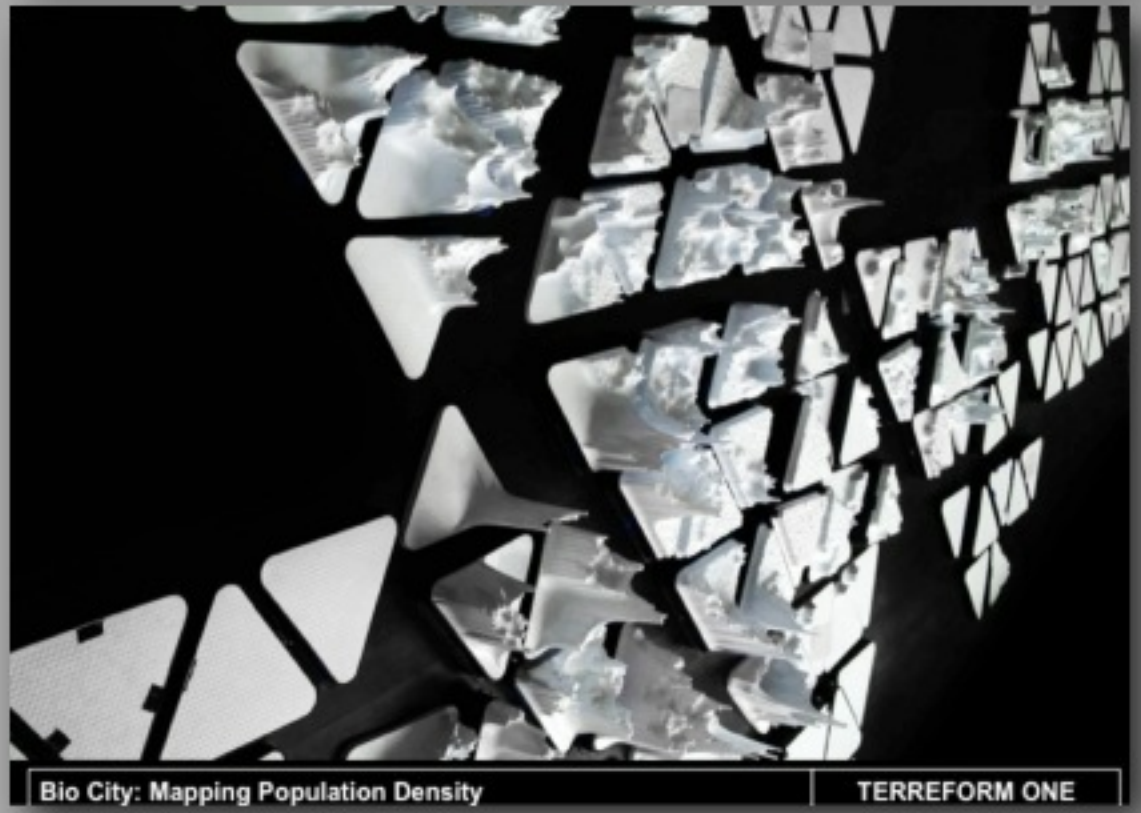

K3
O2
K4
O3
K
K9
K8
O1
K9
Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE

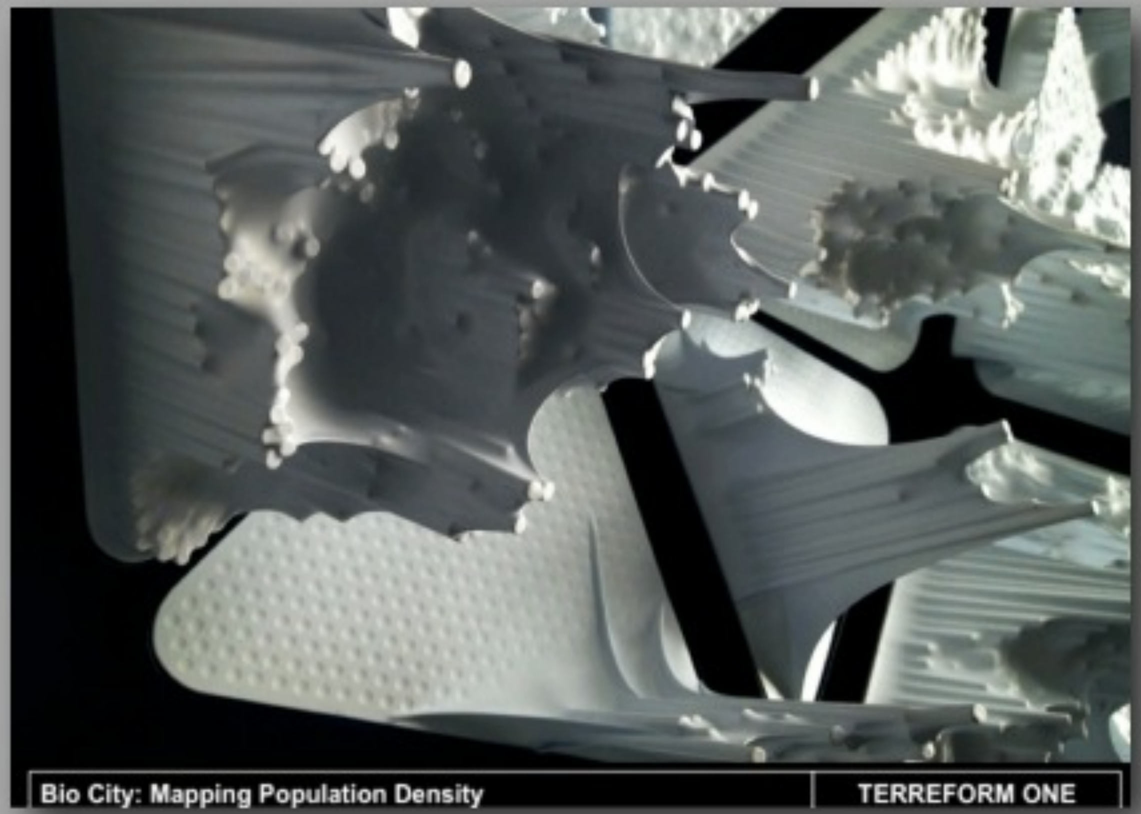

Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE

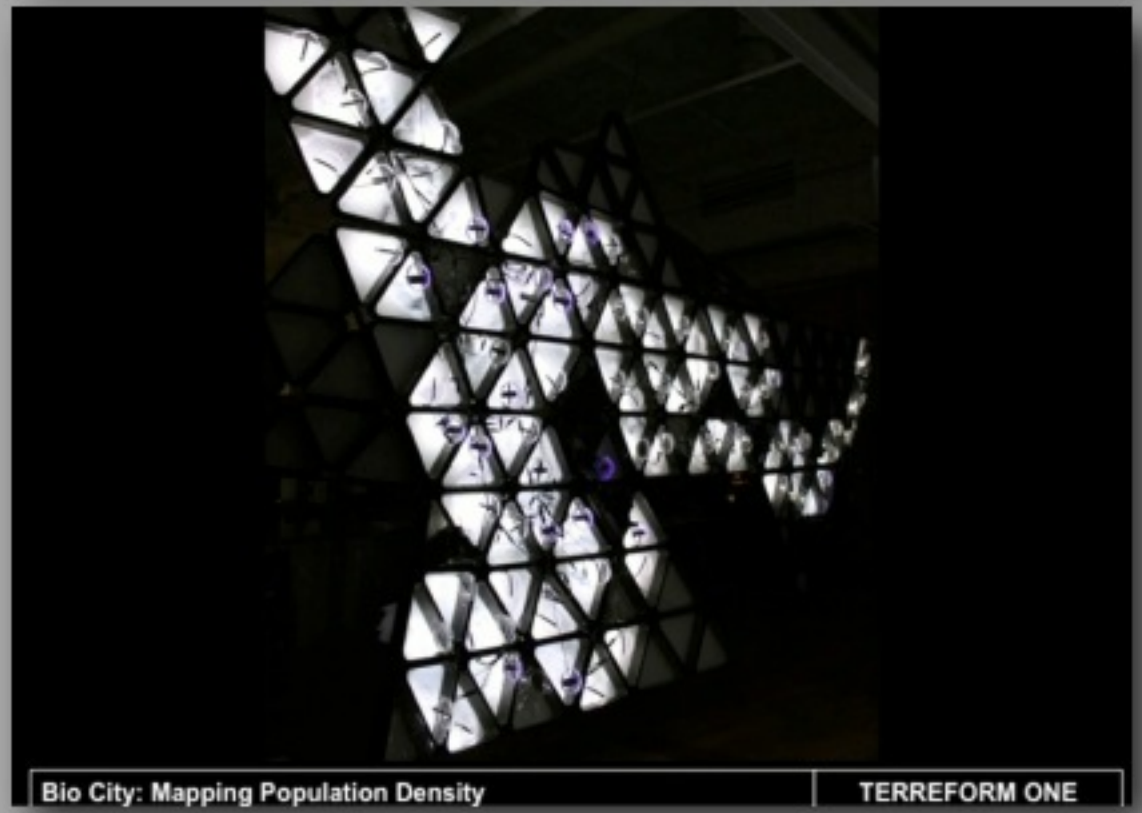

Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE

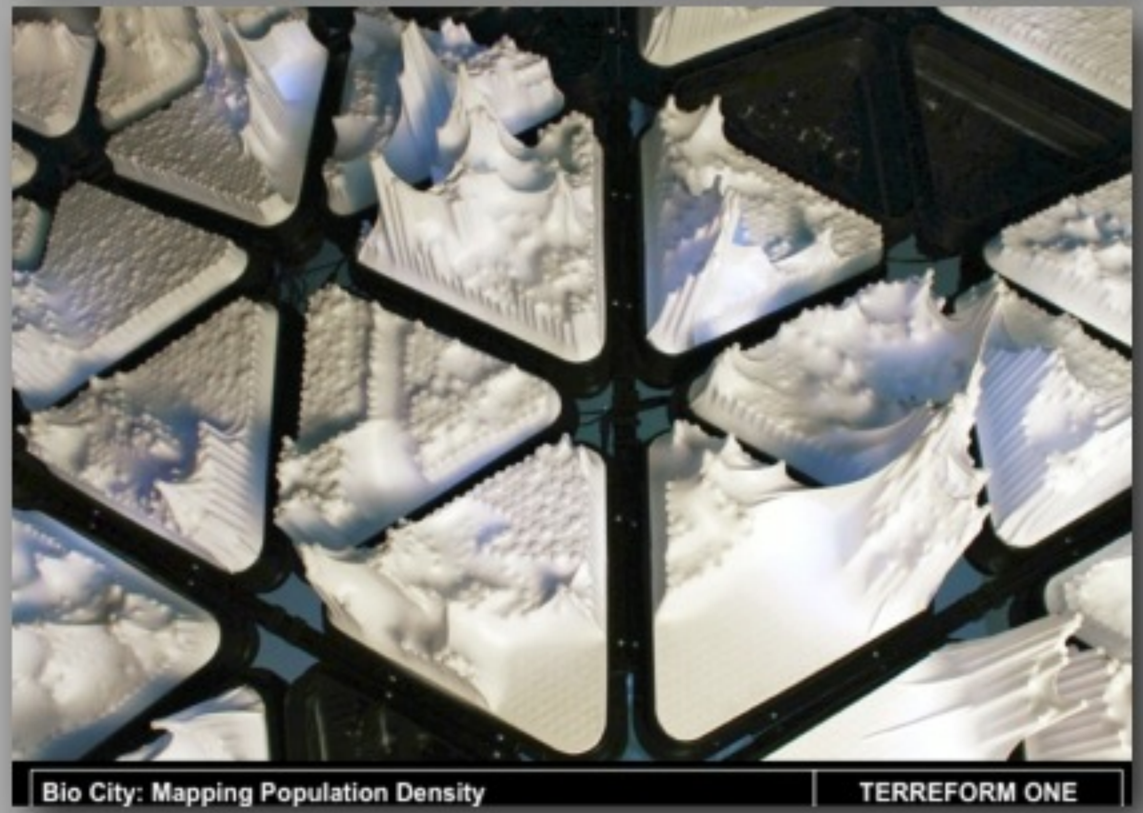

Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE

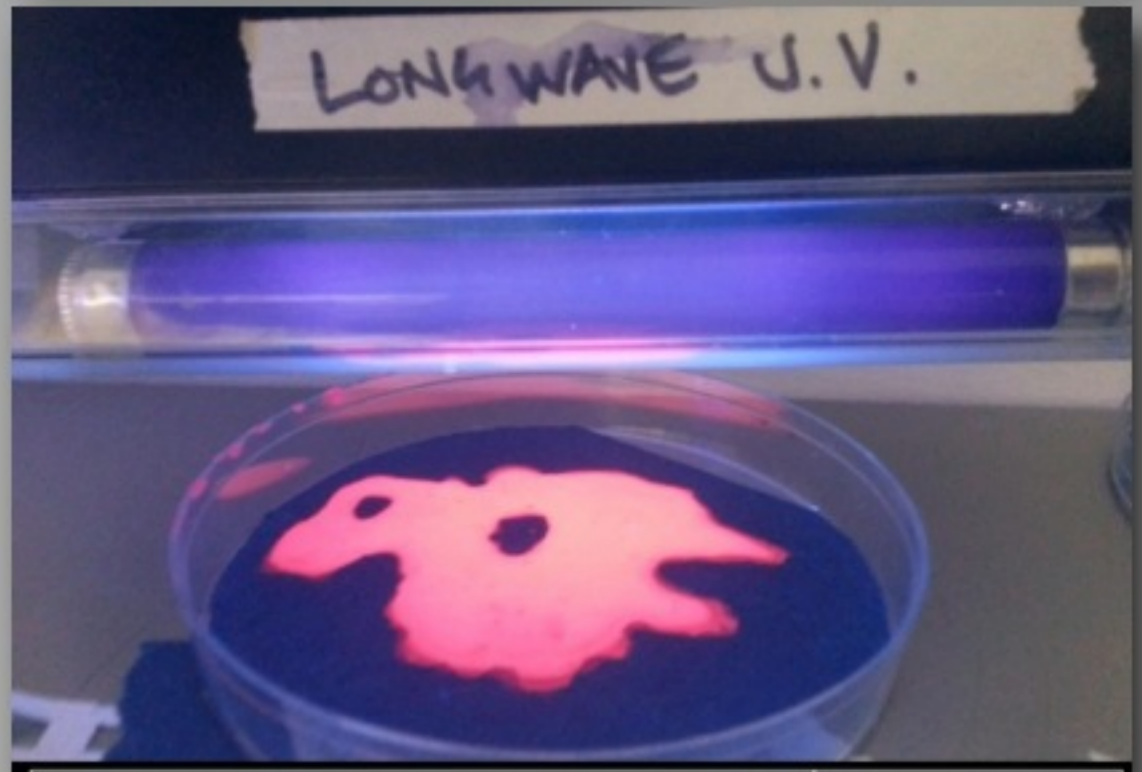

Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density | TERREFORM ONE

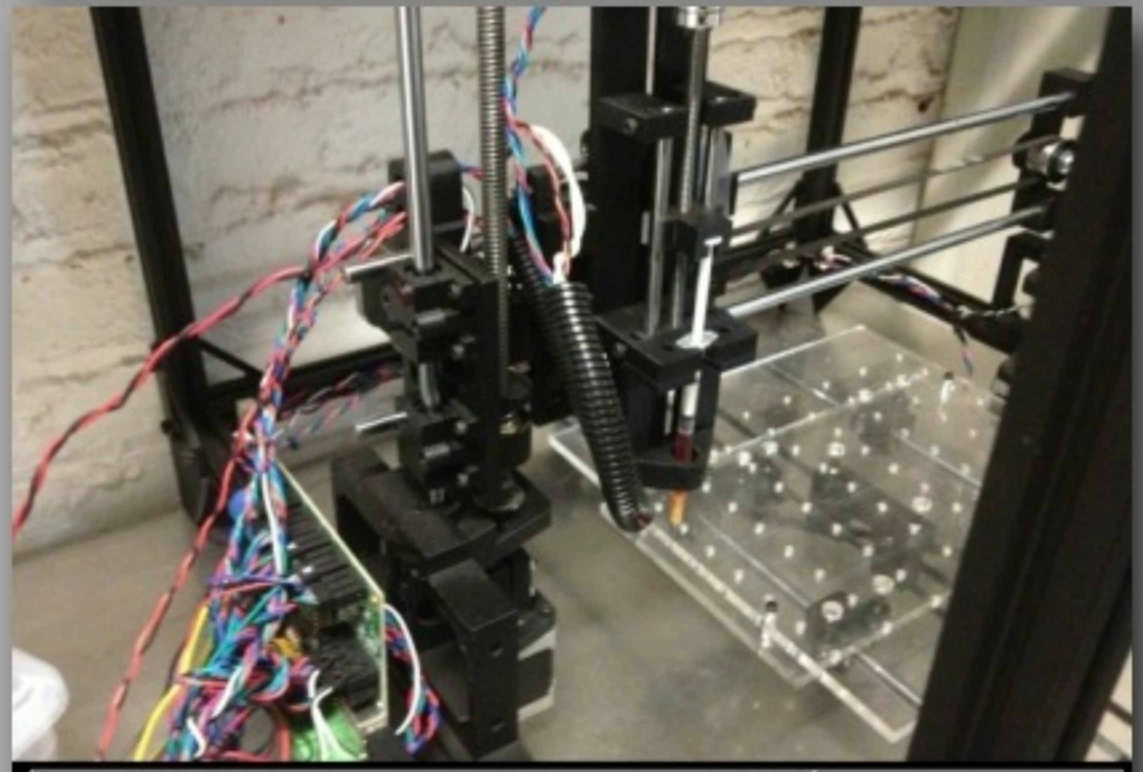

Bio City: Mapping Population Density | TERREFORM ONE


Bio City: Mapping Population Density | TERREFORM ONE

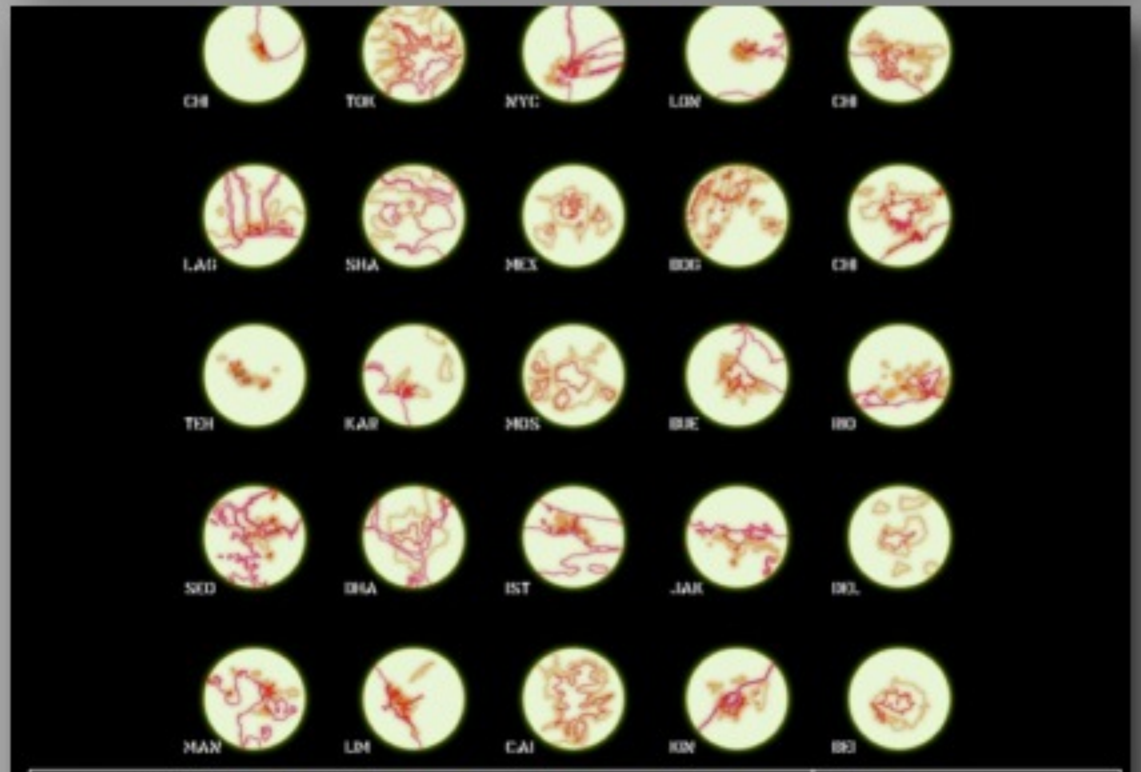


Bio City: Mapping Population Density | TERREFORM ONE

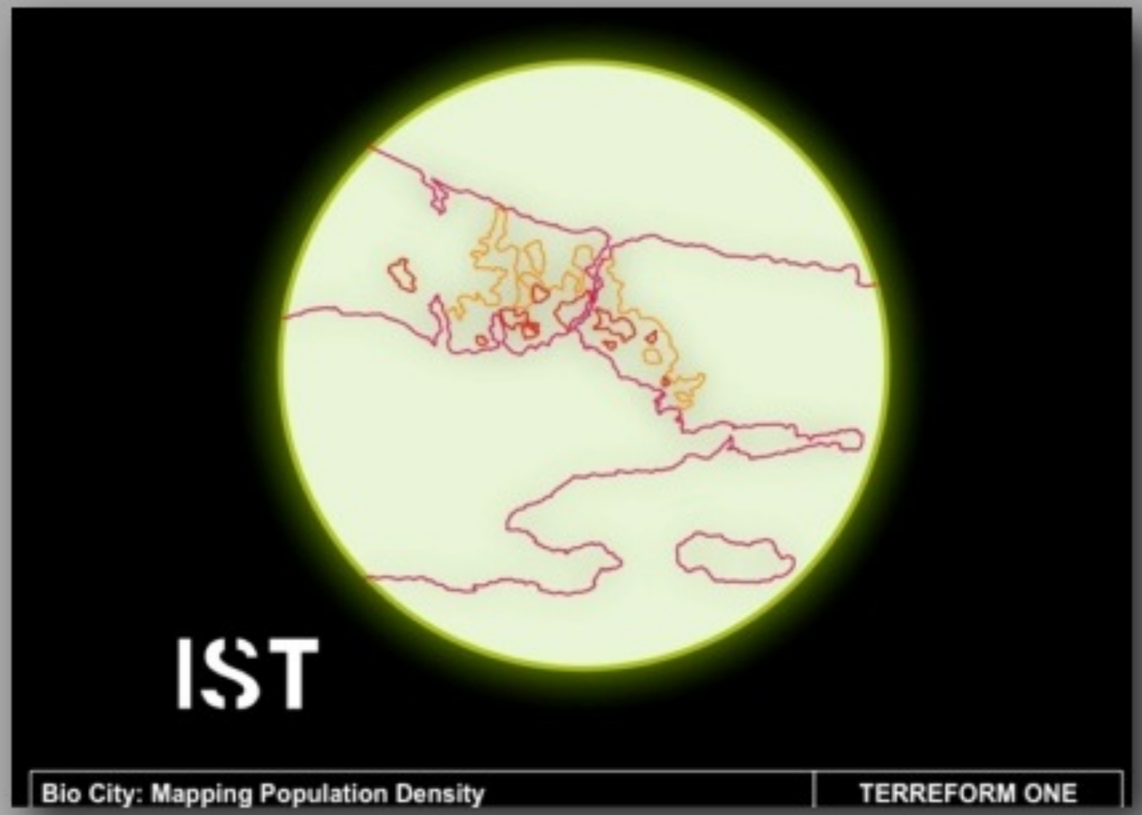

Bio City: Mapping Population Density | TERREFORM ONE


In Vitro Meat Hab: GENSPACE | ECO 02 | TERREFORM ONE

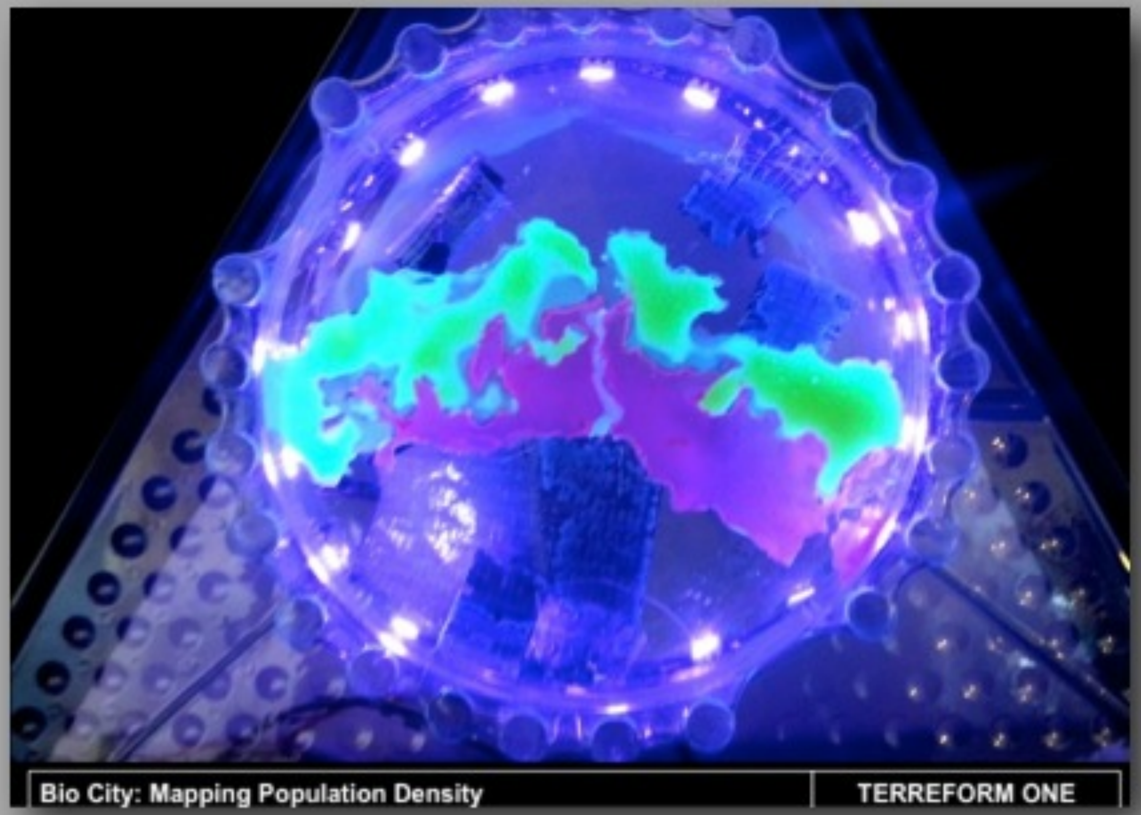

Bio City: Mapping Population Density | TERREFORM ONE


Bio City: Mapping Population Density | TERREFORM ONE


Bio City: Mapping Population Density | TERREFORM ONE


IST
Bio City: Mapping Population Density
TERREFORM ONE


LAC
Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE

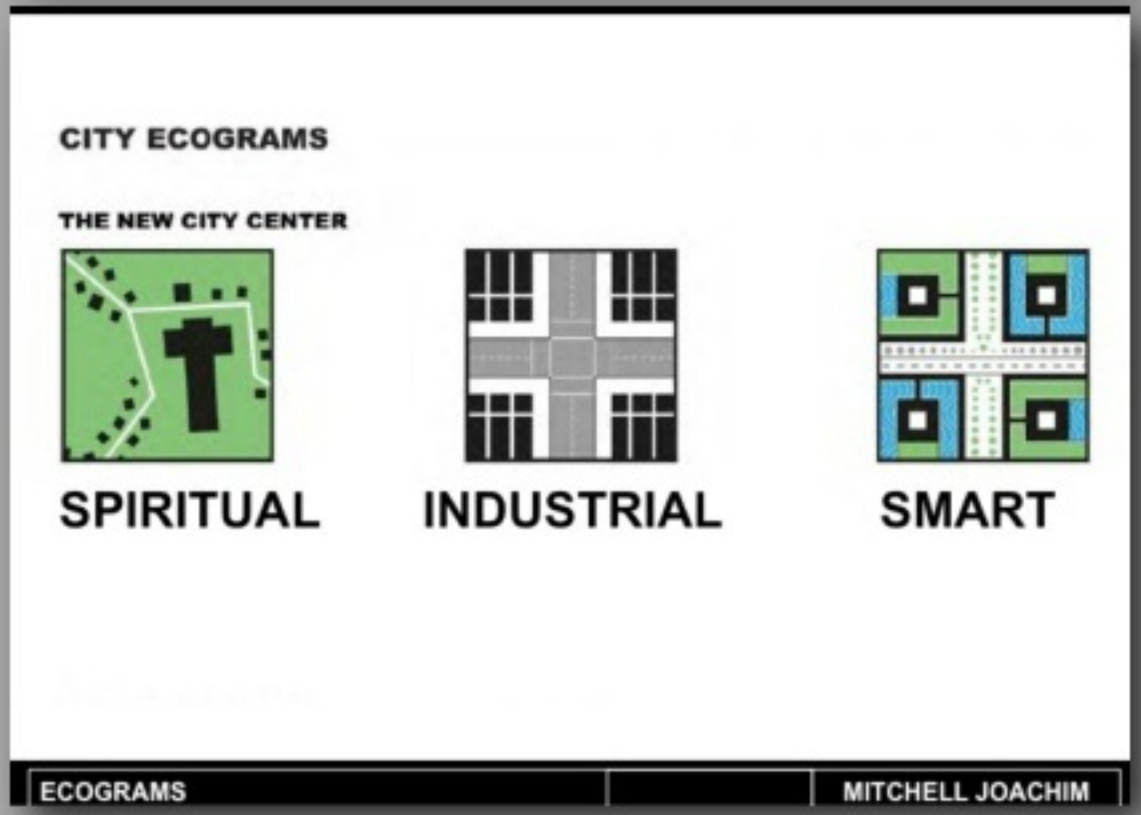

Bio City: Mapping Population Density
TERREFORM ONE


Bio City: Mapping Population Density
TERREFORM ONE


Waterfront of Brooklyn, NY
TERREFORM ONE

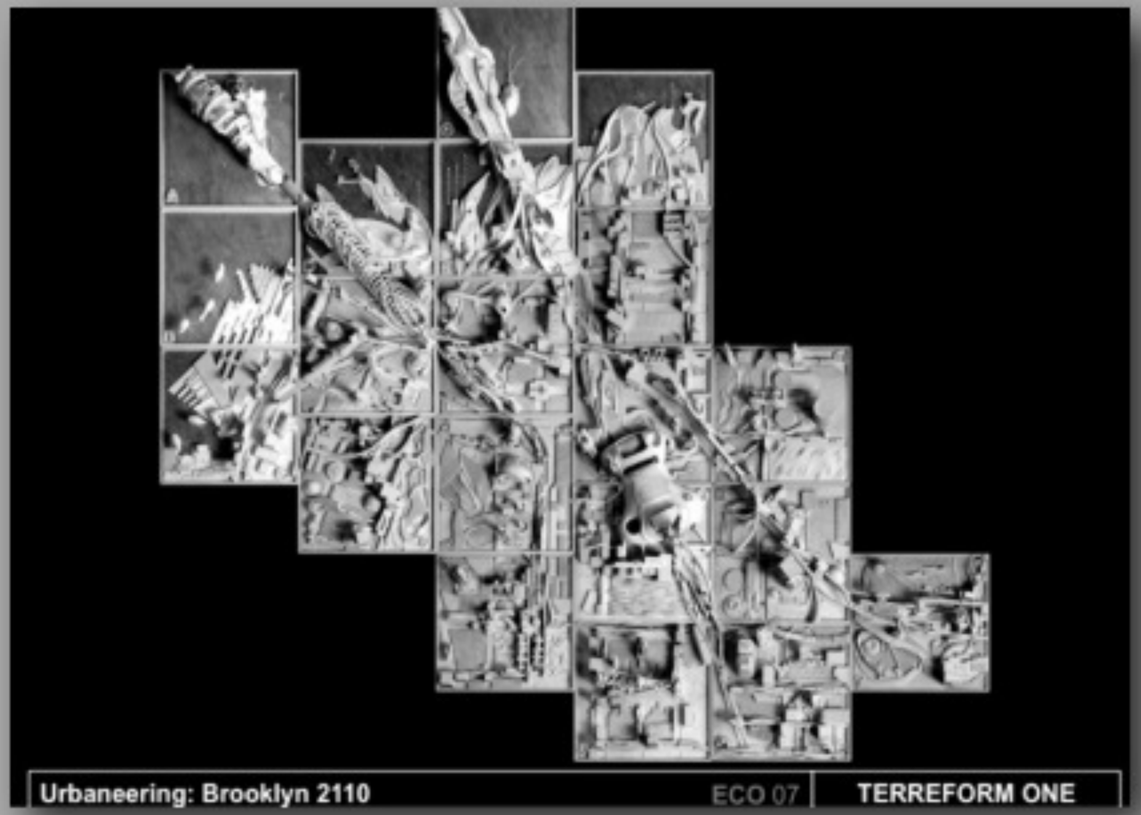

WILLIAMSBURG BRIDGE
MANHATTAN BRIDGE
BROOKLYN BRIDGE
NEW LAB
BROOKLYN NAVY YARD
ONE Lab 2014
LAB 03
TERREFORM ONE

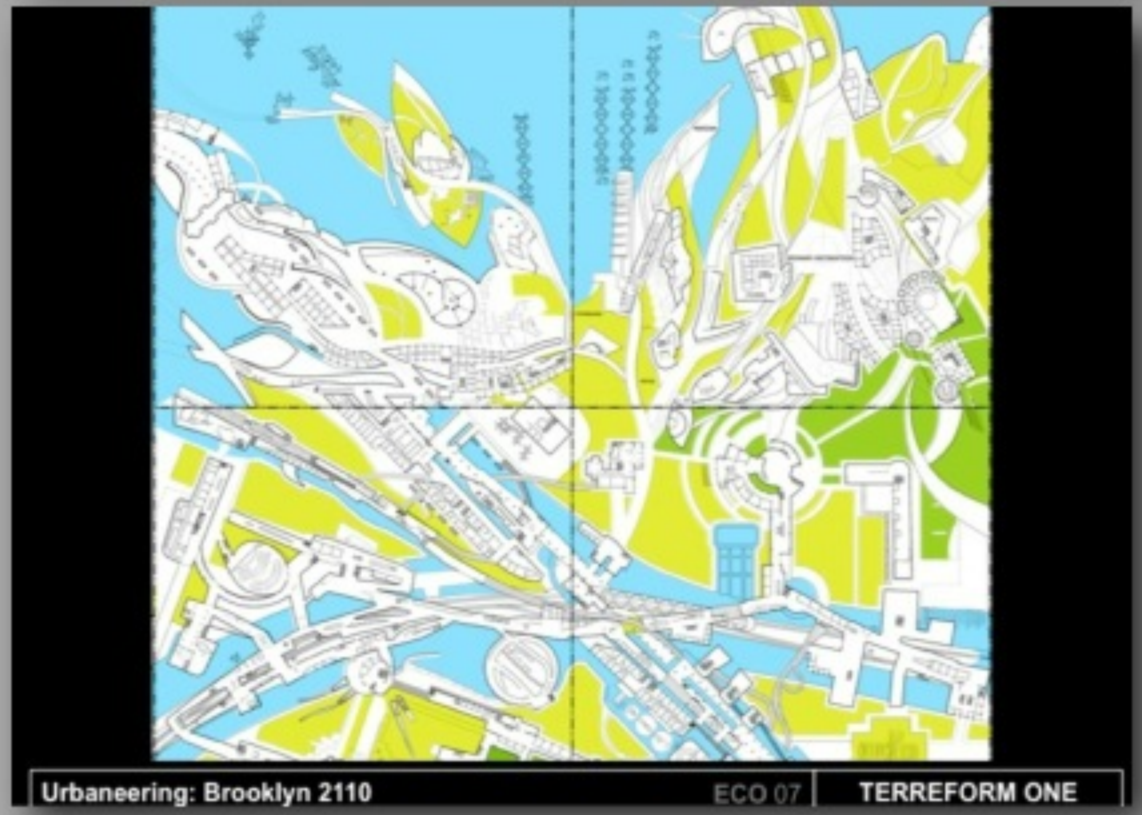

ONE Lab 2014
LAB 03
TERREFORM ONE

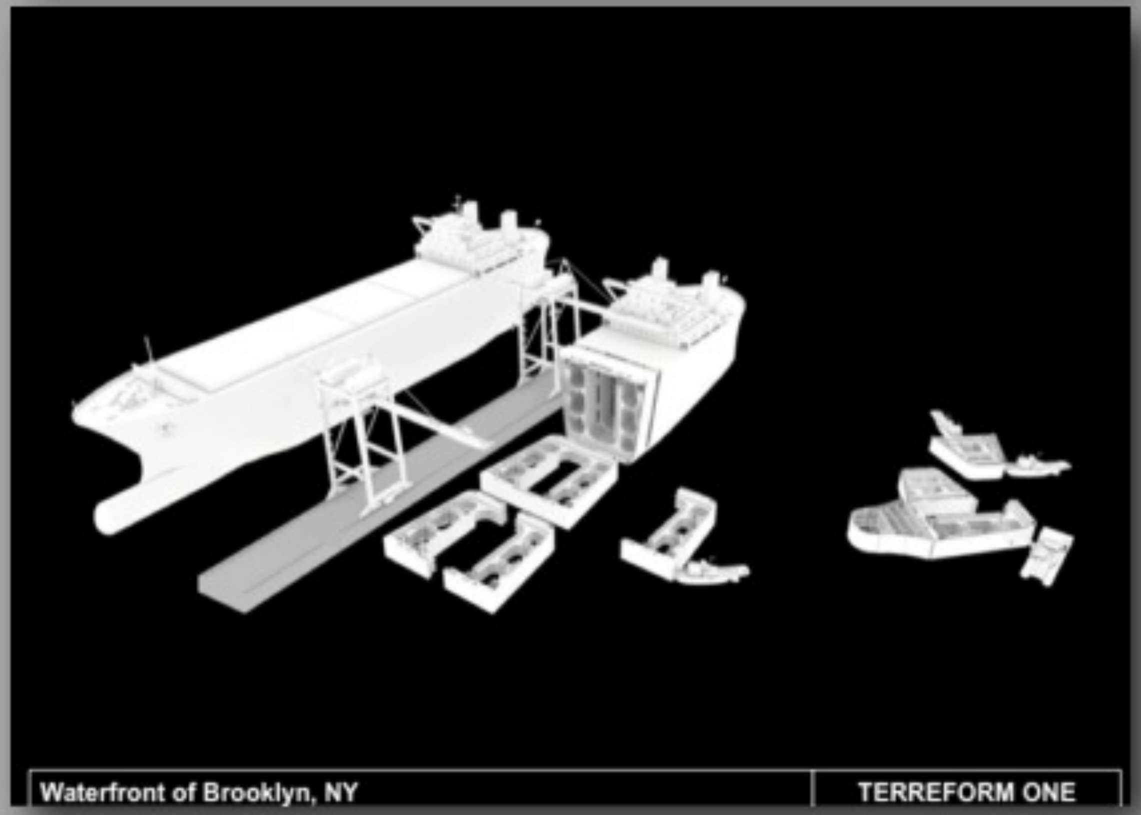

CITY ECOGRAMS
THE NEW CITY CENTER
SPIRITUAL
INDUSTRIAL
SMART
ECOGRAMS
MITCHELL JOACHIM

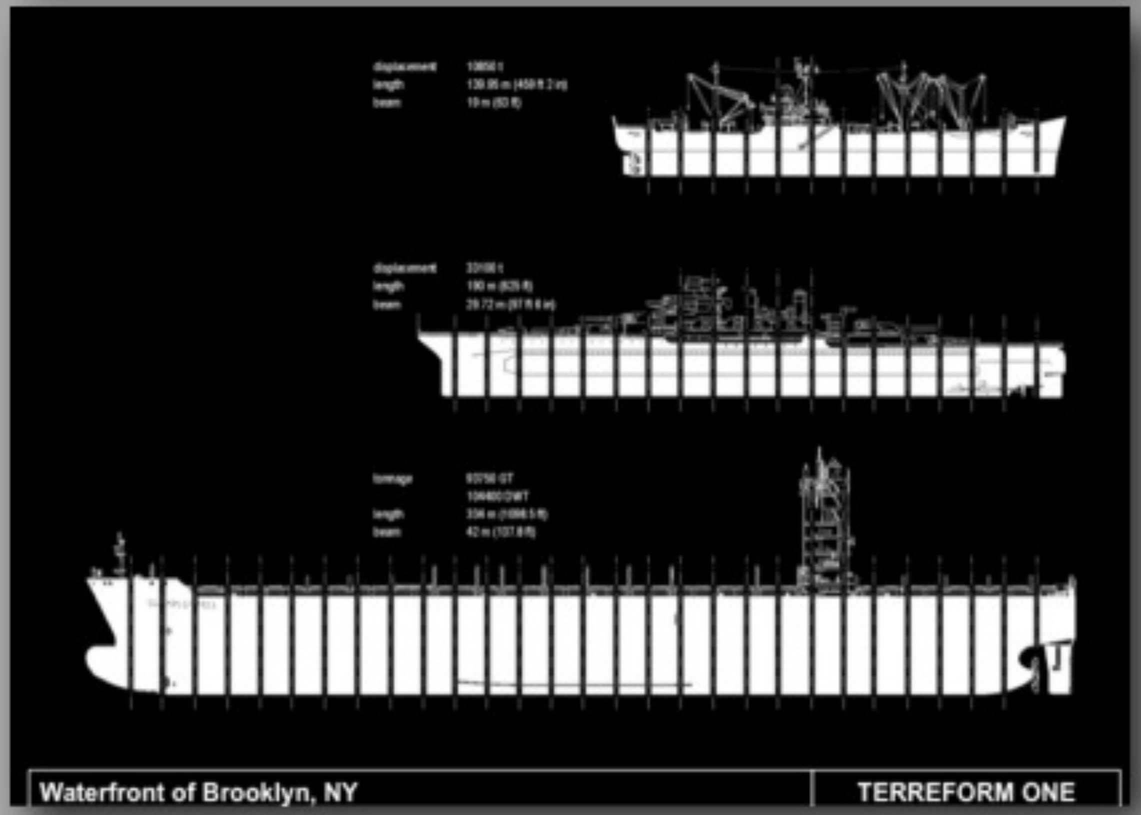

Urbaneering: Brooklyn 2110
ECO 07
TERREFORM ONE


Urbaneering: Brooklyn 2110
ECO 07
TERREFORM ONE


Urbaneering: Brooklyn 2110
ECO 07
TERREFORM ONE


Urbaneering: Brooklyn 2110
ECO 07
TERREFORM ONE


Waterfront of Brooklyn, NY
TERREFORM ONE


Waterfront of Brooklyn, NY
TERREFORM ONE


Waterfront of Brooklyn, NY
TERREFORM ONE


Urbaneering: Governors Hook
TERREFORM ONE


Waterfront of Brooklyn, NY
TERREFORM ONE


NAVY YARDS: Super Docking
ECO 07
MITCHELL JOACHIM


Waterfront of Brooklyn, NY
TERREFORM ONE


Urbaneering: Brooklyn 2110
ECO 07
TERREFORM ONE

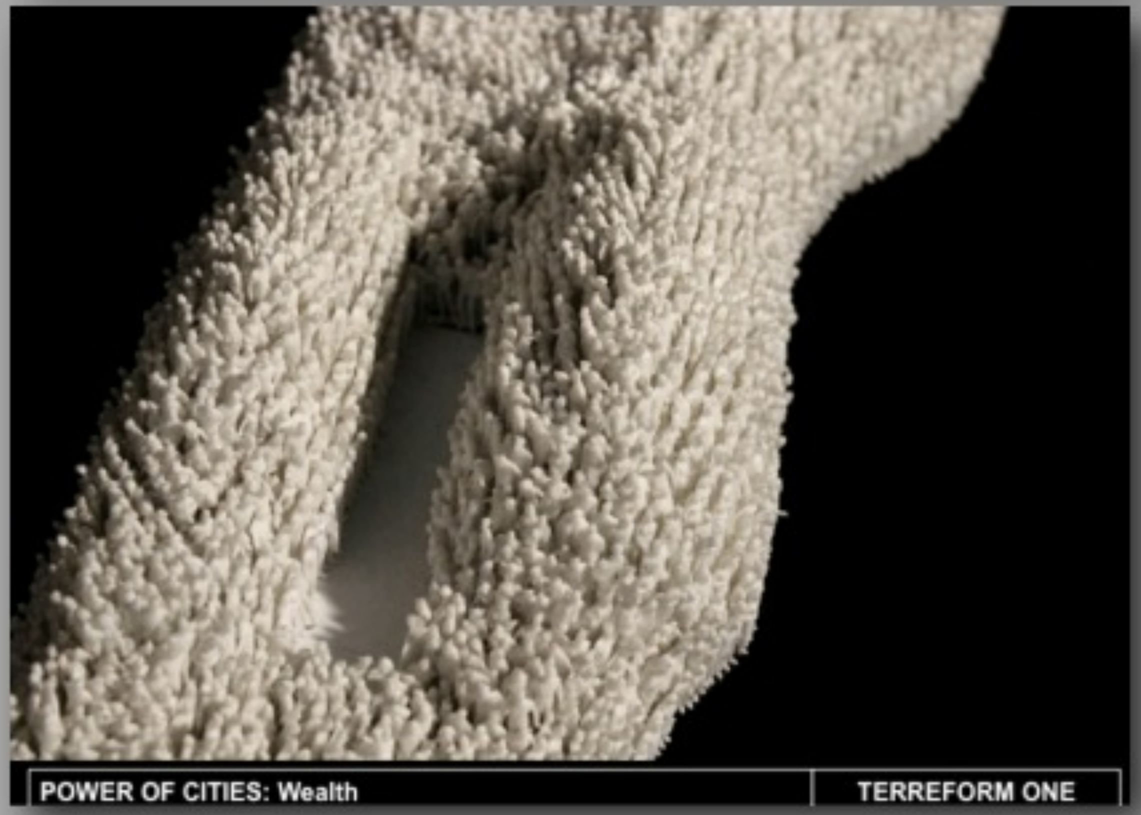

Urbaneering: Brooklyn 2110
ECO 07
TERREFORM ONE

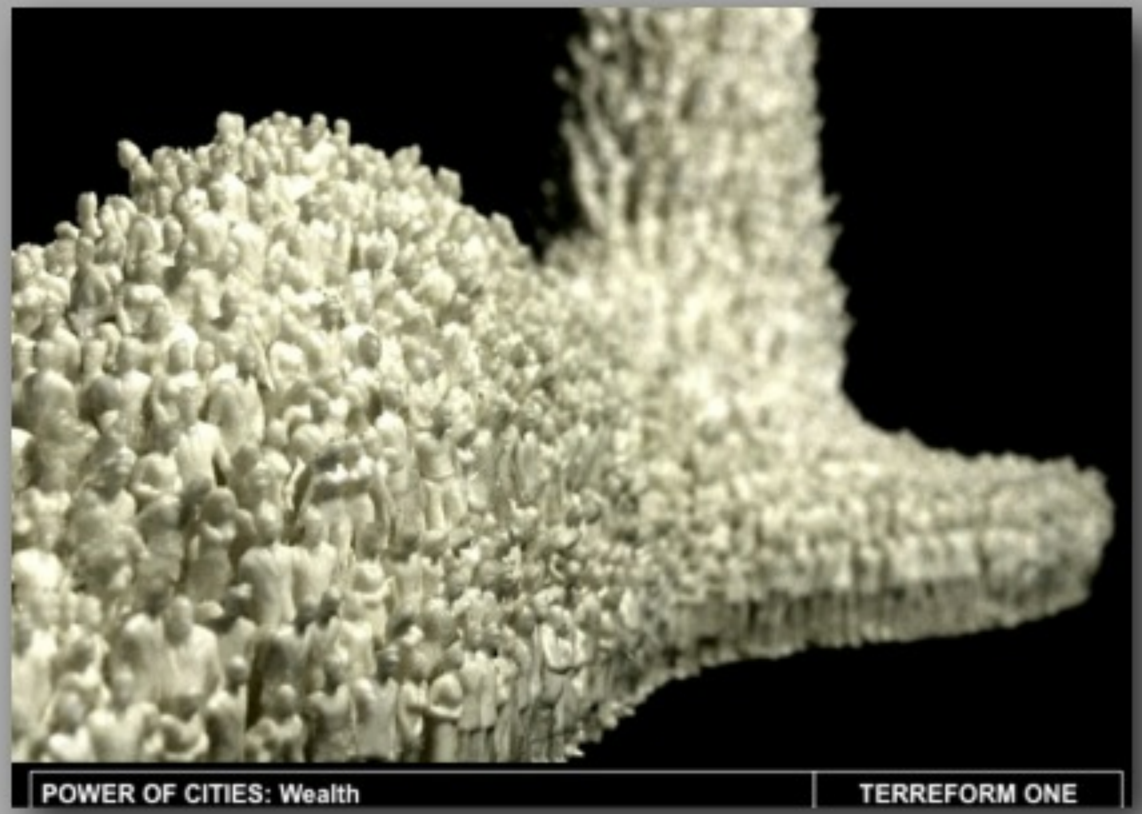

NYC PRODUCES
11.5% of US GDP
POWER OF CITIES: Wealth
TERREFORM ONE

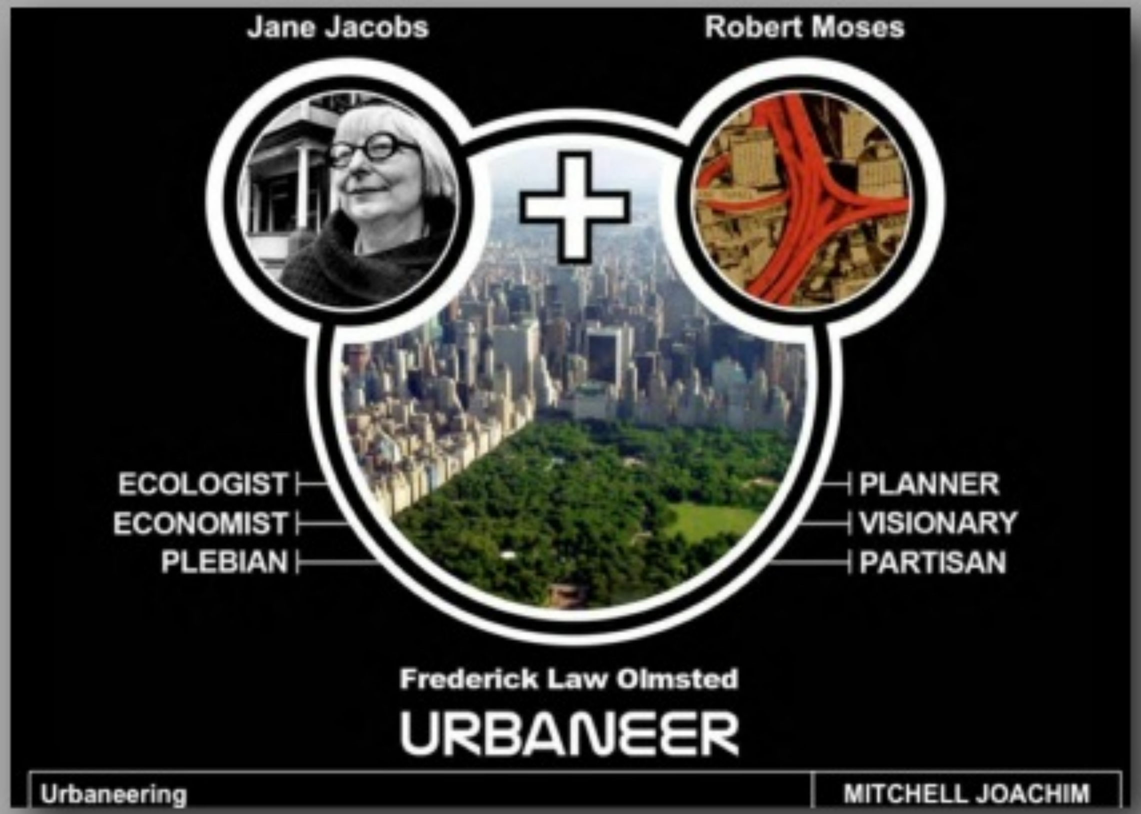

NYC POPULATION INCOME BY LOCATION
99%
City of Equity
$50K PER PERSON
$1.2 MILLION PER WALL STREET EXECUTIVE
1%
City of Wealth
POWER OF CITIES: Wealth
TERREFORM ONE


POWER OF CITIES: Wealth
ECOTRANS 00
TERREFORM ONE


POWER OF CITIES: Wealth
TERREFORM ONE


POWER OF CITIES: Wealth
TERREFORM ONE


POWER OF CITIES: Wealth
TERREFORM ONE


Jane Jacobs
Robert Moses
ECOLOGIST
ECONOMIST
PLEBIAN
PLANNER
VISIONARY
PARTISAN
Frederick Law Olmsted
URBANEER
Urbaneering
MITCHELL JOACHIM


ACTIVIST
ECONOMIST
TEACHER
ARCHITECT
ENGINEER
SOCIOLOGIST
MUSICIAN
GEOGRAPHER
BIOLOGIST
FIREMAN
FARMER
BUILDER
POLITICIAN
ARTIST
CHEF
Urbaneering
TERREFORM ONE


ONE Lab: Future Cities 2012
LAB 03
TERREFORM ONE


ONE Lab: Future Cities 2012
LAB 03
TERREFORM ONE


ONE Lab: Future Cities 2012
LAB 03
TERREFORM ONE


ONE Lab: Future Cities 2012
LAB 03
TERREFORM ONE


ONE Lab: Future Cities 2012
LAB 03
TERREFORM ONE


ONE Lab: Future Cities 2012
LAB 03
TERREFORM ONE


ONE Lab 2014
LAB 03
TERREFORM ONE


ONE Lab 2014
LAB 03
TERREFORM ONE


ONE Lab 2014
LAB 03
TERREFORM ONE


GREEN BRAIN: Open Space
ECOTRANS 00
TERREFORM ONE










IDEAS
THE INNOVATION
+ DESIGN SERIES


08_Tim Geurtjens

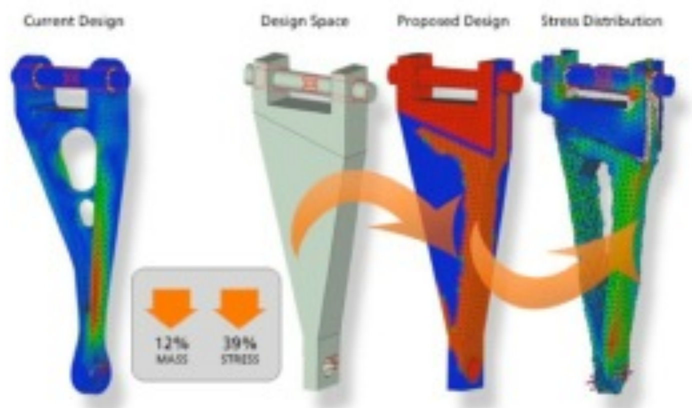
Joris Laarman Lab

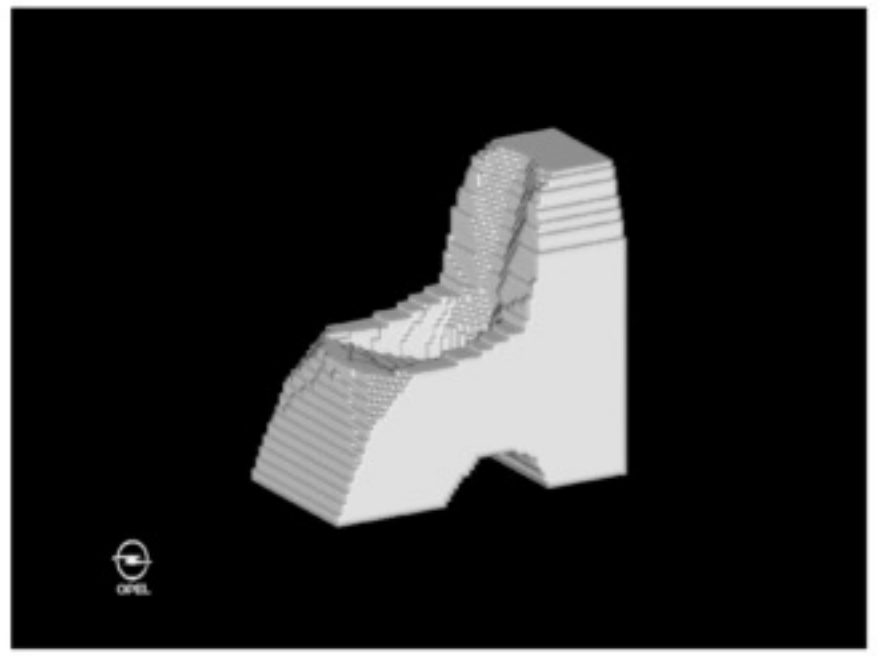
"I believe that it's time that robots became smart."

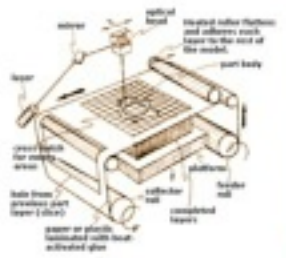
Robot-Guided 3D Printing

Joris Laarman Lab explores topology optimization and additive manufacturing for the creation of high-end, bespoke furniture/ Geurtjens is frustrated at being unable to 3D print at human scales. They developed the MX3D – a multi-axis, versatile robotic 3D printer that produces intricate geometrical, scaffold-free construction in resin and metal. Complicated robotics requires the development of equally complex software.

JORISLAARMANLAB | MX3D

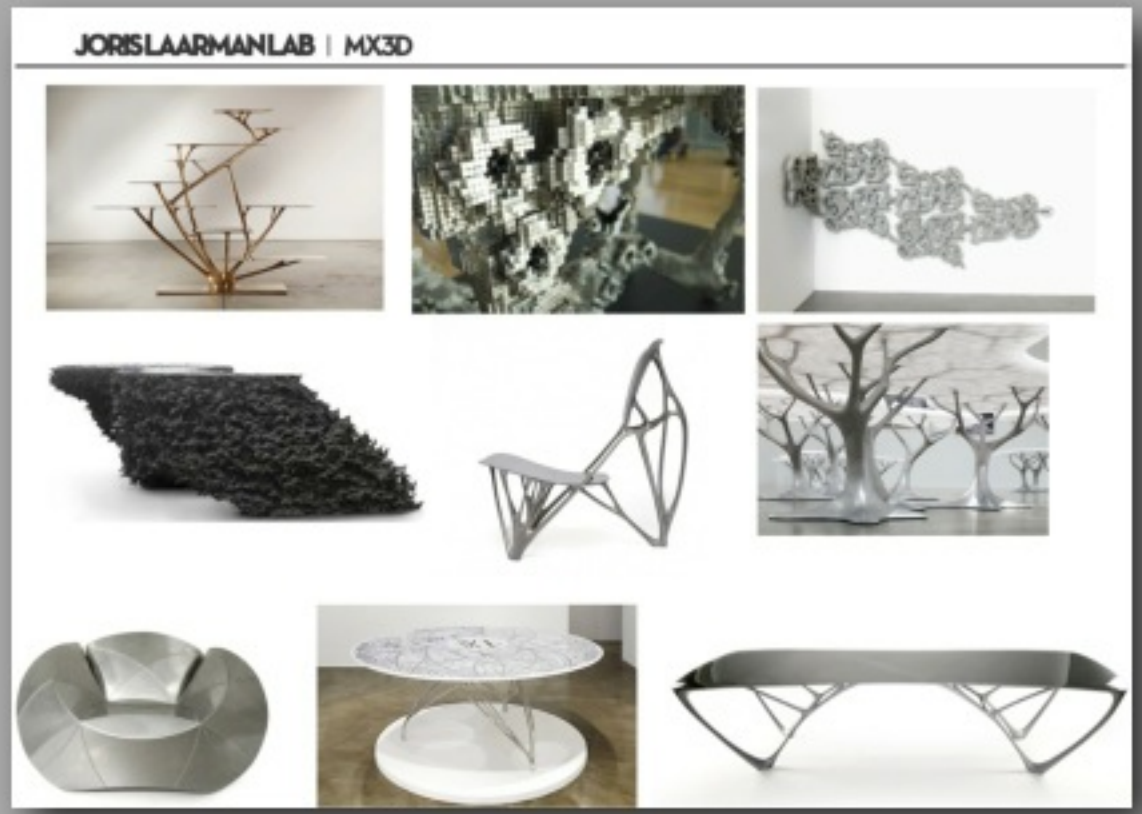


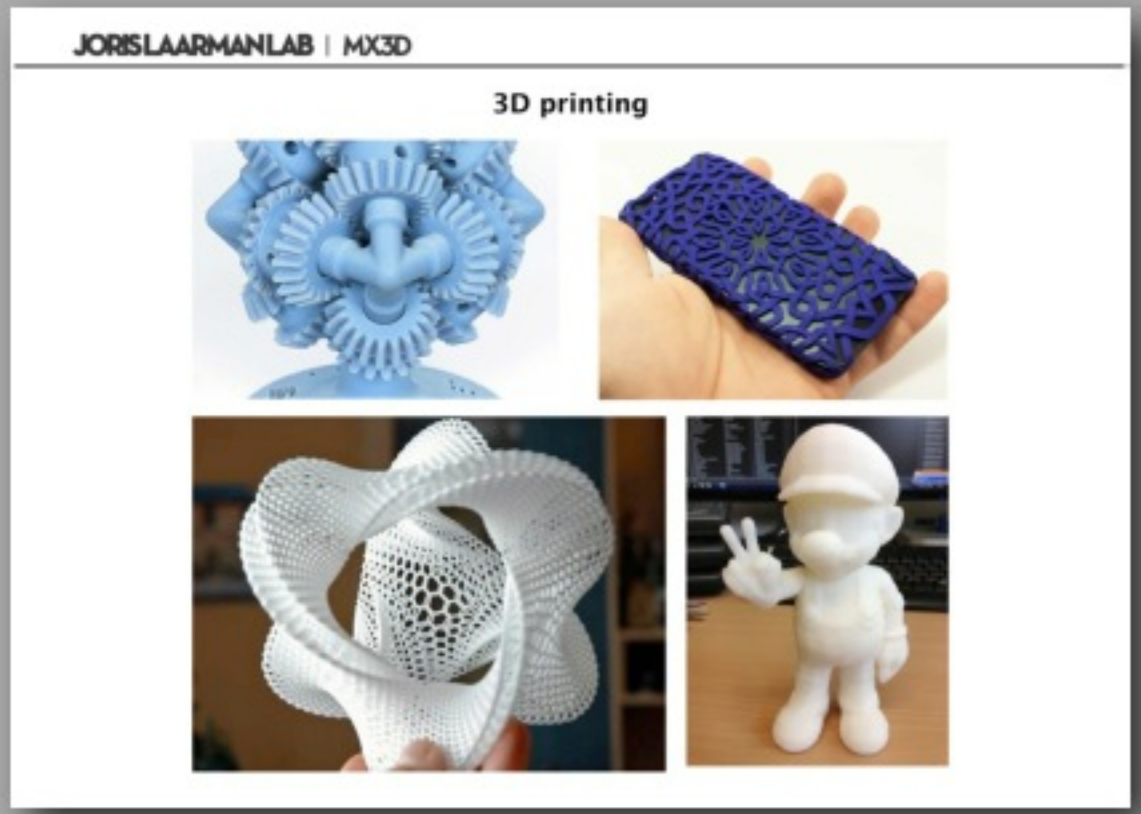


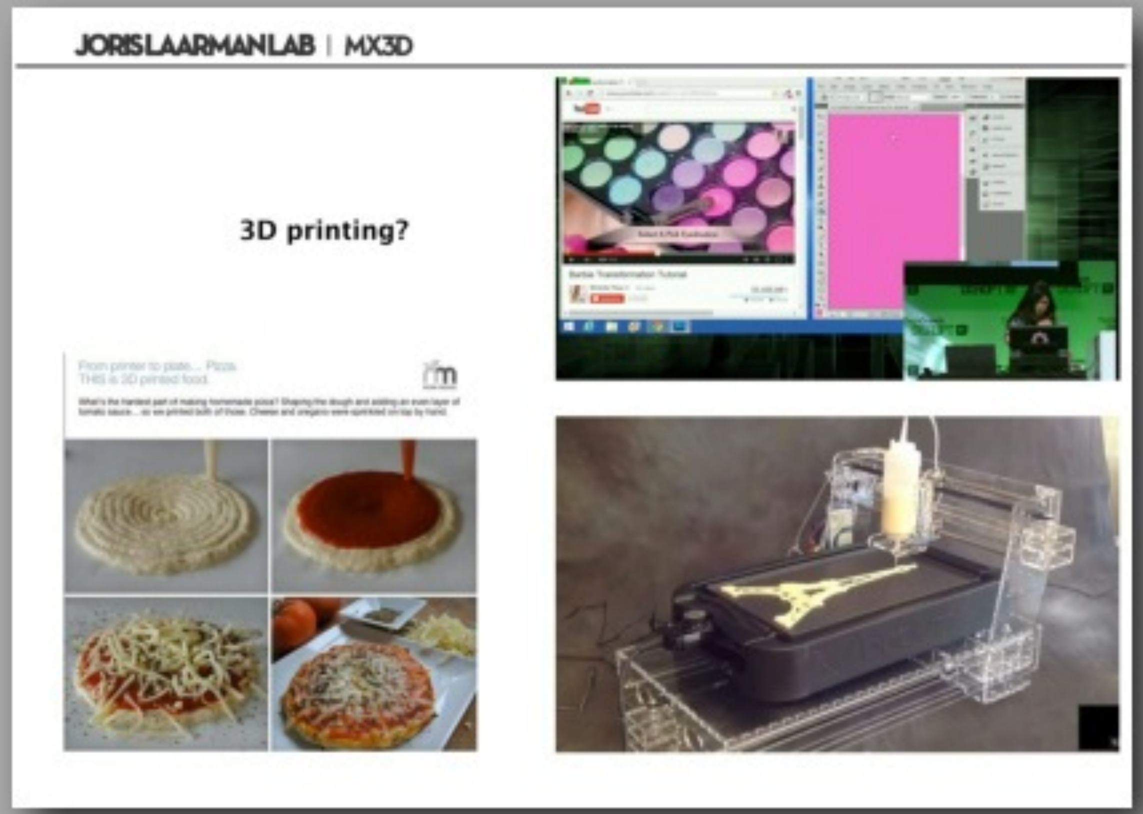


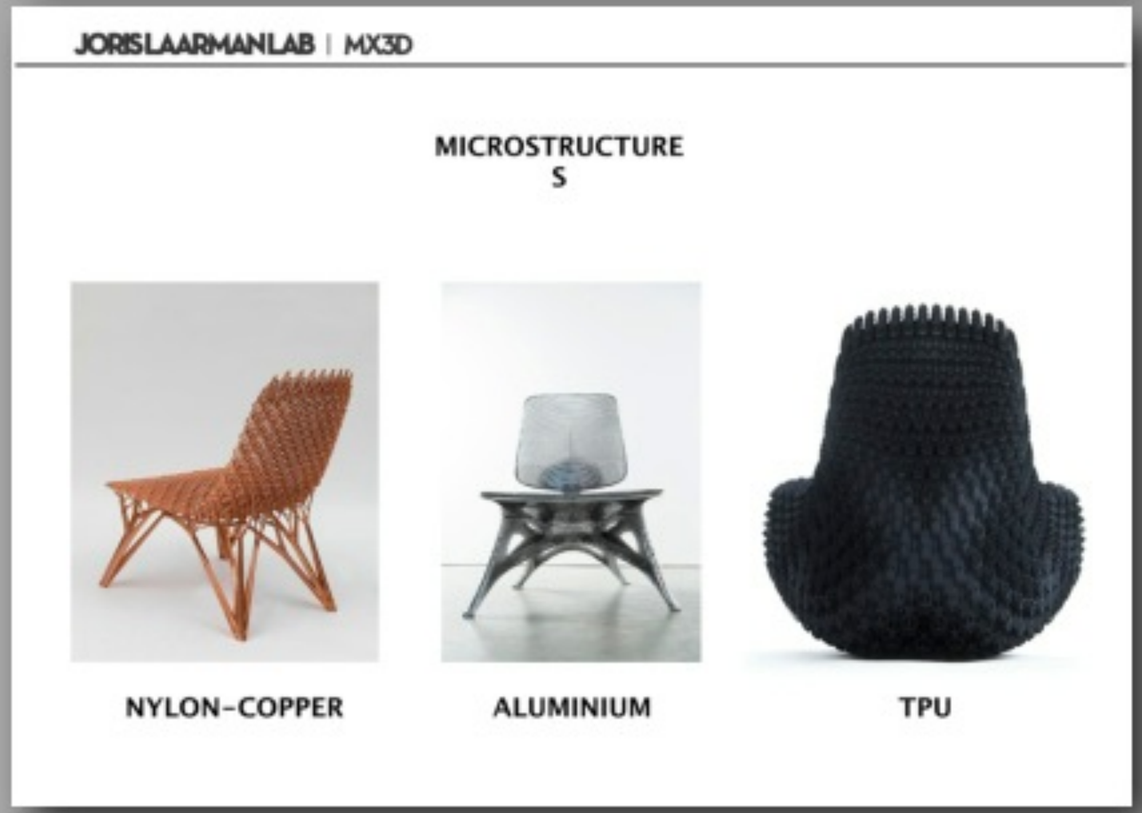
LAMINATED OBJECT MANUFACTURING

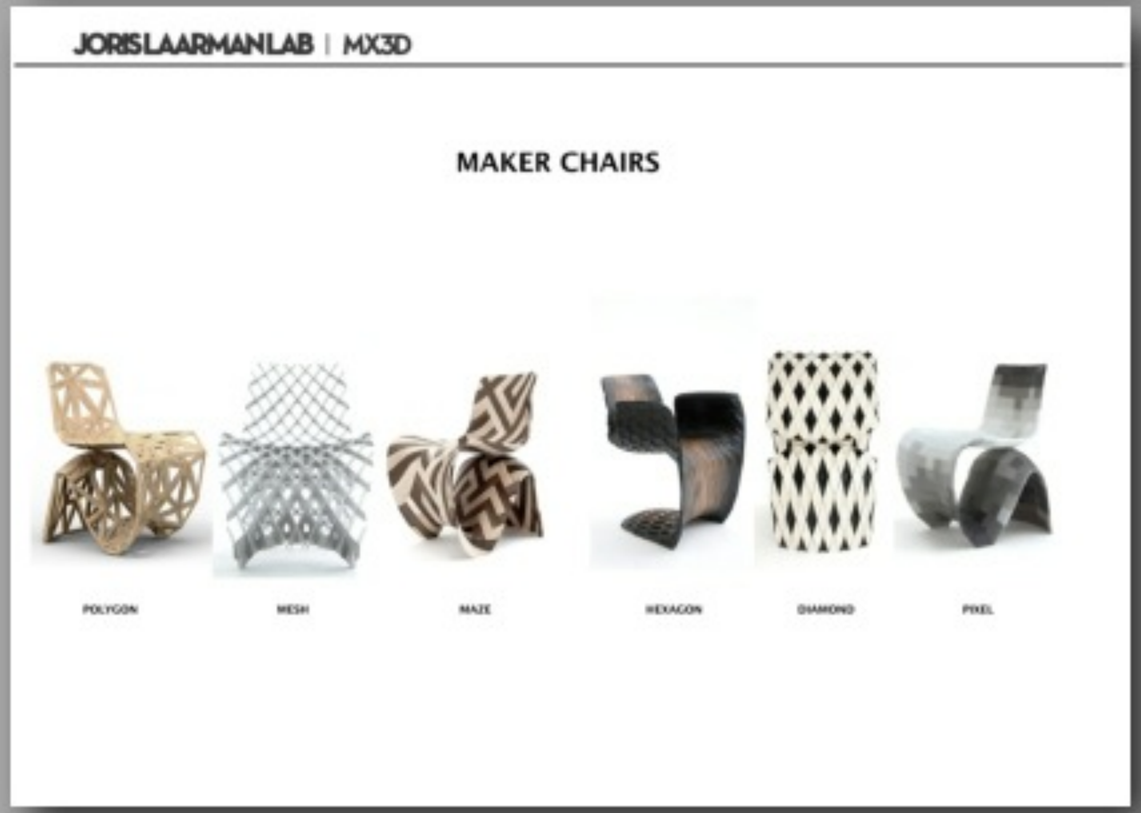
PLASTER MOLD

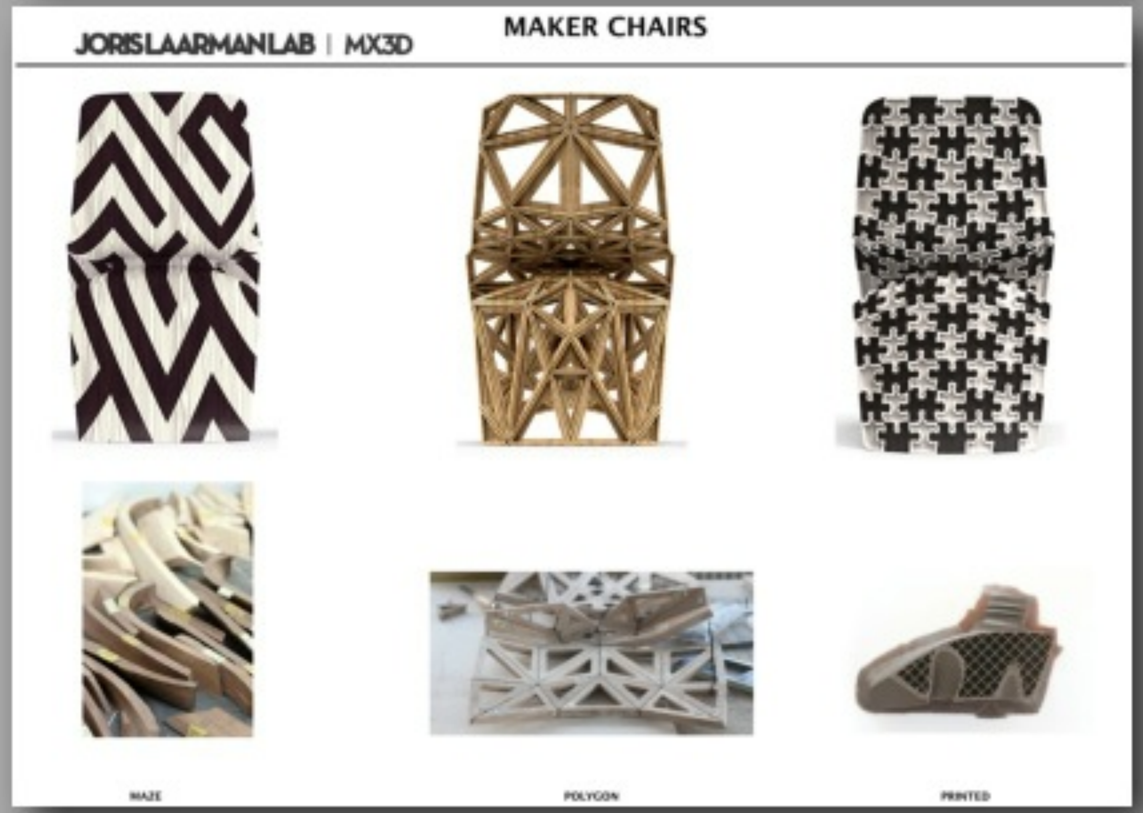

JORISLAARMANLAB | MX3D

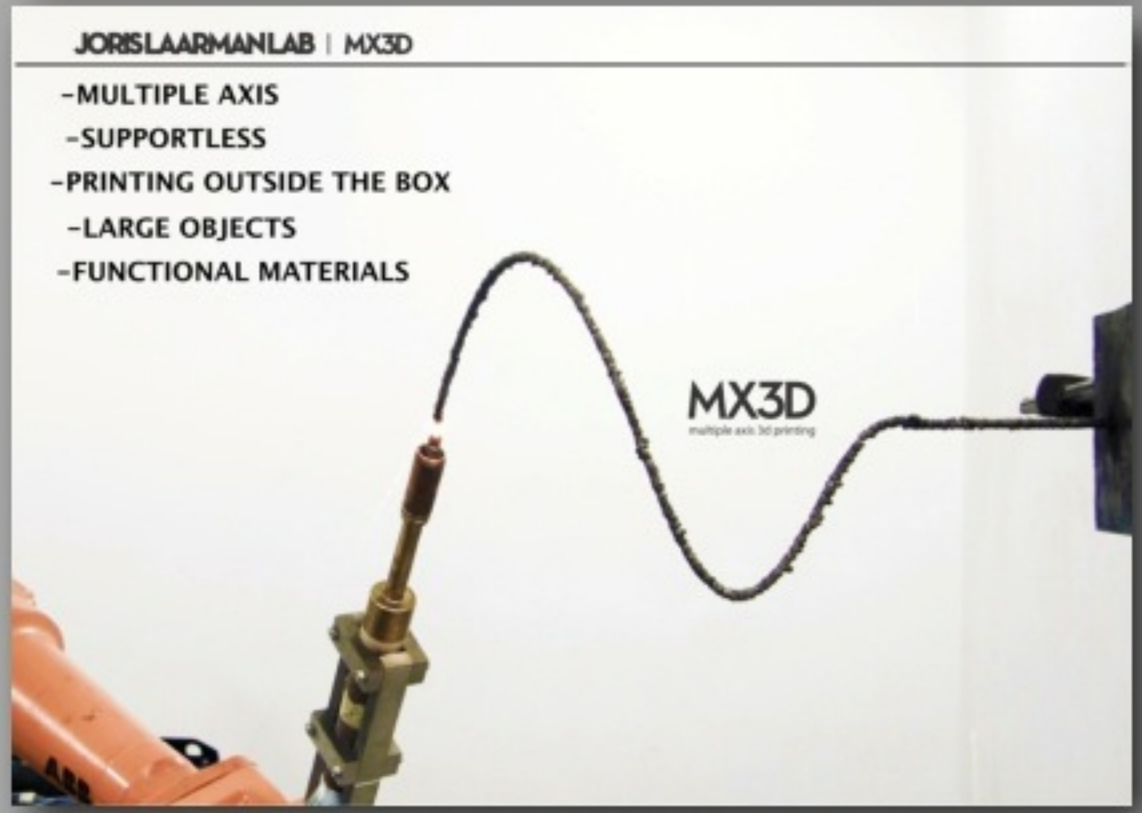

JORISLAARMANLAB | MX3D
3D printing

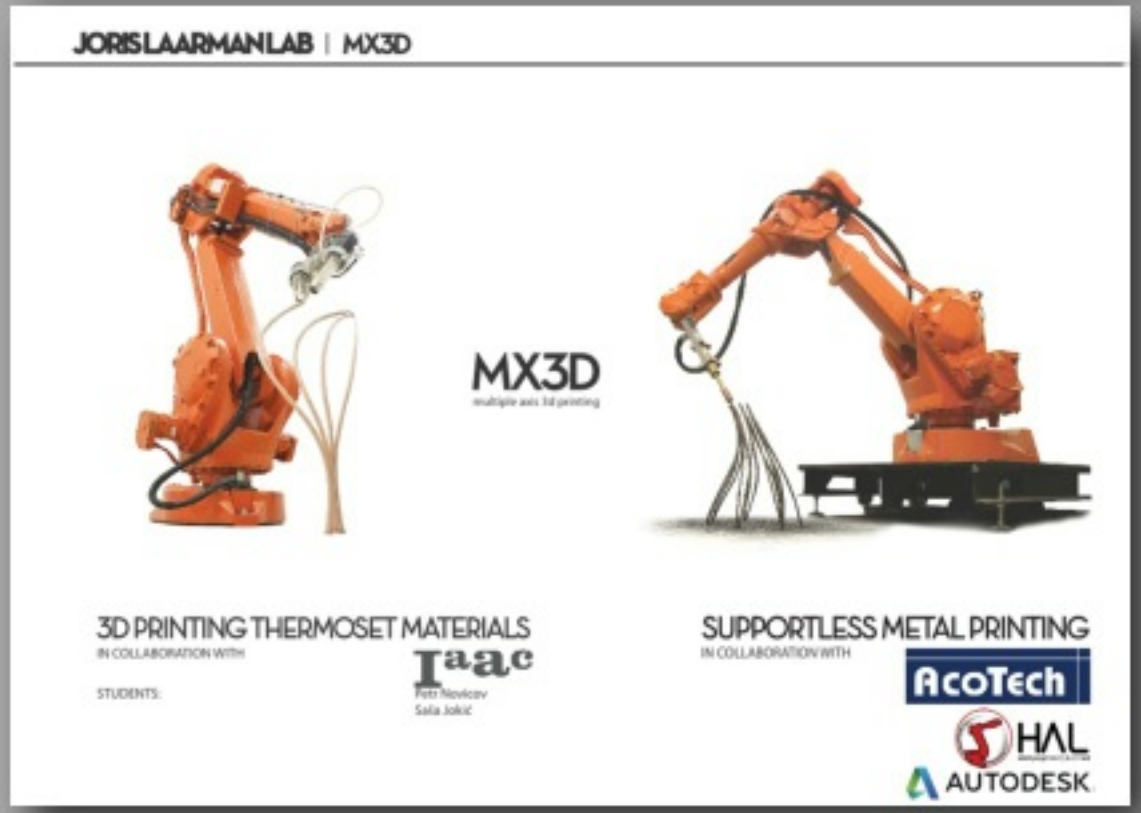

JORISLAARMANLAB | MX3D
3D printing?

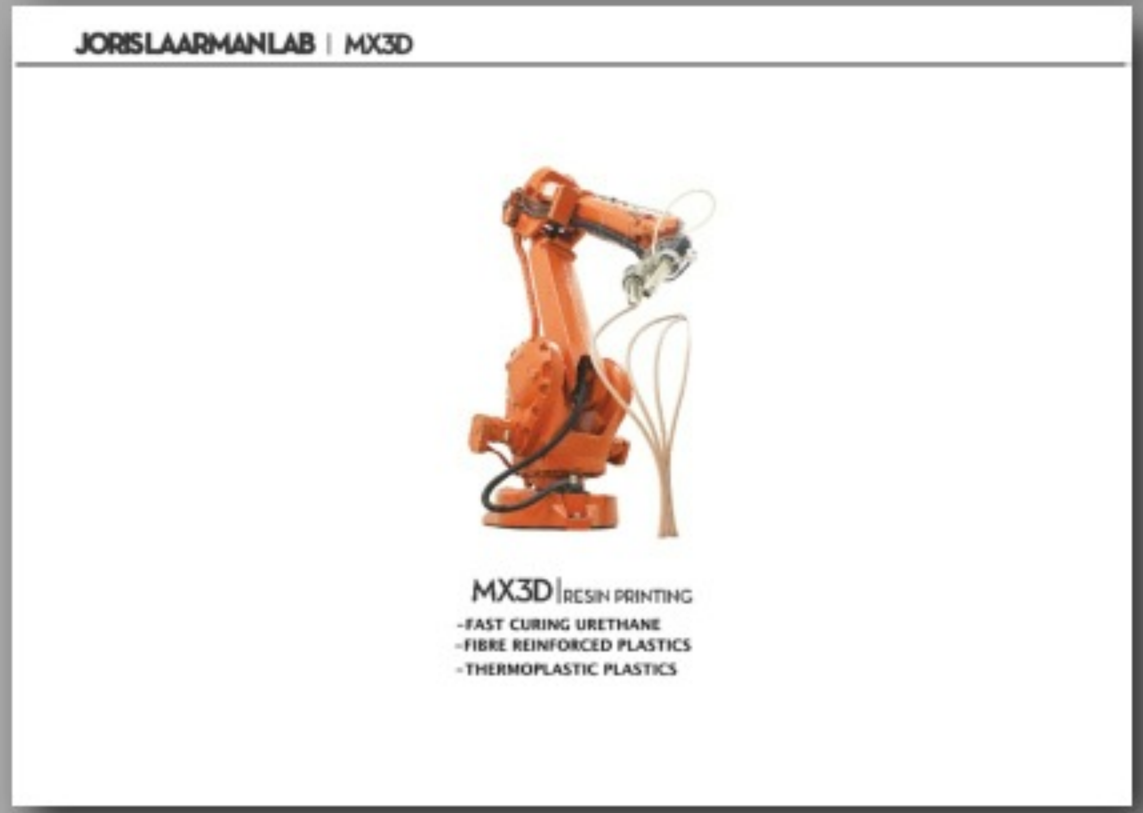

JORISLAARMANLAB | MX3D
MICROSTRUCTURE
S
NYLON-COPPER
ALUMINIUM
TPU


JORISLAARMANLAB | MX3D
MAKER CHAIRS
POLYGON
MESH
MAZE
HEXAGON
DIAMOND
PIXEL


JORISLAARMANLAB | MX3D
MAKER CHAIRS
MAZE
POLYGON
PRINTED


JORISLAARMANLAB | MX3D
-MULTIPLE AXIS
-SUPPORTLESS
-PRINTING OUTSIDE THE BOX
-LARGE OBJECTS
-FUNCTIONAL MATERIALS
MX3D
multiple axis 3d printing


JORISLAARMANLAB | MX3D
MX3D
multiple axis 3d printing
3D PRINTING THERMOSET MATERIALS
IN COLLABORATION WITH
Iaac
STUDENTS:
Petr Novikov
Saša Jokić
SUPPORTLESS METAL PRINTING
IN COLLABORATION WITH
AcoTech
HAL
AUTODESK


JORISLAARMANLAB | MX3D
MX3D | RESIN PRINTING
-FAST CURING URETHANE
-FIBRE REINFORCED PLASTICS
-THERMOPLASTIC PLASTICS

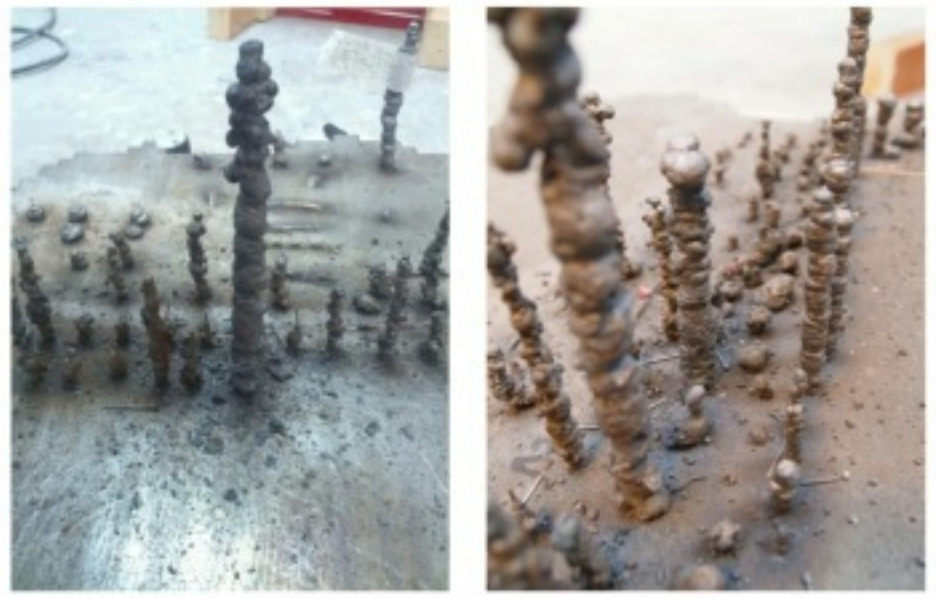
MX3D | RESIN PRINTING

MX3D | RESIN PRINTING

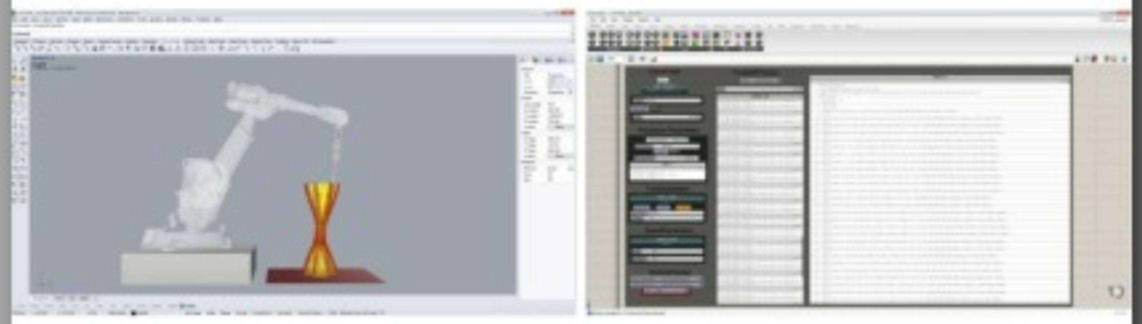
APPLICATIONS

MX3D | METAL PRINTING

- STAINLESS STEEL
- ALUMINIUM
- STEEL
- COPPER
- TITANIUM



SOFTWARE DEVELOPMENT



SOFTWARE BY: HAL

TOOL DEVELOPMENT

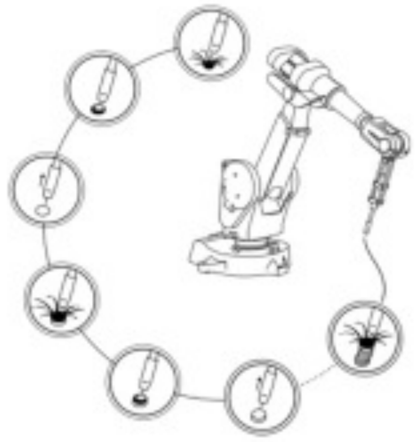
FDM-STRATEGY

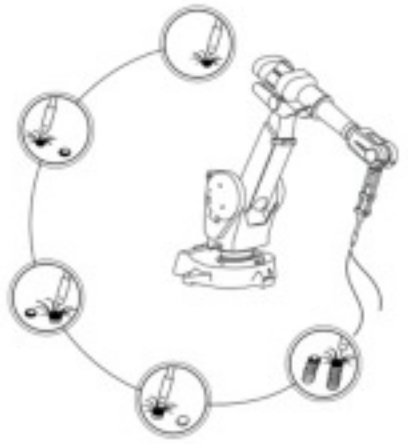
FREE-LINE-STRATEGY

JORISLAARMANLAB | MX3D

SINGLE LINE

MULTIPLE LINES





JORISLAARMANLAB | MX3D

SINGLE LINE

MULTIPLE LINES

JORISLAARMANLAB | MX3D

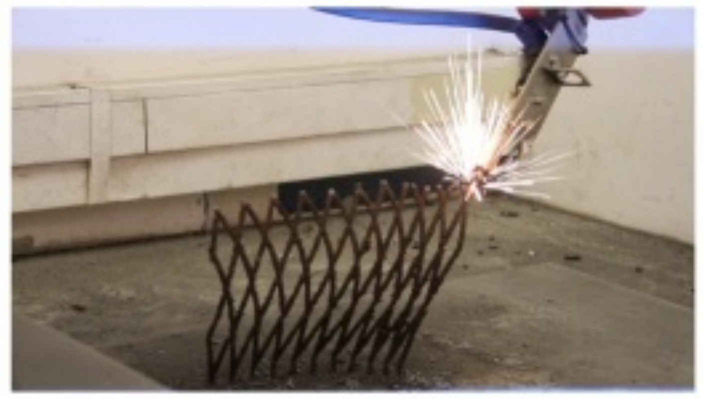
STRUCTURES

JORISLAARMANLAB | MX3D

MAIN FOCUS

-SPEED
-RELIABILITY
-COMPLEXITY GEOMETRY (REORIENTATION
-MATERIALS

JORISLAARMANLAB | MX3D



-SPEED
-RELIABILITY
-COMPLEXITY GEOMETRY (REORIENTATION
-MATERIALS

JORISLAARMANLAB | MX3D

-SPEED
-RELIABILITY
-COMPLEXITY GEOMETRY (REORIENTATION)
-MATERIALS

JORISLAARMANLAB | MX3D

SENSORS

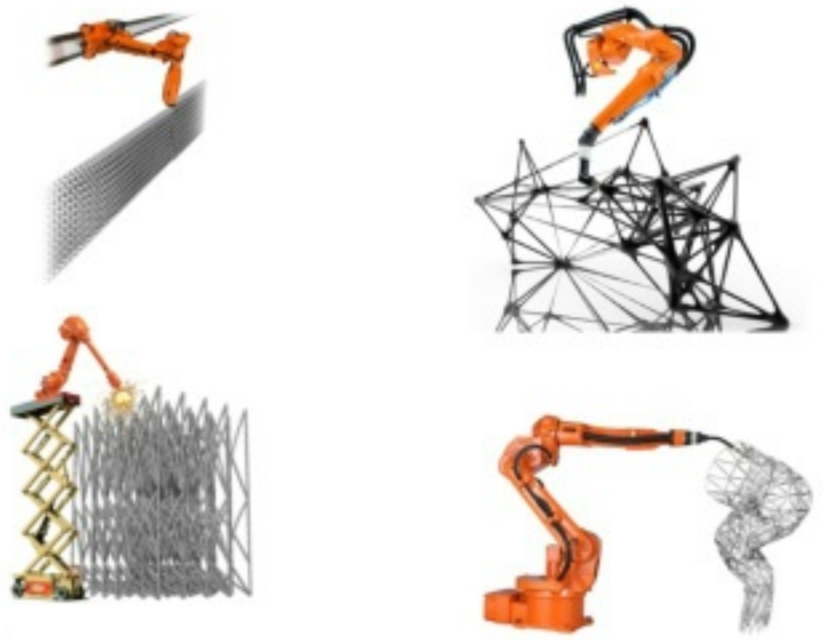
ULSTRASOUND

RED LASER SENSOR

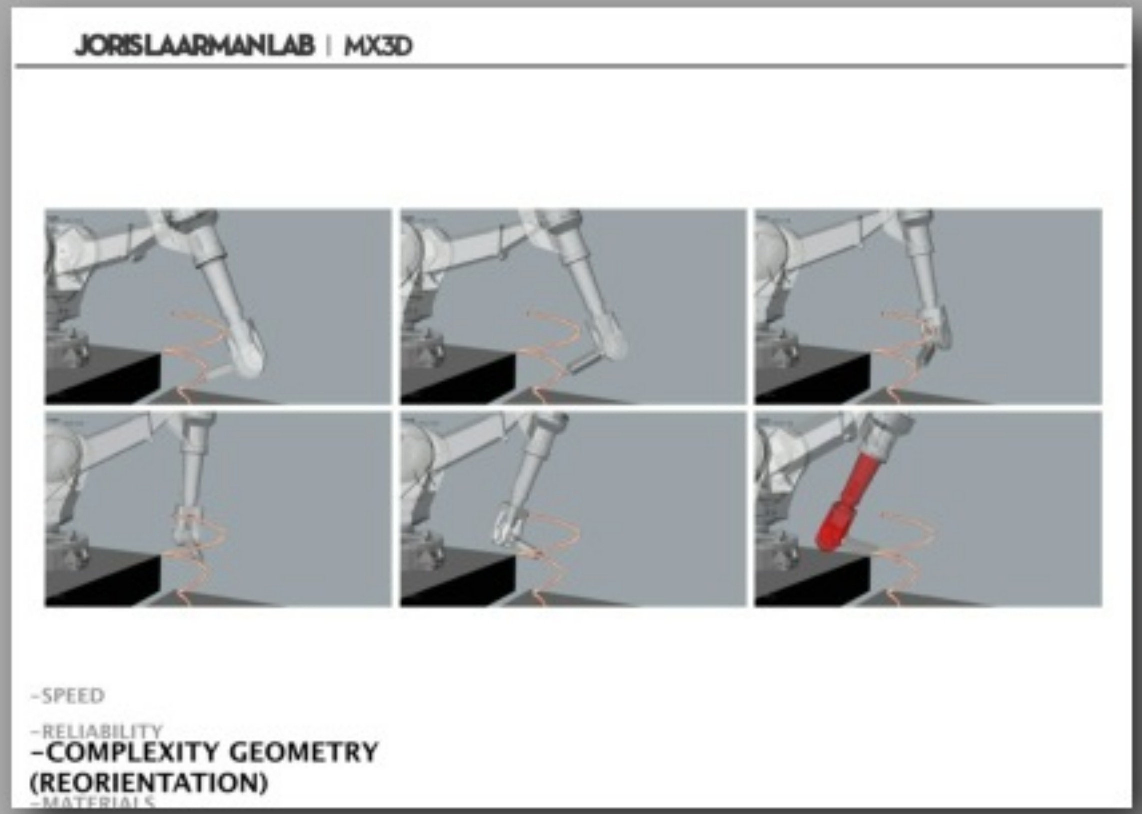
BLUE LASER SENSOR

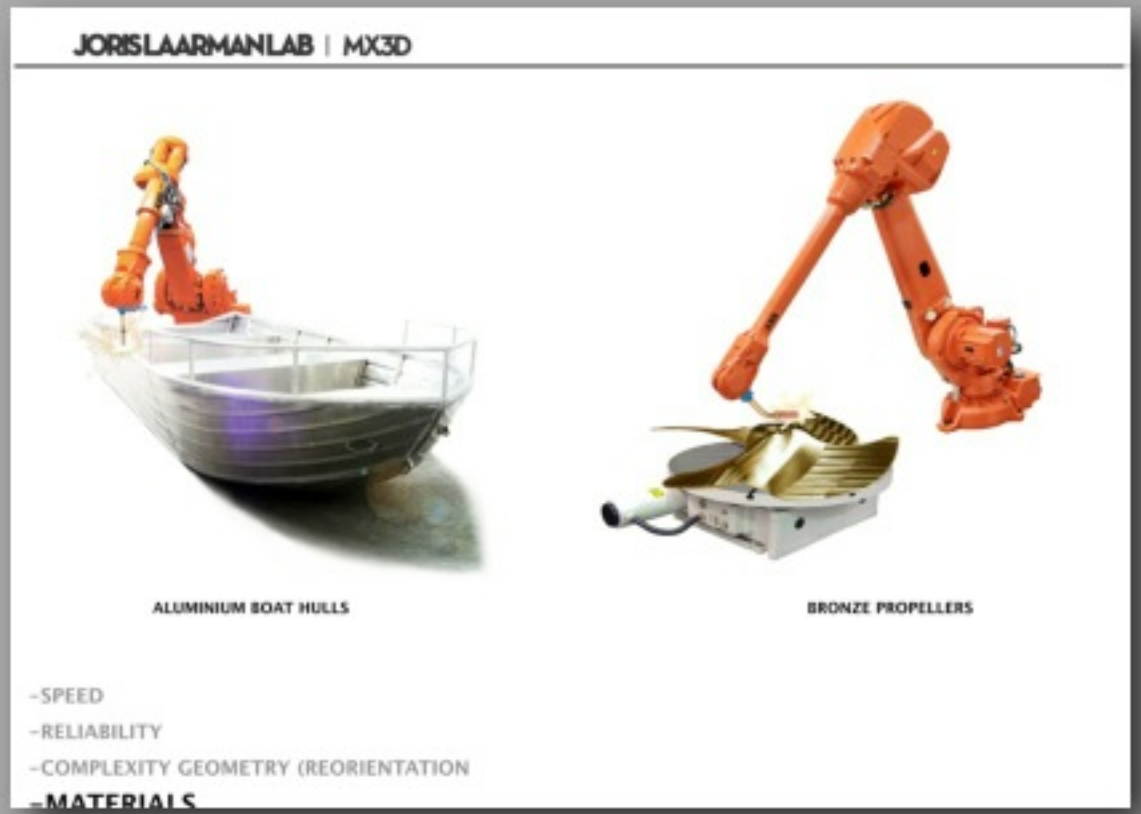
-SPEED
-RELIABILITY
-COMPLEXITY GEOMETRY (REORIENTATION)
-MATERIALS

JORISLAARMANLAB | MX3D

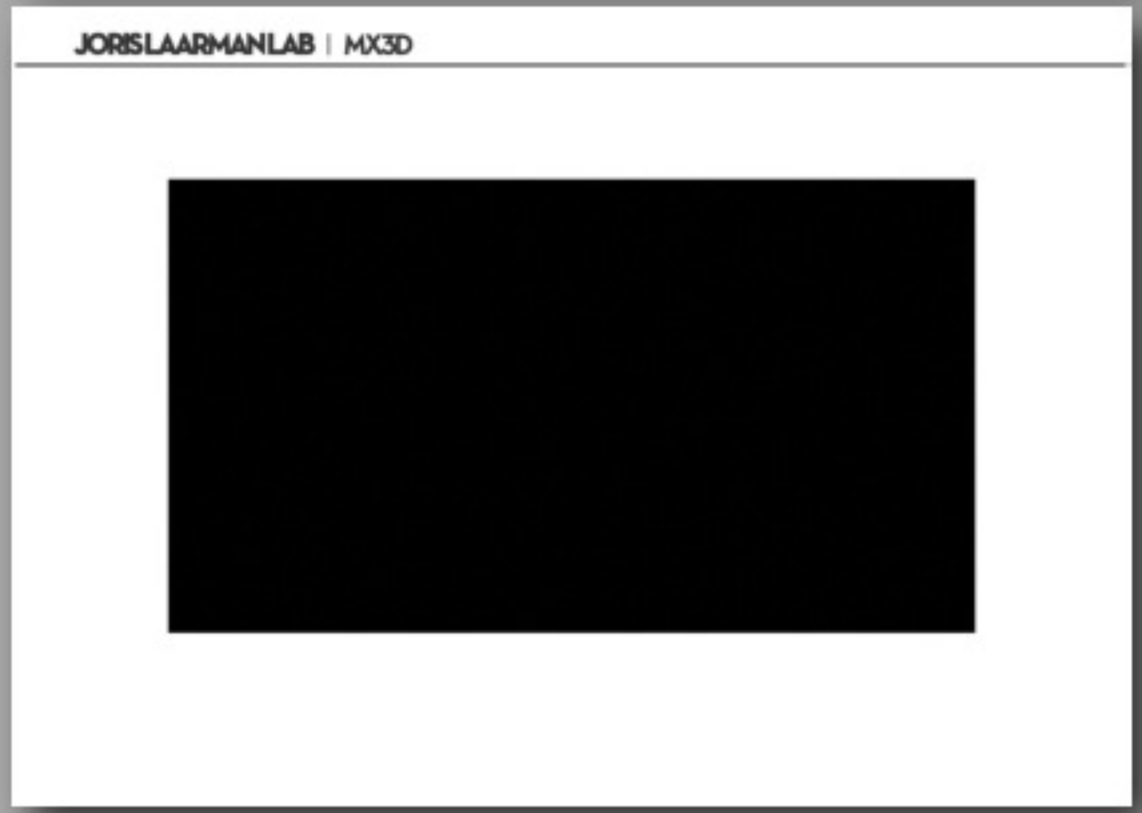


-SPEED
-RELIABILITY
-COMPLEXITY GEOMETRY (REORIENTATION)
-MATERIALS


JORISLAARMANLAB | MX3D
-SPEED
-RELIABILITY
-COMPLEXITY GEOMETRY (REORIENTATION)


JORISLAARMANLAB | MX3D
ALUMINIUM BOAT HULLS
BRONZE PROPELLERS
-SPEED
-RELIABILITY
-COMPLEXITY GEOMETRY (REORIENTATION
-MATERIALS


JORISLAARMANLAB | MX3D
DRAGON BENCH


JORISLAARMANLAB | MX3D


JORISLAARMANLAB | MX3D

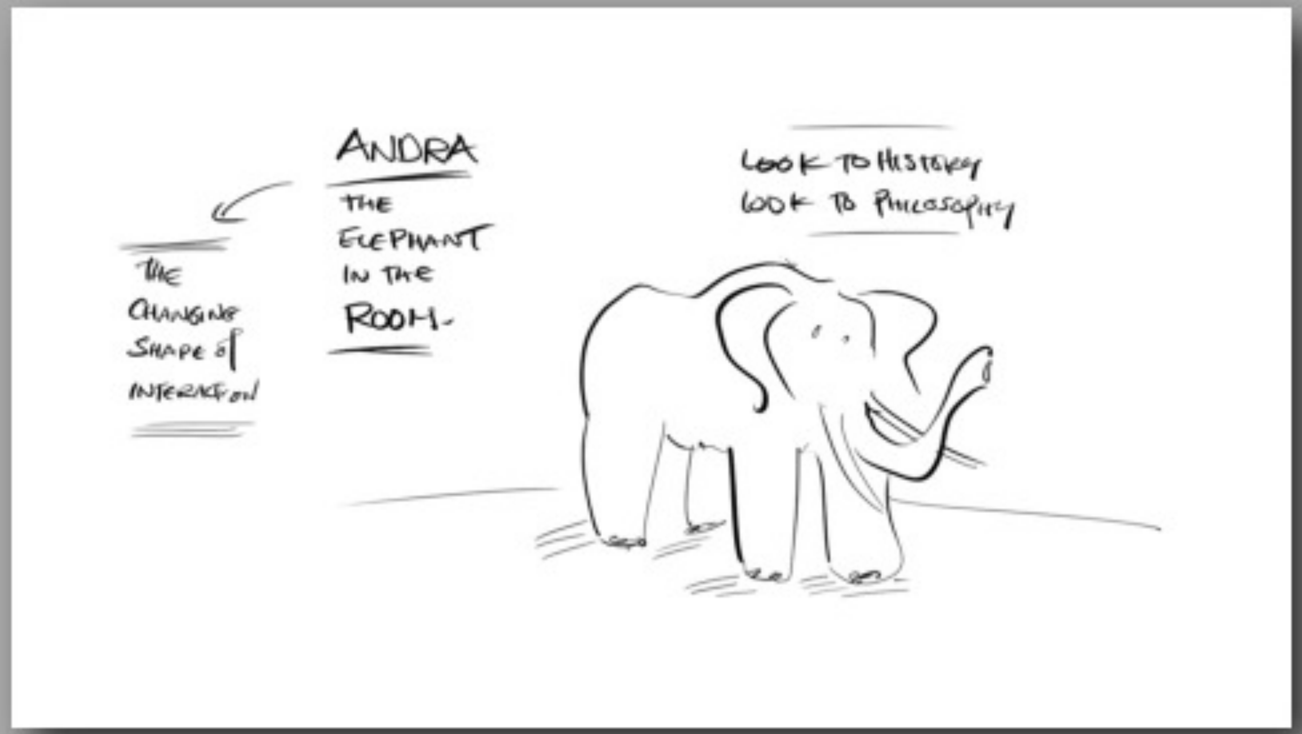
09_Andra Keay

Silicon Valley Robotics

“How can robots help us explore what it means to be human?”

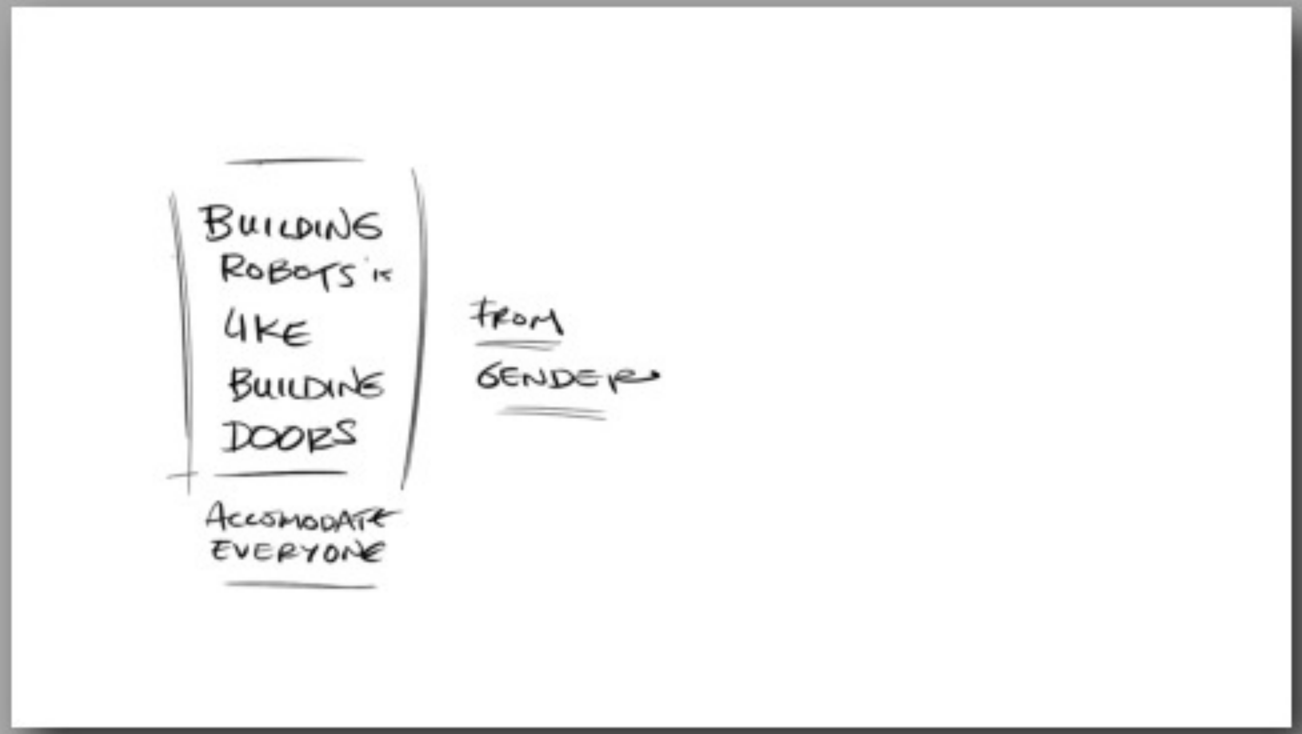
Emerging Trends in the Workplace

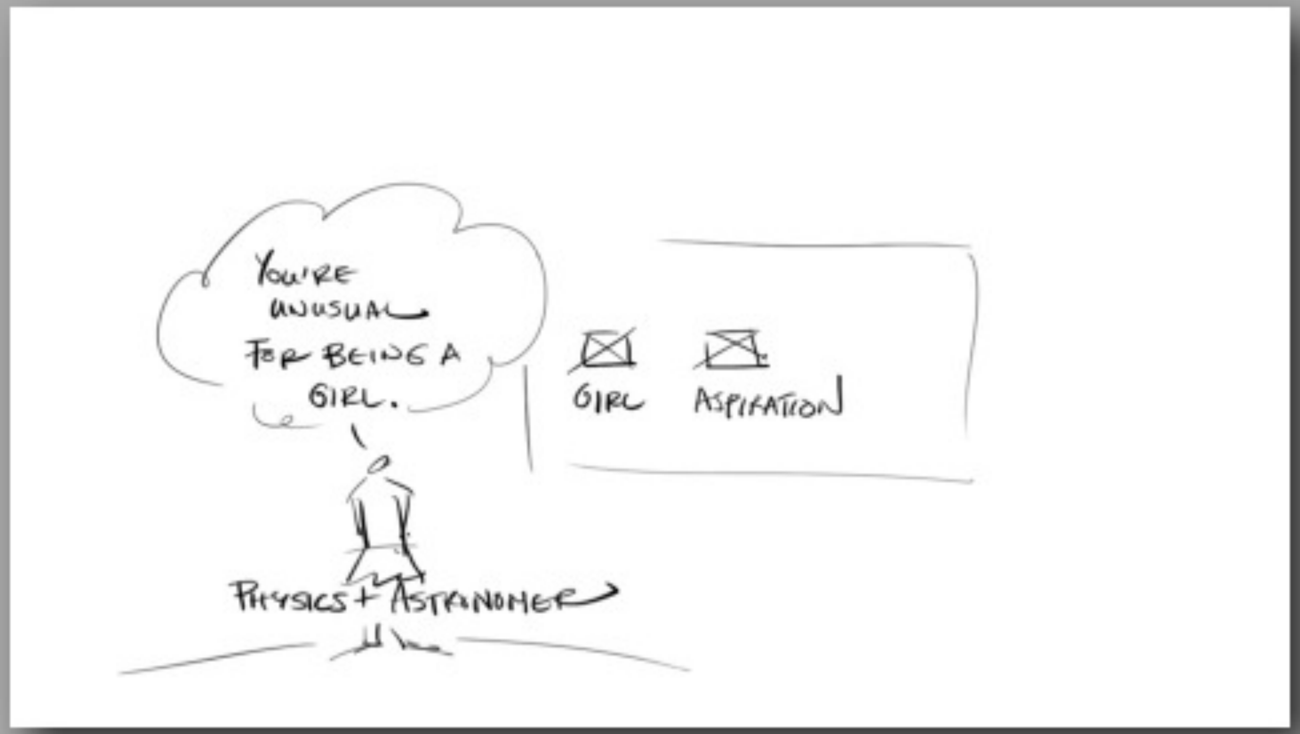
Challenging the male-centric status quo in modern robotics, Keay claims the future is here, but is not evenly distributed. Accusing robotics of suffering from leaky pipeline syndrome, questions around how feminism might influence the field, and why young girls seem to get ‘turned off’ of the electronic or robotic industry were raised. Tying struggles in technological innovation to current notions about emotional vs. rational thinking, Keay suggests that the emerging fields surrounding robotics will require new approaches and thus new understandings about human social dynamics.

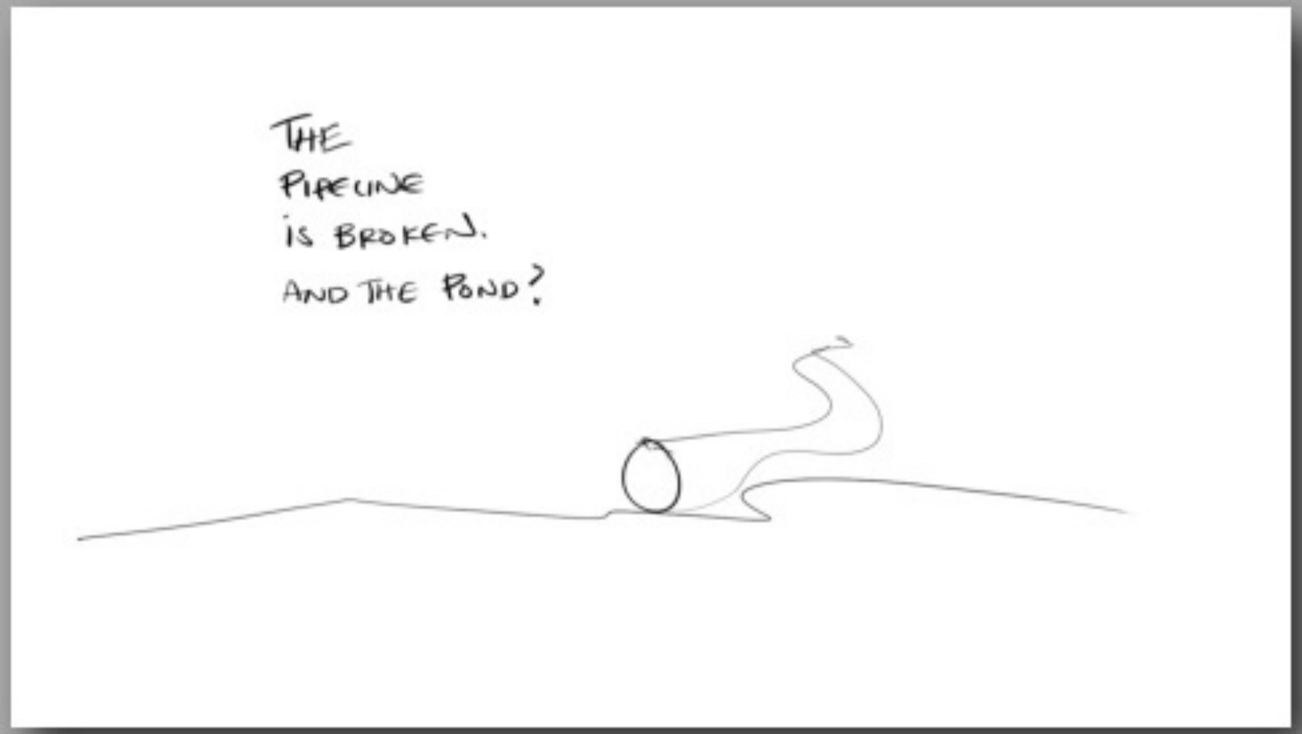

ANDRA
THE ELEPHANT IN THE ROOM.
LOOK TO HISTORY
LOOK TO PHILOSOPHY
THE CHANGING SHAPE OF INTERACTION

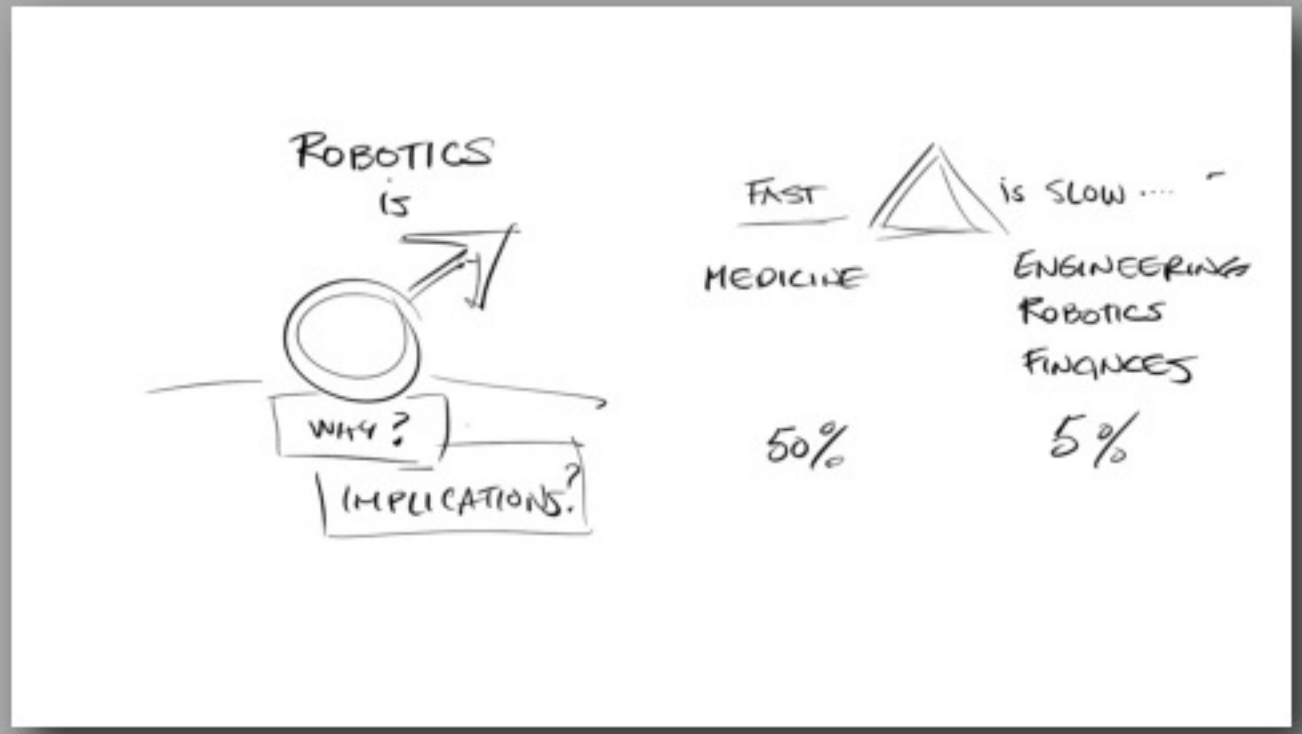

GENDER & ROBOTICS
BAD
WORSE
NEED TO SOLVE

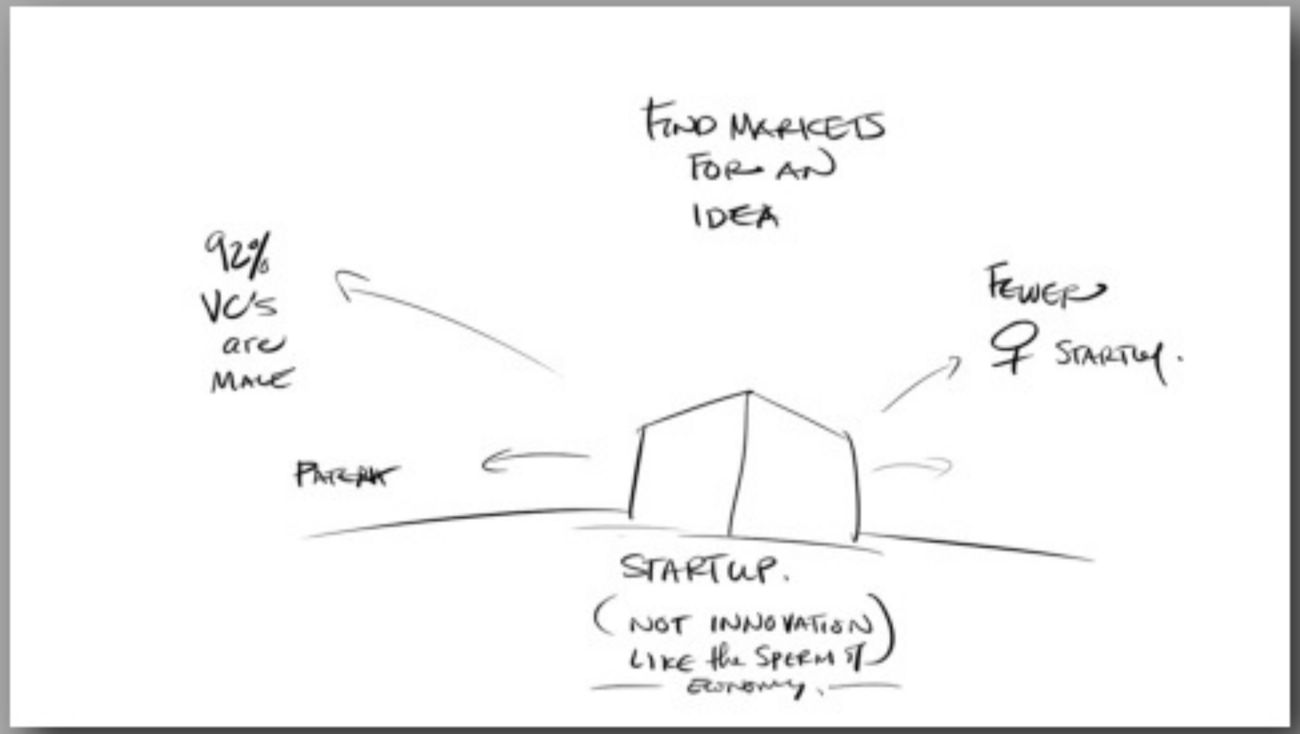

WHO FEELS THE PEOPLE IN THIS ROOM BELIEVES THAT SOCIETY IS REFLECTED
ARE TECHNOLOGIES GENDERED?

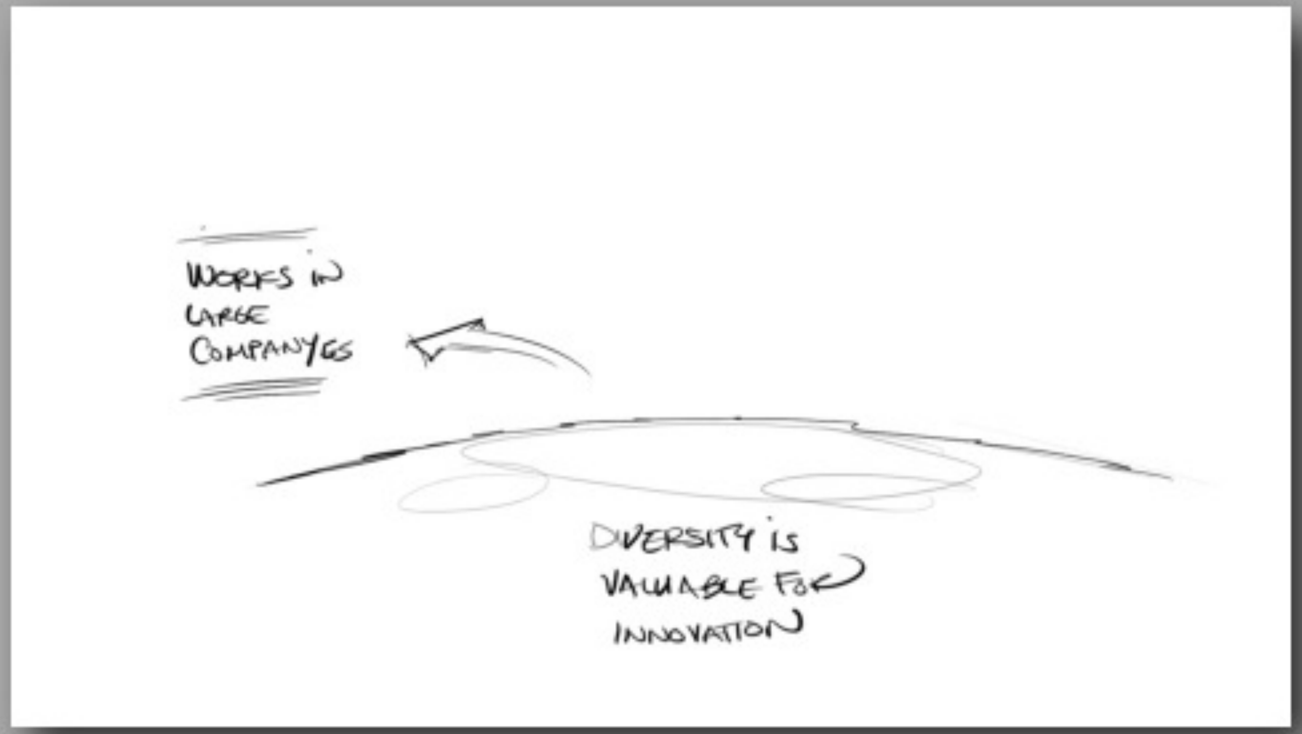

BUILDING ROBOTS IS LIKE BUILDING DOORS
FROM GENDER
ACCOMODATE EVERYONE

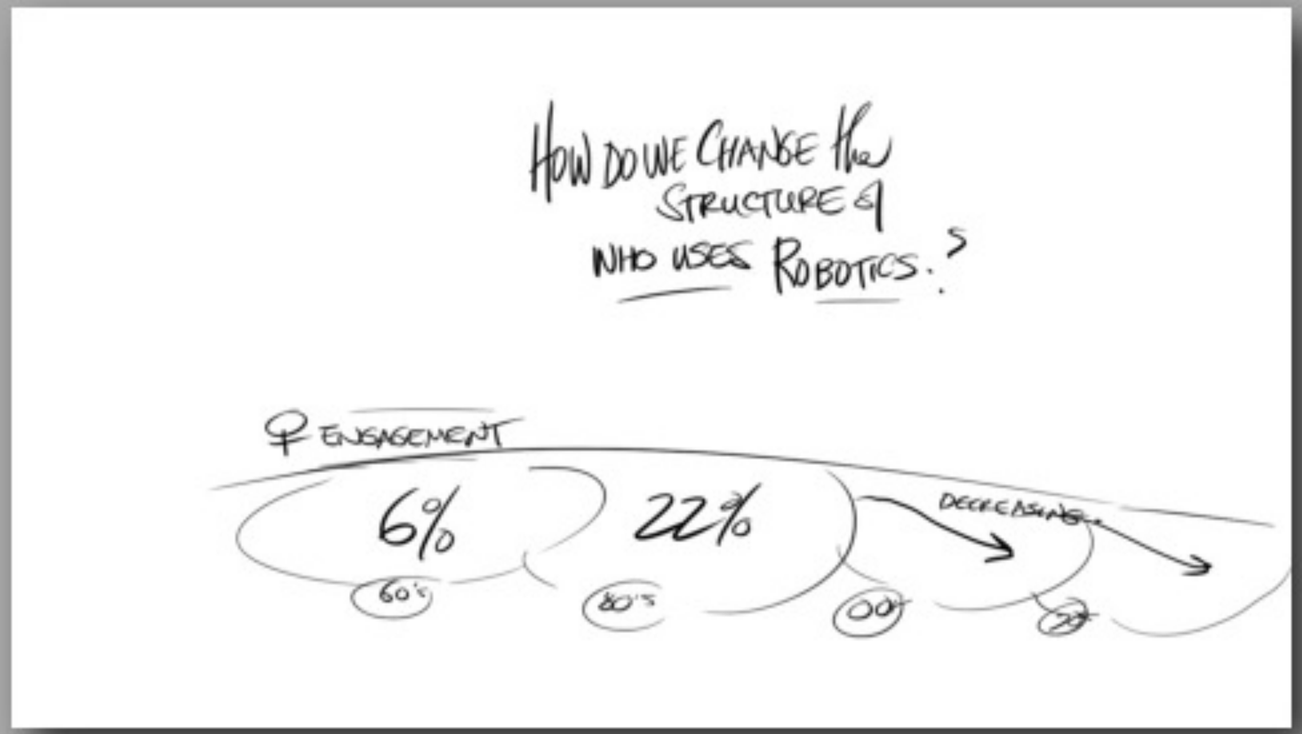

YOU'RE UNUSUAL FOR BEING A GIRL.
GIRL
ASPIRATION
PHYSICS + ASTRONOMER

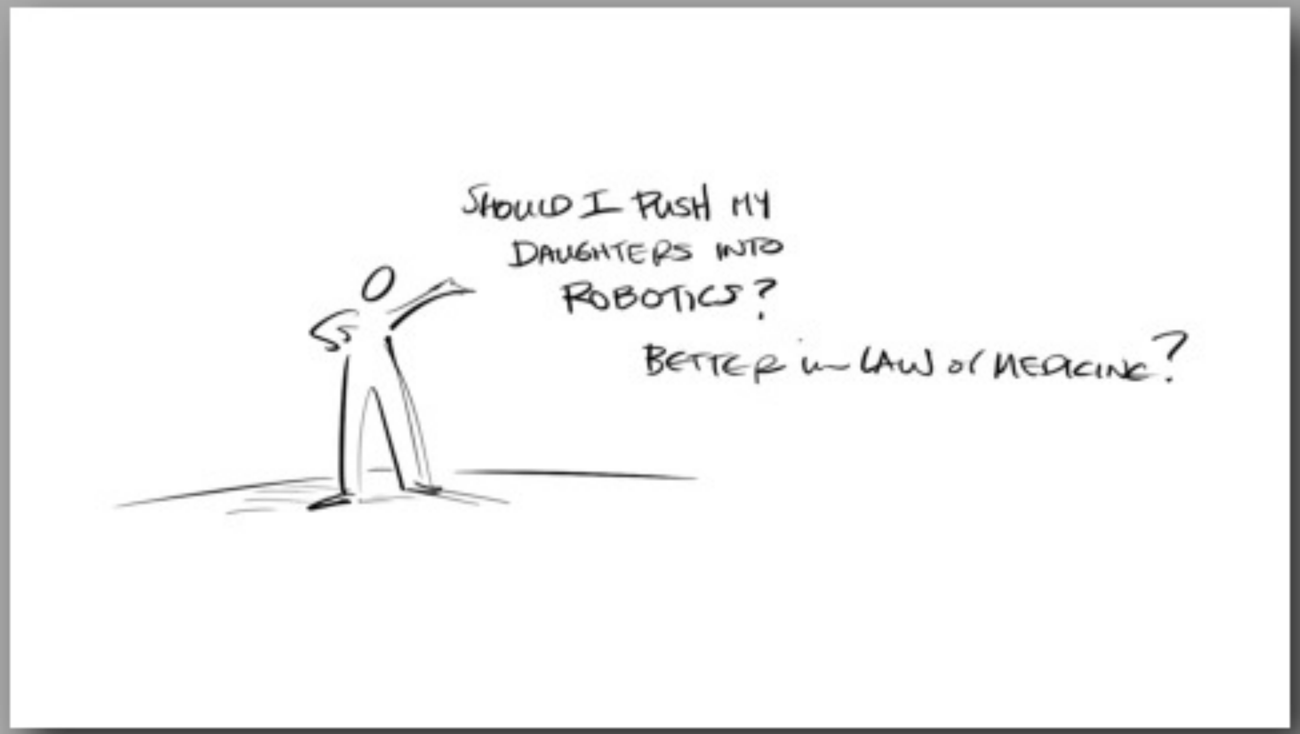

THE PIPELINE IS BROKEN.
AND THE POND?

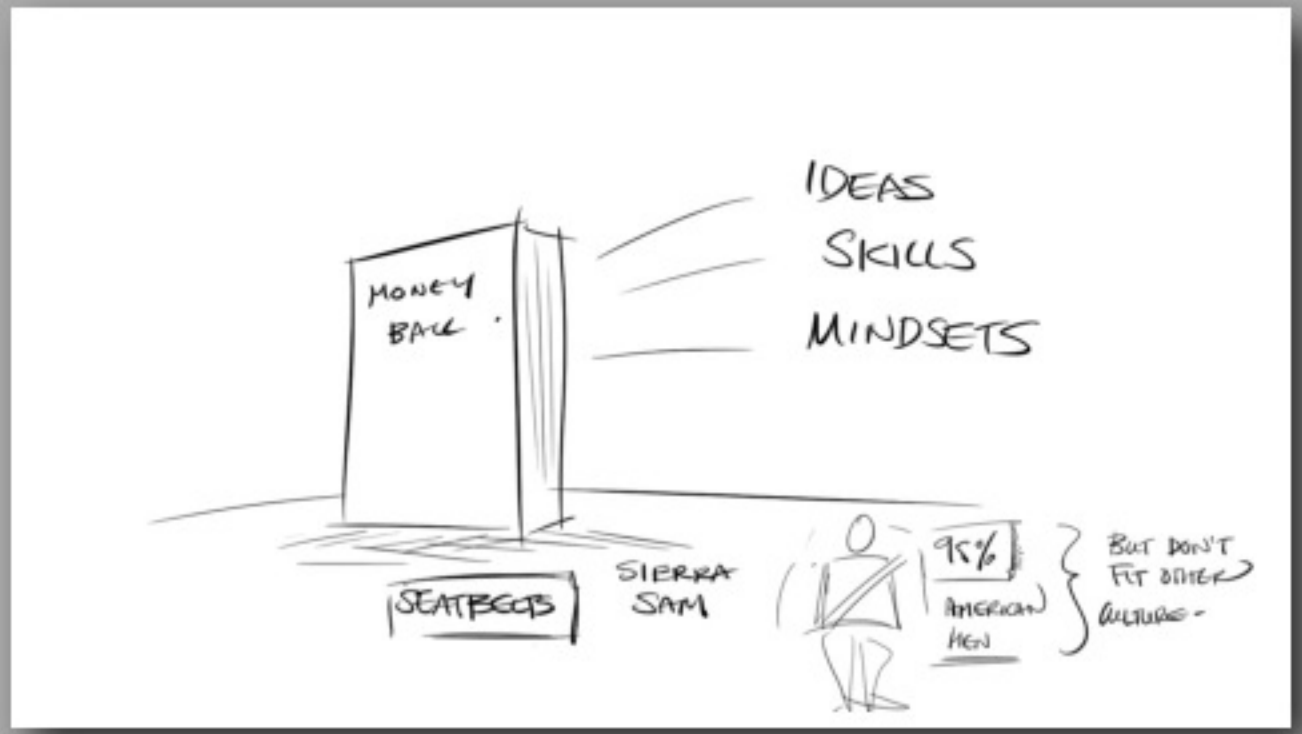

ROBOTICS IS
WHY?
IMPLICATIONS?
FAST
IS SLOW....
MEDICINE
ENGINEERING ROBOTICS FINANCES
50%
5%

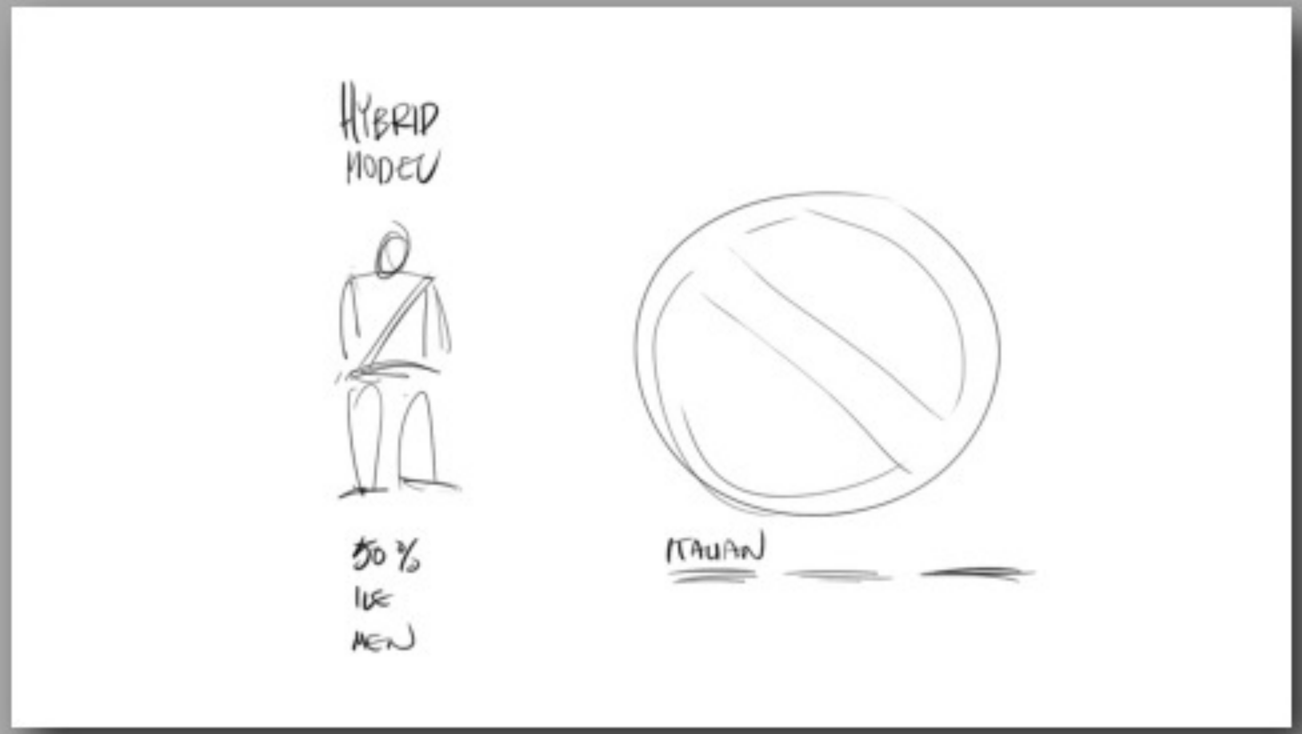

FIND MARKETS FOR AN IDEA
92% VC'S ARE MALE
FEWER ♀ STARTUPS.
STARTUP.
(NOT INNOVATION) LIKE THE SPERM OF ECONOMY.

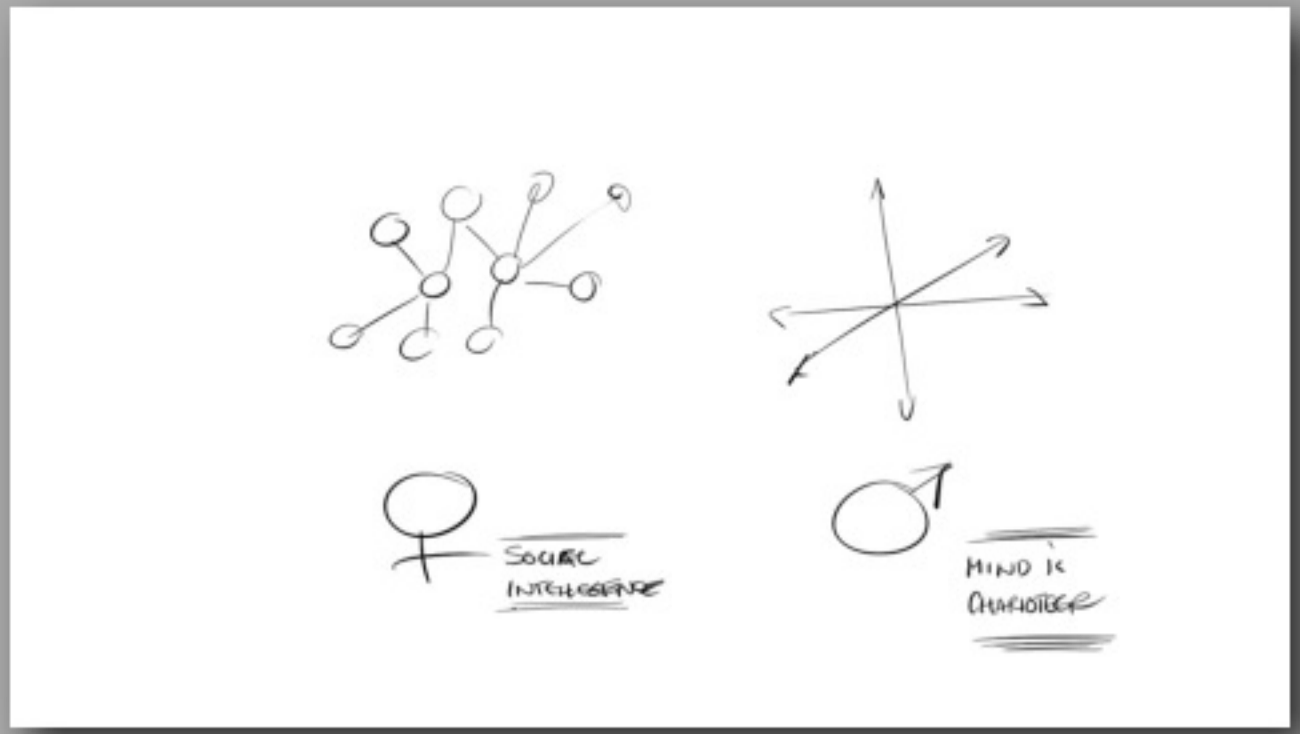

WORKS IN LARGE COMPANIES
DIVERSITY IS VALUABLE FOR INNOVATION

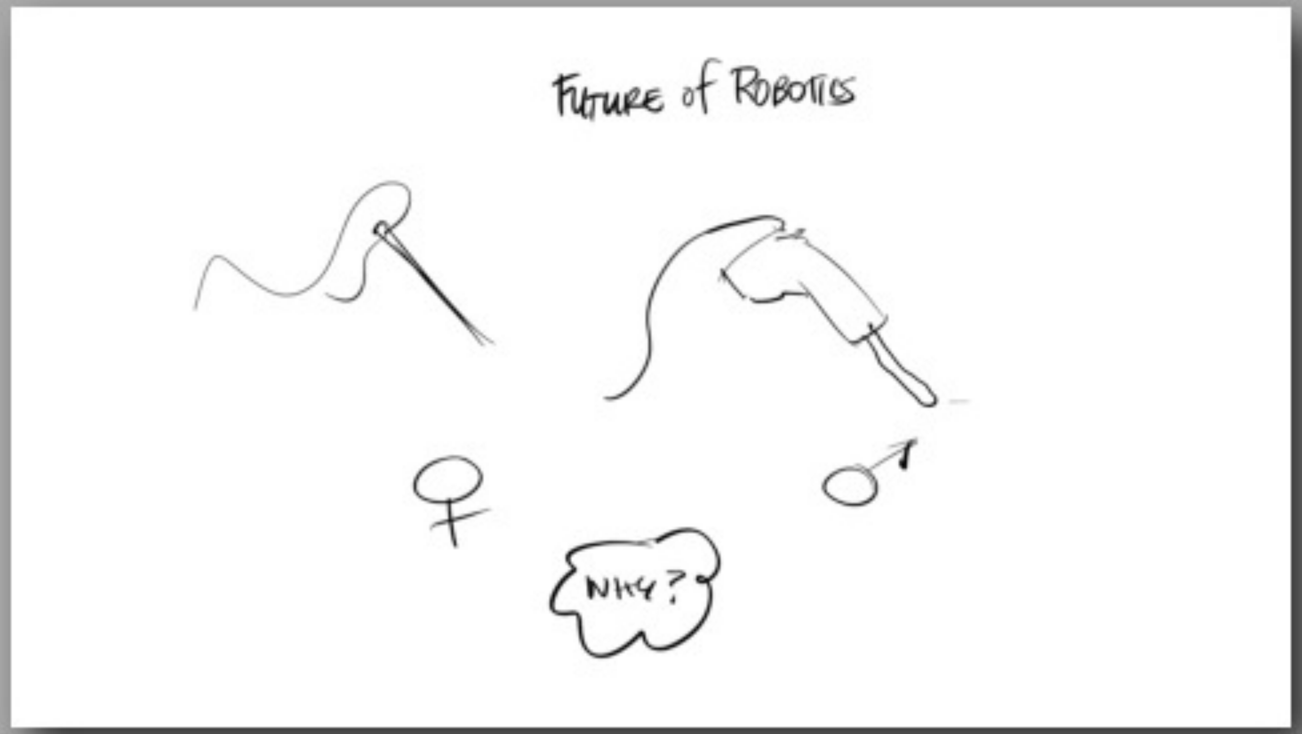

HOW DO WE CHANGE THE STRUCTURE & WHO USES ROBOTICS?
♀ ENGAGEMENT
6%
22%
DECREASING...
60's
80's
00's

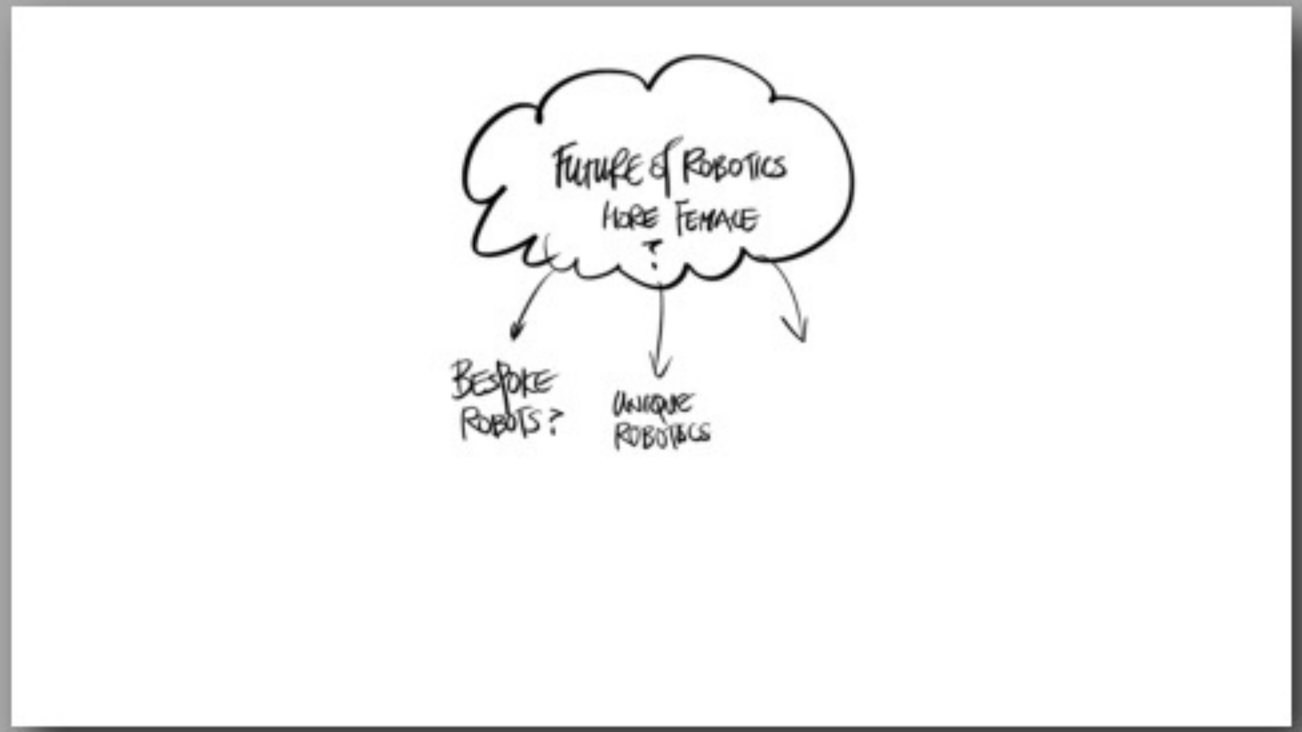

SHOULD I PUSH MY DAUGHTERS INTO ROBOTICS?
BETTER IN LAW OR MEDICINE?


MONEY BACK
IDEAS
SKILLS
MINDSETS
SEATBELTS
SIERRA SAM
95%
AMERICAN MEN
BUT DON'T FIT OTHER CULTURE-


HYBRID MODEL
50% ILE MEN
ITALIAN


SOCIAL INTELLIGENCE
MIND IS CHARACTER


Future of Robotics
WHY?


FUTURE OF ROBOTICS MORE FEMALE?
BESPOKE ROBOTS?
UNIQUE ROBOTICS

10_Simon DiMaio

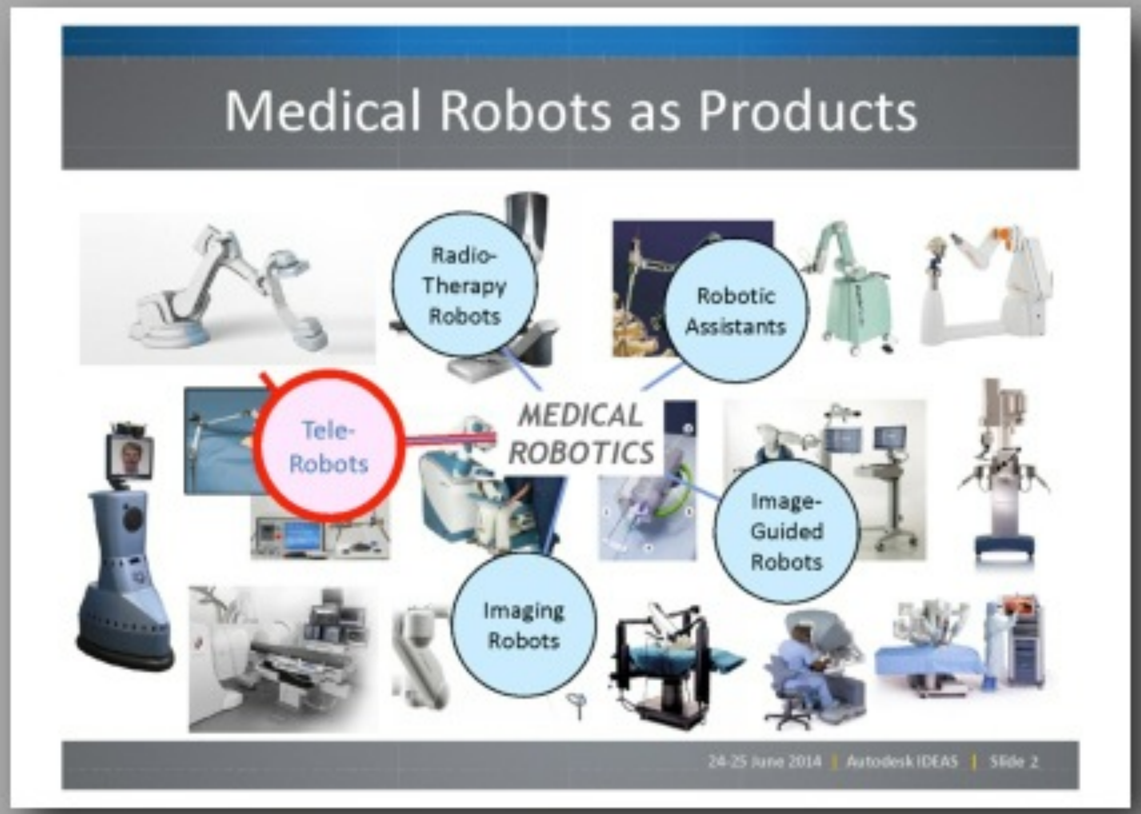
Intuitive Surgical

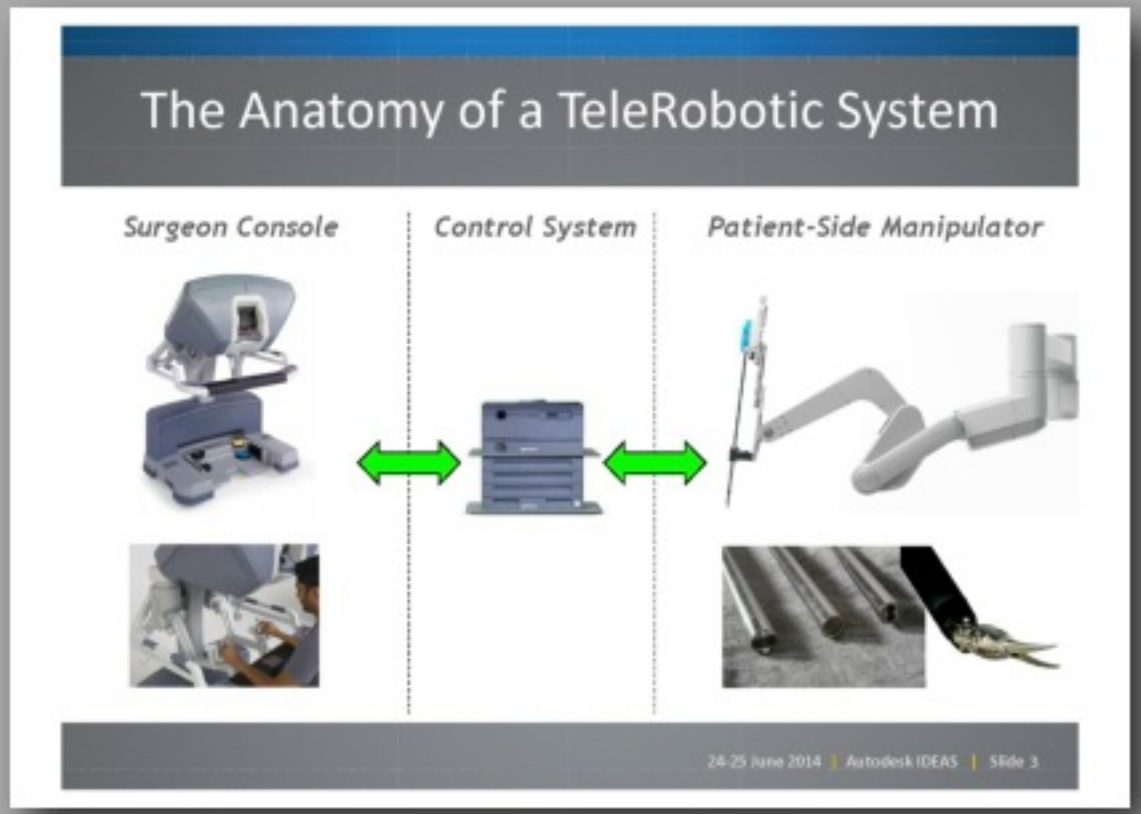
"How can we use robots to make humans into superhumans?"

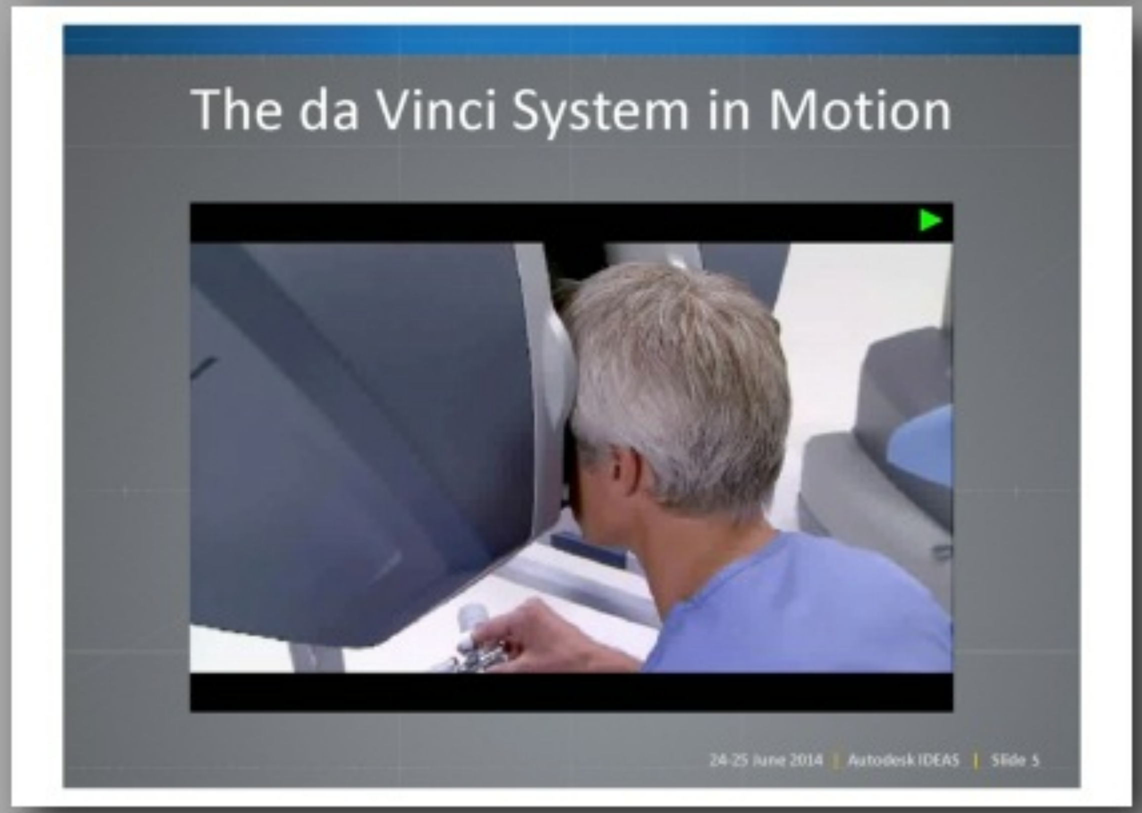
Robotics for Medicine

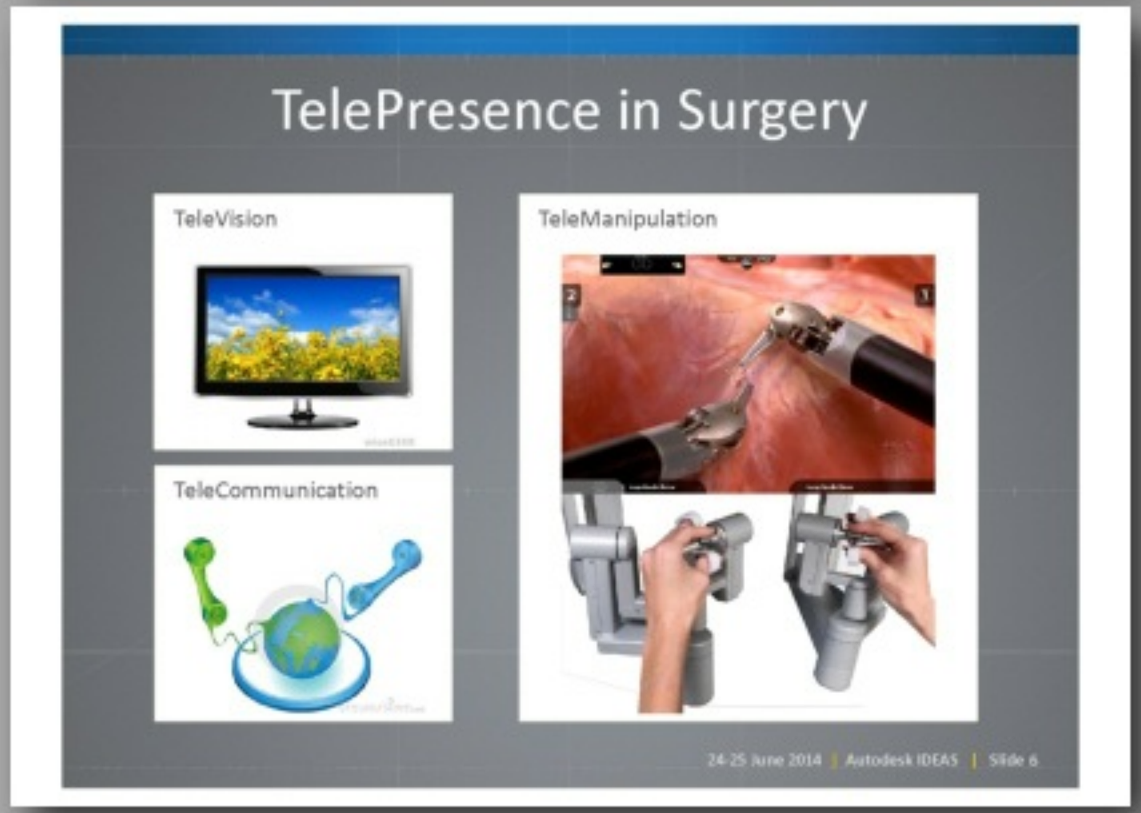
Robotics are instrumental across a wild field of modern medicine – including radiotherapy robotics, robotic assistants, image guided robots, imaging robots and tele-robotics. While great strides have been made in how robotic telemanipulation have augmented and enhanced the surgeon's ability to minimize collateral damage, scarring and post-op side effects, there are equally complex challenges in terms of regulation, litigation and costs. Surgeons are not necessarily responding well to the techno-based training that working alongside modern robots require.

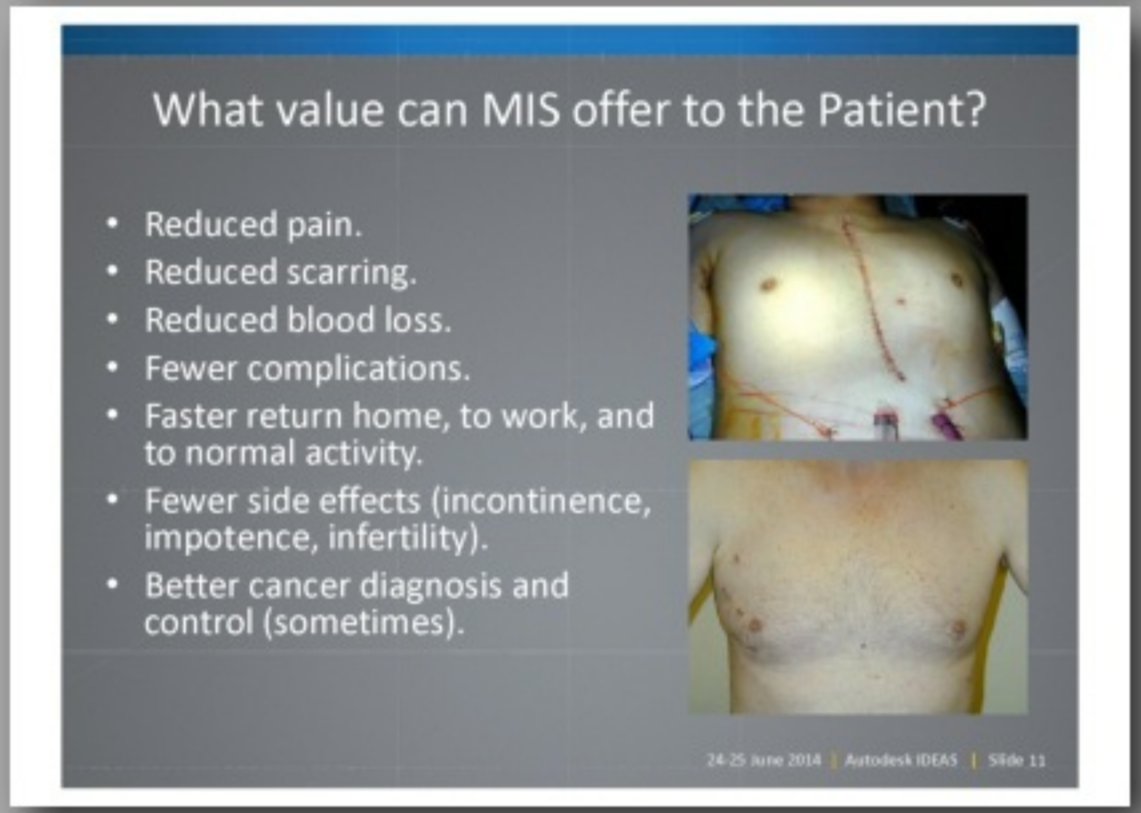

Robotics in Medicine
Simon DiMaio
Intuitive Surgical
25 June 2014

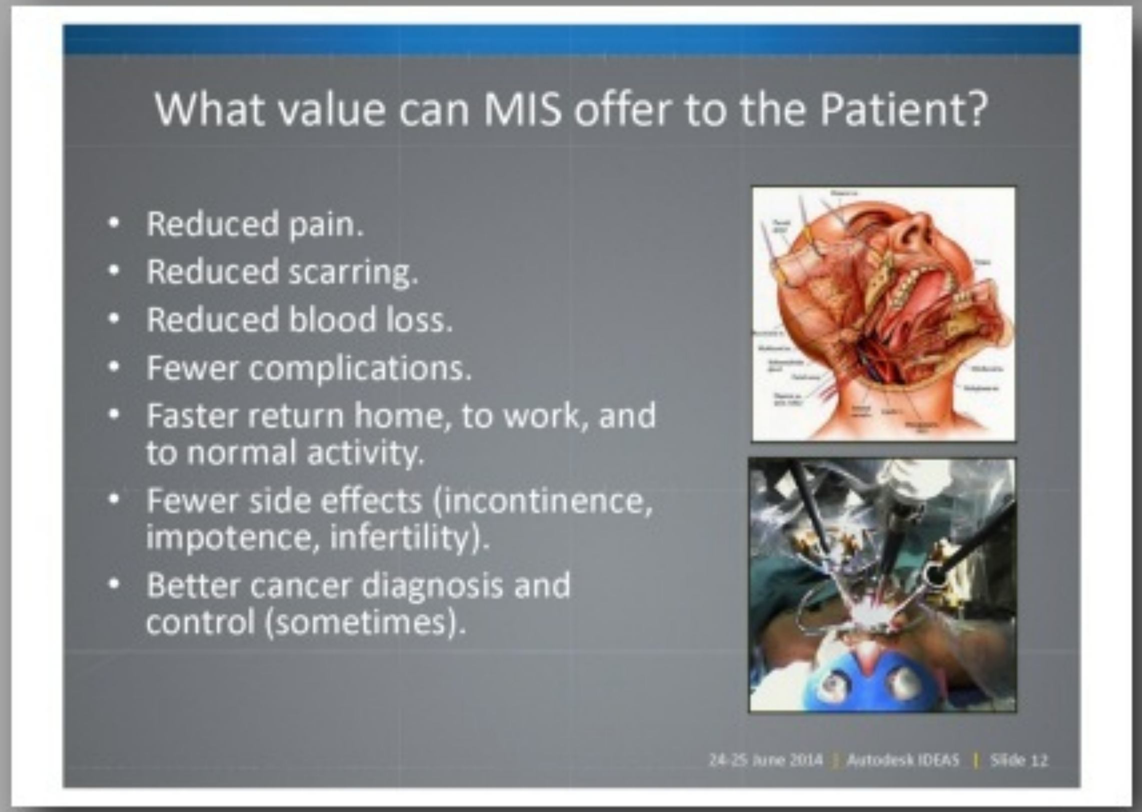

Medical Robots as Products
Radio-Therapy Robots
Robotic Assistants
Tele-Robots
MEDICAL ROBOTICS
Image-Guided Robots
Imaging Robots
24-25 June 2014 | Autodesk IDEAS | Slide 2

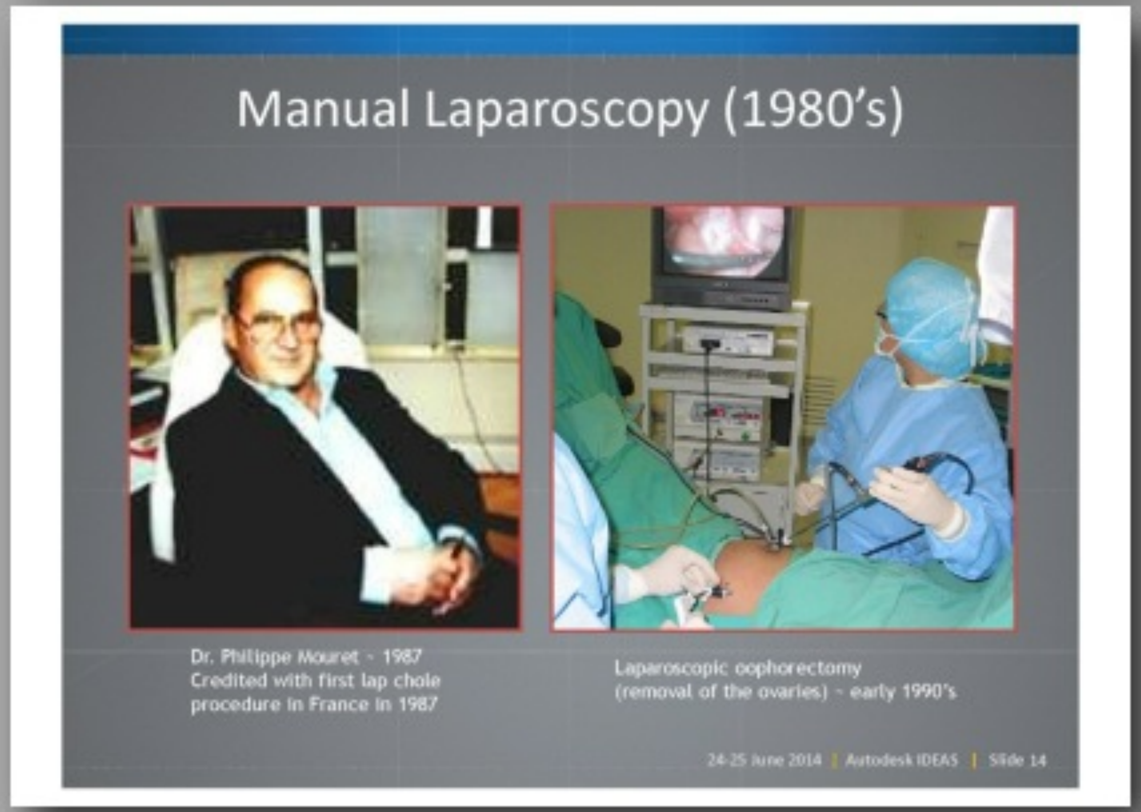

The Anatomy of a TeleRobotic System
Surgeon Console
Control System
Patient-Side Manipulator
24-25 June 2014 | Autodesk IDEAS | Slide 3

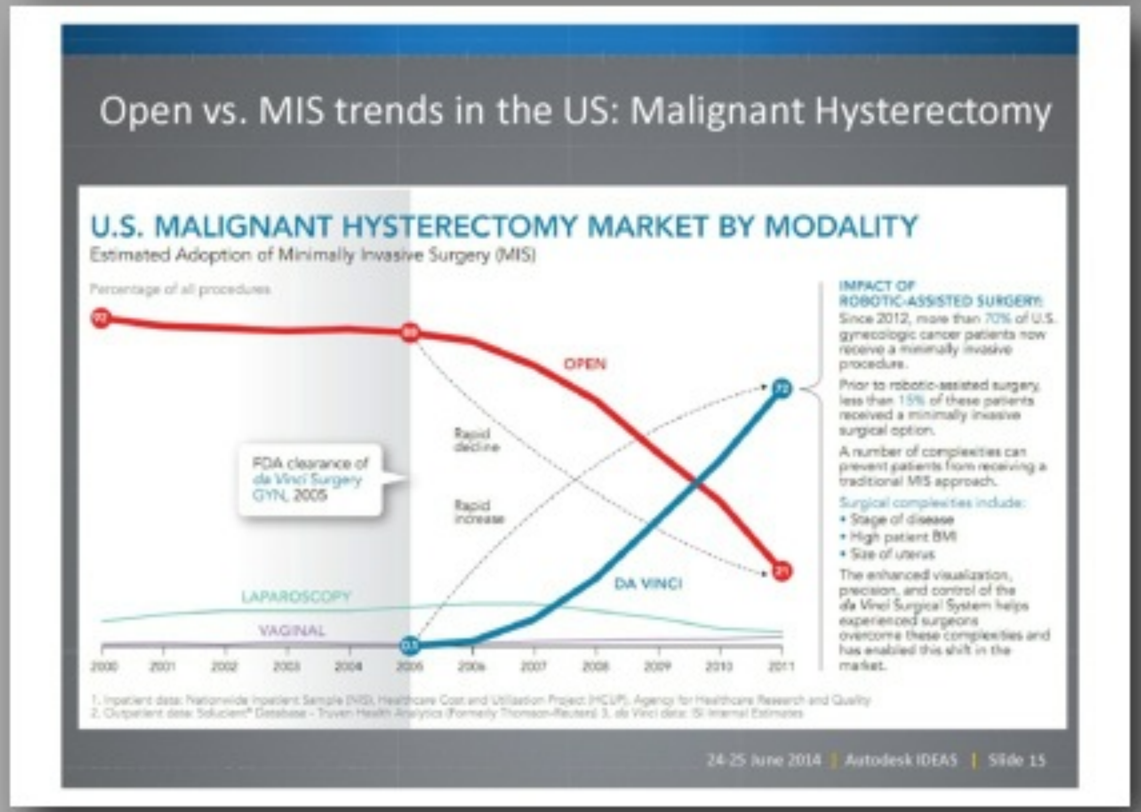

The da Vinci System in Motion
24-25 June 2014 | Autodesk IDEAS | Slide 5


TelePresence in Surgery
TeleVision
TeleManipulation
TeleCommunication
24-25 June 2014 | Autodesk IDEAS | Slide 6


What value can MIS offer to the Patient?
Reduced pain.
Reduced scarring.
Reduced blood loss.
Fewer complications.
Faster return home, to work, and to normal activity.
Fewer side effects (incontinence, impotence, infertility).
Better cancer diagnosis and control (sometimes).
24-25 June 2014 | Autodesk IDEAS | Slide 11


What value can MIS offer to the Patient?
Reduced pain.
Reduced scarring.
Reduced blood loss.
Fewer complications.
Faster return home, to work, and to normal activity.
Fewer side effects (incontinence, impotence, infertility).
Better cancer diagnosis and control (sometimes).
24-25 June 2014 | Autodesk IDEAS | Slide 12


Manual Laparoscopy (1980's)
Dr. Philippe Mouret - 1987
Credited with first lap chole procedure in France in 1987
Laparoscopic oophorectomy (removal of the ovaries) - early 1990's
24-25 June 2014 | Autodesk IDEAS | Slide 14


Open vs. MIS trends in the US: Malignant Hysterectomy
U.S. MALIGNANT HYSTERECTOMY MARKET BY MODALITY
Estimated Adoption of Minimally Invasive Surgery (MIS)
OPEN
DA VINCI
LAPAROSCOPY
VAGINAL
24-25 June 2014 | Autodesk IDEAS | Slide 15

Focus Procedure Areas

>500,000 procedures performed in 2013

Cardiothoracic
- Mitral Valve Repair
- Coronary Revascularization
- Lobectomy – lung cancer

Gynecology
- Hysterectomy – benign and endometrial cancer
- Sacral Colpopexy – pelvic floor reconstruction
- Myomectomy – removal of debilitating fibroids

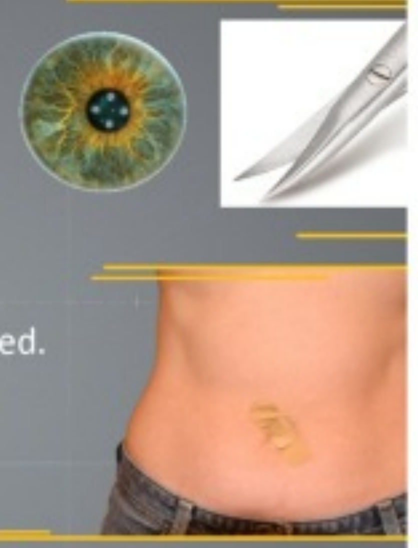
Urology
- Prostatectomy - prostate cancer
- Nephrectomy - kidney cancer
- Cystectomy - bladder cancer
- Pyeloplasty – kidney reconstruction

General Surgery
- Lower Anterior Resection - colorectal cancer

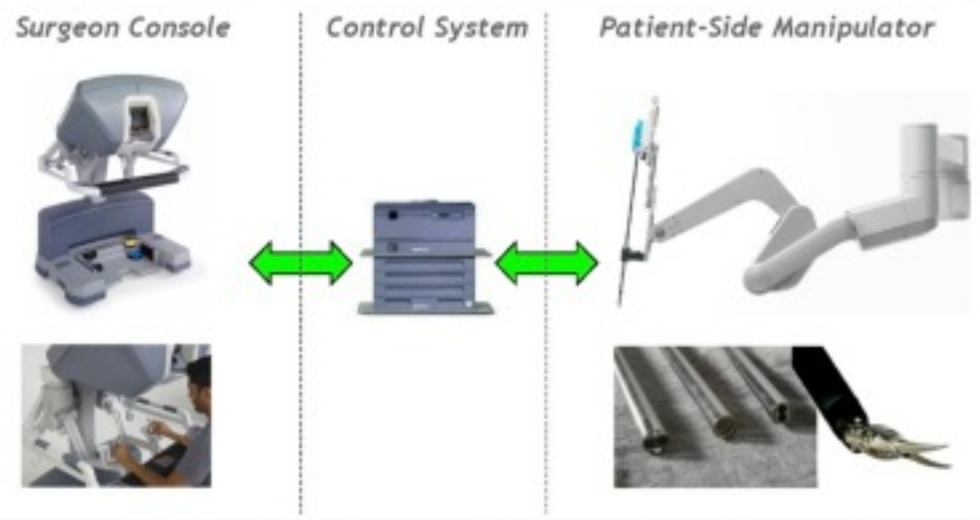
Head and Neck Surgery
- Trans-oral Robotic Surgery (TORS) - throat and base-of-tongue cancer

Opportunities: Ideals in Surgery

1. See disease perfectly.
2. Resect diseased tissue, spare healthy tissue.
3. Reconstruct with precision.
4. Leave as if no surgery was required.



Opportunities: How is technology taking us closer to the Ideal?



The "Software in the Middle"

Our Technology Development Focus

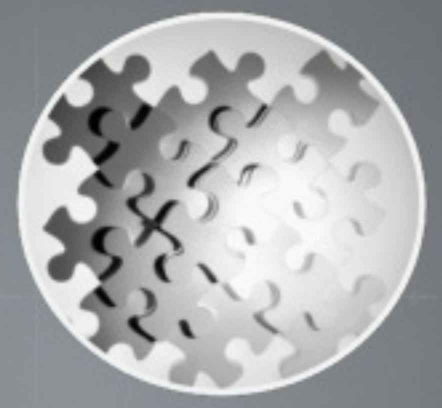
Advanced Imaging: Fluorescence Imaging

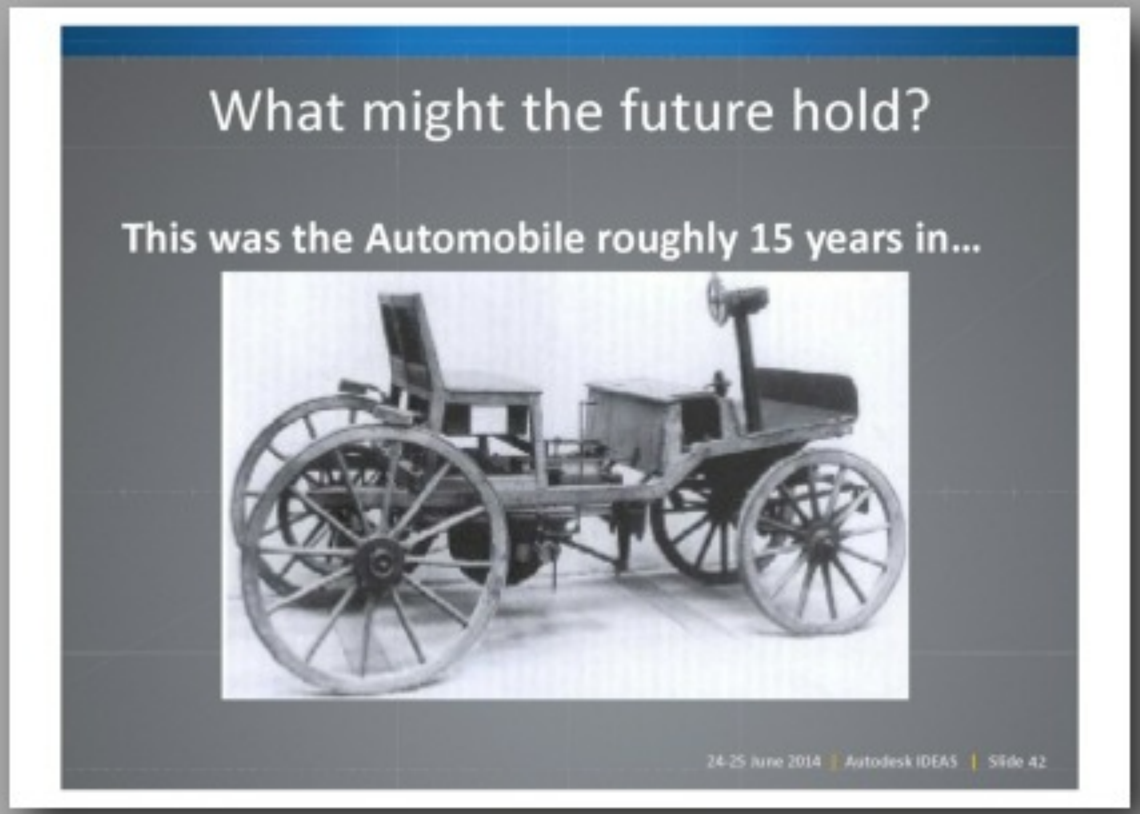
Future Platforms: Single Port Access

Not available for sale. In development.

Some Challenges

- Complexity
- Regulation
- Litigation
- Cost




What might the future hold?
This was the Automobile roughly 15 years in...
24-25 June 2014 | Autodesk IDEAS | Slide 42


The Future Through the Lens of Research
24-25 June 2014 | Autodesk IDEAS | Slide 43


The Future Through the Lens of Research
24-25 June 2014 | Autodesk IDEAS | Slide 44


The Future Through the Lens of Research
24-25 June 2014 | Autodesk IDEAS | Slide 45


The Future Through the Lens of Research
24-25 June 2014 | Autodesk IDEAS | Slide 46


1
2
3
4

11_Ken Goldberg

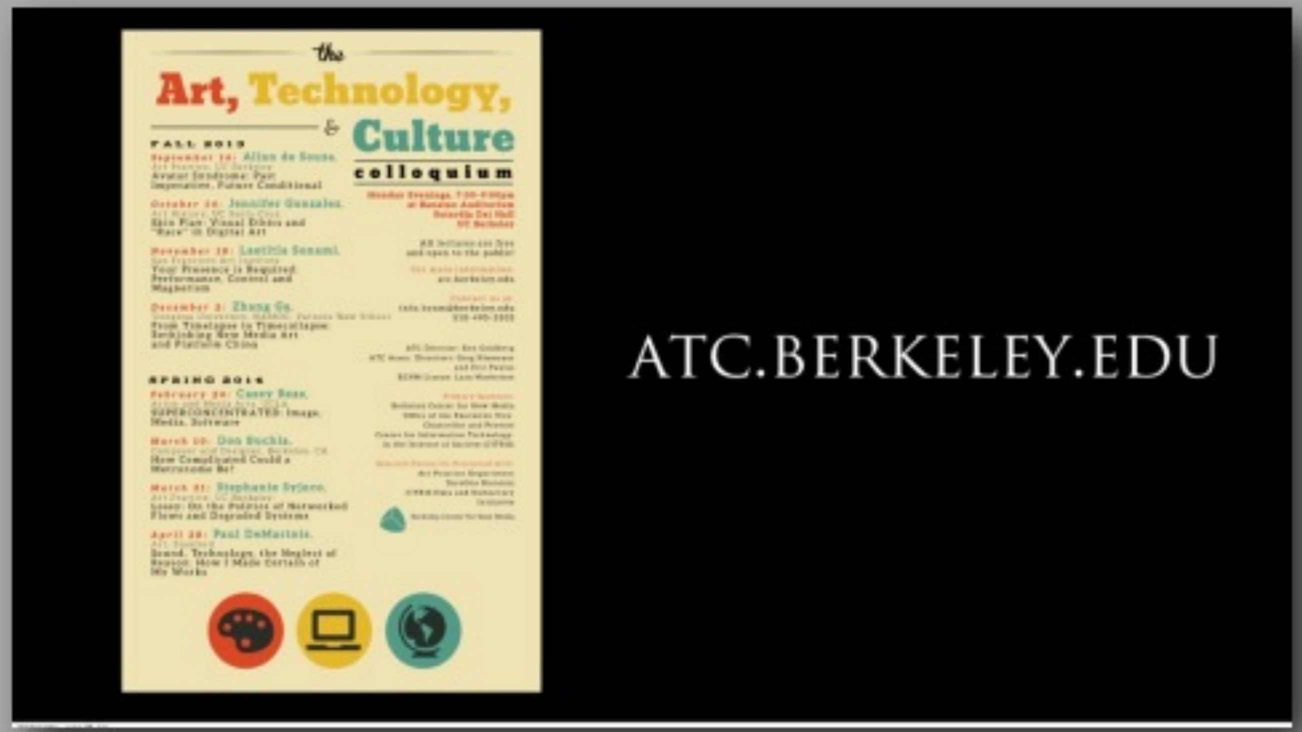
UC Berkeley

"How will the cloud change robotics?"

Academic Research in Robotics

Goldberg focused on the potential power of the cloud to shape the future of robotics. He asked pointed questions about how data should and could be sent to robots across a network. Citing companies who already excel in networked operations – including Google and Amazon – he wondered if robots could learn from human actions and subsequently teach each other. The future of robotics seems to lie in a combination of harnessing big data, improved computing power, and inclusion of robots into the internet of things.

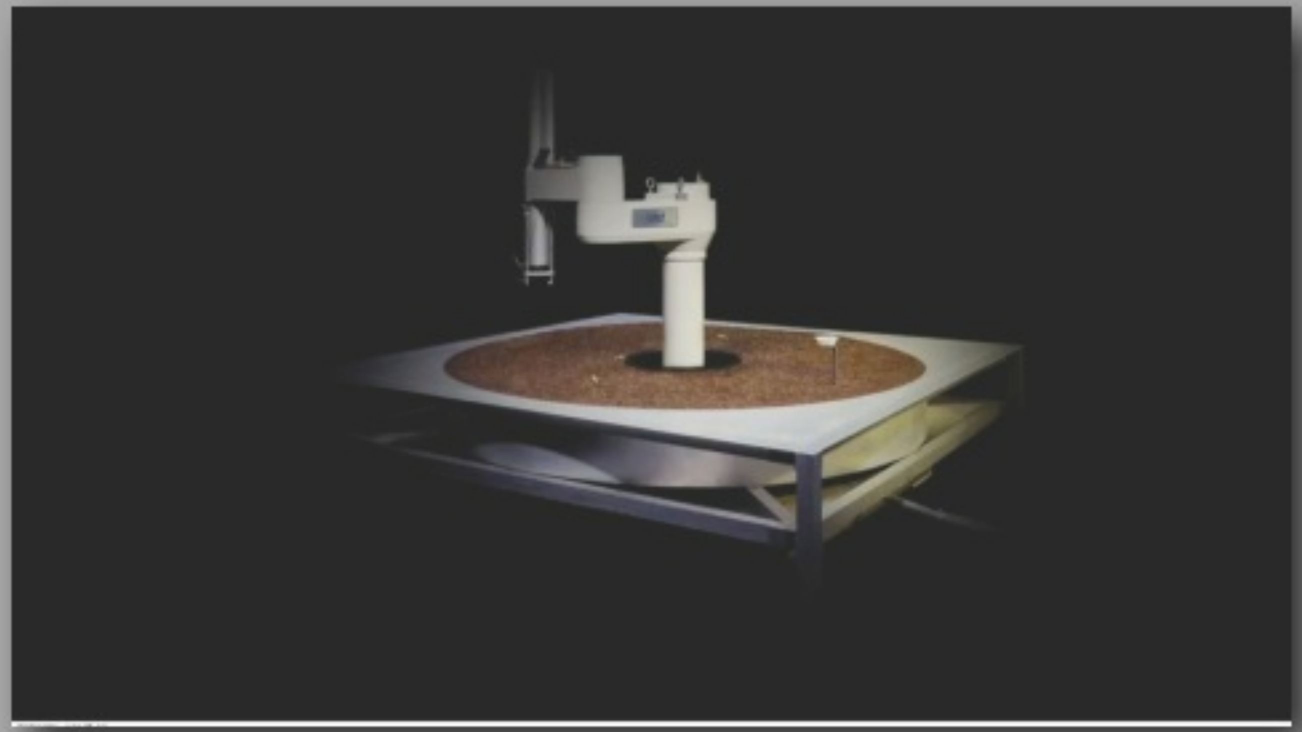

CLOUD ROBOTICS
Ken Goldberg, UC Berkeley


the
Art, Technology, & Culture
colloquium
ATC.BERKELEY.EDU


1993...

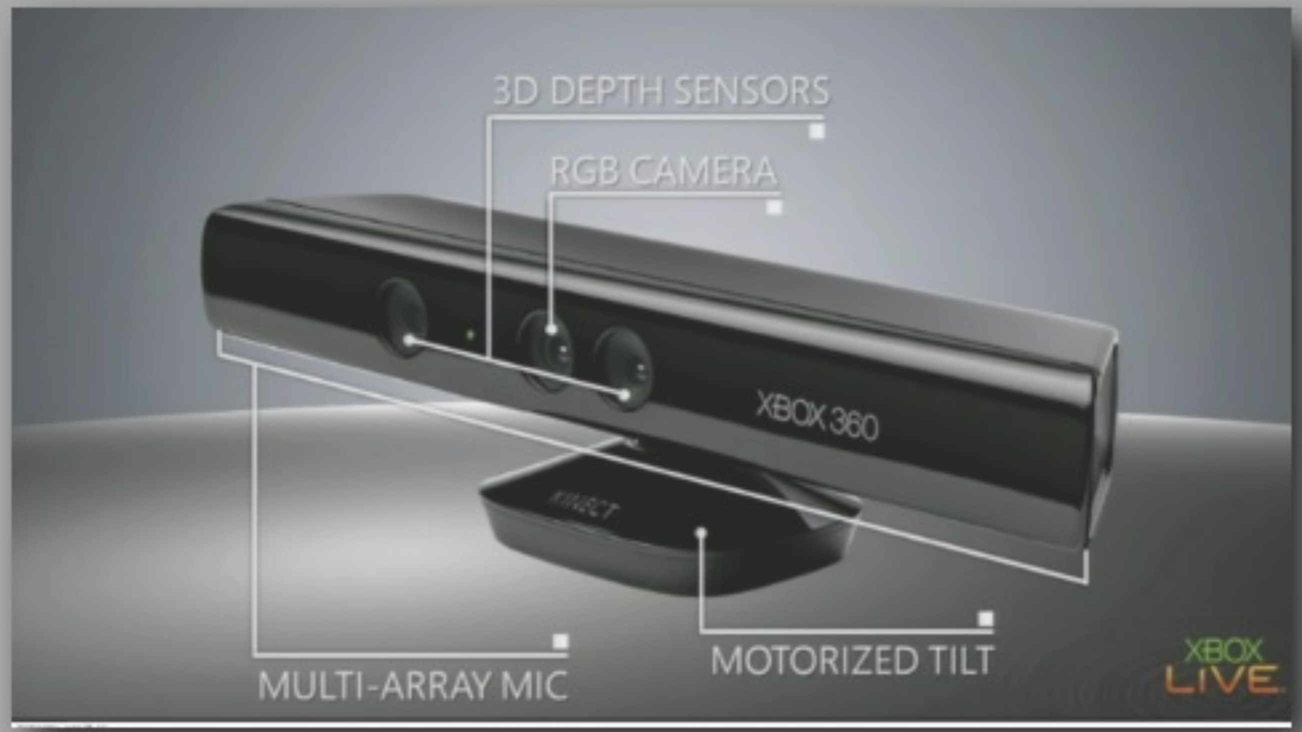

TELEGARDEN


SECTOR: P4
Help
Water
(Plant)
Options
Comments
Aerial
Movie
Info



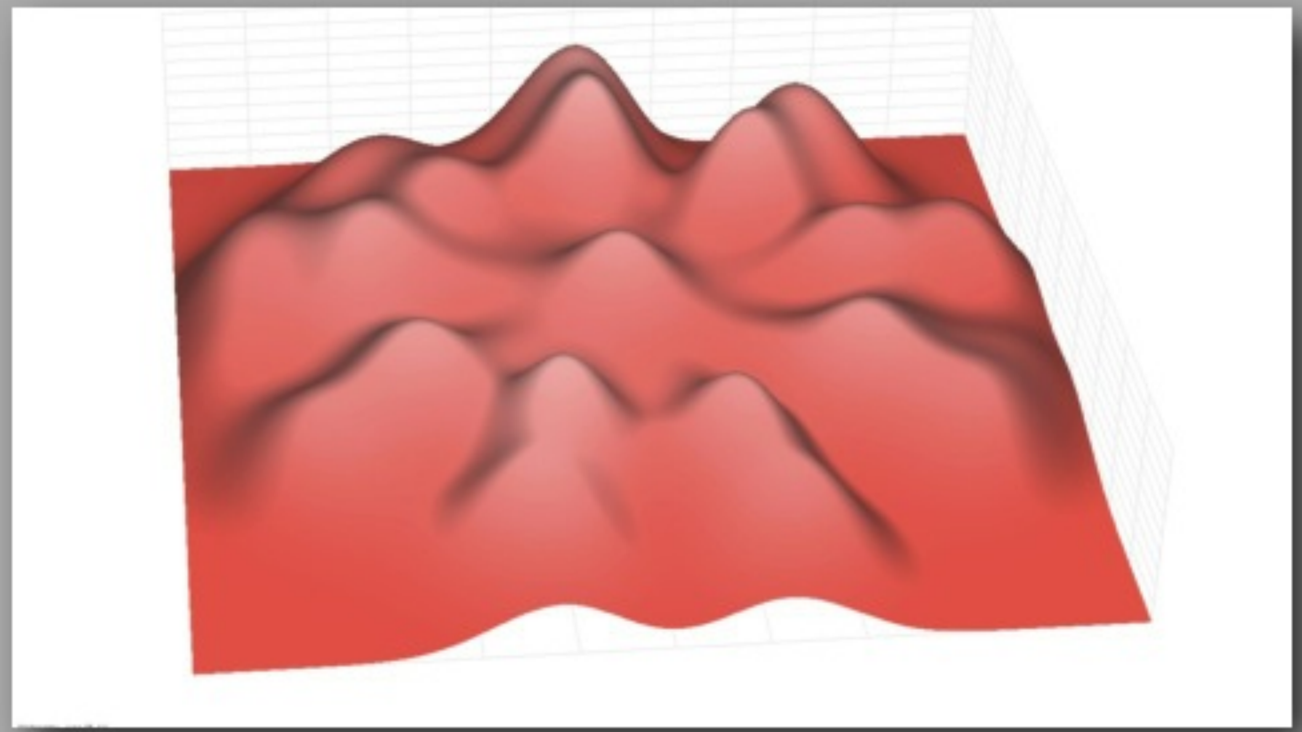

...2014.

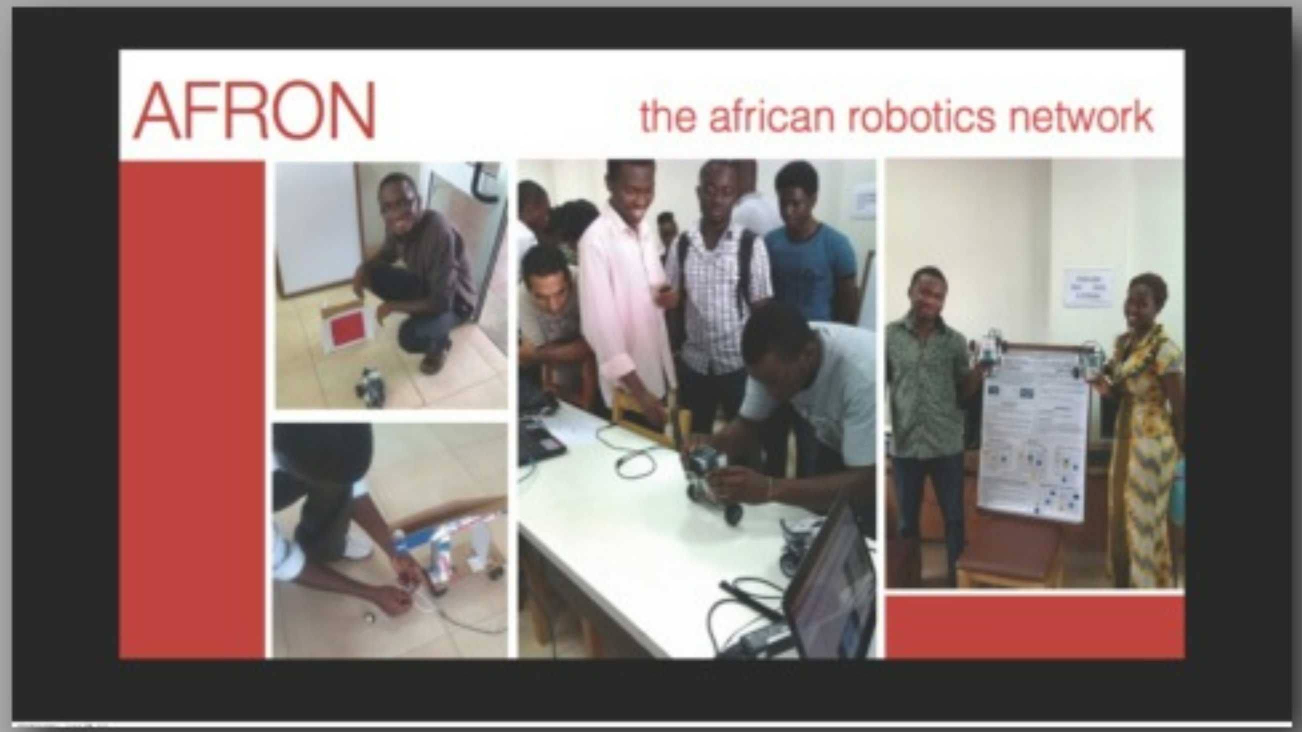

5,000,000 Service Robots
10,000 Defense Robots
2,000 surgical Robots

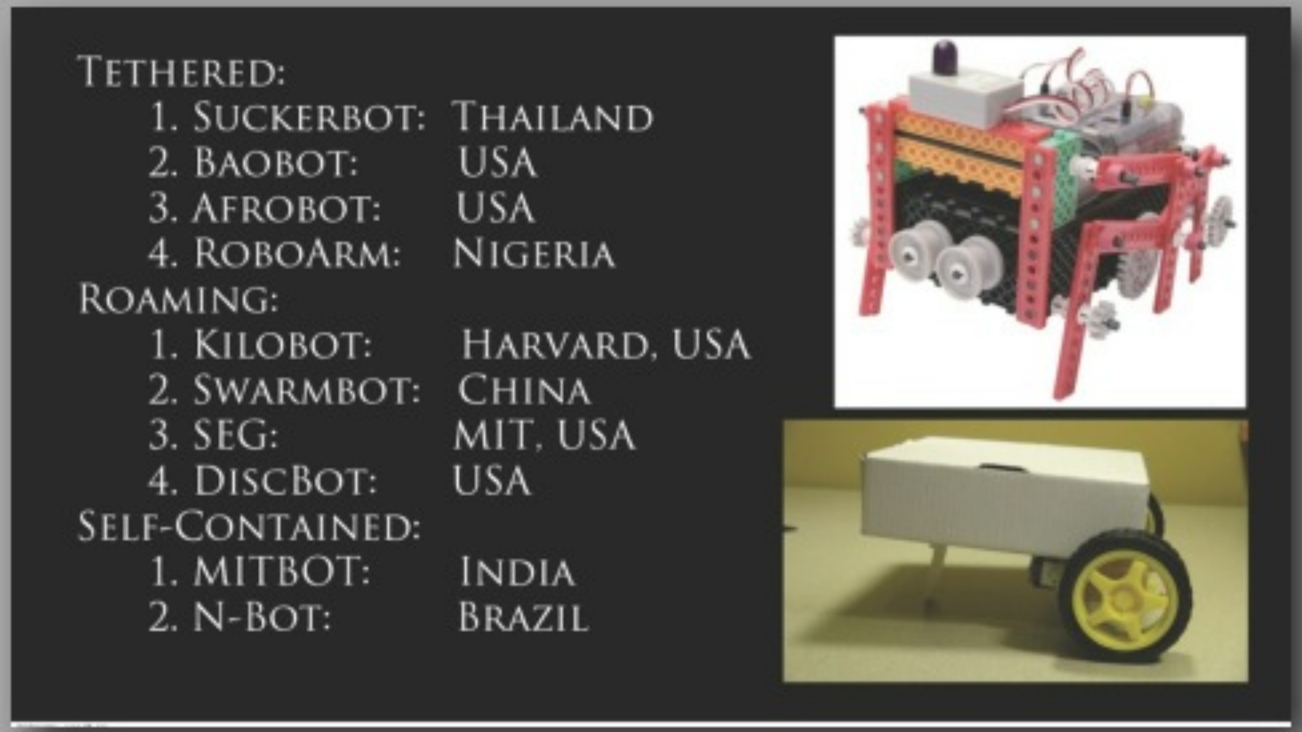


A ROBOT WILL BE TRULY AUTONOMOUS WHEN YOU INSTRUCT IT TO GO TO WORK AND IT DECIDES TO GO TO THE BEACH INSTEAD.

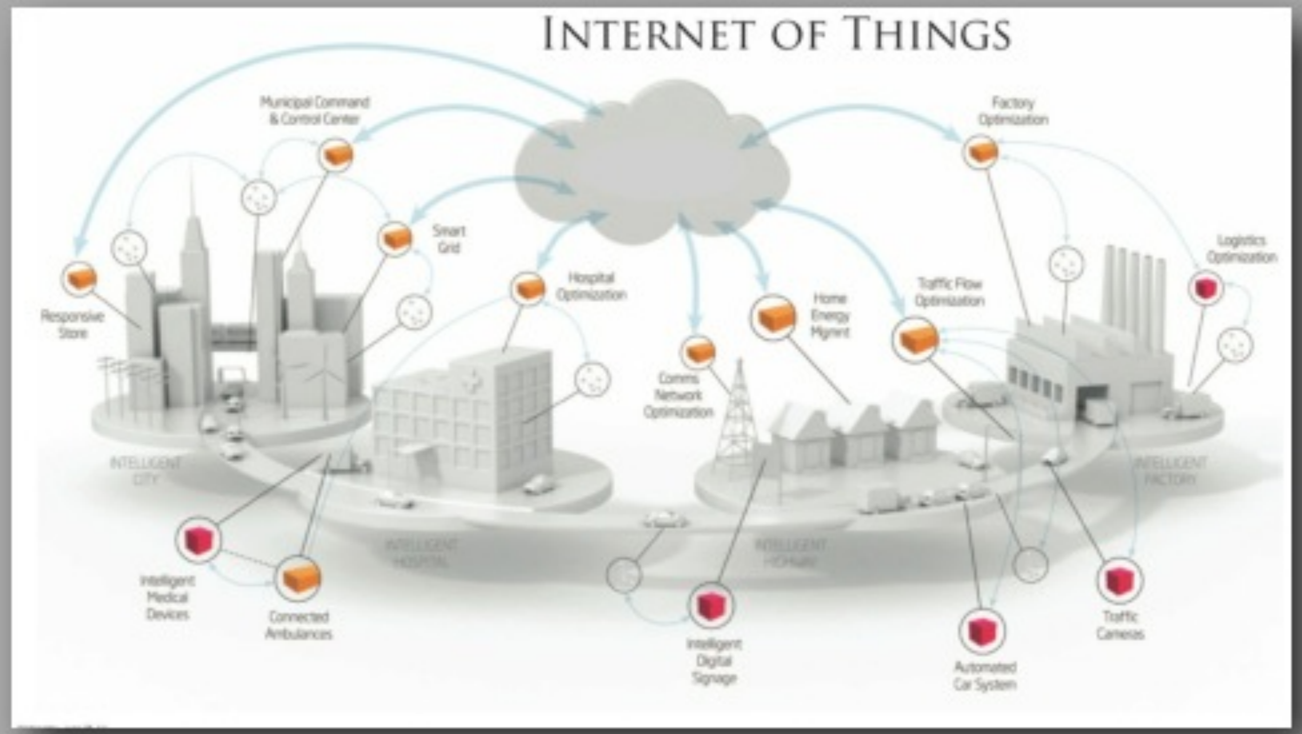
- BRAD TEMPLETON



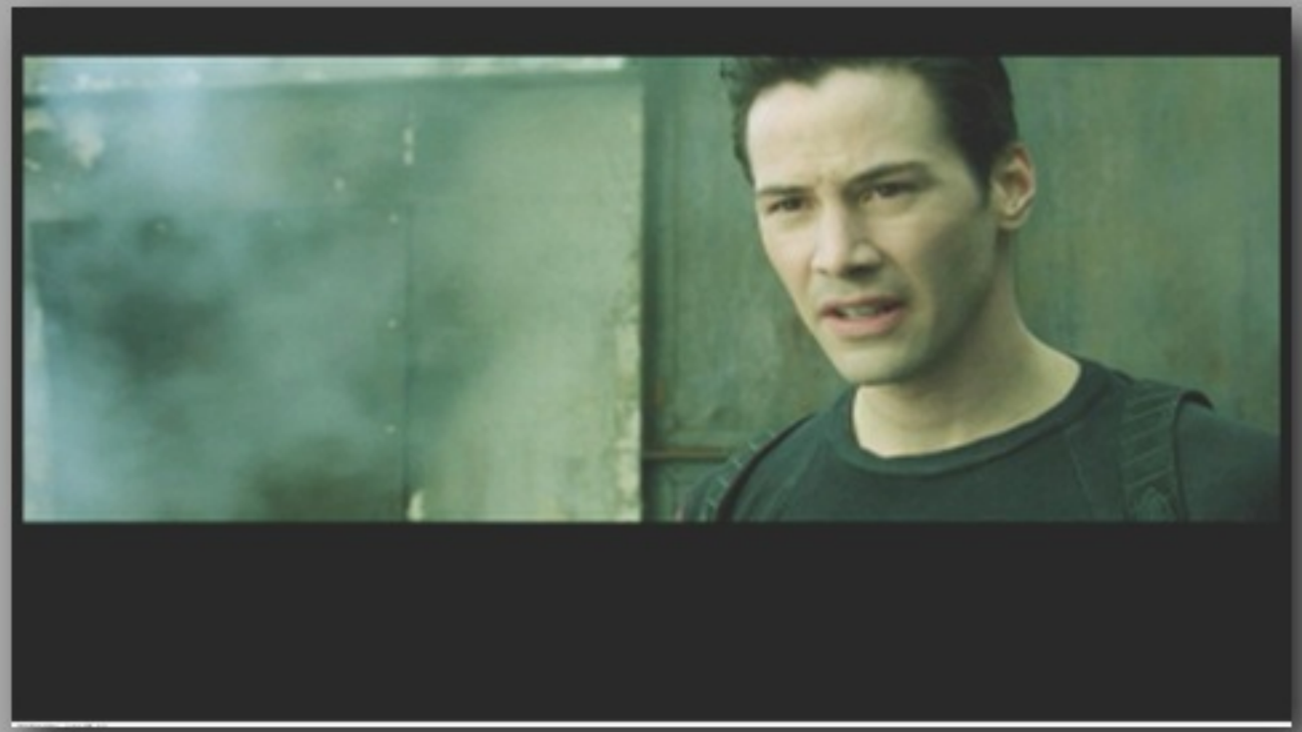

AFRON
the african robotics network

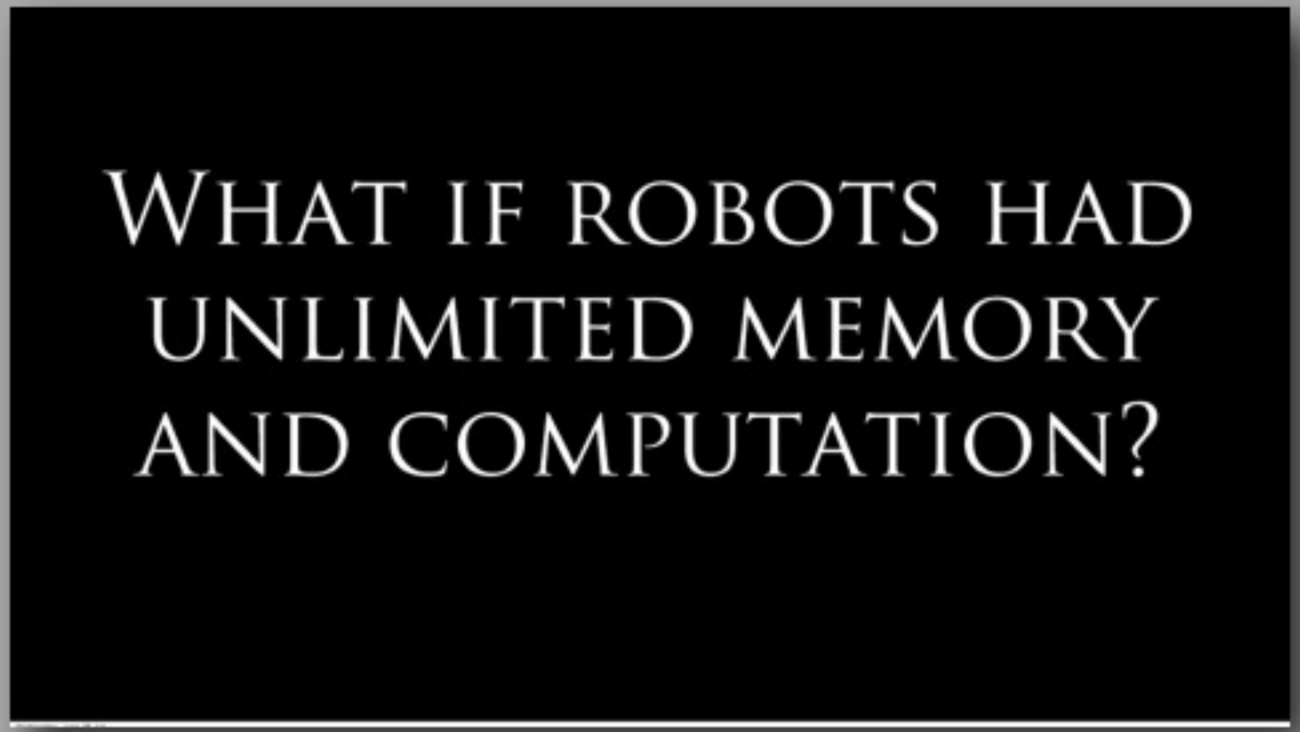

Tethered:
1. Suckerbot: Thailand
2. Baobot: USA
3. Afrobot: USA
4. RoboArm: Nigeria
Roaming:
1. Kilobot: Harvard, USA
2. Swarmbot: China
3. SEG: MIT, USA
4. DiscBot: USA
Self-Contained:
1. MITbot: India
2. N-Bot: Brazil


LollyBot


INTERNET OF THINGS

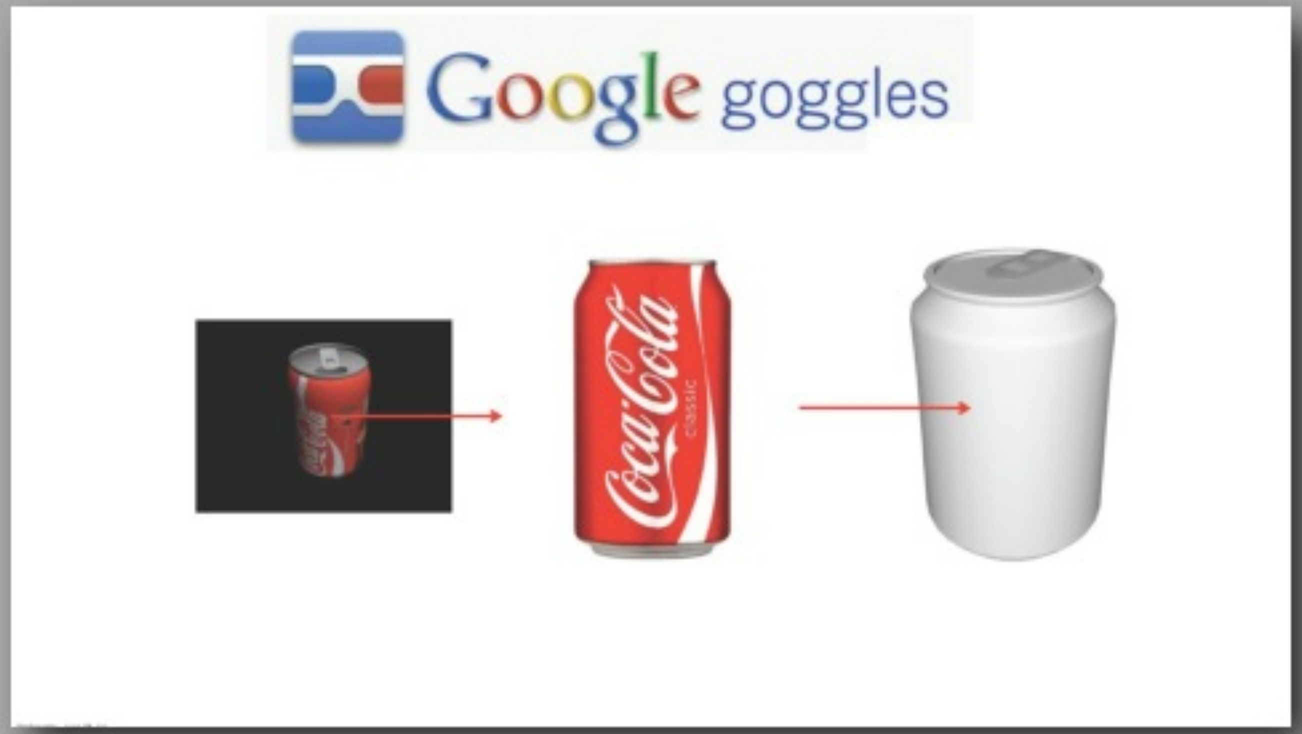

CLOUD ROBOTICS
1. BIG DATA: IMAGES, MAPS, MODELS
2. CLOUD COMP.: EC2 FOR STATISTICAL LEARNING
3. OPEN-SOURCE: HUMANS SHARING CODE, DATA, DESIGNS
4. ROBOT LEARNING: ROBOTS SHARING DATA, OUTCOMES
5. CALL CENTERS: ON-DEMAND HUMAN GUIDANCE

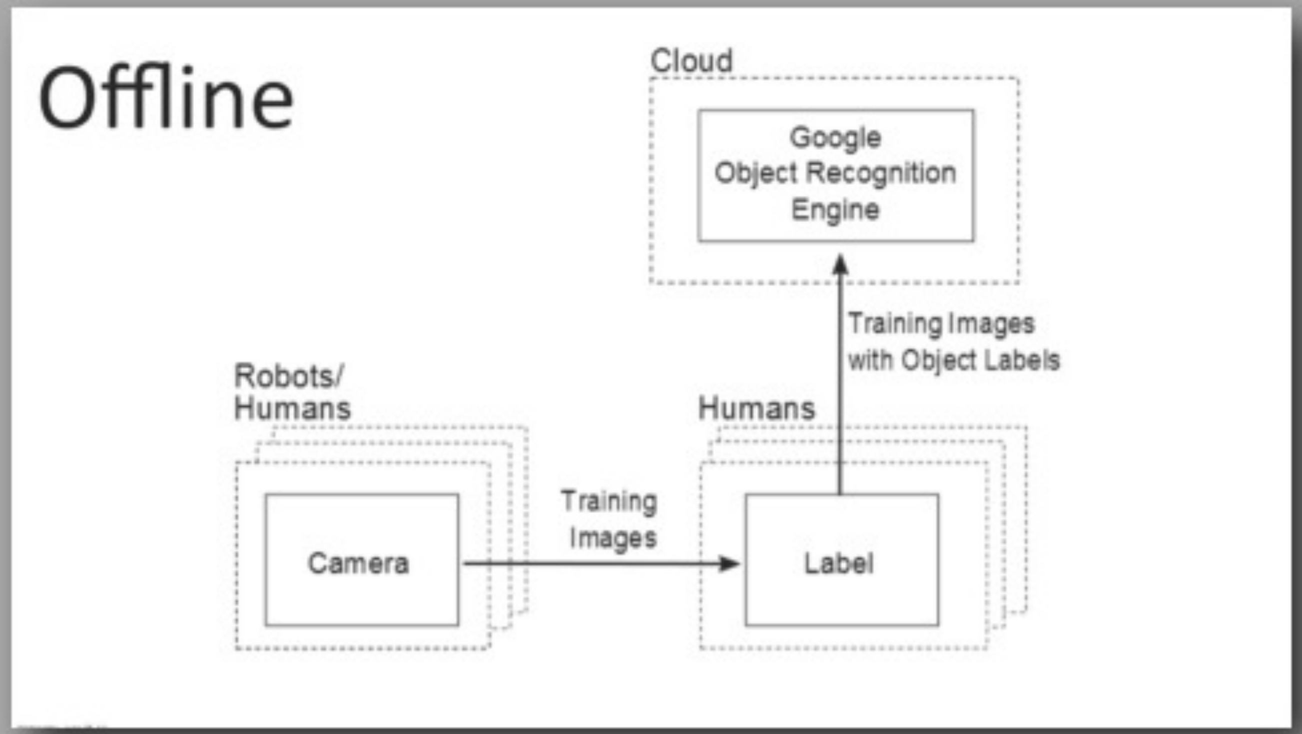


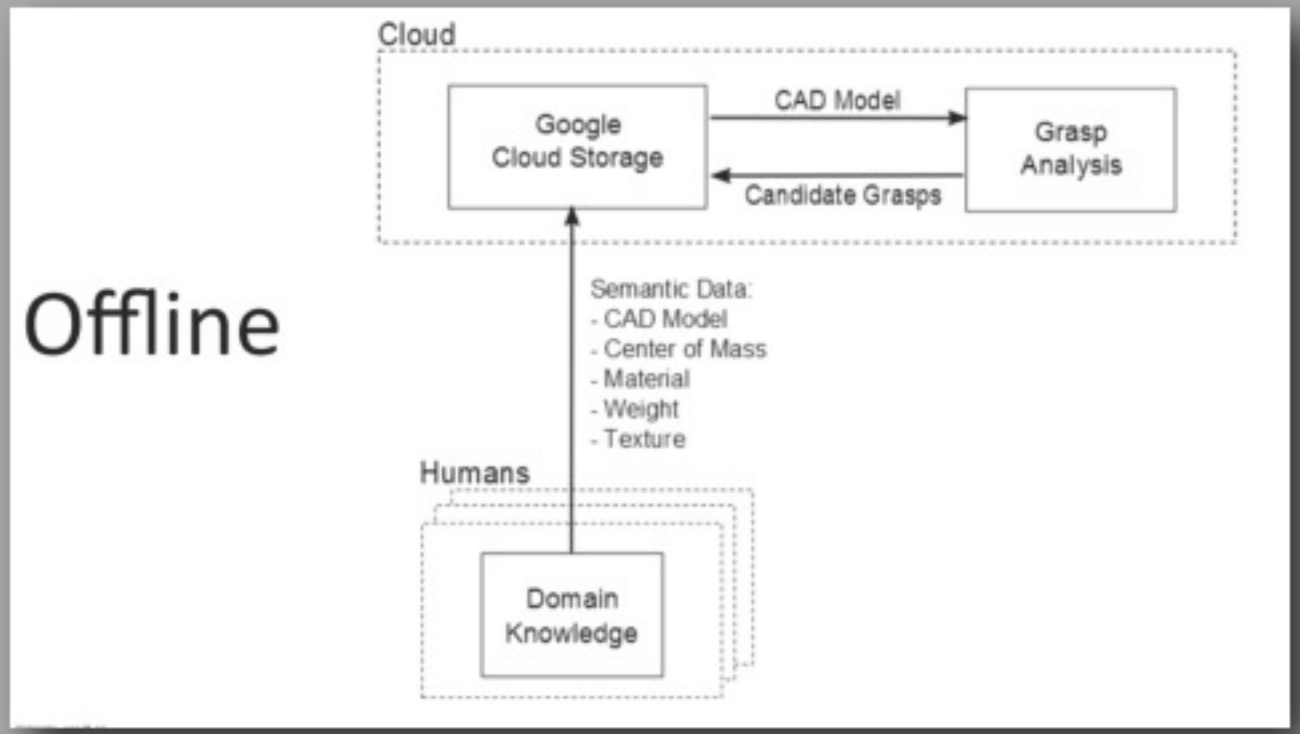

WHAT IF ROBOTS HAD UNLIMITED MEMORY AND COMPUTATION?

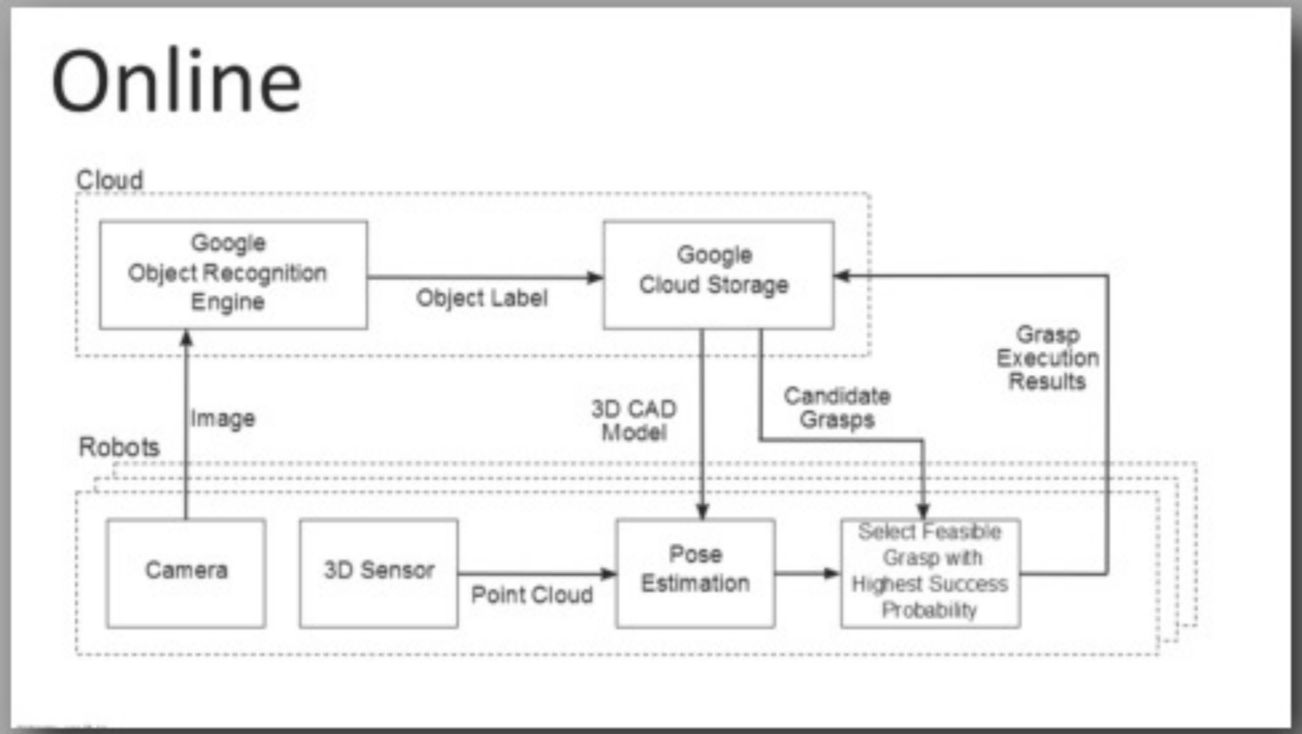

OUTLINE
INTRODUCTION
GRASPING
SHAPE UNCERTAINTY
OBJECT IDENTIFICATION
HEALTHCARE
RADIATION THERAPY
"SUPERHUMAN" SURGERY
FUTURE DIRECTIONS


Google goggles
terrazas de los andes
Product Search


Google goggles
Coca-Cola







Outline

Introduction

Grasping

Shape Uncertainty

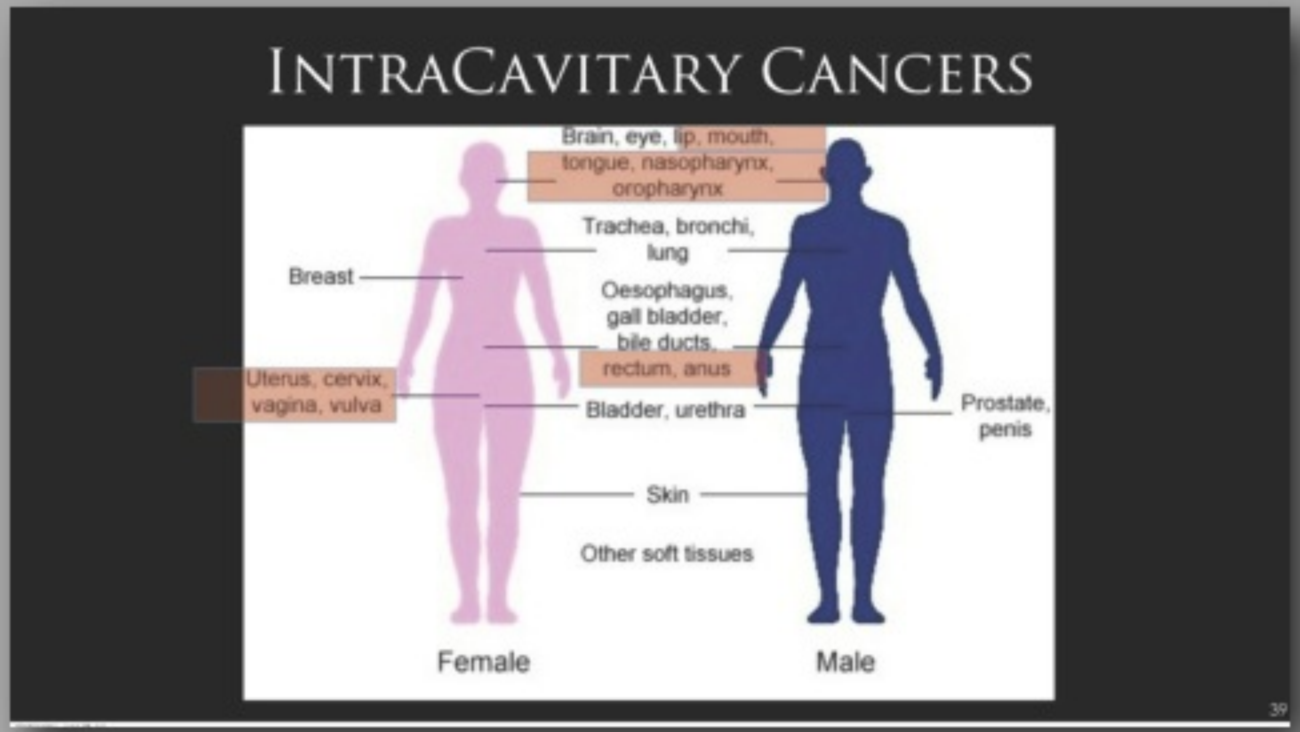
Object identification

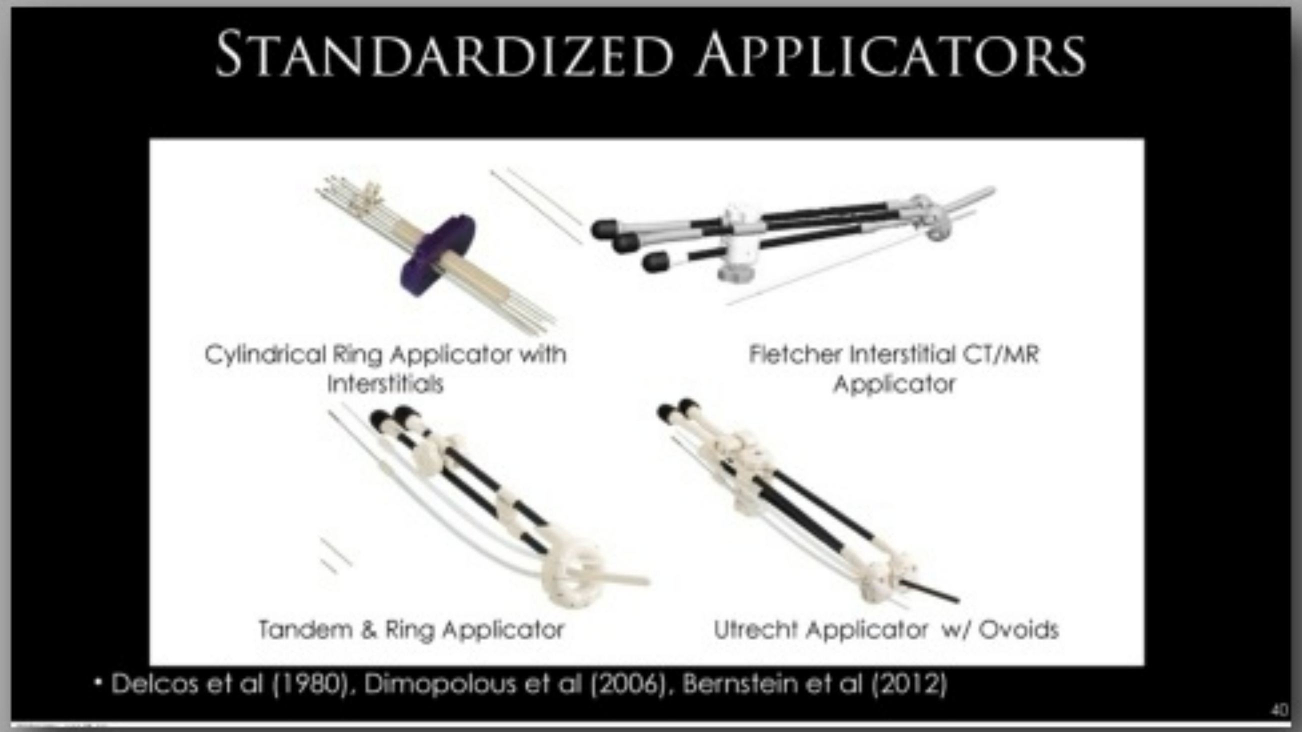
Healthcare

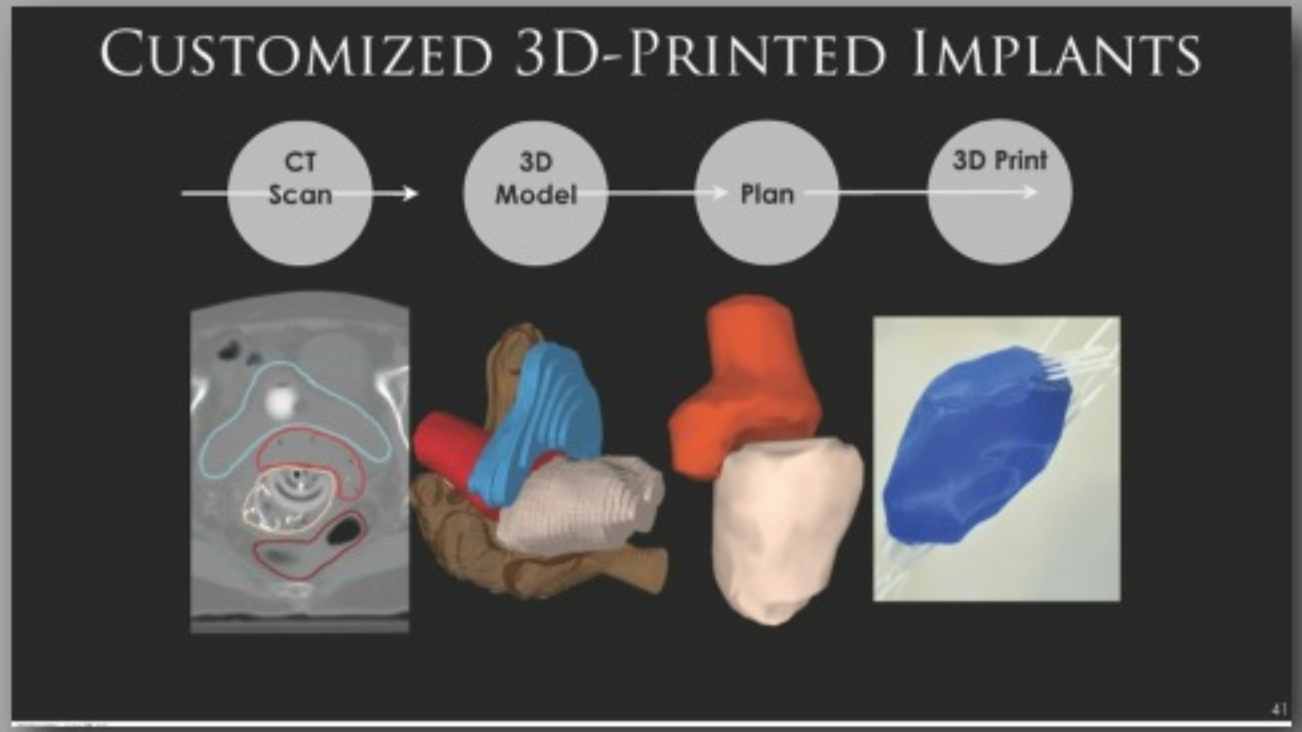
Radiation Therapy

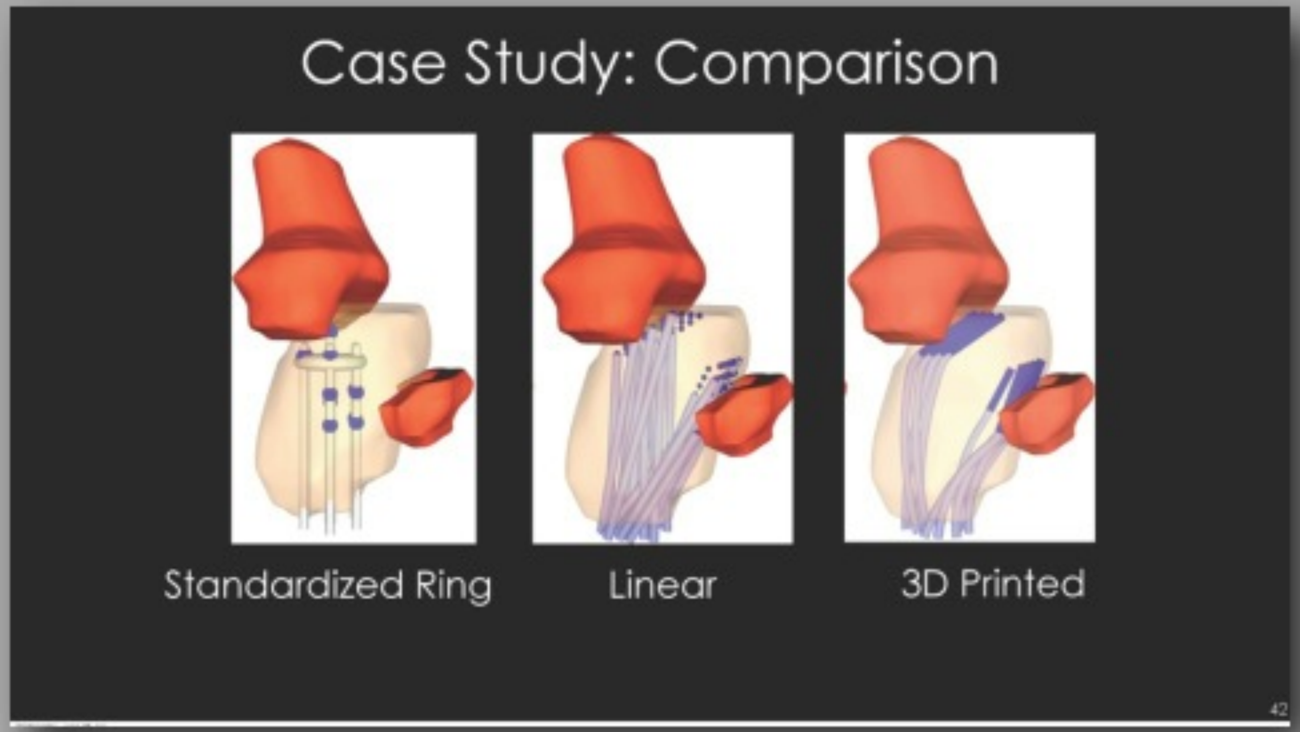
"Superhuman" Surgery

Future Directions









Outline

Intro: 5 Reasons

Cloud-Enabled Grasping

Stochastic Shape Uncertainty

Object ID w/Google Goggles

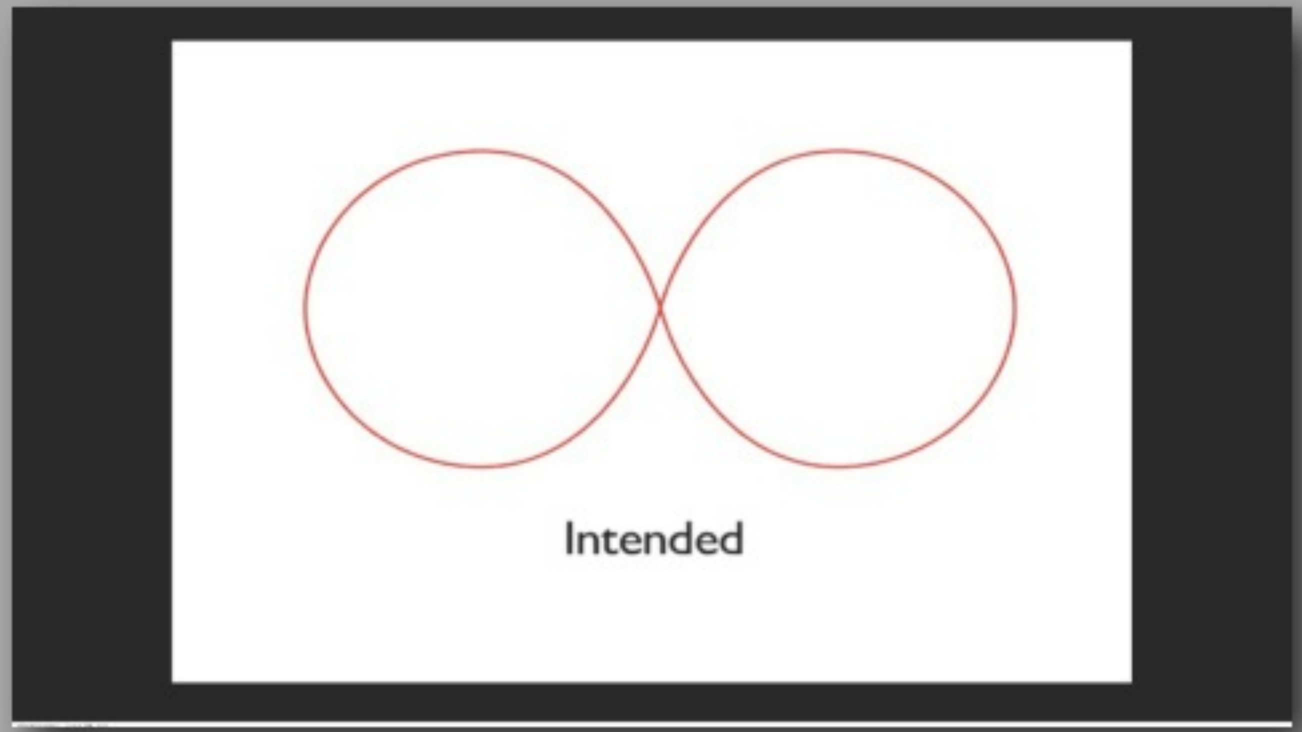
Cloud-Enabled Surgery

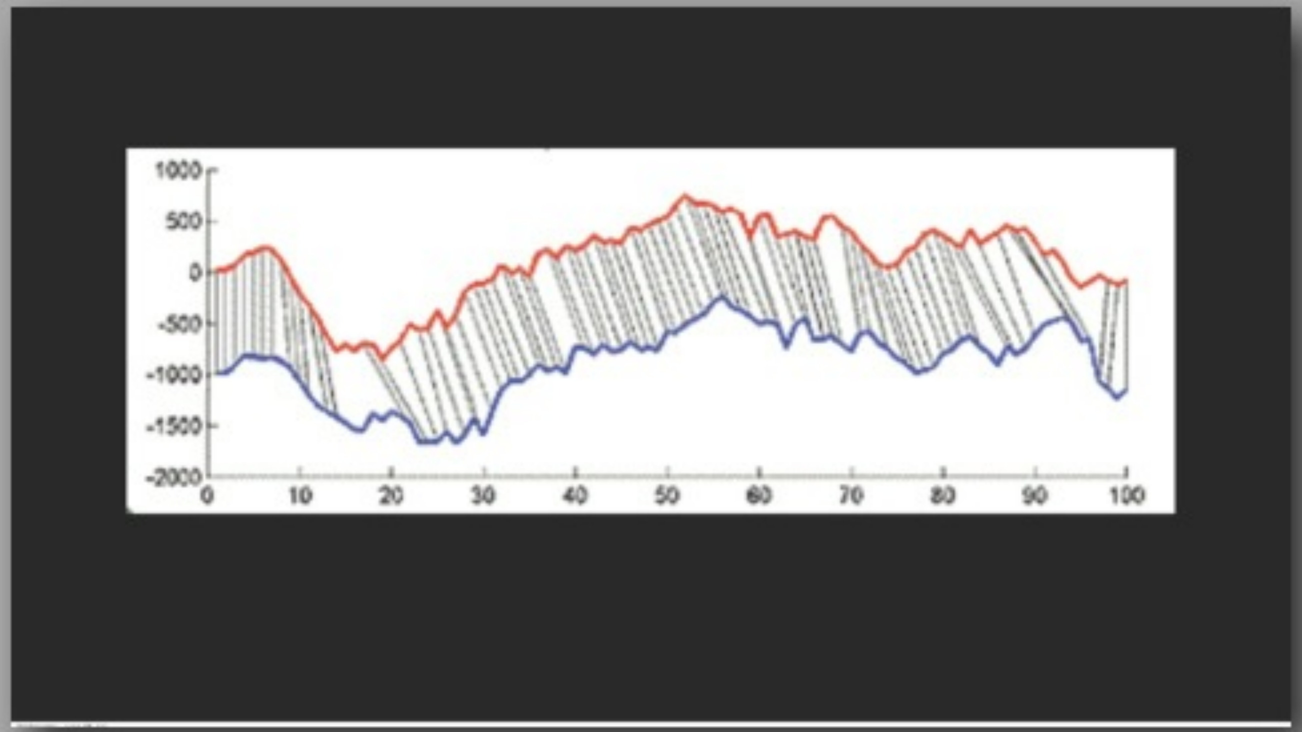
Robot-Assisted Brachytherapy

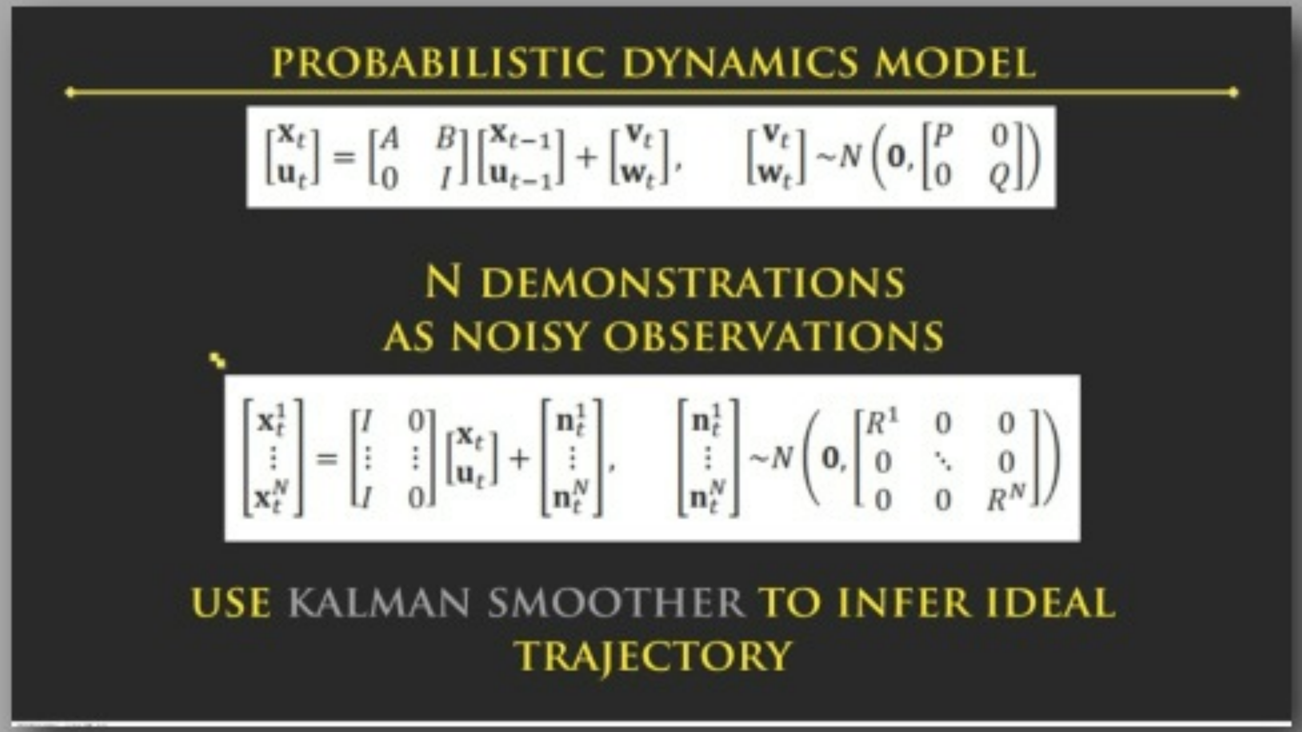
"Superhuman" Surgery

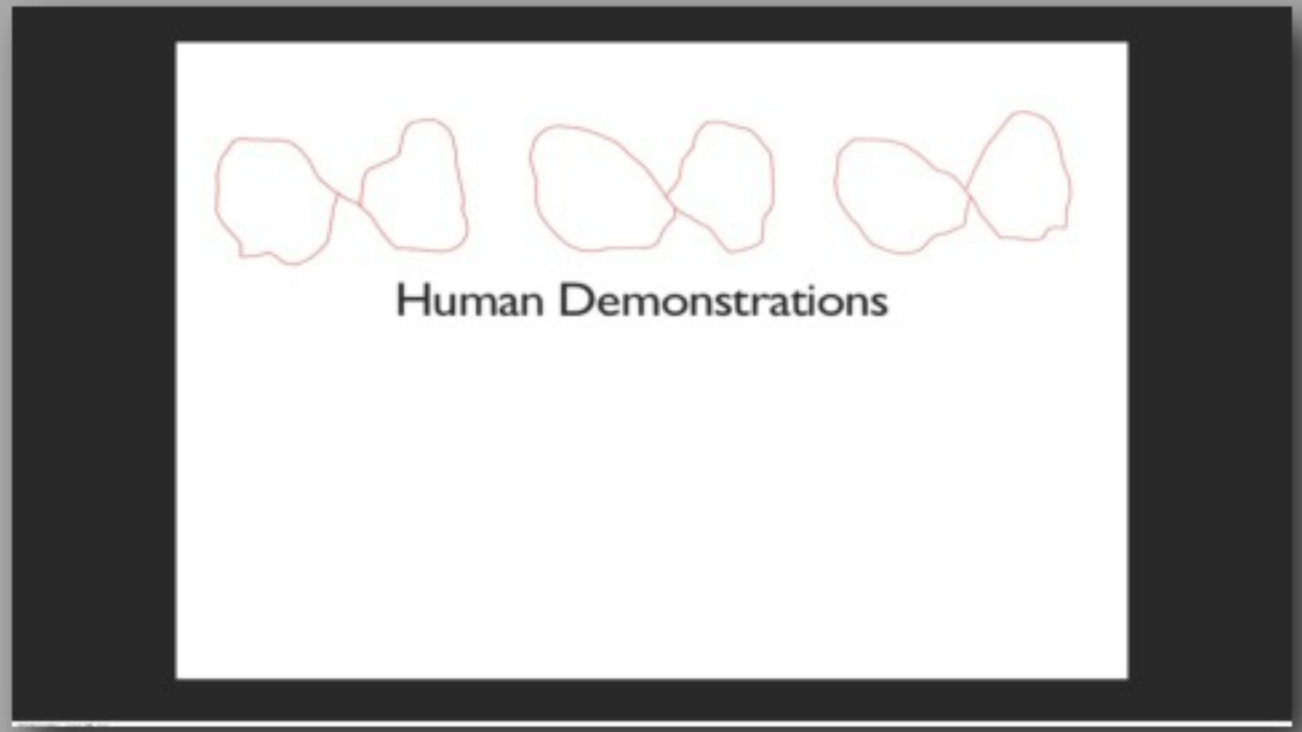
Future Directions

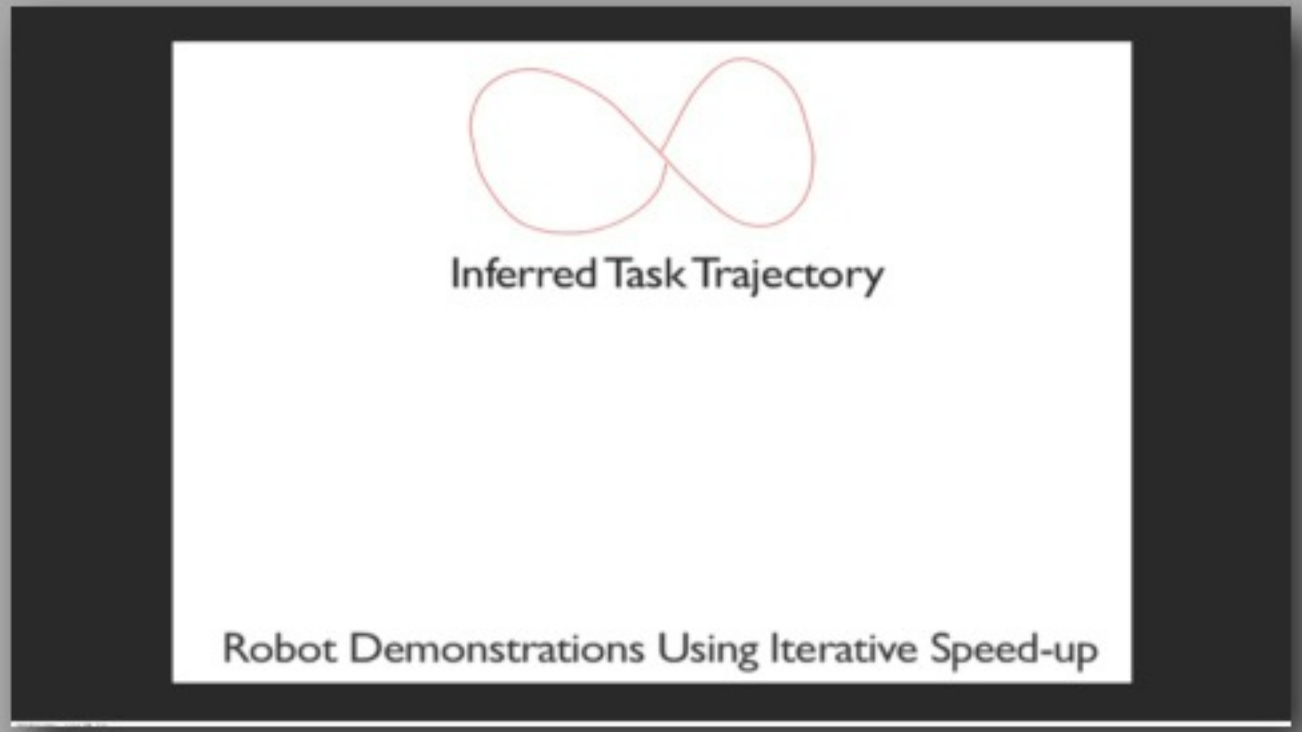

Sideways Flip


Intended


1000
500
0
-500
-1000
-1500
-2000
0
10
20
30
40
50
60
70
80
90
100


PROBABILISTIC DYNAMICS MODEL
$\begin{bmatrix}\mathbf{x}_t\\ \mathbf{u}_t\end{bmatrix} = \begin{bmatrix}A & B\\ 0 & I\end{bmatrix}\begin{bmatrix}\mathbf{x}_{t-1}\\ \mathbf{u}_{t-1}\end{bmatrix} + \begin{bmatrix}\mathbf{v}_t\\ \mathbf{w}_t\end{bmatrix}, \quad \begin{bmatrix}\mathbf{v}_t\\ \mathbf{w}_t\end{bmatrix} \sim N\left(\mathbf{0}, \begin{bmatrix}P & 0\\ 0 & Q\end{bmatrix}\right)$
N DEMONSTRATIONS
AS NOISY OBSERVATIONS
$\begin{bmatrix}\mathbf{x}_t^1\\ \vdots\\ \mathbf{x}_t^N\end{bmatrix} = \begin{bmatrix}I & 0\\ \vdots & \vdots\\ I & 0\end{bmatrix}\begin{bmatrix}\mathbf{x}_t\\ \mathbf{u}_t\end{bmatrix} + \begin{bmatrix}\mathbf{n}_t^1\\ \vdots\\ \mathbf{n}_t^N\end{bmatrix}, \quad \begin{bmatrix}\mathbf{n}_t^1\\ \vdots\\ \mathbf{n}_t^N\end{bmatrix} \sim N\left(\mathbf{0}, \begin{bmatrix}R^1 & 0 & 0\\ 0 & \ddots & 0\\ 0 & 0 & R^N\end{bmatrix}\right)$
USE KALMAN SMOOTHER TO INFER IDEAL TRAJECTORY


Human Demonstrations


Inferred Task Trajectory
Robot Demonstrations Using Iterative Speed-up

Related Work:

[19] Rajesh Arumugam, V.R. Enti, Liu Bingbing, Wu Xiaojun, Krishnamoorthy Baskaran, F.F. Kong, A.S. Kumar, K.D. Meng, and G.W. Kit. DAvinCi: A Cloud Computing Framework for Service Robots. In IEEE International Conference on Robotics and Automation, pages 3084{3089. IEEE, 2010.
[20] Luigi Atzori, Antonio Iera, and Giacomo Morabito. The Internet of Things: A Survey. Computer Networks, 54(15):2787{2805, October 2010.
[21] Dmitry Berenson, Pieter Abbeel, and Ken Goldberg. A Robot Path Planning Framework that Learns from Experience. IEEE International Conference on Robotics and Automation, pages 3671{3678, May 2012.
[22] Bharat Bhargava, Pelin Angin, and Lian Duan. A Mobile-Cloud Pedestrian Crossing Guide for the Blind. In International Conference on Advances in Computing & Communication, 2011.
[23] Matei Ciocarlie, Kaijen Hsiao, E. G. Jones, Sachin Chitta, R.B. Rusu, and I.A. Sucan. Towards Reliable Grasping and Manipulation in Household Environments. In Intl. Symposium on Experimental Robotics, pages 1{12, New Delhi, India, 2010.
[24] Matei Ciocarlie, Caroline Pantofaru, Kaijen Hsiao, Gary Bradski, Peter Brook, and Ethan Dreyfuss. A Side of Data With My Robot. IEEE Robotics & Automation Magazine, 18(2):44{57, June 2011.
[30] Zhihui Du, Weiqiang Yang, Yinong Chen, Xin Sun, Xiaoying Wang, and Chen Xu. Design of a Robot Cloud Center. In International Symposium on Autonomous Decentralized Systems, pages 269{275. IEEE, March 2011.
[39] Eric Guizzo. Cloud Robotics: Connected to the Cloud, Robots Get Smarter, 2011.

Survey article (2014):
http://goldberg.berkeley.edu/cloud-robotics/

IEEE TRANSACTIONS ON
AUTOMATION SCIENCE AND ENGINEERING

Automation plays an increasingly important role in the global economy and in our daily lives. Automation is changing manufacturing as well as healthcare, security, and energy. The IEEE Transactions on Automation Science and Engineering (T-ASE) publishes new abstractions, algorithms, theory, methodologies, models, systems, and case studies that can be applied across industries to significantly advance efficiency, quality, productivity, and reliability for society:

http://ieee-ras.org/publications/t-ase

Google

cisco

NSF

Thank you.

"Man is a robot...with defects."
- Emile Cioran

@ken_goldberg, UC Berkeley


IDEA
Diego
Tamburini

11_ Jeff Kramer

MTD Products

"I'm interested in autonomous systems and robotics."

Challenges in Creating Next-Gen Robotics

Kramer identified five major challenges in manufacturing: sensing, perception, integration, control and cost. Of these, sensor innovation is perhaps the most important to pursue, as it is often the robot's ability to sense that bottleneck design and implementation. In terms of how robotics affects the work itself, the value of robots is not their speed but their accuracy. Dynamic, autonomous, multi-purpose robot are a dream until human workers can be more flexible.

Challenges in Robotics

Jeff Kramer

Who am I?

Lead Robotics Engineer

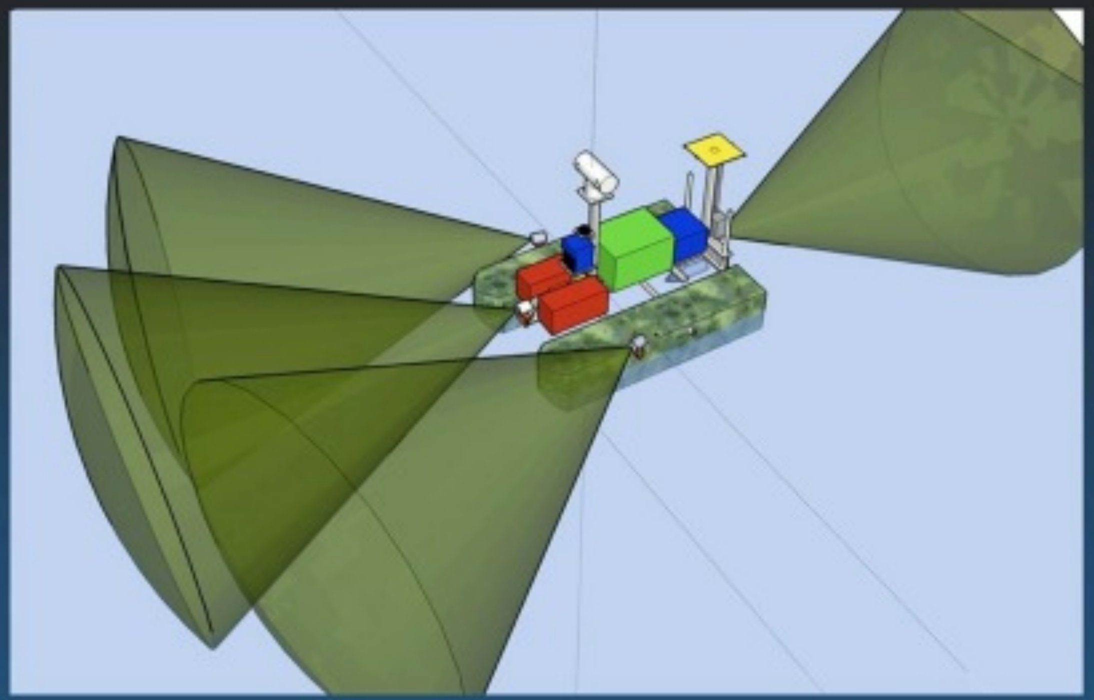
MTD

For A Growing World.™

A few past projects…

Sensing, perception and cost were the biggest issues

Sensing was the biggest issue



Sensing and perception was the biggest issue

NATIONAL ROBOTICS
NREC
ENGINEERING CENTER
THE ROBOTICS INSTITUTE
Carnegie Mellon

HYBRID SAFETY SYSTEM

SPONSORED BY OFFICE OF NAVAL RESEARCH UNDER CONTRACT #N00014-03-C-0413

DISTRIBUTION A
APPROVED FOR PUBLIC RELEASE DISTRIBUTION IS UNLIMITED
CASE #43-078-12

Sensing and integration were the biggest issues

COMMAND FOR HAULING

Sensing, perception and integration were the biggest issues

Solution simulation: forklifts w/robotic arms. End effectors contain lasers, sensors, cameras & vacuums.

Sensing, control and integration were the biggest issues

Integration is the biggest issue

A Consumer Robotics Product

Sensing and cost are the biggest issues

Sensors are a bottleneck

Cost
Capability
Power
Size

Perception follows

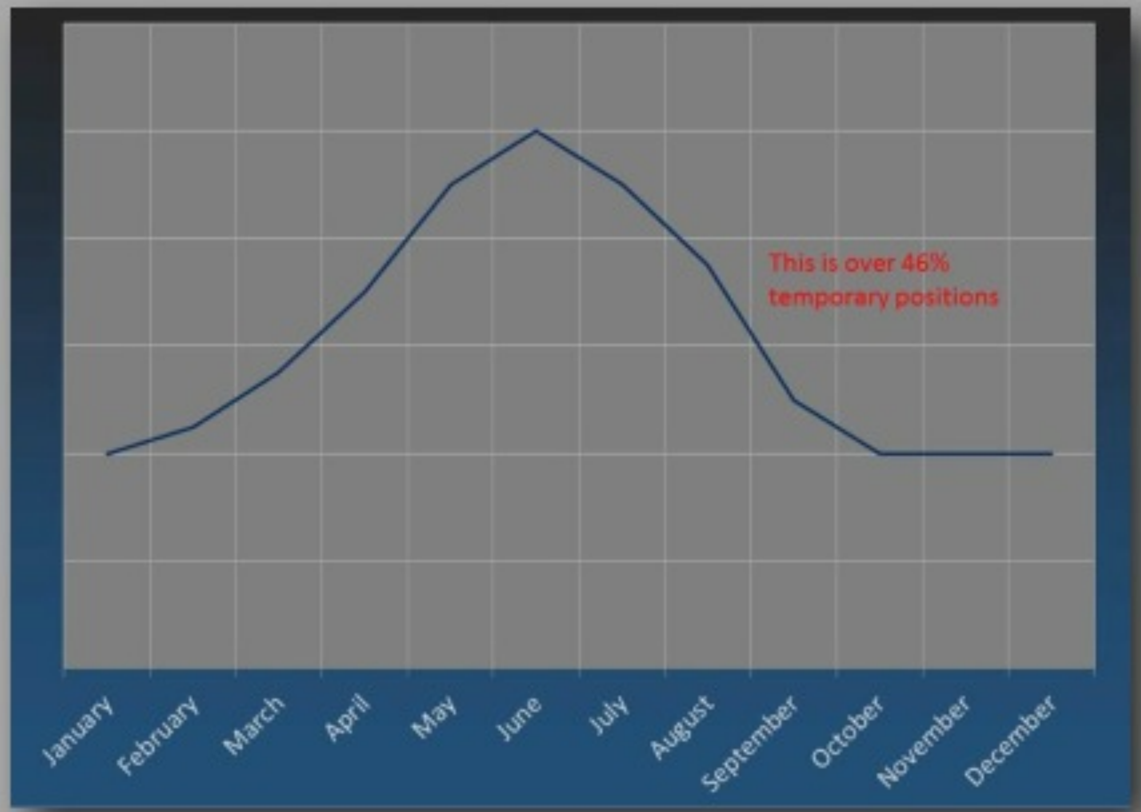
Challenges in the Industry

Industrial Robots

The real value of industrial robots is in quality, not speed or cost

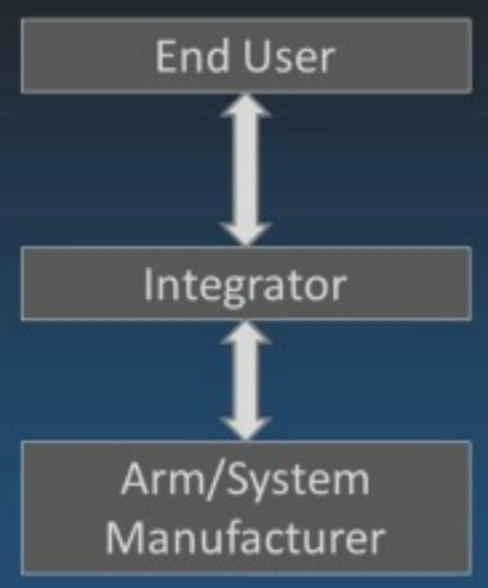
Industrial robots are too expensive and don’t do enough quickly

The current “robots will take our jobs” lede is misguided



Humans are adaptable

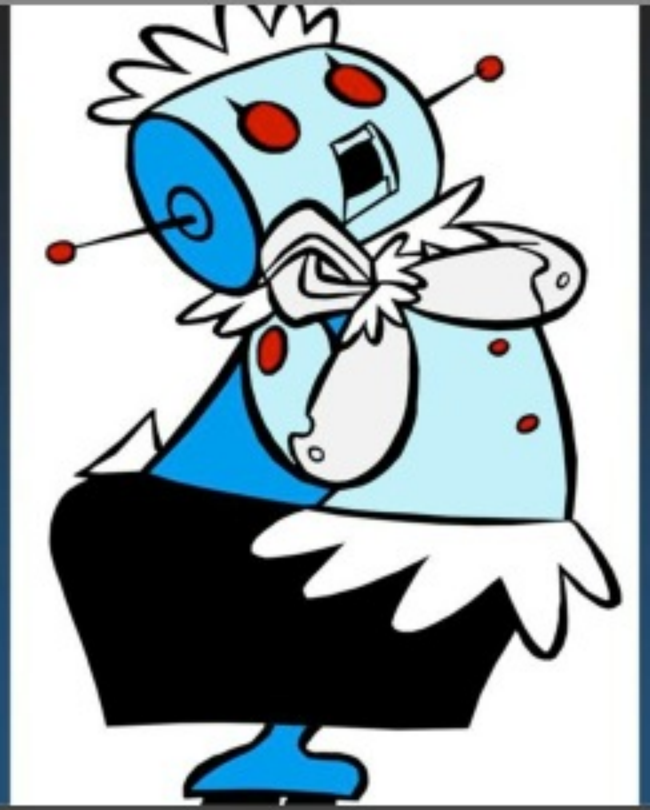
Integration Mistakes/Problems



Consumer Robotics

Consumer robots suffer from science fiction bias

We can do anything…



…but that.

A robot is a robot until it works well.
Then it is just a tool.

Robots looking for a purpose

Generality kills a robot product

Cost

Anchoring

Sensors
Batteries
Motors

User Experience Challenges

Building a robot for the real consumer

Thank you

11_Chad Sweet

Qualcomm

"I'm interested in intelligence in robotic systems."

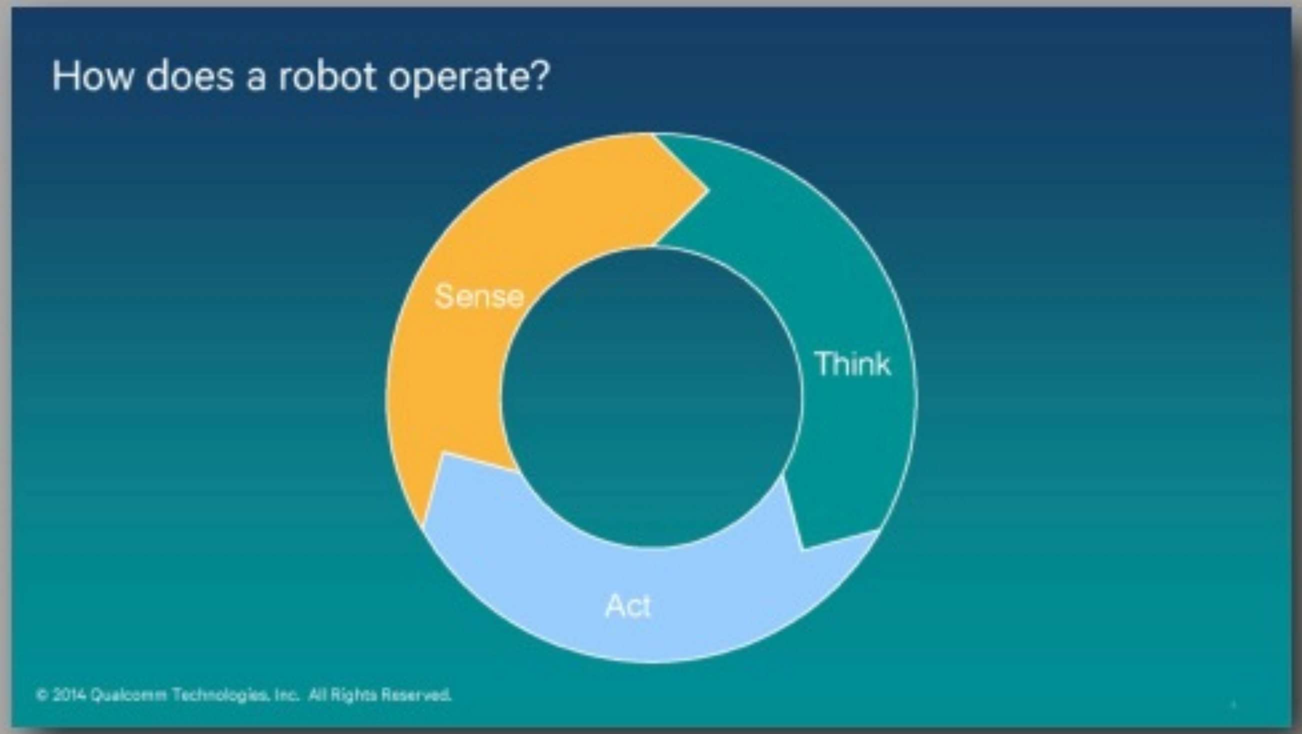
Areas of Research and Investigation

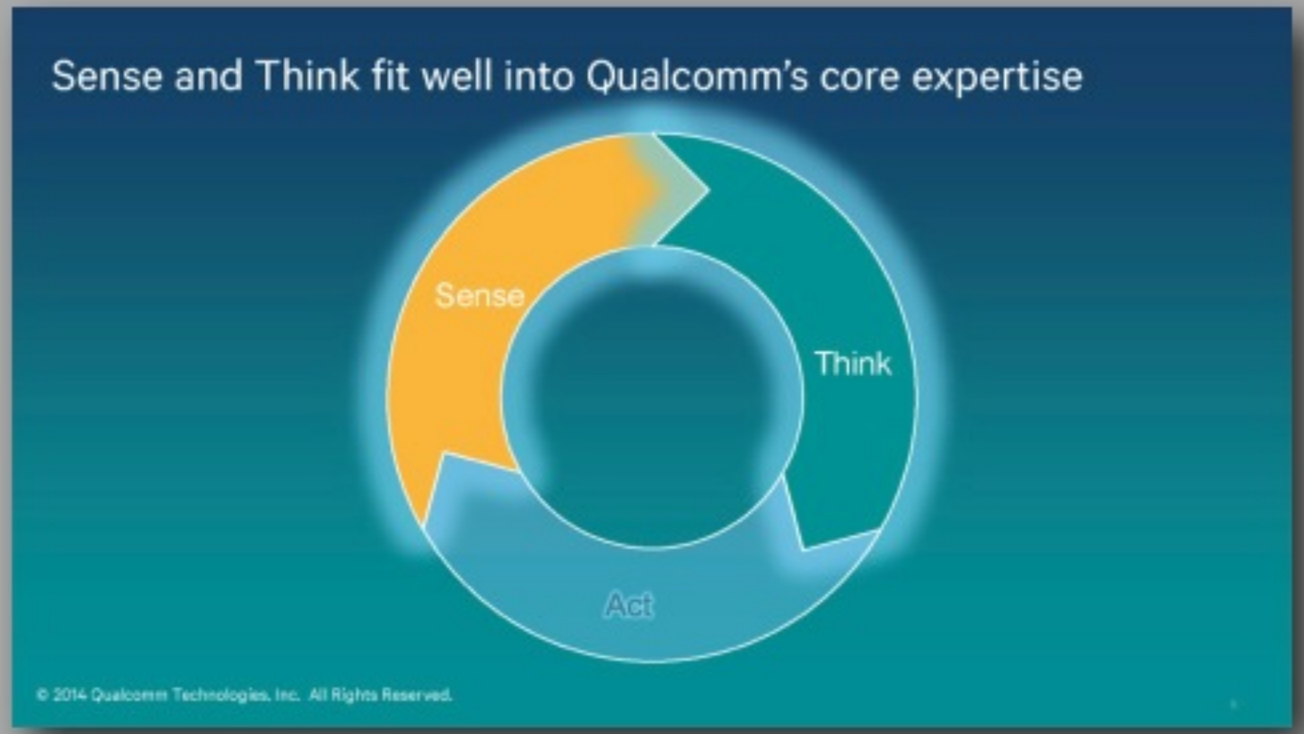
How might innovations in cell phone technology make better robots. Smart phones offer robotics developers high bandwidth processing, 10 sensors in most models as well as always-on context awareness. These factors help deal with the challenges modern robotics face in terms of helping them understand the world around them, in terms of cost (expensive 3D sensors), autonomous behavior (complex CPUs and NPUs) and actuation (the need for general purpose, time sensitive applications).

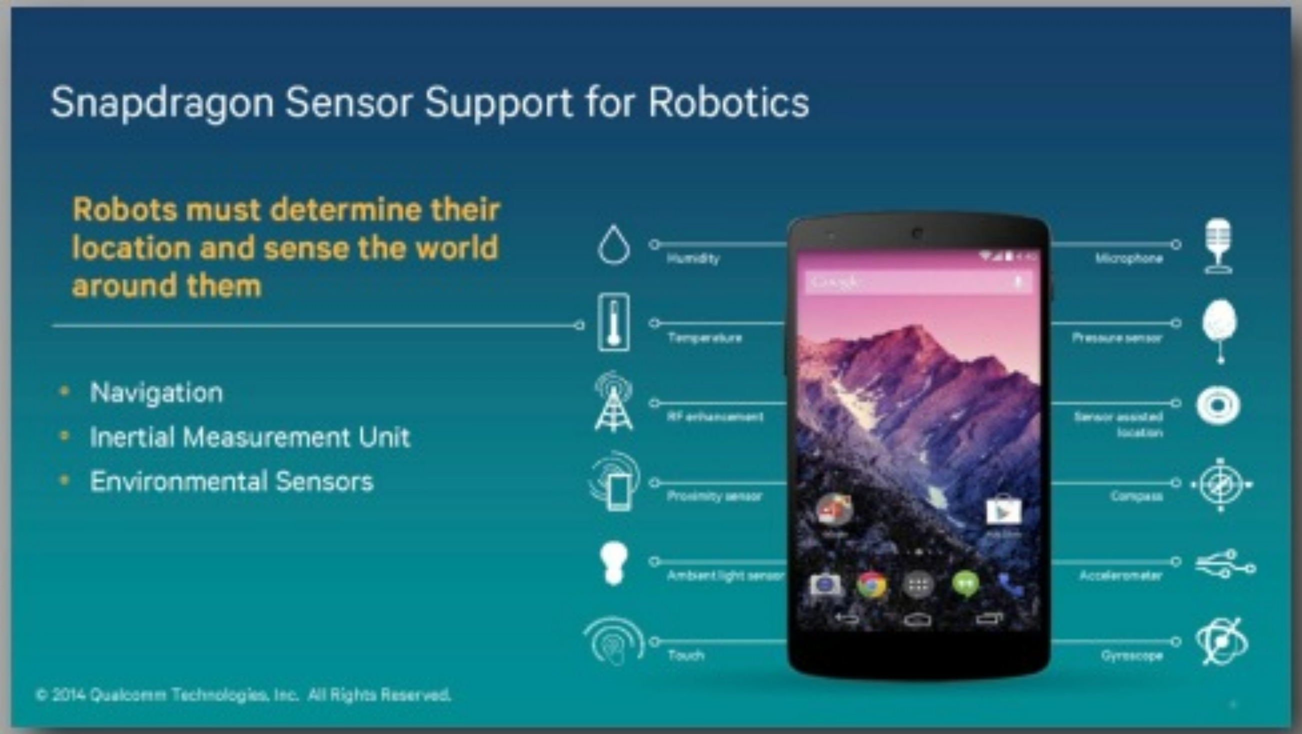

QUALCOMM


Chad Sweet
Director of Engineering
Qualcomm Technologies, Inc.
June 25, 2014
Qualcomm Robotics
QUALCOMM

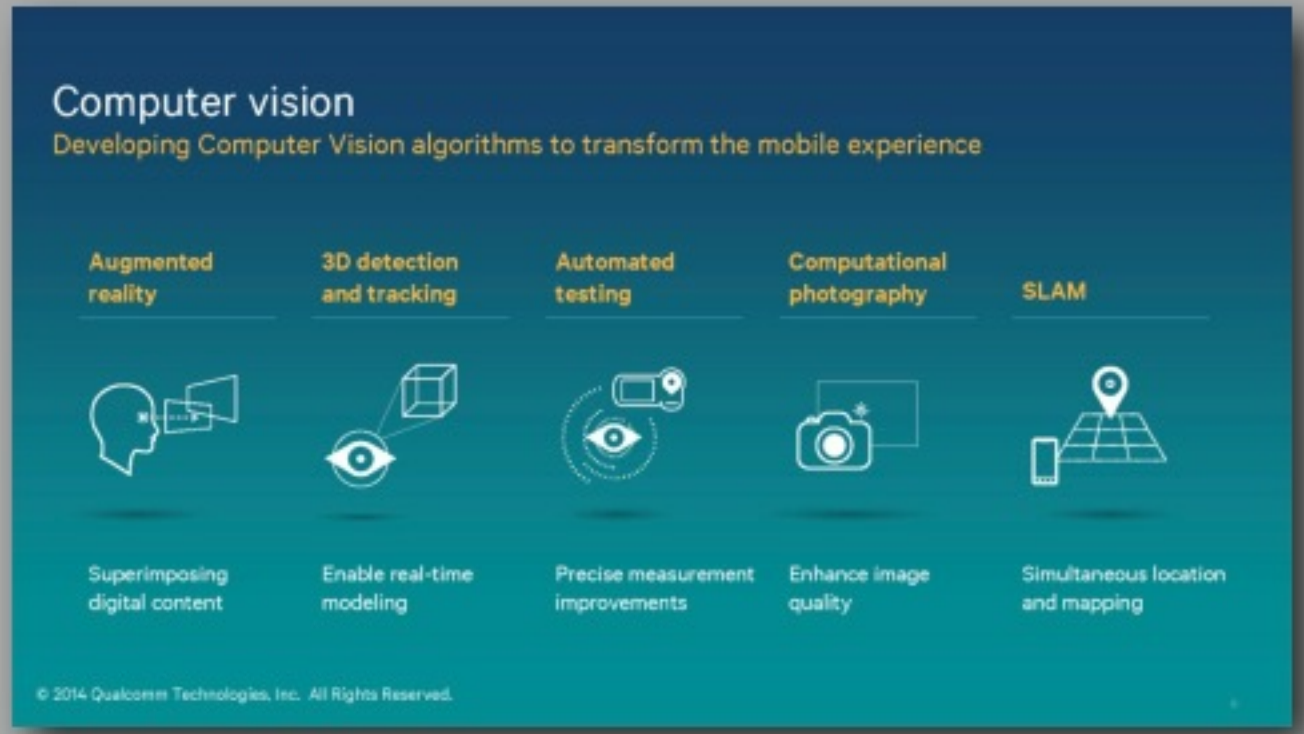

Qualcomm and Robotics?
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.


How does a robot operate?
Sense
Think
Act
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.

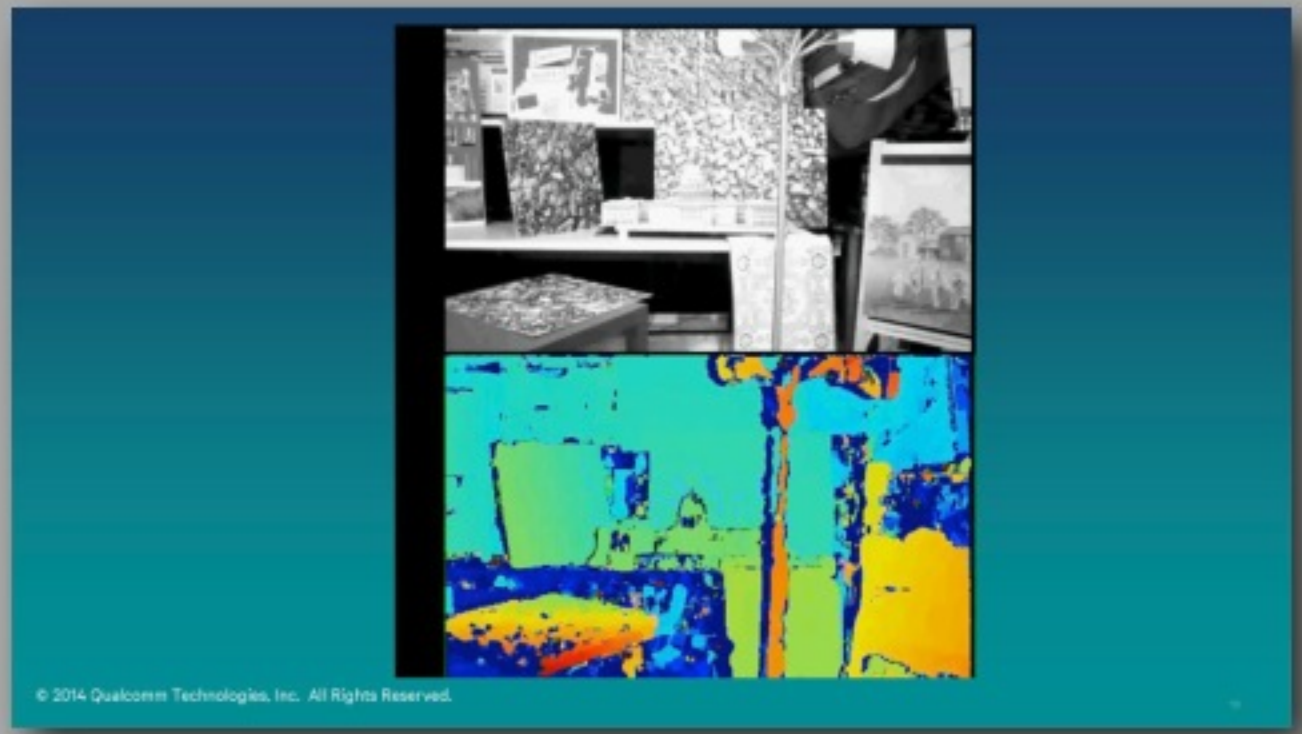

Sense and Think fit well into Qualcomm's core expertise
Sense
Think
Act
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.


Snapdragon Sensor Support for Robotics
Robots must determine their location and sense the world around them
Navigation
Inertial Measurement Unit
Environmental Sensors
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.

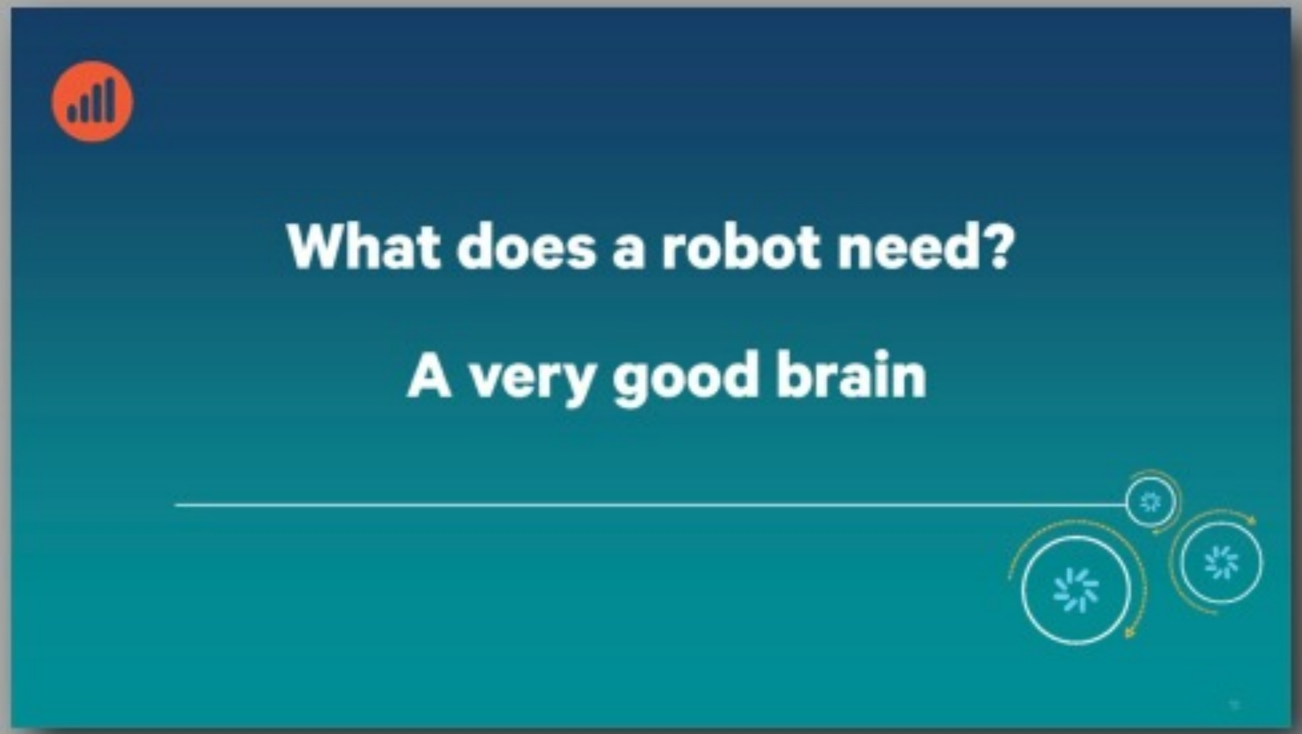

Always-on context awareness
Ultra low-power raw data sensor capture & fusion
Inferred context to implement battery optimization strategies
(E.G. Actions, motion, environment, places)
Usage prediction models
A smarter, always-on smartphone
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.

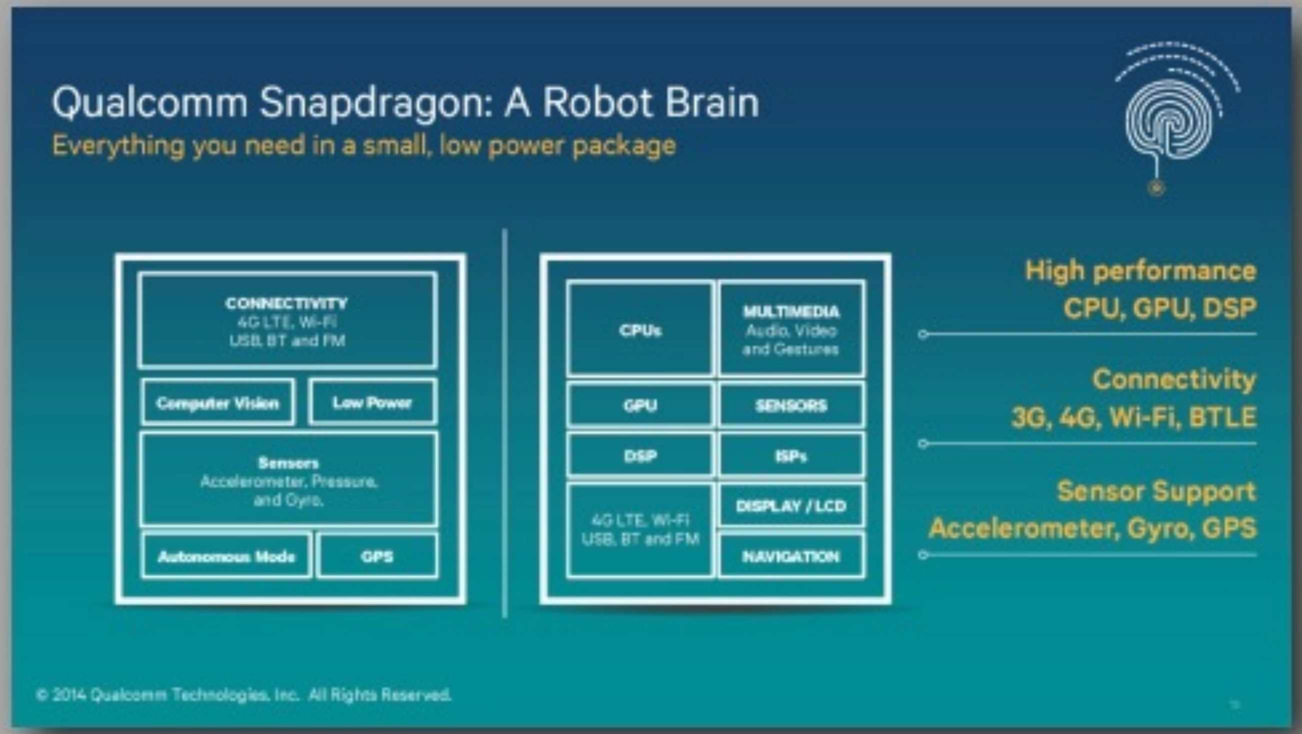

Computer vision
Developing Computer Vision algorithms to transform the mobile experience
Augmented reality
3D detection and tracking
Automated testing
Computational photography
SLAM
Superimposing digital content
Enable real-time modeling
Precise measurement improvements
Enhance image quality
Simultaneous location and mapping
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.

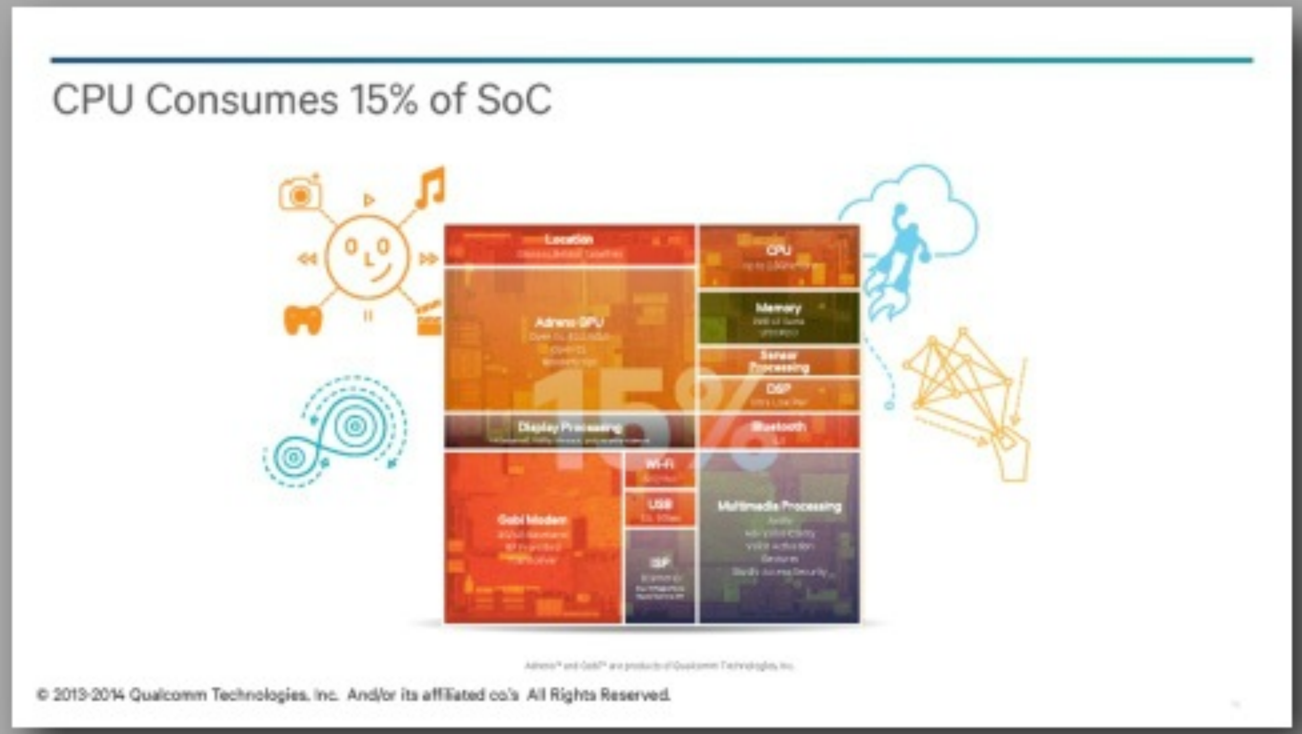

Depth map derived stereo camera processing on snapdragon processor

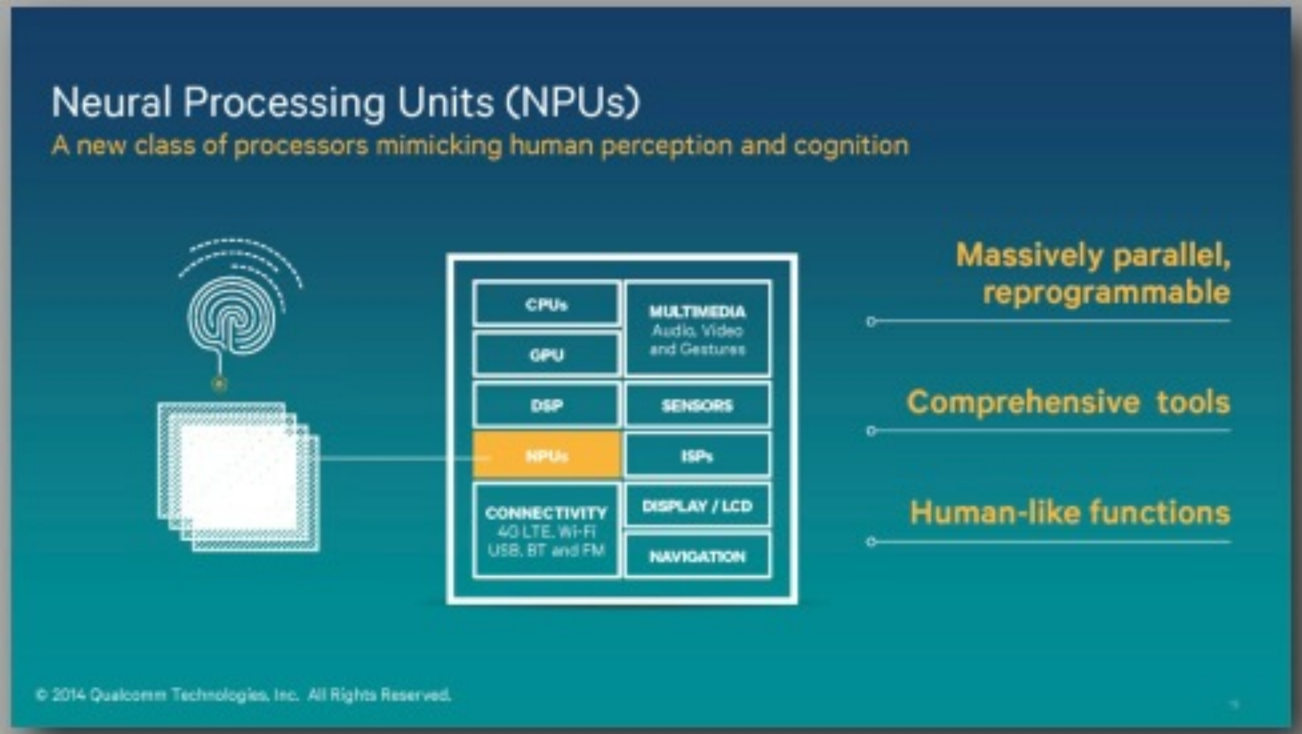

© 2014 Qualcomm Technologies, Inc. All Rights Reserved.


Challenges In Sensory Processing
Low Cost 3D Sensing
Machine Readable World for Low-light
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.

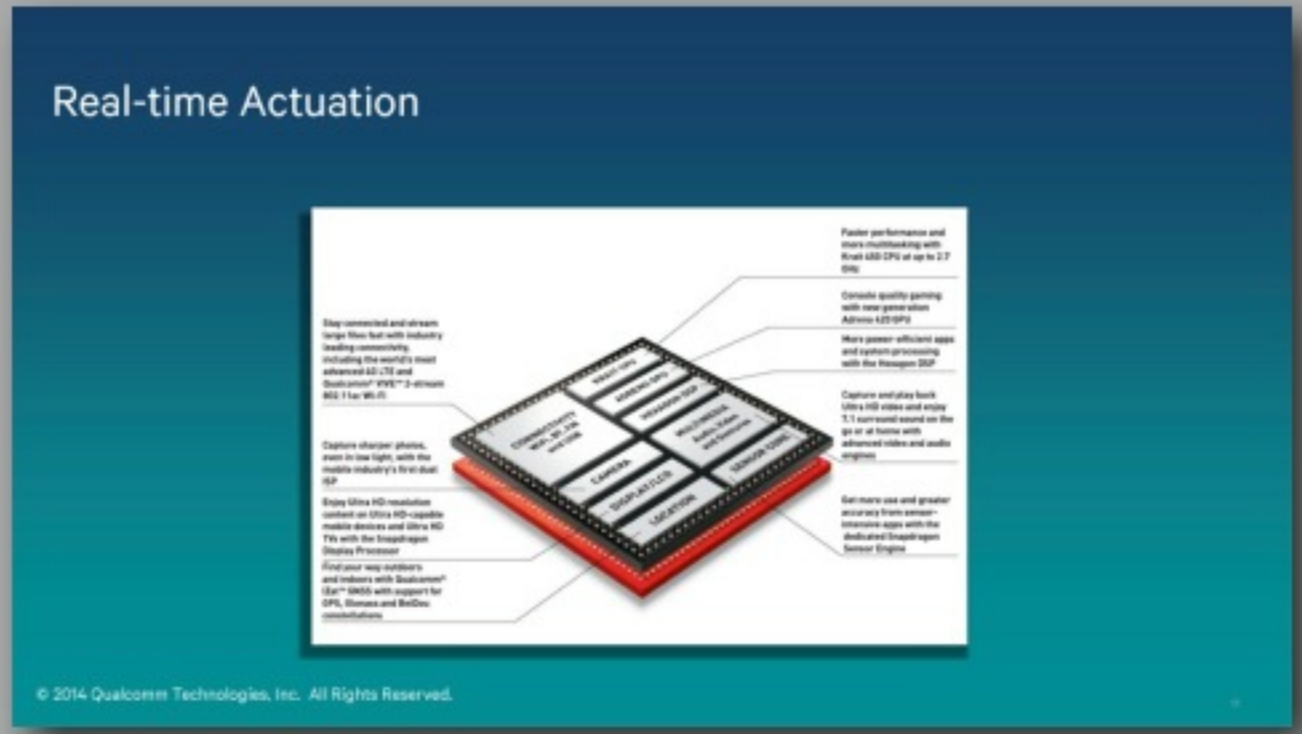

What does a robot need?
A very good brain


Qualcomm Snapdragon: A Robot Brain
Everything you need in a small, low power package
CONNECTIVITY
4G LTE, Wi-Fi
USB, BT and FM
Computer Vision
Low Power
Sensors
Accelerometer, Pressure, and Gyro.
Autonomous Mode
GPS
CPUs
MULTIMEDIA
Audio, Video and Gestures
GPU
SENSORS
DSP
ISPs
4G LTE, Wi-Fi
USB, BT and FM
DISPLAY / LCD
NAVIGATION
High performance
CPU, GPU, DSP
Connectivity
3G, 4G, Wi-Fi, BTLE
Sensor Support
Accelerometer, Gyro, GPS
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.


CPU Consumes 15% of SoC
15%
© 2013-2014 Qualcomm Technologies, Inc. And/or its affiliated co's. All Rights Reserved.


Neural Processing Units (NPUs)
A new class of processors mimicking human perception and cognition
CPUs
MULTIMEDIA
Audio, Video and Gestures
GPU
DSP
SENSORS
NPUs
ISPs
CONNECTIVITY
4G LTE, Wi-Fi
USB, BT and FM
DISPLAY / LCD
NAVIGATION
Massively parallel, reprogrammable
Comprehensive tools
Human-like functions
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.


Challenges In Autonomous Behavior
Navigate dangerous and unknown environments
What to do in Failure Scenarios
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.


Real-time Actuation
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.


Dragon Rovers
© 2014 Qualcomm Technologies, Inc. All Rights Reserved.

Challenges In Actuation

- Infinite Requirements in Building a General Purpose Platform

Thank you

Follow us on: f in

For more information on Qualcomm, visit us at:
www.qualcomm.com & www.qualcomm.com/blog

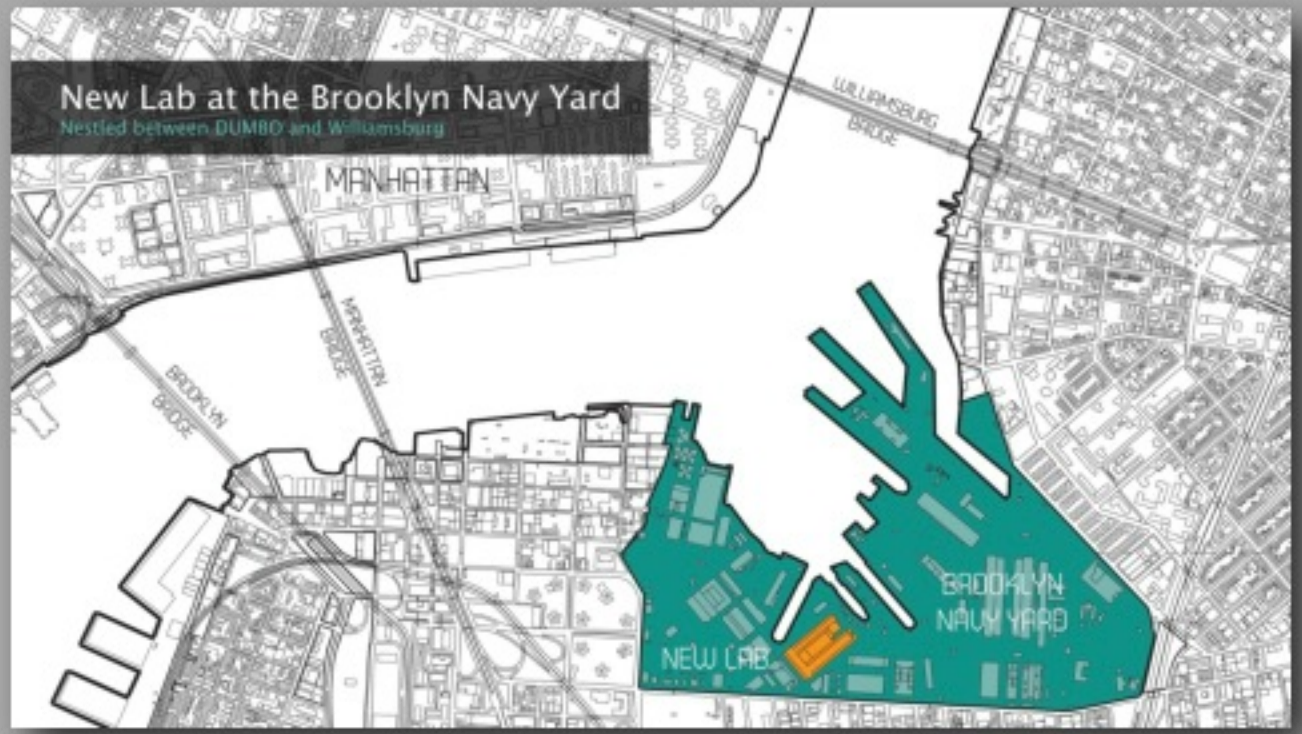
11_Scott Cohen

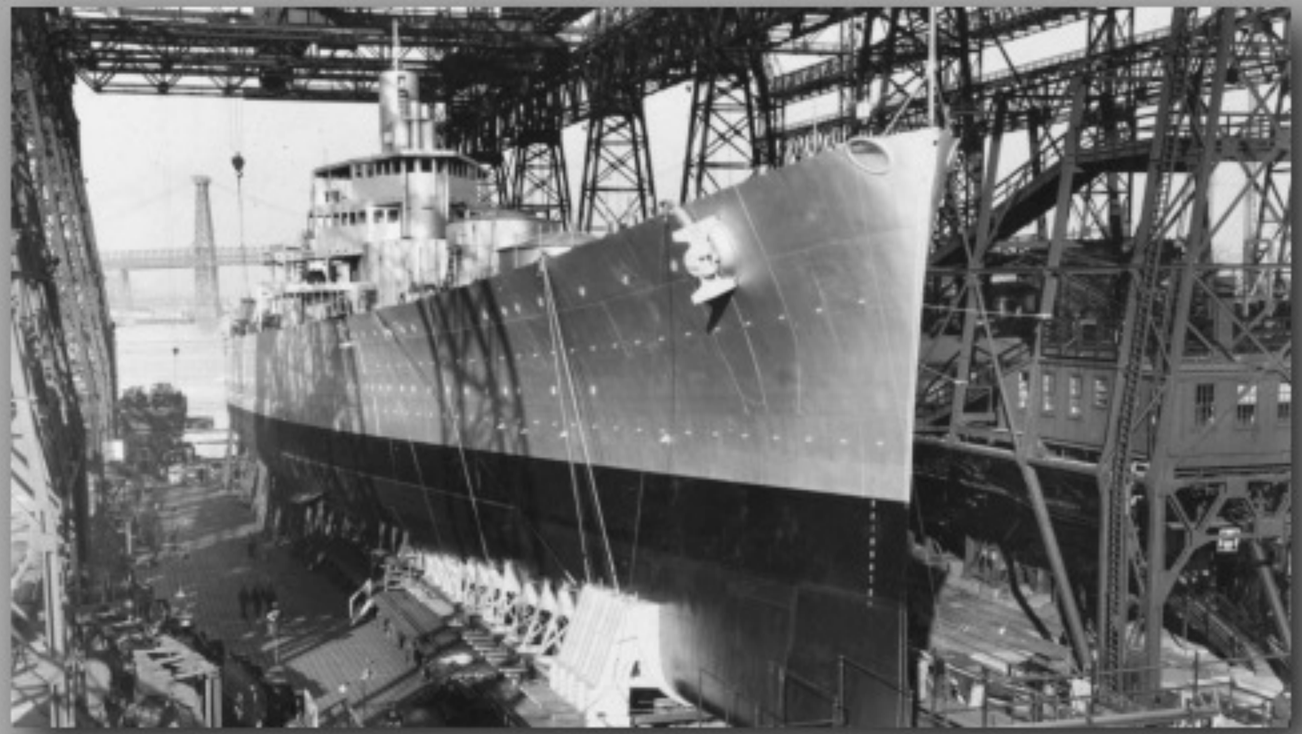
New Lab

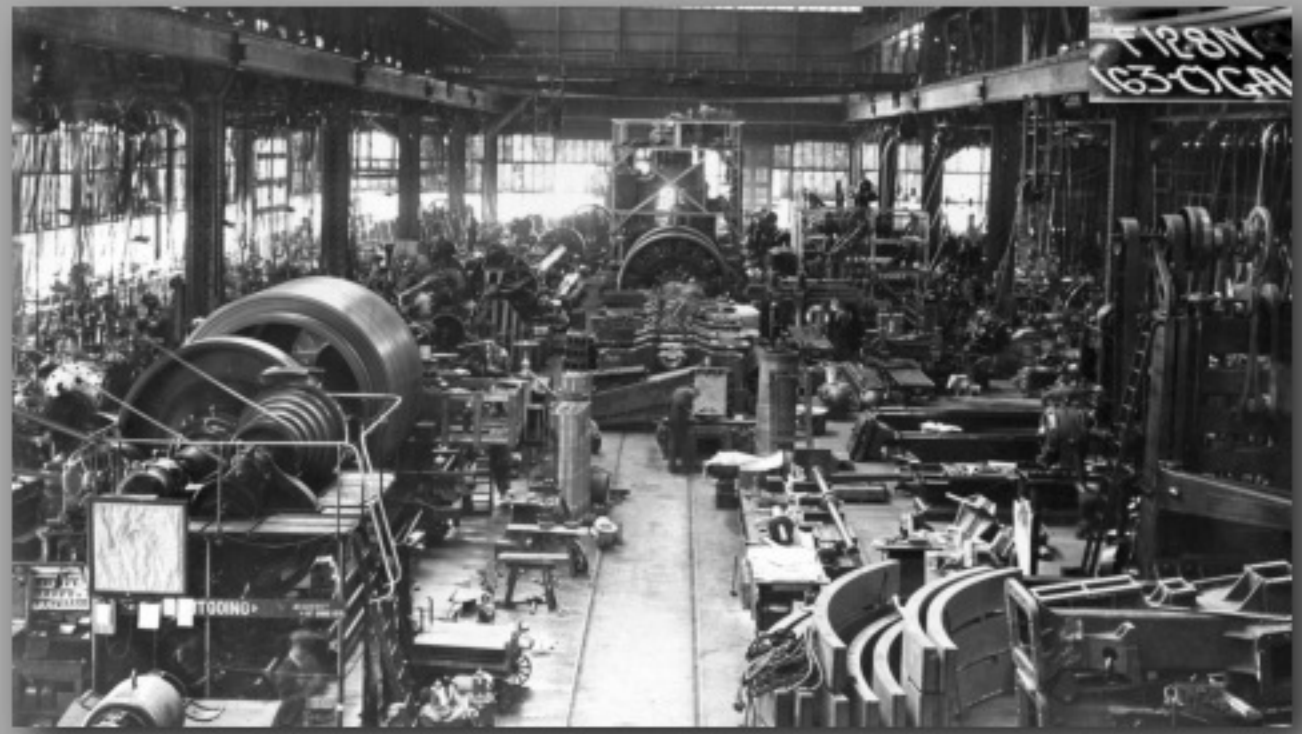
"I'm interested in creating surprising adjacencies between humans and robots."

Industry Makers

Cohen's cast light on the value of cross-pollination between the maker movement and modern robotics. He illustrated how physical spaces can be created to allow for innovation and exploration into making better robots. Is it possible, he asked, to harness the inventive process of hardware communities by providing people with the tools and space necessary to actualize ideas? Seeking to invite serendipity, Cohen is in the process of creating a multidisciplinary co-working and fabrication space in New York where designers, engineers and entrepreneurs innovate and grow businesses under one roof.

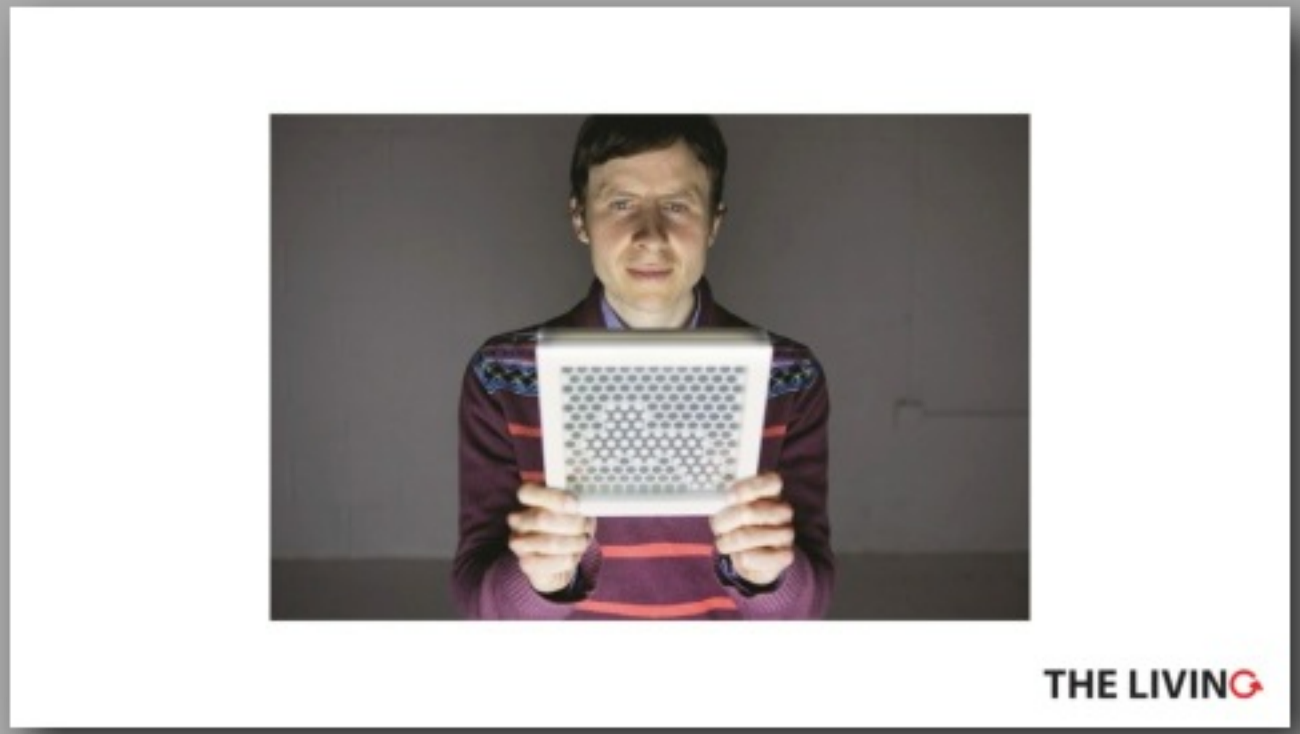

New Lab at the Brooklyn Navy Yard
Nestled between DUMBO and Williamsburg
MANHATTAN
WILLIAMSBURG BRIDGE
MANHATTAN BRIDGE
BROOKLYN BRIDGE
BROOKLYN NAVY YARD
NEW LAB






State-of-the-art manufacturing circa 1940s

What is
state-of-the-art
manufacturing
today?



Unemployable

A movement afoot…

A new age in manufacturing

Flexibility

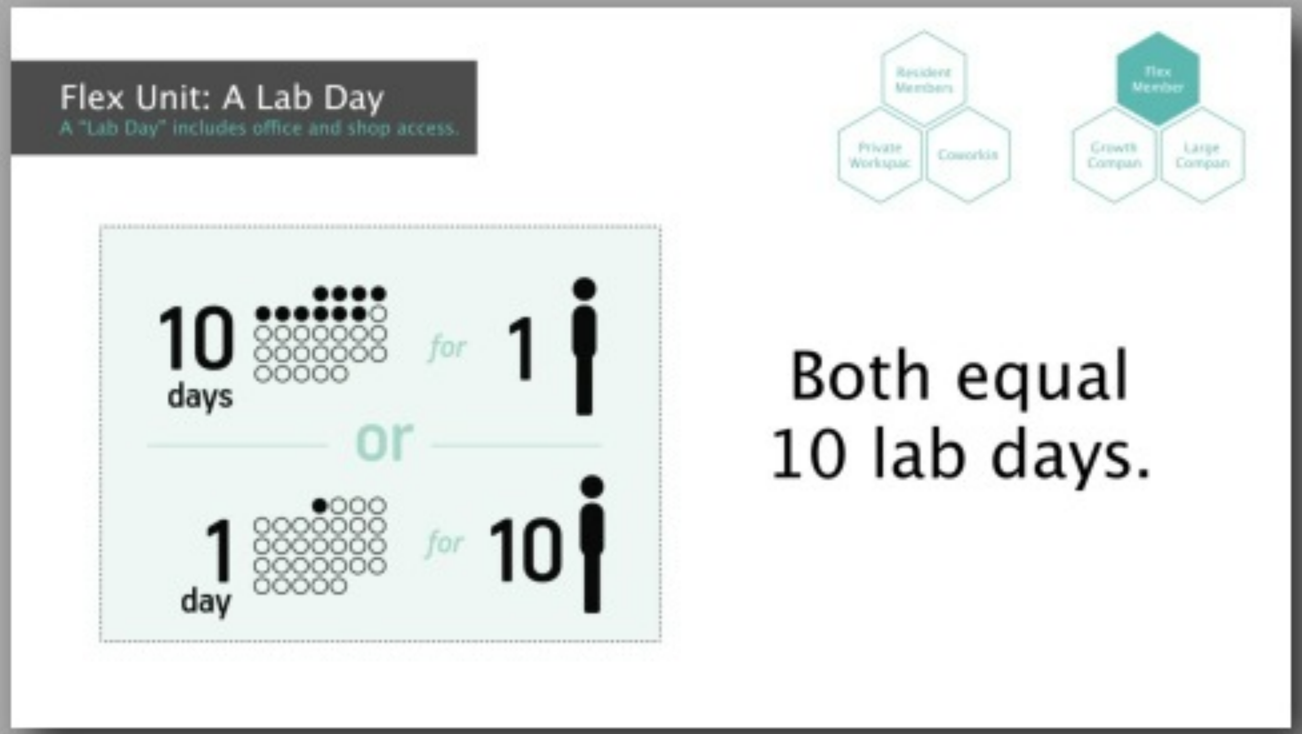
Collaboration

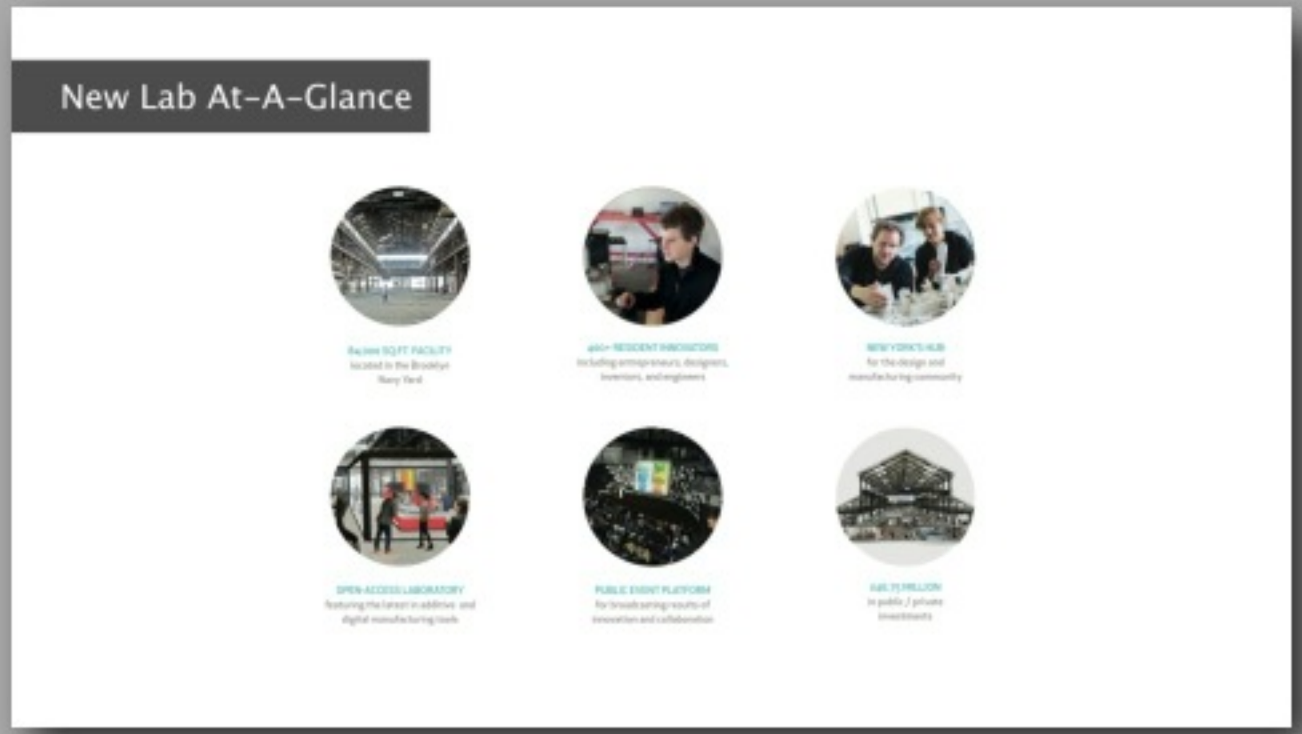
Prototype

Serendipity


A multidisciplinary coworking and fabrication space in New York City where designers, engineers and entrepreneurs innovate and grow businesses under one roof.
Old Building, New Ideas

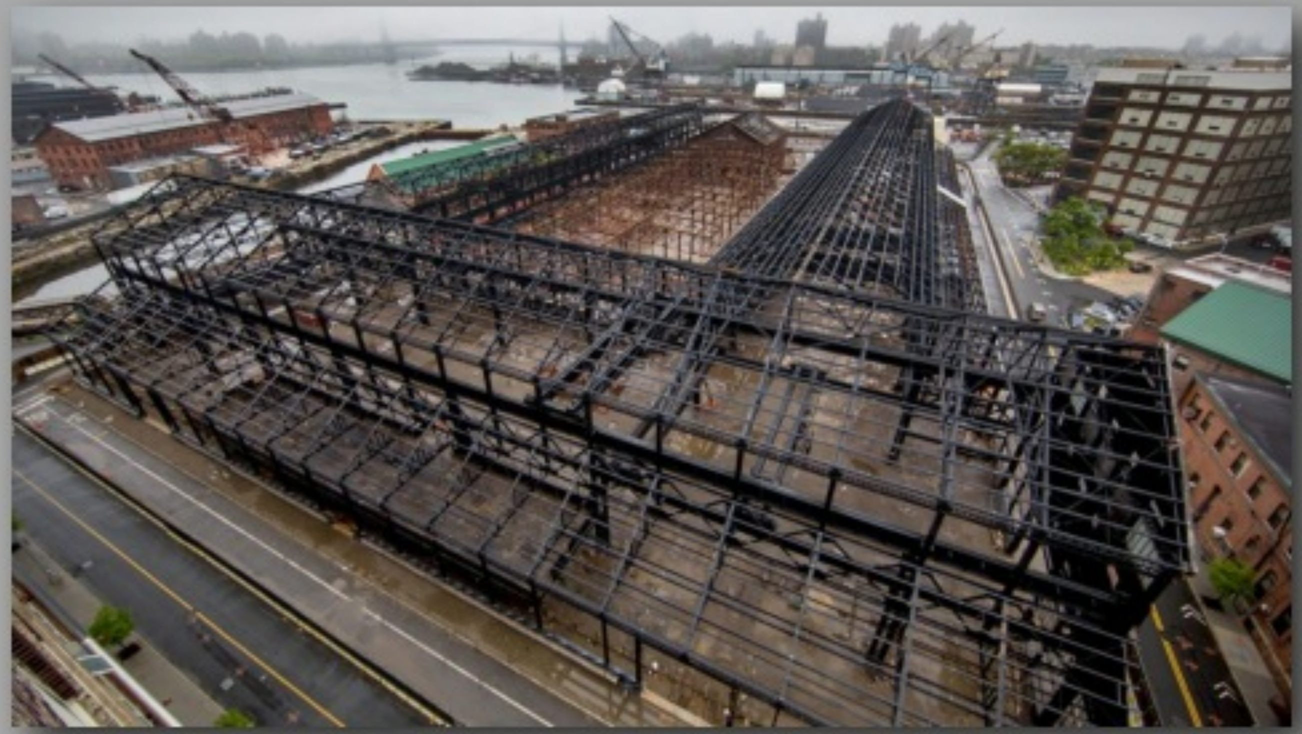

Membership/Tenant Offerings
There are 2 types of membership packages.
Resident Members
Private Workspace
Coworking
Flex Members
Growth Company
Large Company


Flex Unit: A Lab Day
A "Lab Day" includes office and shop access.
10 days for 1
or
1 day for 10
Both equal 10 lab days.


New Lab At-A-Glance


The Ecosystem
Workspace + Prototyping
Events
Community


The Ecosystem
A growing New Lab network
Autodesk Software
EOS 3D Printing
Columbia University Advanced Manufacturing Education
RPI C.A.S.E. Building Biometrics
Dragon Innovation Manufacturing, Process Engineering
Protei Oceanic Drones
Within Lab Additive Manufacturing Optimization, Software
Honeybee Robotics Advanced Robotics
D.N.I. Transportation, Solar, Industrial
Nanotronics Imaging Polymer Systems, Nano
10xBeta Medical Products
RockPaperRobot Robotics
Richard Burdon Biotech, Knowledge Management
Terreform ONE Built Environment, Synthetic Biology
Jason Krugman Studio LED Specialist, Consumer Products
The Living Building Engineering
Bioworks Institute Biomedical, Biotechnology
Biolite Stove Smart Appliances
Machine Made Digital Fabrication
Plethora Rapid Manufacturing
GoTenna Mesh Networks




Thank You

12_Franck Messmer

Delcam

“I’m interested in manufacturing an industrial robotic revolution.”

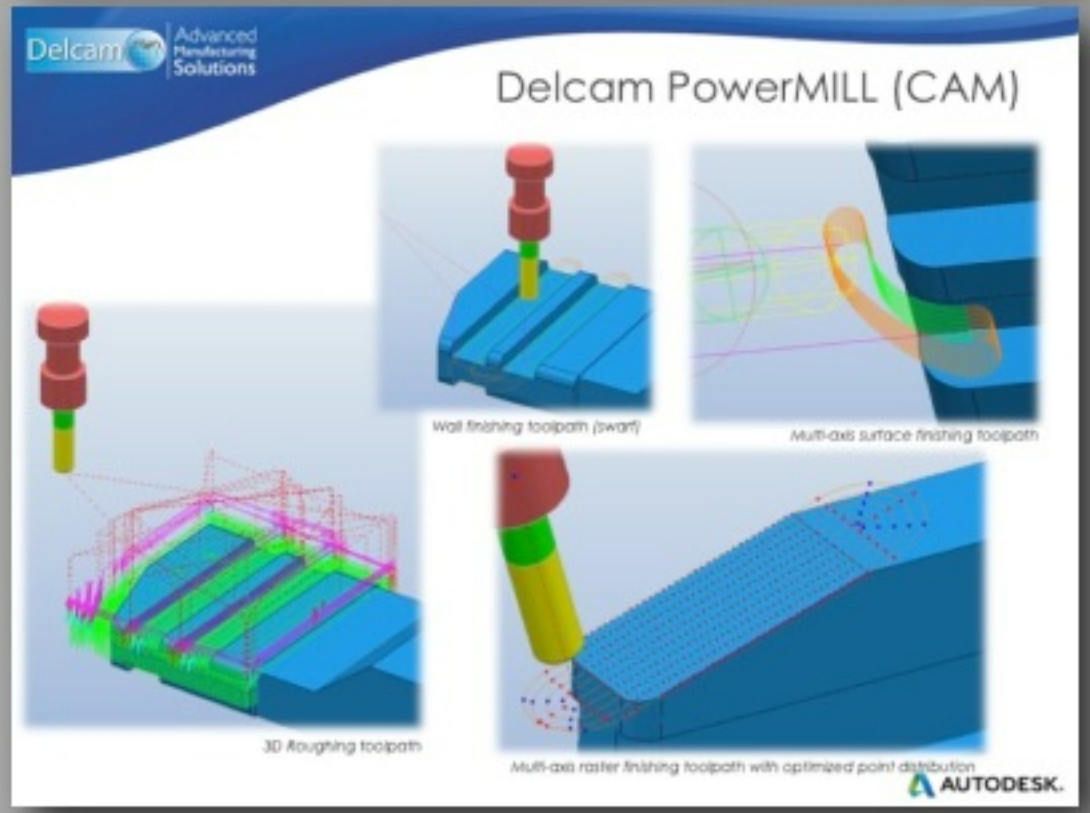
Robotic Revolutions in Manufacturing

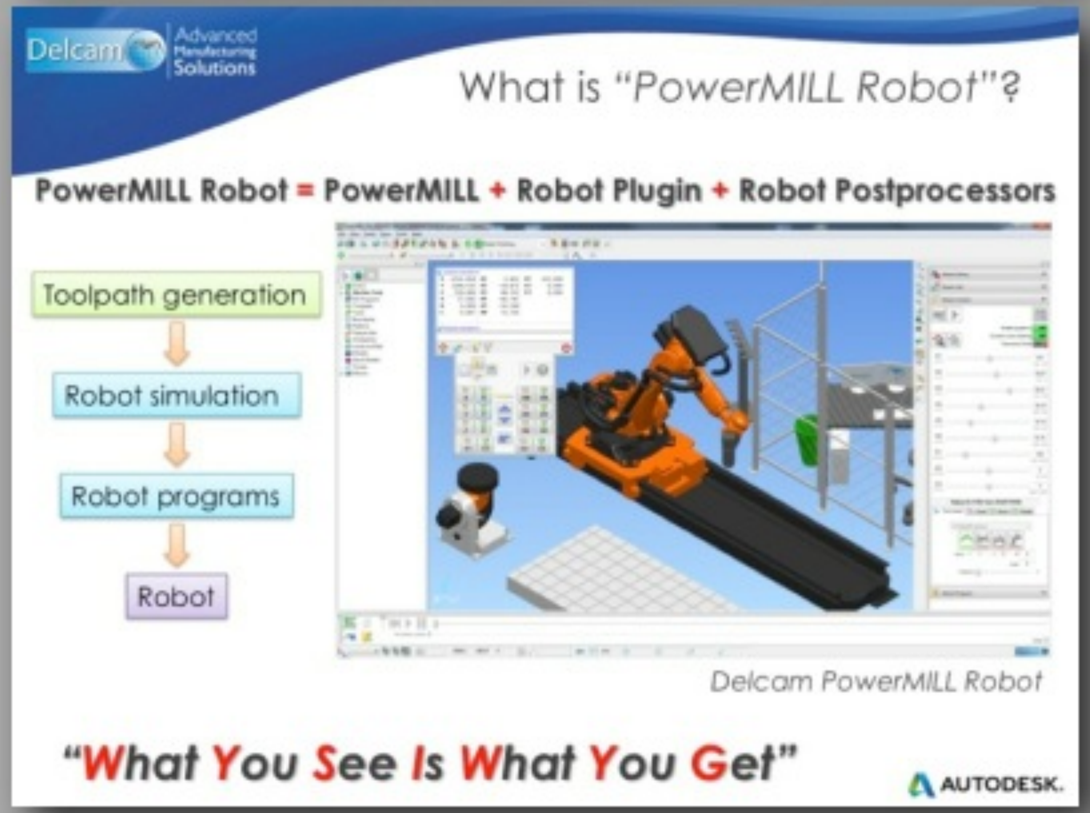
Throughout his presentation, Messmer, co-founder of DelCam (recently acquired by Autodesk) sought to promote the use of robotics for the creation and manufacture of things. Citing robots as cost-effective and versatile, the use of robots to mill parts for everything from construction to shoemaking to metal work, he identified that machines and robots are not, and should not be perceived as competitors. Cautioning against too much optimism, Messner identified common robot related problems that still pervade the industry. These include deviation from nominal kinematics, issues with compliance and joint errors.


Delcam Advanced Manufacturing Solutions
Delcam Robotics Solutions
Autodesk – IDEAS
KUKA
ABB
AUTODESK.


Delcam Advanced Manufacturing Solutions
Advanced Manufacturing with Robots
Autodesk - IDEAS
Mr. Franck Messmer
Principal Robotics Software Engineer
Delcam Ltd, Birmingham, UK
© Autodesk acquisition since 2014.02
Product: "PowerMILL Robot"
Background:
- Mechanical and CAM software development University in France
- 7 years at Delcam France (Bespoke projects and CNC postprocessors)
- 4 years at Delcam PLC, UK (Development of Robotics)
- Participate to EU robotics research projects...
AUTODESK.


Delcam Advanced Manufacturing Solutions
PowerMILL Robot
Overview
AUTODESK.


Delcam Advanced Manufacturing Solutions
Delcam PowerMILL (CAM)
Wall finishing toolpath (swarf)
Multi-axis surface finishing toolpath
3D Roughing toolpath
Multi-axis raster finishing toolpath with optimized point distribution
AUTODESK.


Delcam Advanced Manufacturing Solutions
What is "PowerMILL Robot"?
PowerMILL Robot = PowerMILL + Robot Plugin + Robot Postprocessors
Toolpath generation
Robot simulation
Robot programs
Robot
Delcam PowerMILL Robot
"What You See Is What You Get"
AUTODESK.


Delcam Advanced Manufacturing Solutions
Why to simulate?
Vector constraint along X axis (vector 1,0,0)
Vector constraint along Y axis (vector 0,1,0)
Axis 1 (A) is set to STATIC (no moves during simulation)
Axis 5 (E) is set to STATIC (no moves during simulation)
AUTODESK.

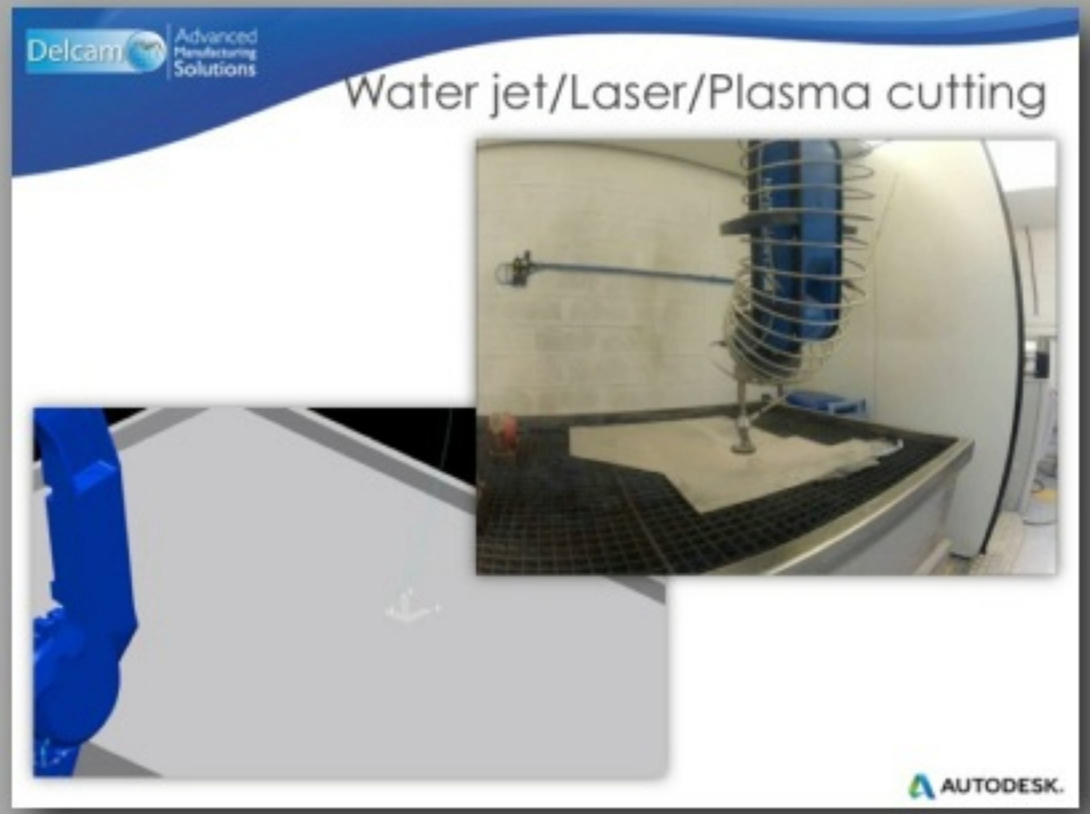

Delcam Advanced Manufacturing Solutions
Supported robot
KUKA
ABB
STÄUBLI
MOTOMAN
FANUC ROBOTICS
HYUNDAI
COMAU ROBOTICS
Kawasaki Robot
NACHi
AUTODESK.


Delcam Advanced Manufacturing Solutions
Supported robot
Industrial robots with up to 6 external axes...
Motoman robot
ABB robot
+ 2 axis positioner
KUKA robot
+ linear track
Fanuc robot
AUTODESK.


Delcam Advanced Manufacturing Solutions
Machine tool vs Robot
Machine tools and robots are not competitors!
VS.
Different machines = Different applications
AUTODESK.

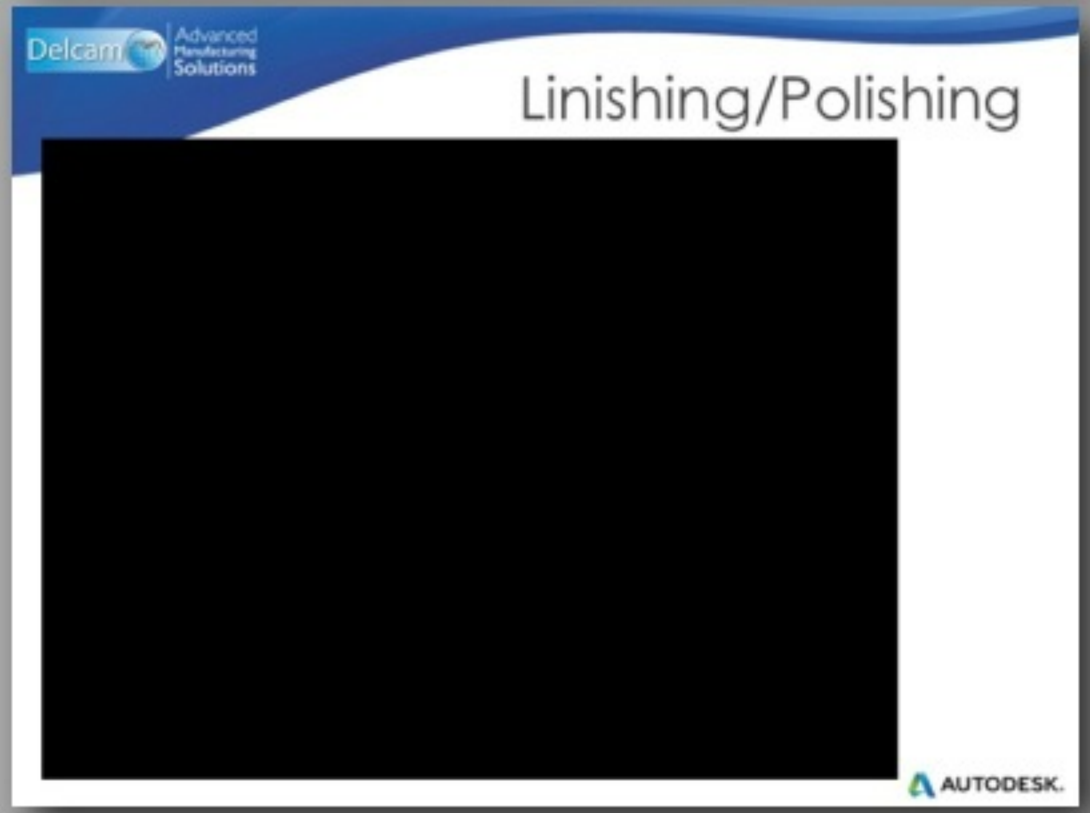

Accuracy is critical.
Metallic parts
Accuracy is not critical.
Non metallic parts.
Size, flexibility, environment is critical.
Non metallic parts & Not only milling applications!


Delcam
Advanced
Manufacturing
Solutions
Examples...
AUTODESK.


Water jet/Laser/Plasma cutting
AUTODESK.


Additive manufacturing
Cladding / Welding
AUTODESK.


Linishing/Polishing
(Grinding)
AUTODESK.


Linishing/Polishing
AUTODESK.


Carbon/glass fibre moulds
AUTODESK.


Entertainment
AUTODESK.


Shoe market
AUTODESK.


Delcam
Cork industry
• Rotary table
• 2x1m table with vacum
• Tool Changer
AUTODESK.


Delcam
Concrete industry
Danish Technological Institute
• TailorCrete – EU funded research project, integrating robotics and automation into concrete construction industry.
AUTODESK.

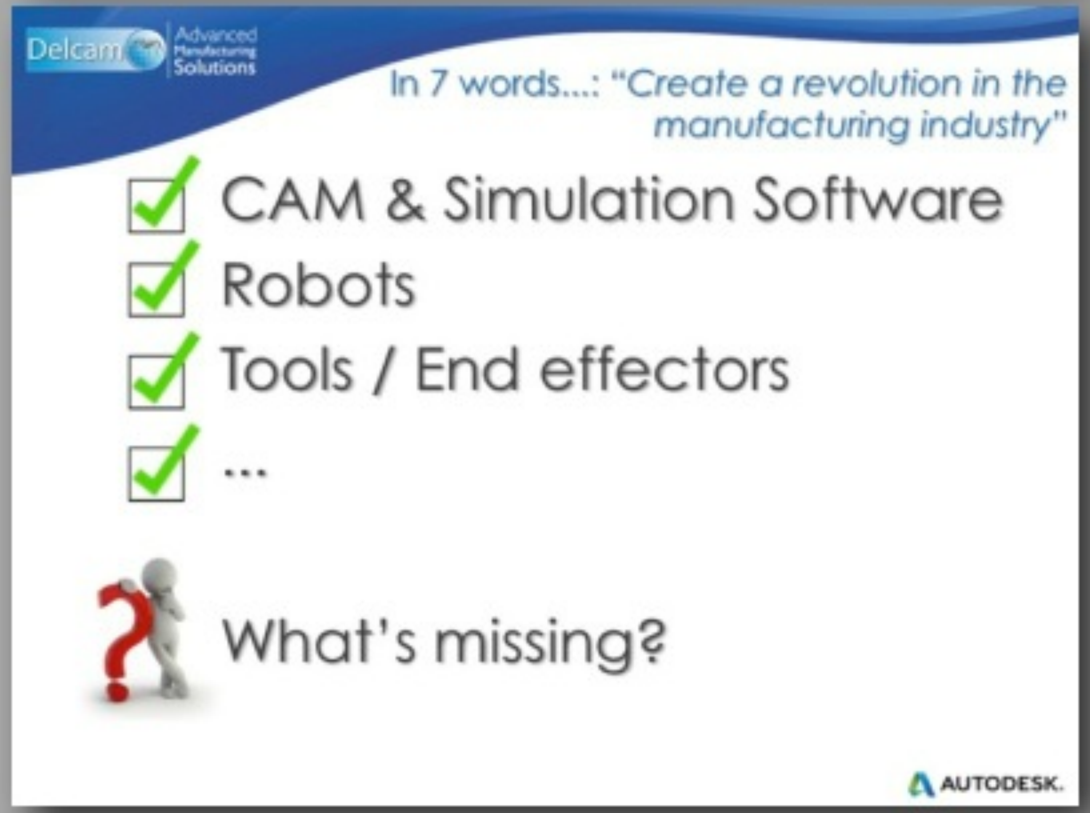

Delcam
Concrete industry
AUTODESK.

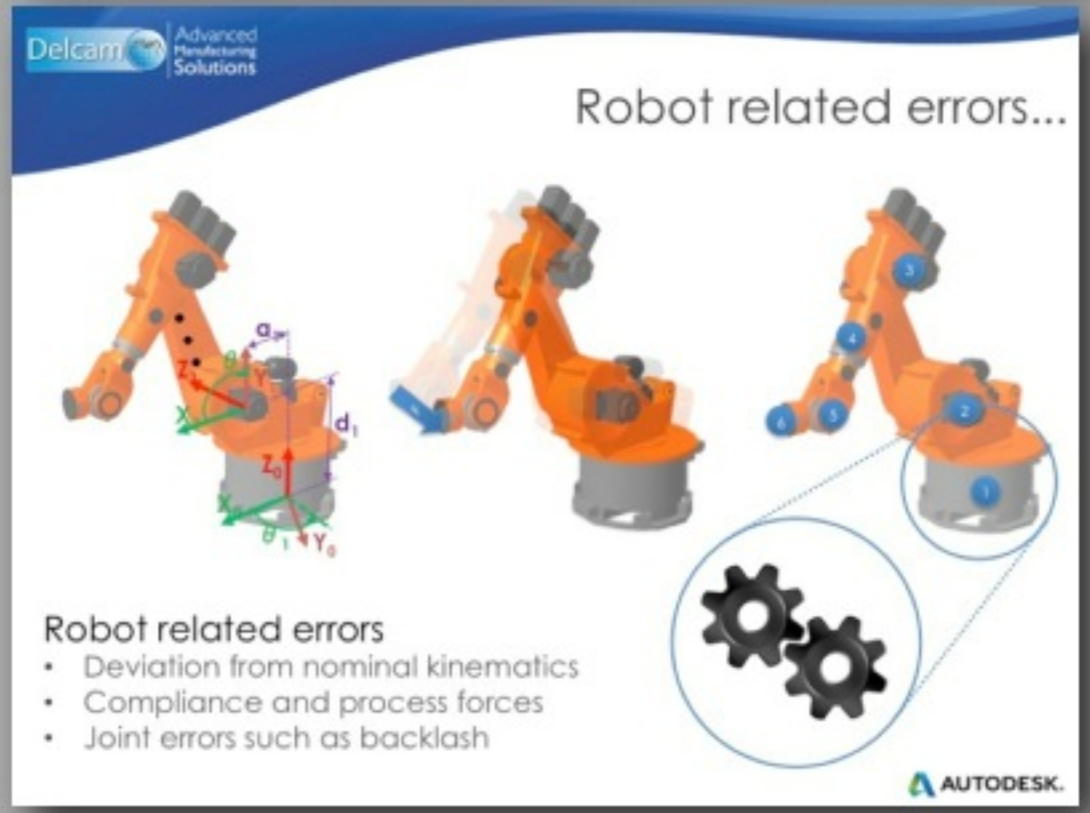

Delcam
Art, sculpting, stone machining
AUTODESK.


Delcam
Prototyping (large models, scale 1)
AUTODESK.


Delcam
Design & Research
AUTODESK.


And much more…


Delcam
In 7 words…: "Create a revolution in the manufacturing industry"
CAM & Simulation Software
Robots
Tools / End effectors
…
What's missing?
AUTODESK.


Delcam
Robot related errors…
Robot related errors
• Deviation from nominal kinematics
• Compliance and process forces
• Joint errors such as backlash
AUTODESK.

To create a revolution in the manufacturing industry...

How to improve robot accuracy?

Thank You


IDEAS


SERIES
HOW TO
IMPROVE
ROBOT





IDEAS
THE INNOVATION
+ DESIGN SE


13_Marc Freese

Coppelia Robotics

“How smart do we actually want robots to be?”

Changes in Industrial Robotics

Presenting on how virtual simulations might help designers and operators gain useful data on robotic accuracy, Freese posited that those working in the field need to change how they think about the value of simulations and understand that this will require a shift from robot-centric approach to an environment-centric one. IHe identified how simulations reduce cost and time spent on planning as well as increase safety and flexibility and allow for exploration into scenarios or solutions which are impossible to test in real time. Promoting the need for an consistently updated behaviour library in order to meet the variety of needs of the programmers, the software has been given to education institutions in order to expand research into what it is capable of.

Marc Freese
COPPELIA ROBOTICS

What is simulation?

From robot-centric
to
environment-centric

Why simulation?

Cost
Safety
Time
Flexibility
About the impossible
...

No one-to-one correspondency between simulation and reality

A few examples...

Unsolved interesting problems

Open source

14_Russell Loveridge

NCCR Digital Fabrication

“I’m interested in robots joining architecture in the digital age.”

Challenges in the Building Industry

Informed by both the Swiss mentality of precision and design, and the larger research project into digital fabrication, Loveridge explored how to use robots to build additively with actual building materials on a large scale. The NCCR, comprised of designers, technologists and architects, seeks to create new innovations in the realization and utilization of construction robots for building erection, renovations and repairs. Loveridge and team imagine that advances in sensor technology will allow robots to exist on-side and alongside human beings.

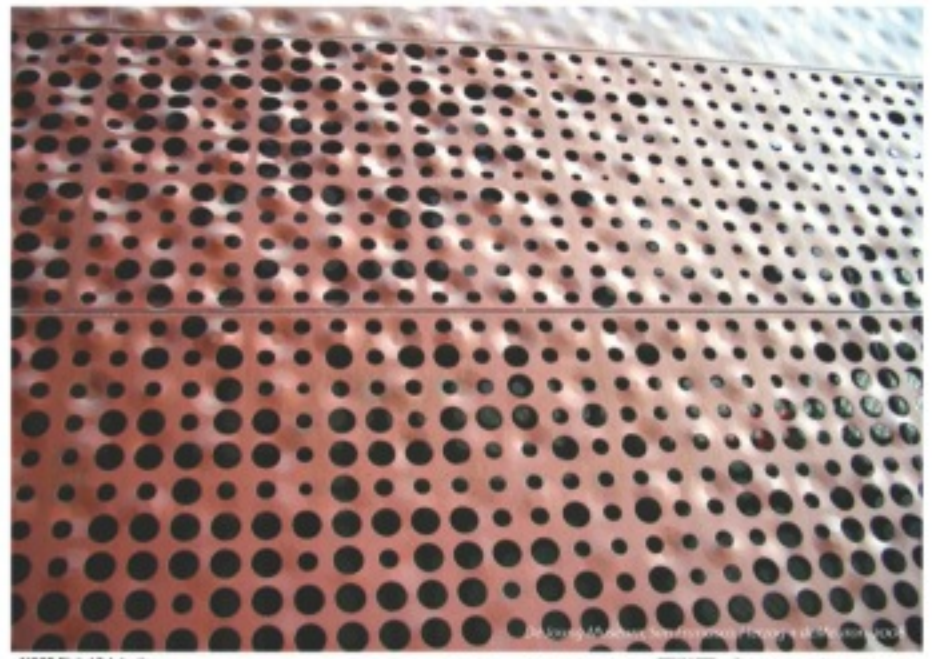
SWISS
NCCR DIGITAL FABRICATION
Innovative Building Processes in Architecture

Director
Prof Matthias Kohler

Managing Director
Russell Loveridge

Home Institution
ETH Zürich

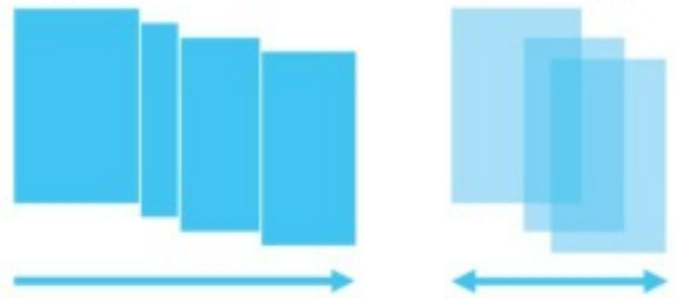
Beijing Olympic Stadium, Herzog + deMeuron, 2008



Productivity per work hour (Switzerland)

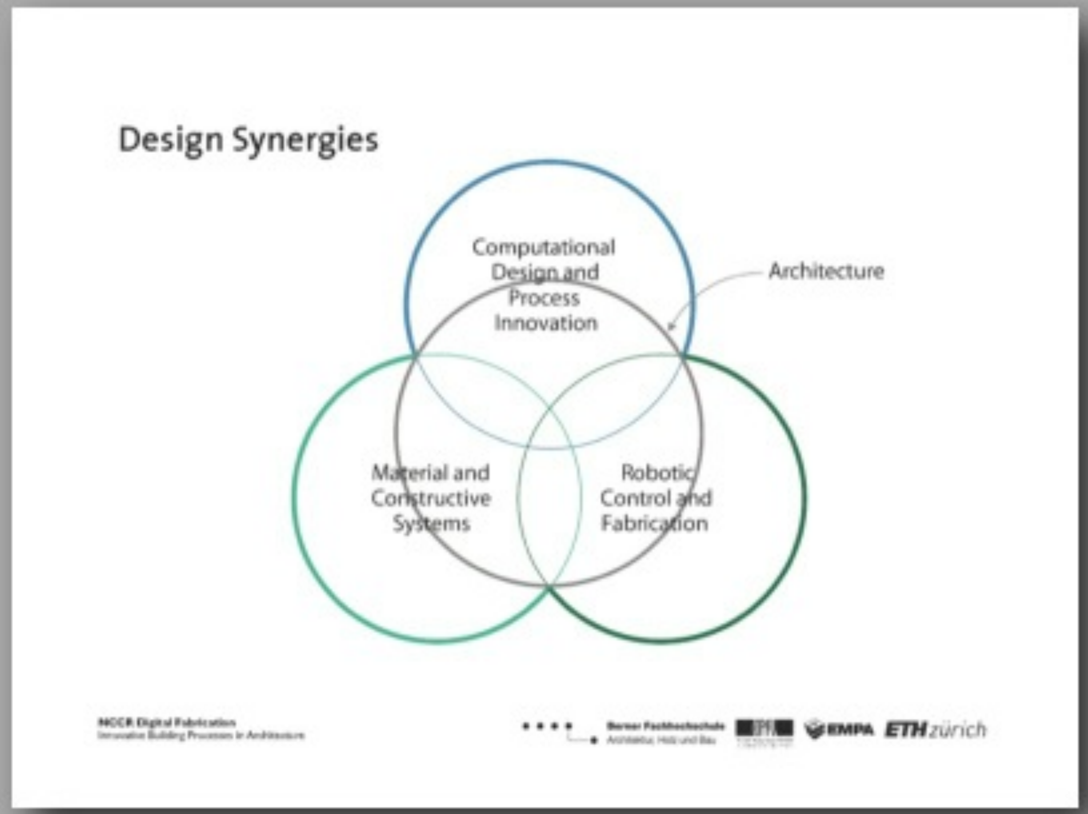
	1991	2011
Finance	100%	216%
Manufacturing	100%	175%
Construction	100%	121%

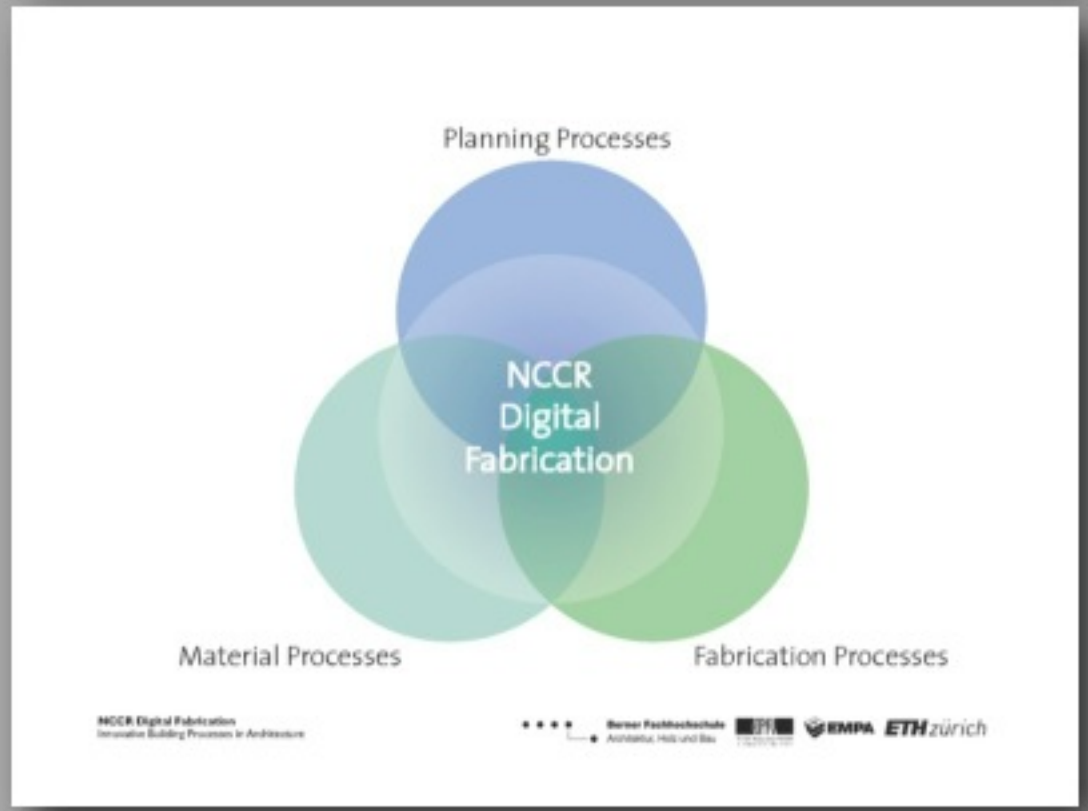
Increase in Flexibility and Efficiency




SWISS
NCCR DIGITAL FABRICATION
Innovative Building Processes in Architecture
ETH zürich


Contents
1. Why?
2. Who?
3. How?
4. With what?
5. Where?
ETH zürich


Design Synergies
Computational Design and Process Innovation
Architecture
Material and Constructive Systems
Robotic Control and Fabrication
ETH zürich


Planning Processes
NCCR Digital Fabrication
Material Processes
Fabrication Processes
ETH zürich

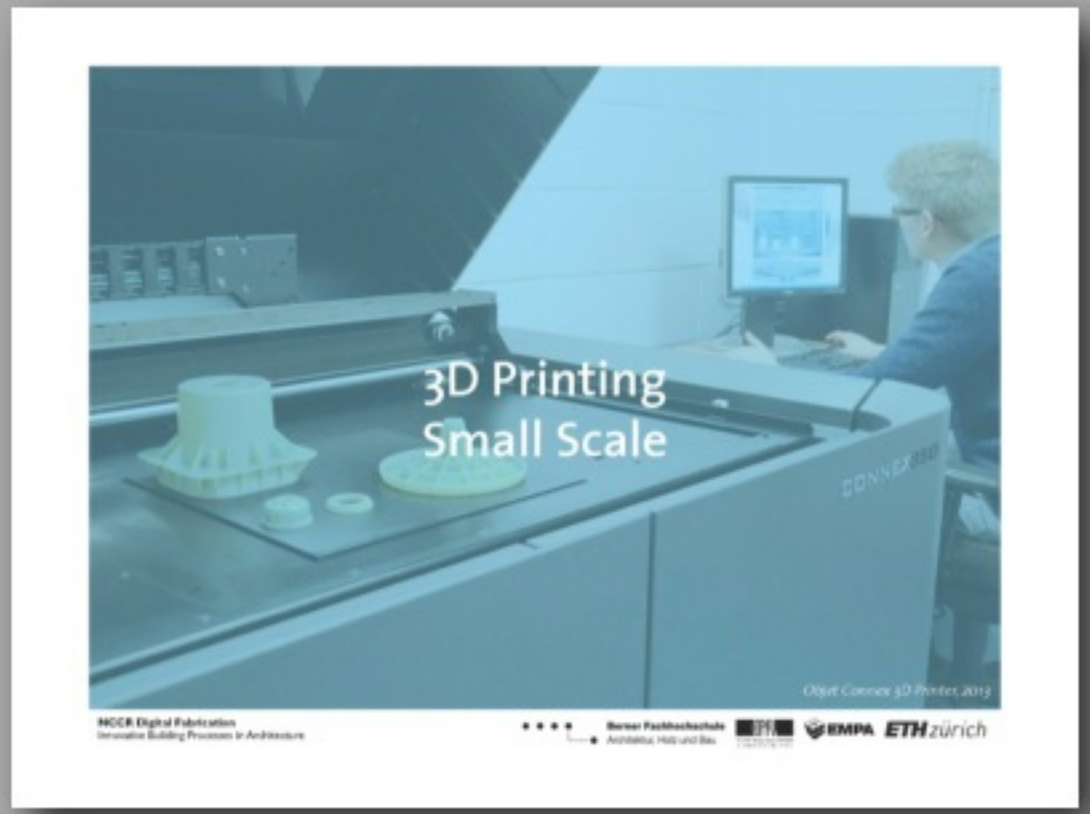

Team of Principal Investigators
Fabio Gramazio
ETHZ
Matthias Kohler
ETHZ
ETH zürich


Team of Principal Investigators
Philippe Block
ETHZ
Jonas Buchli
ETHZ
Raffaello D'Andrea
ETHZ
Robert Flatt
ETHZ
Fabio Gramazio
ETHZ
Guillaume Habert
ETHZ
Matthias Kohler
ETHZ
Sacha Menz
ETHZ
Manfred Morari
ETHZ
Mark Pauly
EPFL
Peter Richner
EMPA
Oddo Schoch
BUAS
Roy Smith
ETHZ
Yves Weinand
EPFL
ETH zürich


Unique configuration of expertise
Building Structures
Agile Robotics
Dynamic Systems
Building Materials
Digital Fabrication
Sustainability
Digital Fabrication
Building Processes
Automation
Computation
NEST Demonstrator
Process Modelling
Control Systems
Timber Structures
ETH zürich

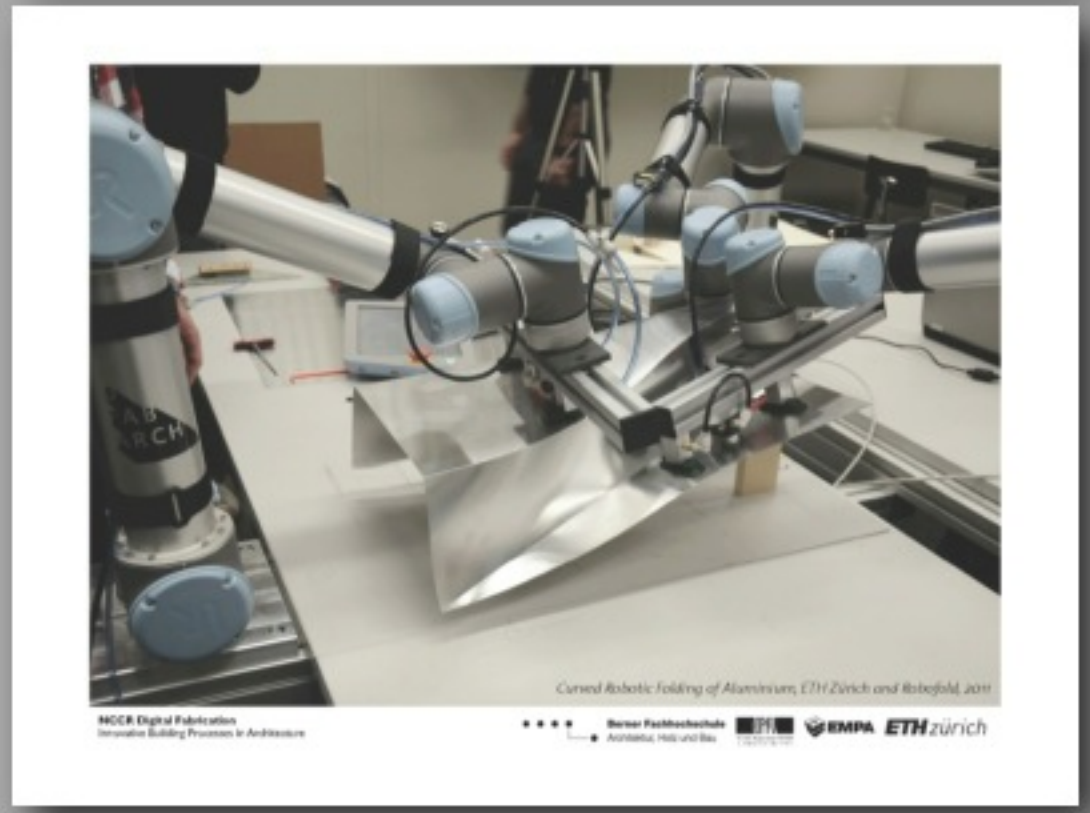

Contents
1. Why?
2. Who?
3. How?
4. With what?
5. Where?
ETH zürich


ETH zürich

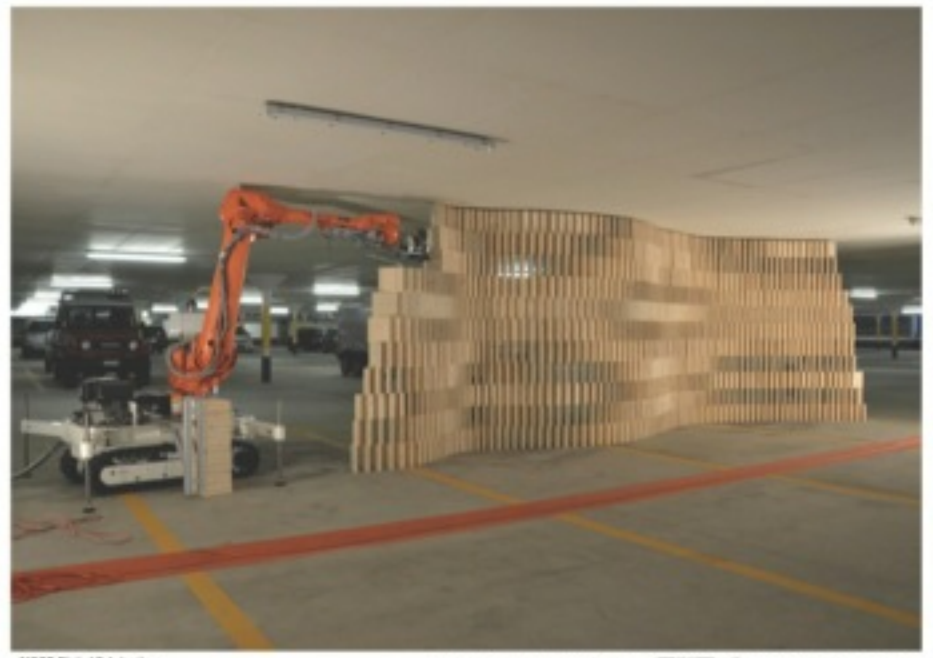

3D Printing
Small Scale
Objet Connex 3D Printer, 2013

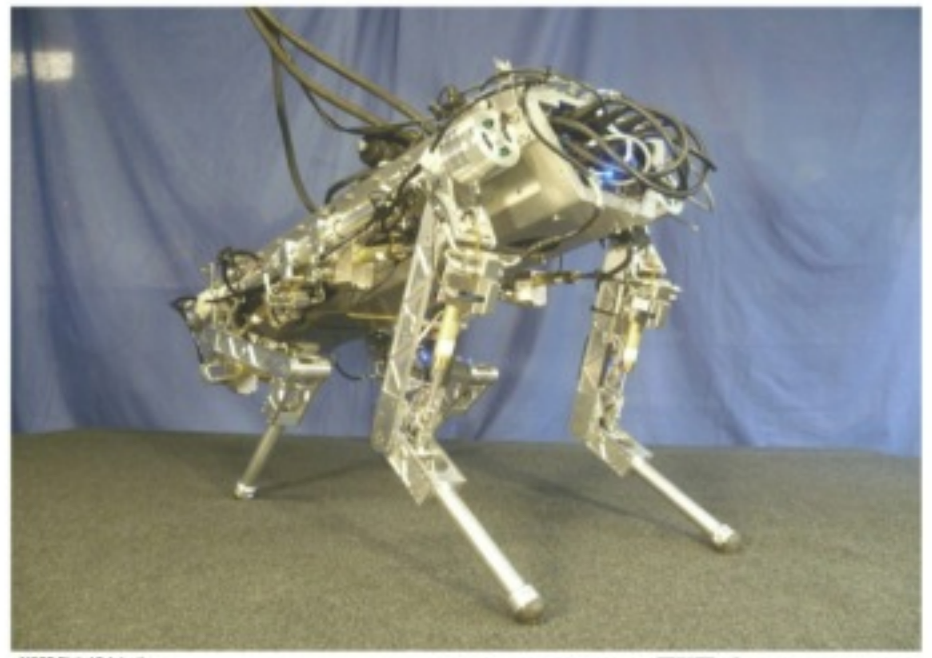

Robotic Fabrication
Large Scale


Customizable
Digital Fabrication



Contents





The Economist, April 2012

The Economist, March/April 2014

Evolution of research

- Element scale › Building scale
- Single robotic system › Multi-robotic collaborations
- Flexible automation › Adaptive robotic fabrication
- Discipline-based research › Interdisciplinary research

Contents

1. Why?
2. Who?
3. How?
4. With what?
5. Where?

What this NCCR creates

- Validation of research findings under long-term conditions
- Direct technology transfer into building industry and practice
- Innovation as motivation for the risk-averse construction sector
- Synthesis of interdisciplinary knowledge and technology
- Education and training for young and advanced researchers
- A world leading institute in digital fabrication of architecture

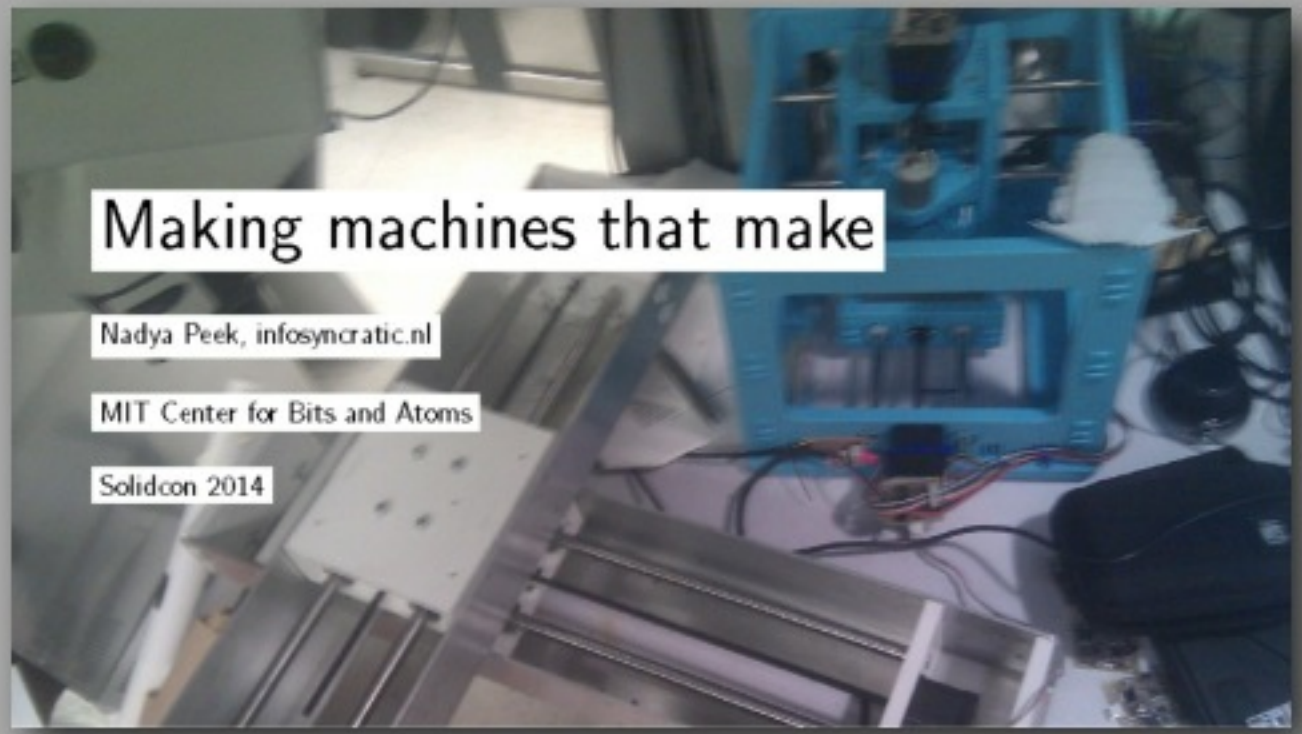
15_Nadya Peek

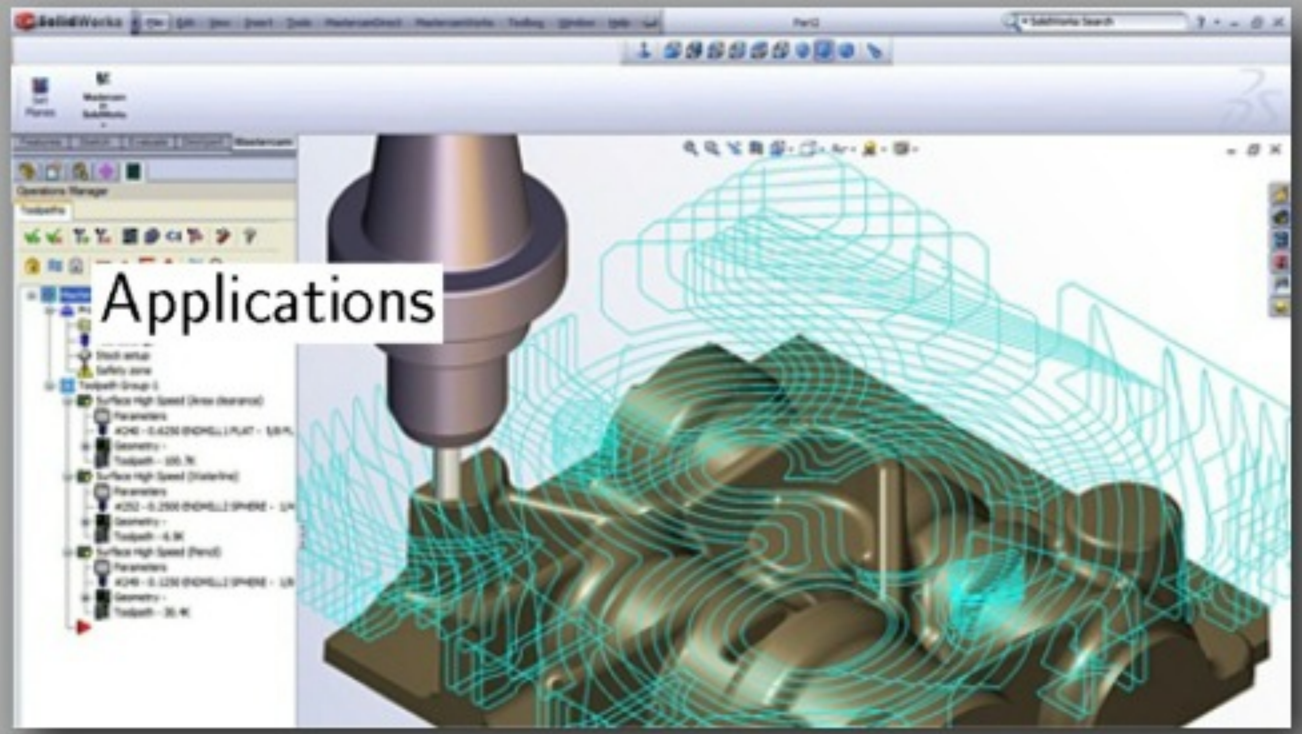
MIT Center for Bits and Atoms

"I'm interested in object-oriented hardware meeting object-oriented software."

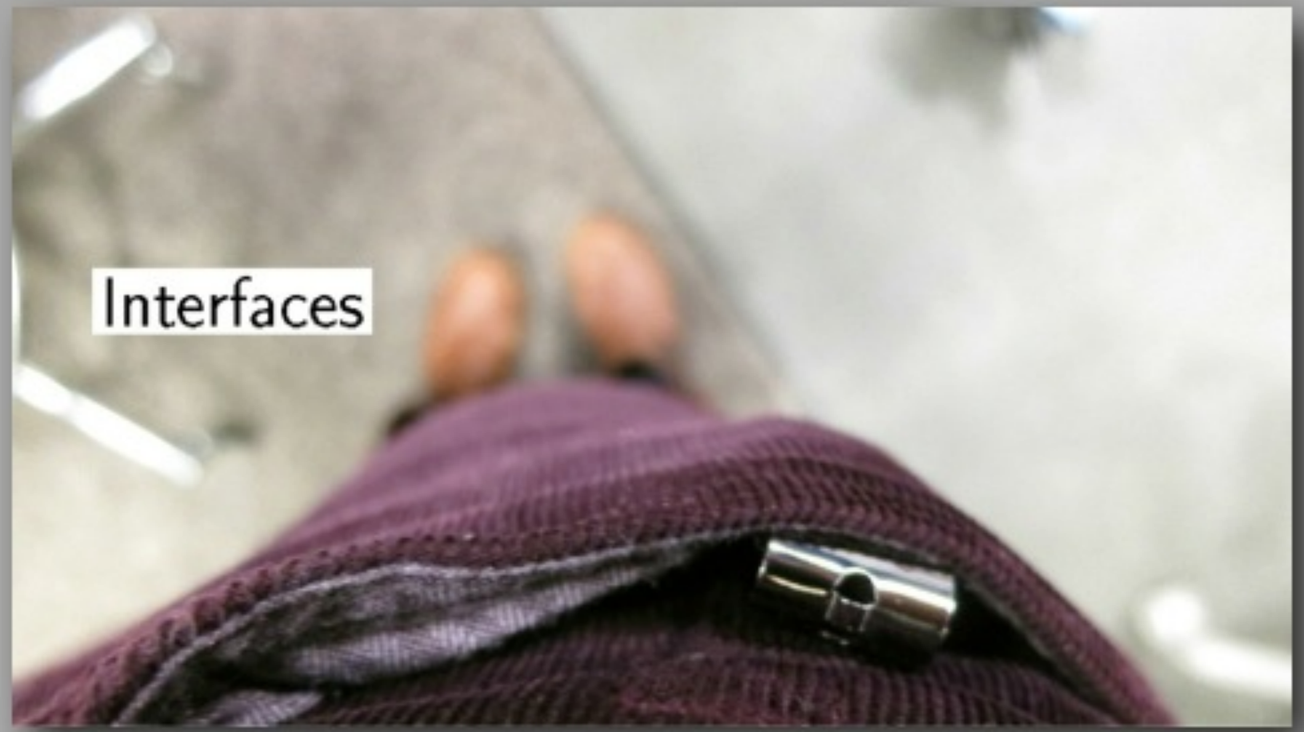
Makers and Consumers

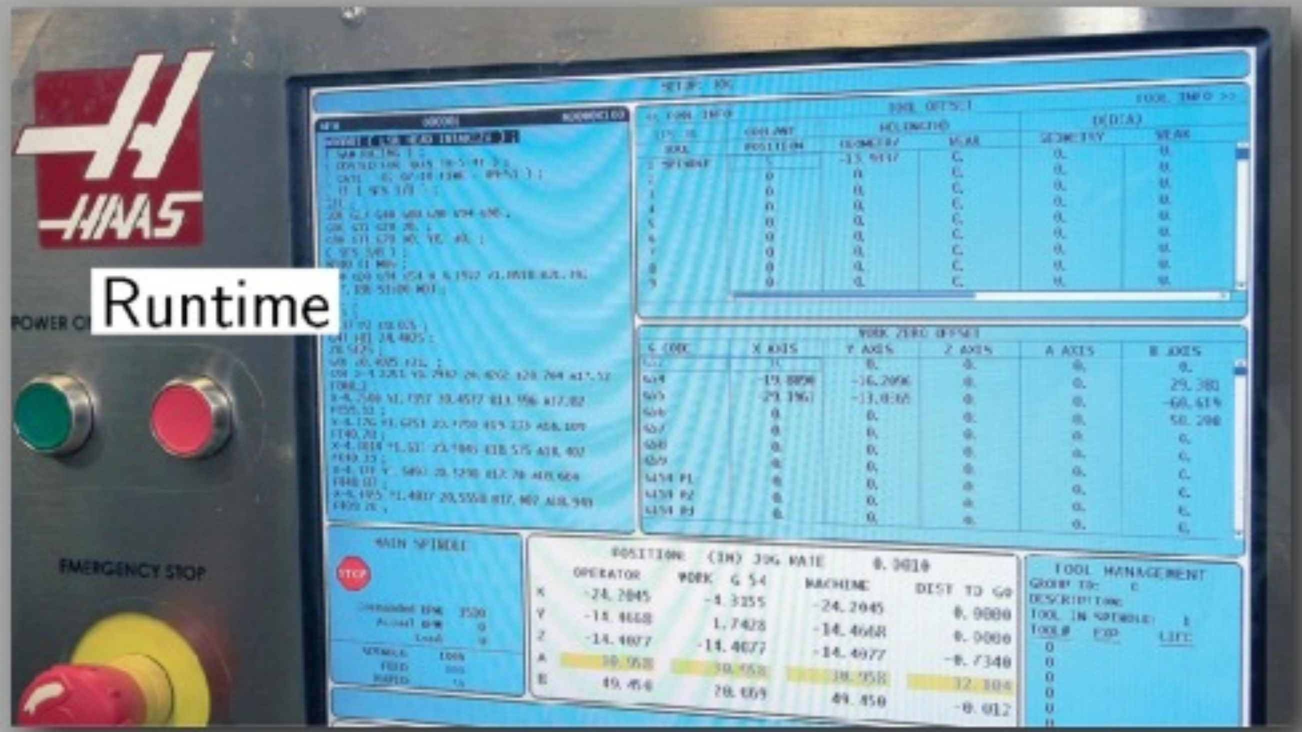
Seeking ways to the allow the maker-side of robotic more accessible and available to non-specialists, Peek and others at the MIT Center for Bits and Atoms created Pop-Fab – a portable 3D printing and milling machine. Admittedly more machine-builder than roboticist, her desire to decompose machines into simple motions that can be translated across platforms offers insight into robots from top to bottom, including how applications and interfaces, control systems, sensors, actuators and mechanical systems might be made simpler, cheaper and less cumbersome to learn and use.

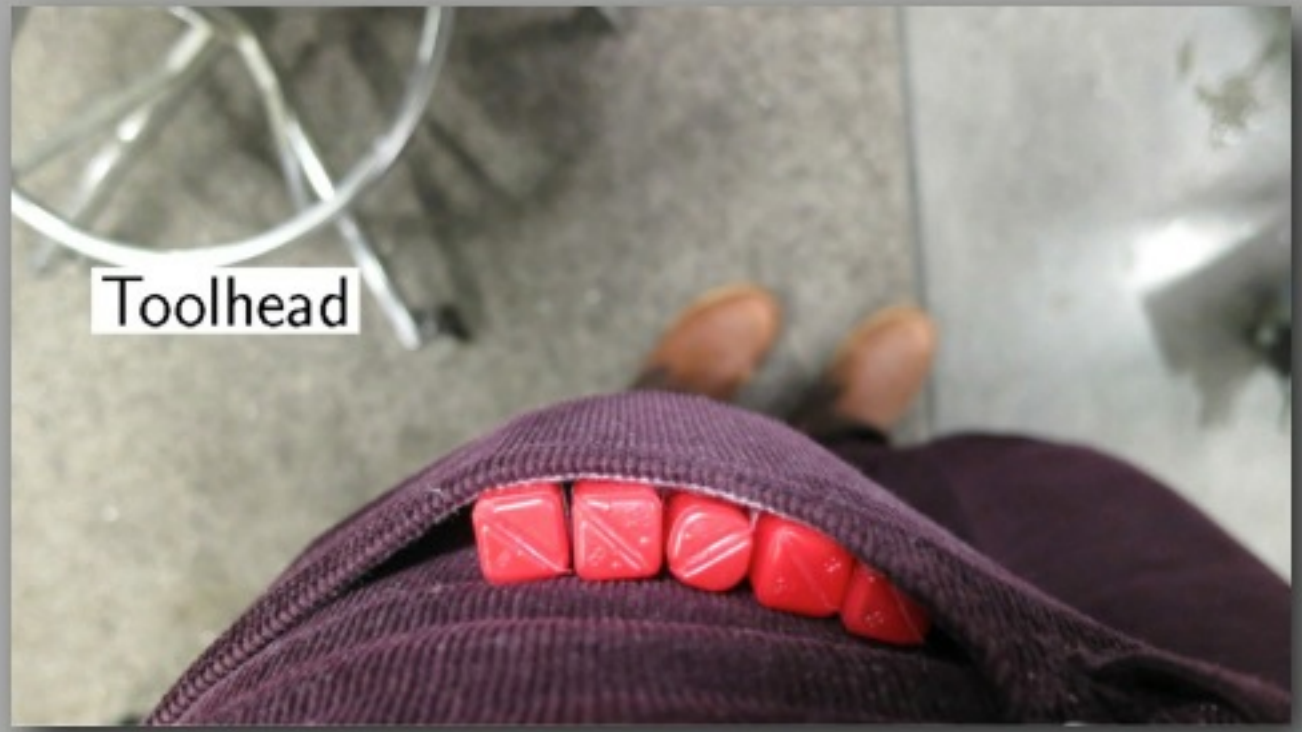


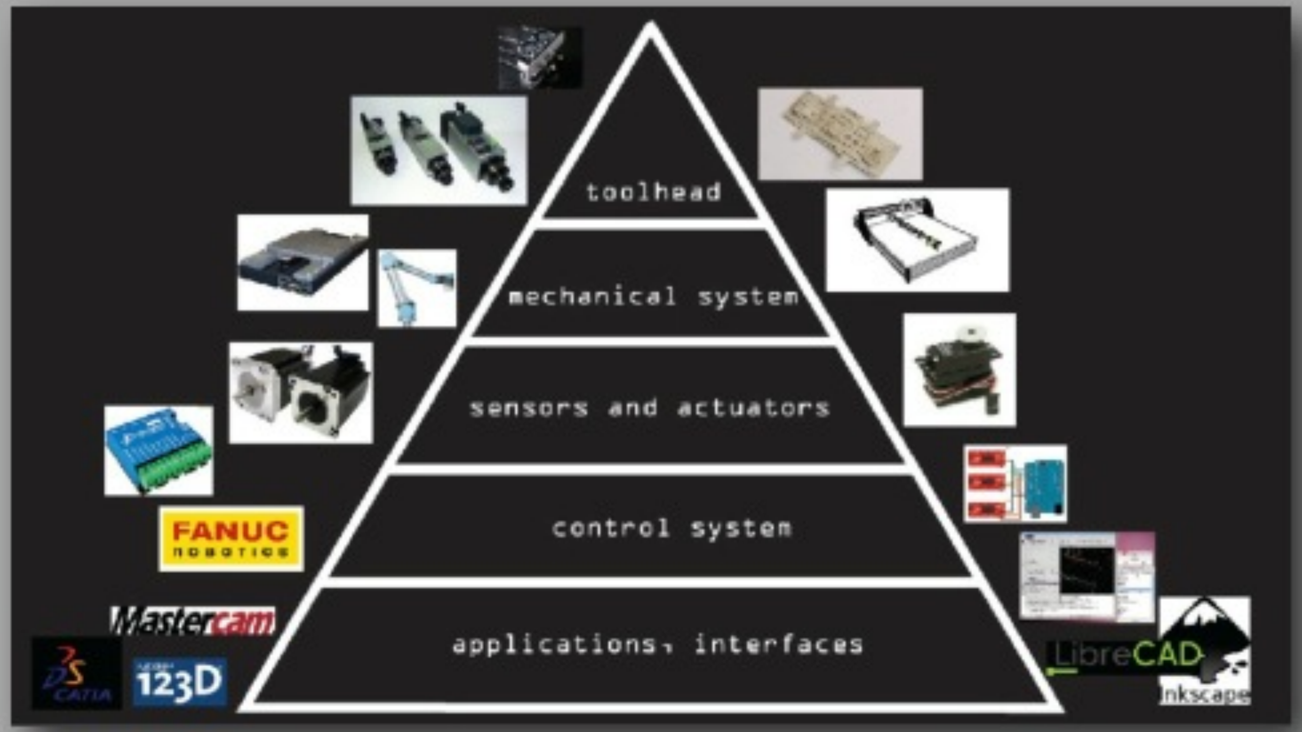


G-code	Functions	G-code	Functions
G0	Rapid positioning	G53	Move in absolute machine coordinate system
G1	Linear interpolation	G54 à G59	Use fixture offset 1 to 6, G59 to select a general fixture number
G2	Clockwise circular / helical interpolation	G61	Exact Stop mode
G3	Counterclockwise circular / helical interpolation	G64	Constant Velocity mode
G4	Dwell	G73	Canned cycle - drilling - fast pullback
G10	Coordinate system origin setting	G80	Cancel canned cycle mode
G12	Clockwise circular pocket	G81	Canned cycle - drilling
G13	Counterclockwise circular pocket	G82	Canned cycle - drilling with dwell
G15	Polar Coordinate moves in G0 and G1	G83	Canned cycle - peck drilling
G16	oves in G0 and G1	G84	Canned cycle - right hand rigid taping (not yet implemented)
G17		G85	Canned cycle - boring, no dwell, feed out
G18		G86	Canned cycle - boring, spindle stop, rapid out
G19	YZ plane select	G87	Canned cycle - back boring (not yet implemented)
G20	Inch unit	G88	Canned cycle - boring, spindle stop, manual out
G21	Millimeter unit	G89	Canned cycle - boring, dwell, feed out
G28	Return machine home (parameters 5161 to 5166)	G90	Absolute distance mode
G30	Return machine home (parameters 5181 to 5186)	G91	Incremental distance mode
G28.1	Reference axis	G92	Offset coordinates and set parameters
G31	Straight Probe	G92.1	Reset G92 offset and parameter
G40	Cancel cutter radius compensation	G92.2	Reset G92 offset but leave parameters untouched
G41	Start cutter radius compensation left	G92.3	Recall G92 from parameters
G42	Start cutter radius compensation right	G93	Inverse time feed mode
G43	Apply tool lenght offset (plus)	G94	Feed per minute mode
G49	Cancel tool lenght offset	G95	Feed per revolution mode
G50	Reset all scale factors to 1.0	G98	Initial level return after canned cycles
G51	Set axis data input scale factors	G99	R-point level return after canned cycles

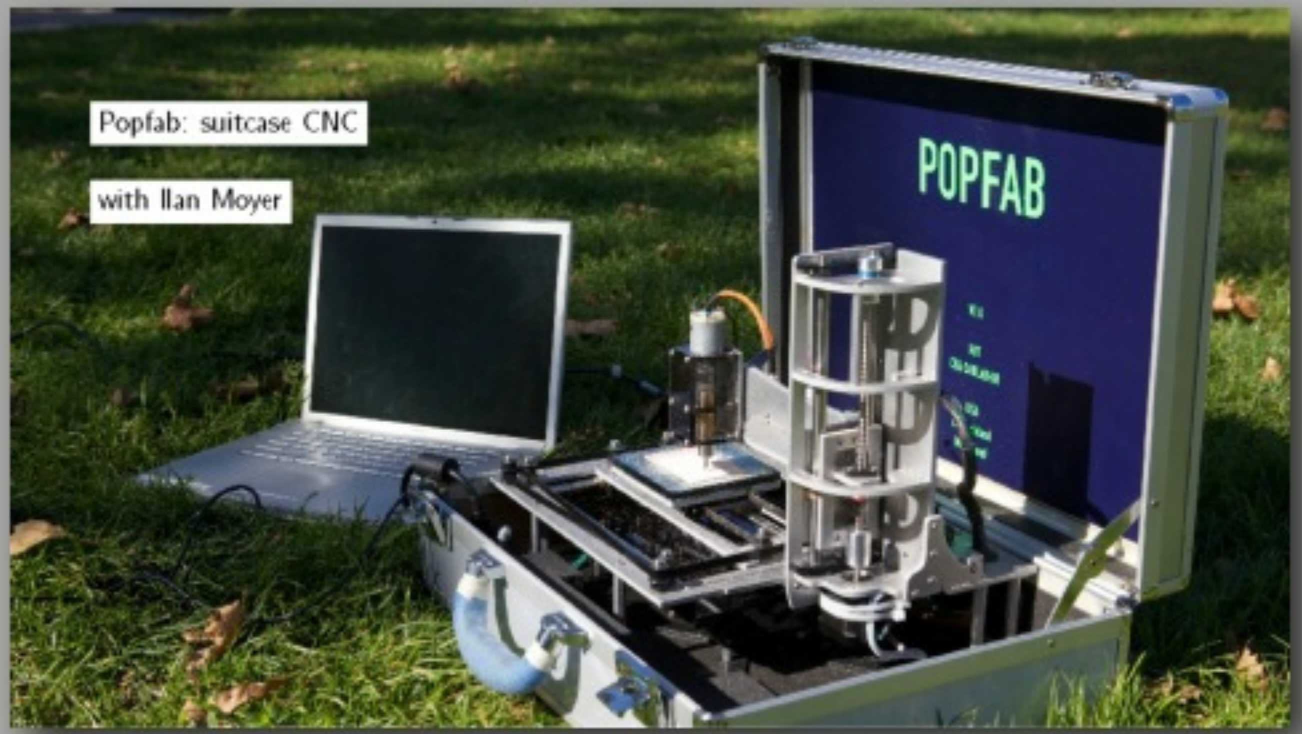


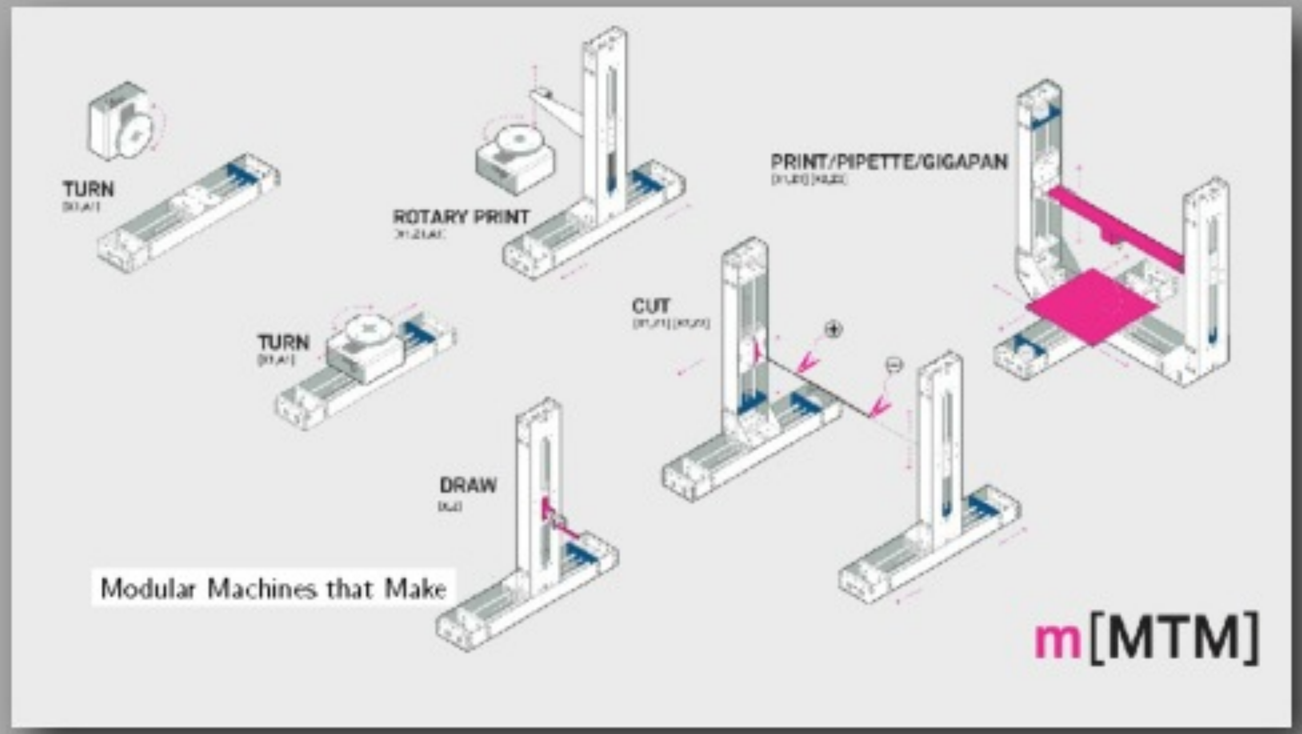


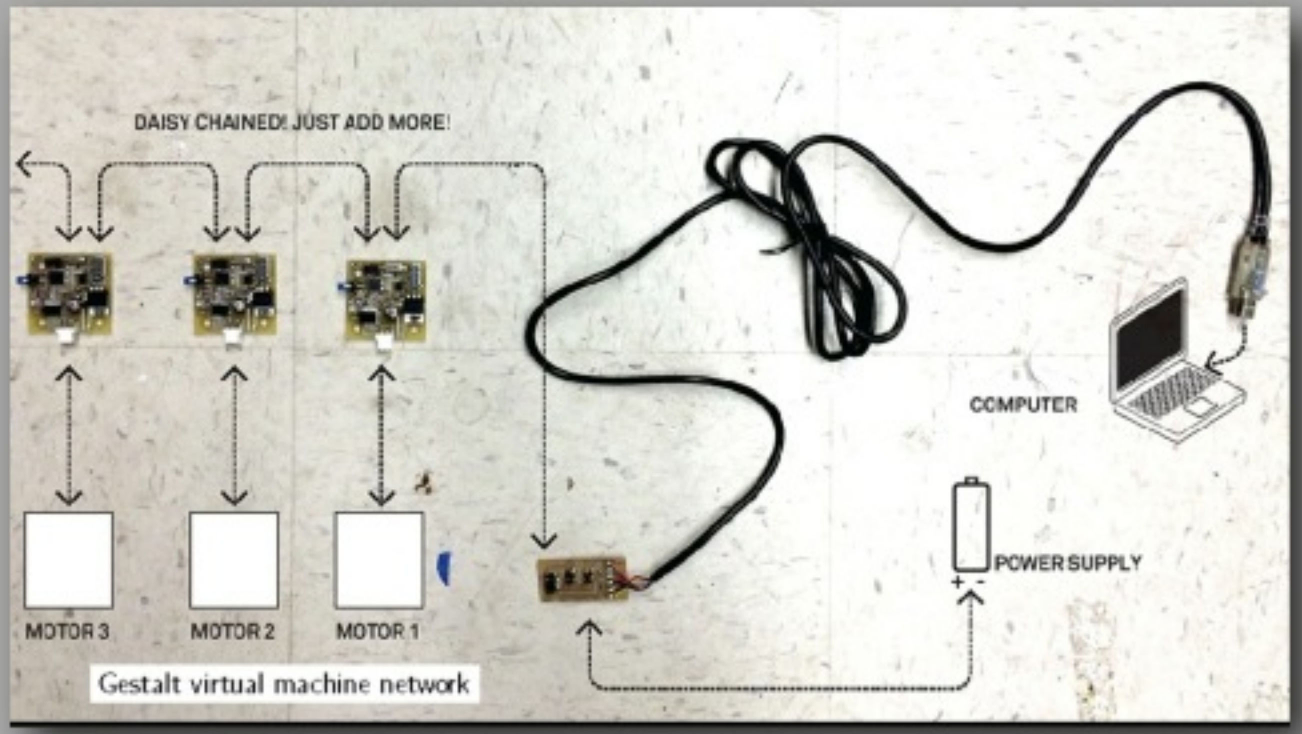


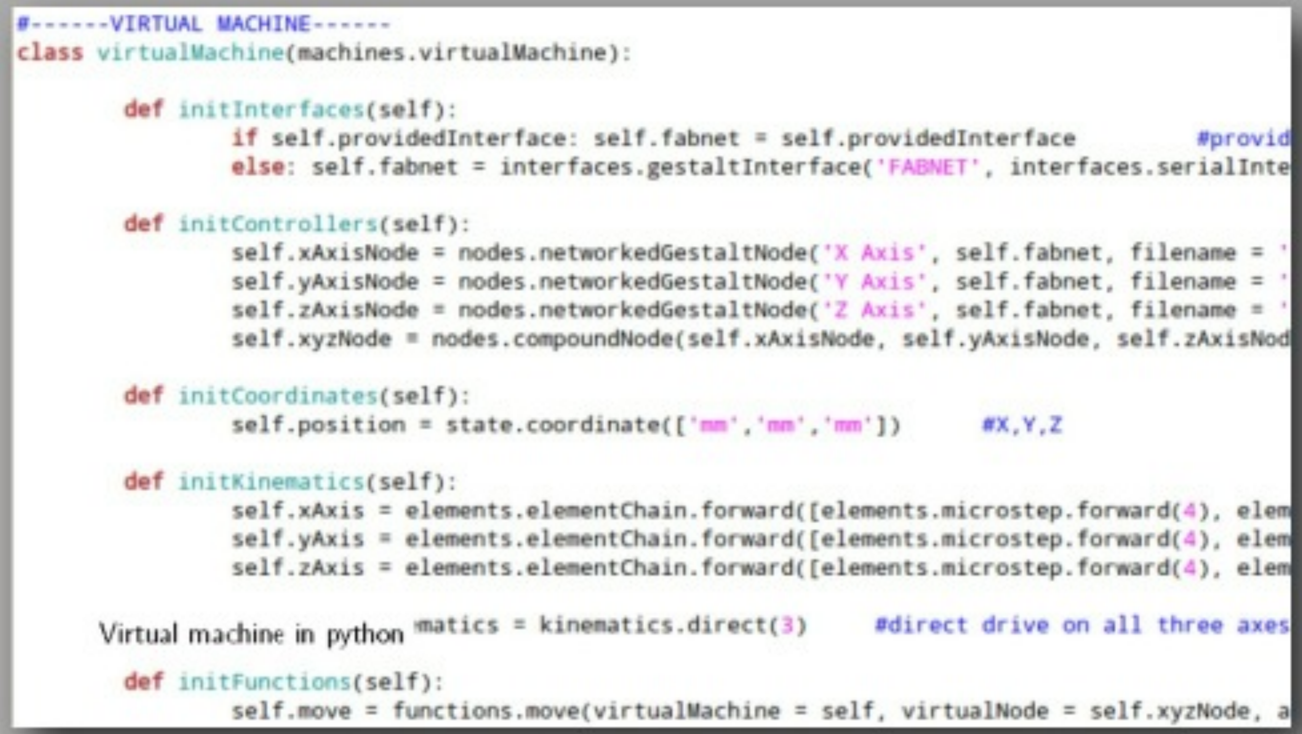



large format machining
structure fabrication
composite tooling
lasercutter
engraving
press-fit assembly
videoconference
classes
collaboration
electronics
surface-mount assembly
embedded programming
vinylcutter
screen printing
flexible circuits
computing
design
manufacturing
3D scanning and printing
prototype production
reverse engineering
precision machining
circuits boards
molding and casting

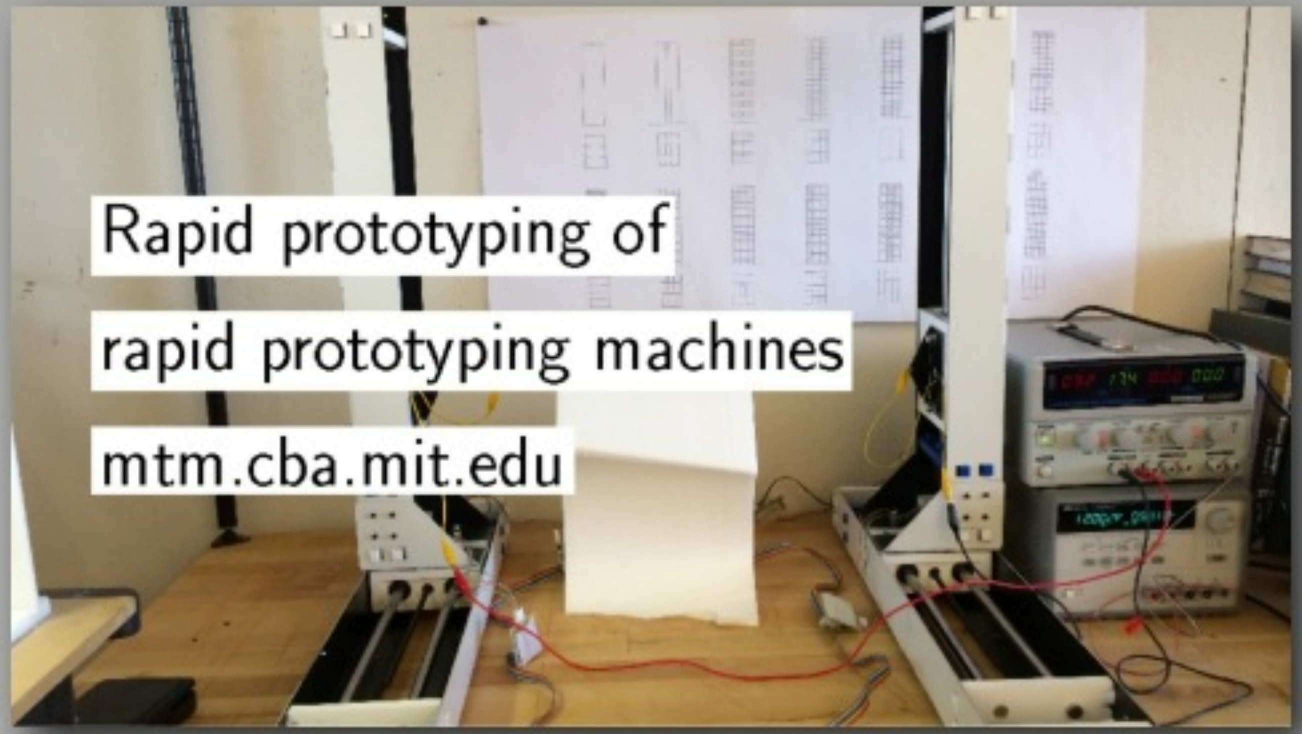

Popfab: suitcase CNC
with Ilan Moyer
POPFAB

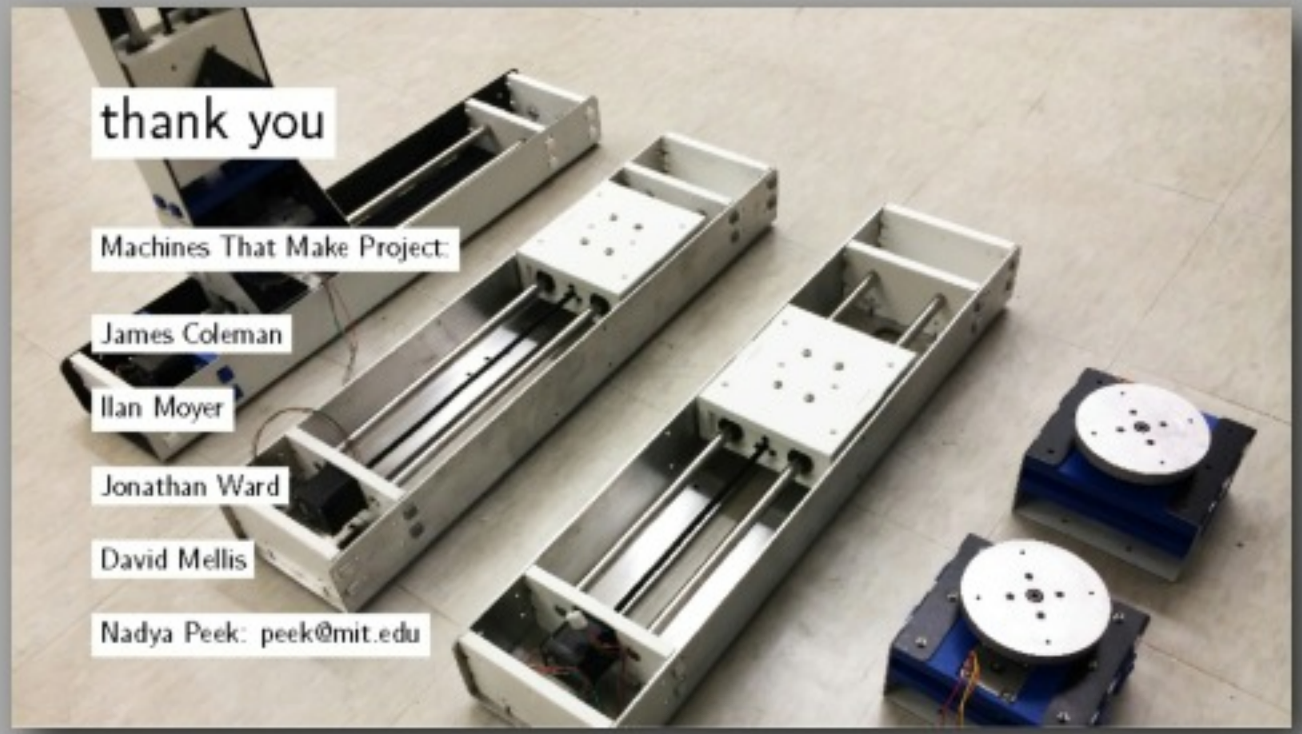

TURN
ROTARY PRINT
PRINT/PIPETTE/GIGAPAN
TURN
CUT
DRAW
Modular Machines that Make
m[MTM]


DAISY CHAINED! JUST ADD MORE!
COMPUTER
POWER SUPPLY
MOTOR 3
MOTOR 2
MOTOR 1
Gestalt virtual machine network


#------VIRTUAL MACHINE------
class virtualMachine(machines.virtualMachine):
def initInterfaces(self):
if self.providedInterface: self.fabnet = self.providedInterface
else: self.fabnet = interfaces.gestaltInterface('FABNET', interfaces.serialInte
def initControllers(self):
self.xAxisNode = nodes.networkedGestaltNode('X Axis', self.fabnet, filename =
self.yAxisNode = nodes.networkedGestaltNode('Y Axis', self.fabnet, filename =
self.zAxisNode = nodes.networkedGestaltNode('Z Axis', self.fabnet, filename =
self.xyzNode = nodes.compoundNode(self.xAxisNode, self.yAxisNode, self.zAxisNod
def initCoordinates(self):
self.position = state.coordinate(['mm','mm','mm']) #X,Y,Z
def initKinematics(self):
self.xAxis = elements.elementChain.forward([elements.microstep.forward(4), elem
self.yAxis = elements.elementChain.forward([elements.microstep.forward(4), elem
self.zAxis = elements.elementChain.forward([elements.microstep.forward(4), elem
Virtual machine in python
matics = kinematics.direct(3) #direct drive on all three axes
def initFunctions(self):
self.move = functions.move(virtualMachine = self, virtualNode = self.xyzNode, a


PCB Milling


Rapid prototyping of
rapid prototyping machines
mtm.cba.mit.edu


thank you
Machines That Make Project:
James Coleman
Ilan Moyer
Jonathan Ward
David Mellis
Nadya Peek: peek@mit.edu

16_Terry Fong

NASA Ames Research Center

"I'm interested in building effective and fluid human-robot teams."

Moonshot Thinking

Positioning NASA's current space exploration strategy as deeply invested in robotics and co-human and robot interaction, Fong asked how robots might be used to improve and enhance human experiences and experiments before, during, and after a mission. Robots are being imagined as improving the upcoming mission to the moon, augmenting initial planning, executing a preliminary site visit, updating and upgrading materials once on the lunar surface, and continuing work after their human counterparts have left. As well, NASA is exploring remote rover operation on Mars through human controllers in orbit.

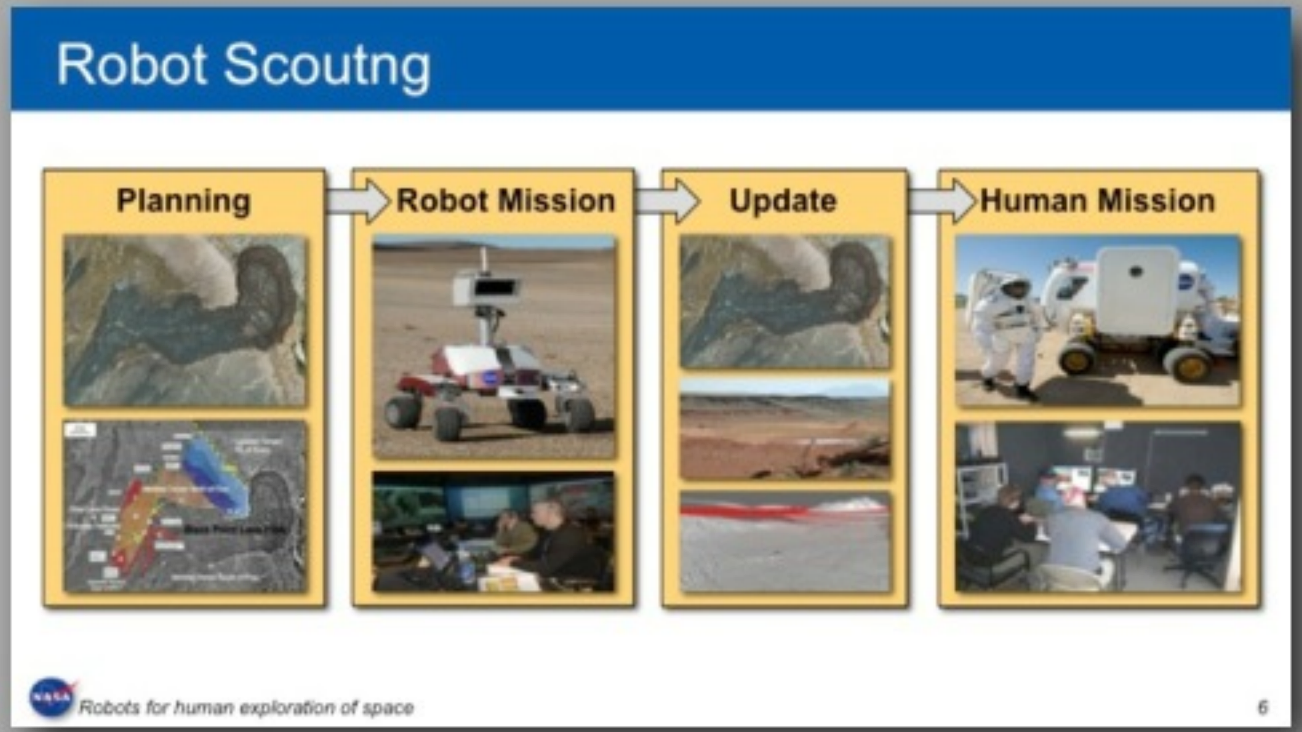

NASA
Robots for Human Exploration of Space
Terry Fong
Intelligent Robotics Group
NASA Ames Research Center
terry.fong@nasa.gov


Apollo Surface Operations
Jack Schmitt & Lunar Roving Vehicle
(Apollo 17 – December 1972)

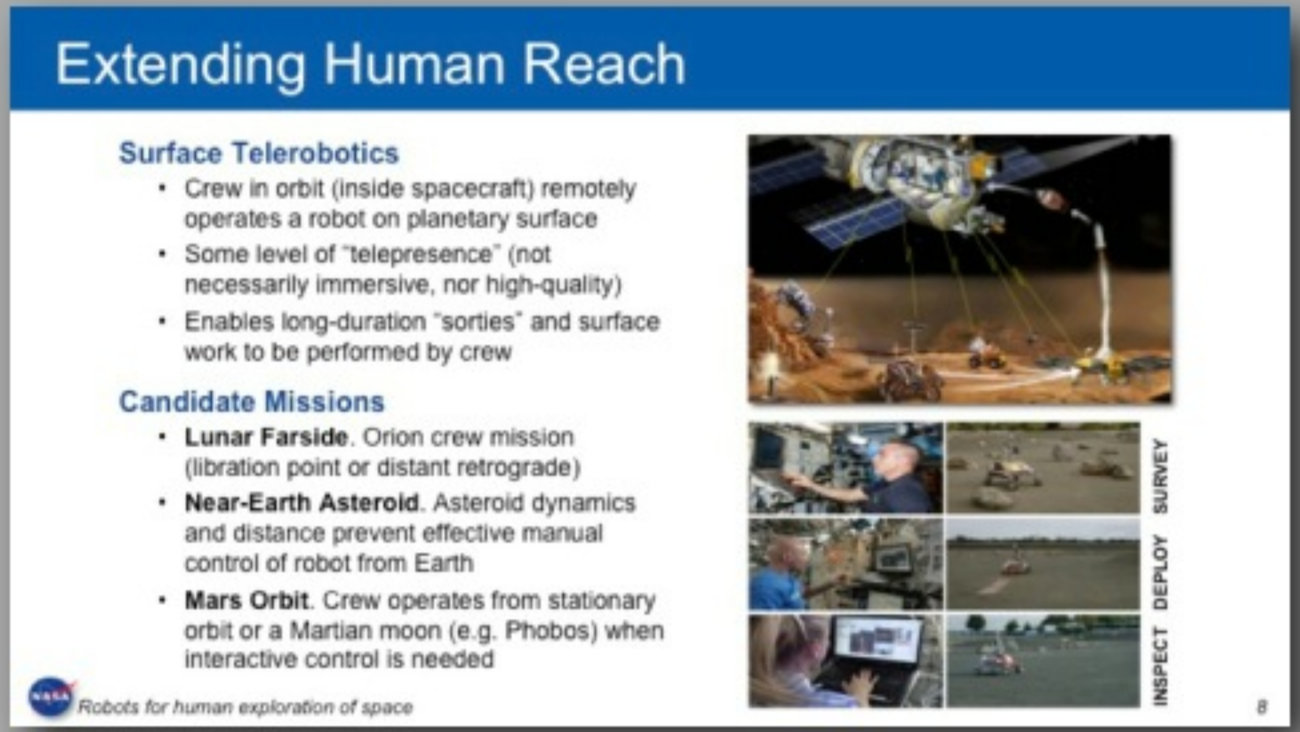

What's Changed Since Apollo?
Kaguya
Chandrayaan
LRO
3D simulation
Phoenix
Zoë
ATHLETE, K10, Chariot
MER, Sojourner, MSL
Dante II
Robots for human exploration of space
3


EARTH RELIANT
MISSION: 6 TO 12 MONTHS
RETURN TO EARTH: HOURS
PROVING GROUND
MISSION: 1 TO 12 MONTHS
RETURN TO EARTH: DAYS
MARS READY
MISSION: 2 TO 3 YEARS
RETURN TO EARTH: MONTHS
Mastering fundamentals aboard the International Space Station
U.S. companies provide access to low-Earth orbit
Expanding capabilities by visiting an asteroid redirected to a lunar distant retrograde orbit
The next step: traveling beyond low-Earth orbit with the Space Launch System rocket and Orion spacecraft
Developing planetary independence by exploring Mars, its moons and other deep space destinations
www.nasa.gov


Robots for Human Exploration
Purpose
• Increase human productivity
• Improve mission planning & execution
• Off-load routine work to robots
Before Crew
• Scouting & prospecting
• Site prep, deploy equipment, etc.
Supporting Crew
• Extend human reach
• In-flight maintenance
After Crew
• Follow-up & close-out work
• Site survey, supplementary tasks, etc.
Robots for human exploration of space
5


Robot Scoutng
Planning
Robot Mission
Update
Human Mission
Robots for human exploration of space
6


In-Flight Maintenance
Motivation: Skylab
• Micro-meteoroid + sun shield tore off at launch … and took a main solar array with it
• Almost lost the vehicle due to lack of power and overheating … before it was ever used!
• Astronauts had to do emergency repairs
• Future pre-deployments to deep space will need robots to do this type of work
Inspect & monitor
• Conduct routine surveys and inventory
• Check and document payload status
Routine maintenance
• Change air/water filters
• Perform water draw on life support system
Emergency response
• Assess environment after fire event
• Identify, evaluate and repair leaks
• Operate hatches, valves, mechanisms, etc.
Robots for human exploration of space
7


Extending Human Reach
Surface Telerobotics
• Crew in orbit (inside spacecraft) remotely operates a robot on planetary surface
• Some level of "telepresence" (not necessarily immersive, nor high-quality)
• Enables long-duration "sorties" and surface work to be performed by crew
Candidate Missions
• Lunar Farside. Orion crew mission (libration point or distant retrograde)
• Near-Earth Asteroid. Asteroid dynamics and distance prevent effective manual control of robot from Earth
• Mars Orbit. Crew operates from stationary orbit or a Martian moon (e.g. Phobos) when interactive control is needed
SURVEY
DEPLOY
INSPECT
Robots for human exploration of space
8


Robotic Follow-Up
Robots for human exploration of space
9

Challenge #1: Human-Robot Interaction

Key questions

- How to improve **human-robot team productivity** (coordination, task distribution, communication)?
- How to **reduce the # of people** in ground control?
- How to facilitate **crew-control** (training, skills, etc)?
- How to support **proximal interaction** for a variety of users (bystander, teammate, technician, etc)?

Challenge #2: Non-prehensile Manipulation

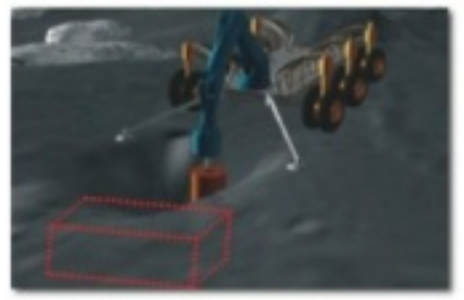
Key questions

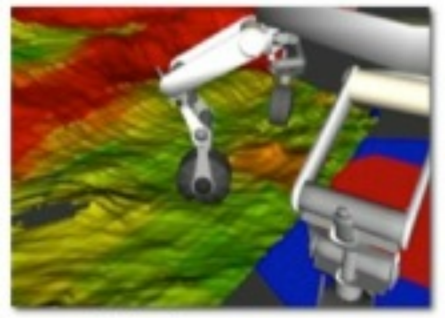
- How can we manipulate the world **without** using a dexterous end-effector (robot hand)?
- How do we plan and control the use of **pushing, tapping, dragging, rolling, pivoting**, etc?
- What modeling / understanding of the **interaction physics** (friction, contact, mass, etc) is needed?

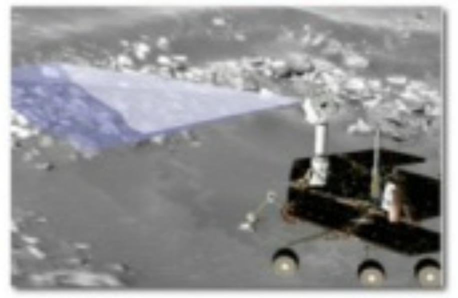
Challenge #3: Effective Simulation

Key questions

- How can we use simulation for **research** and **testing** (regression testing, V&V, etc)?
- How can we simulate **human-robot interaction**?
- How can we better simulate **physical phenomena** and unstructured, natural environments (especially when parameters are ill-defined)?







IDEAS_09
ROBOT DESIGN CHALLENGE

For a creative and playful break in between the first and second series of IDEAS presentations, participants constructed and battled robots in teams, getting a hands-on experience with some of the issues and opportunities that had surfaced during the day.





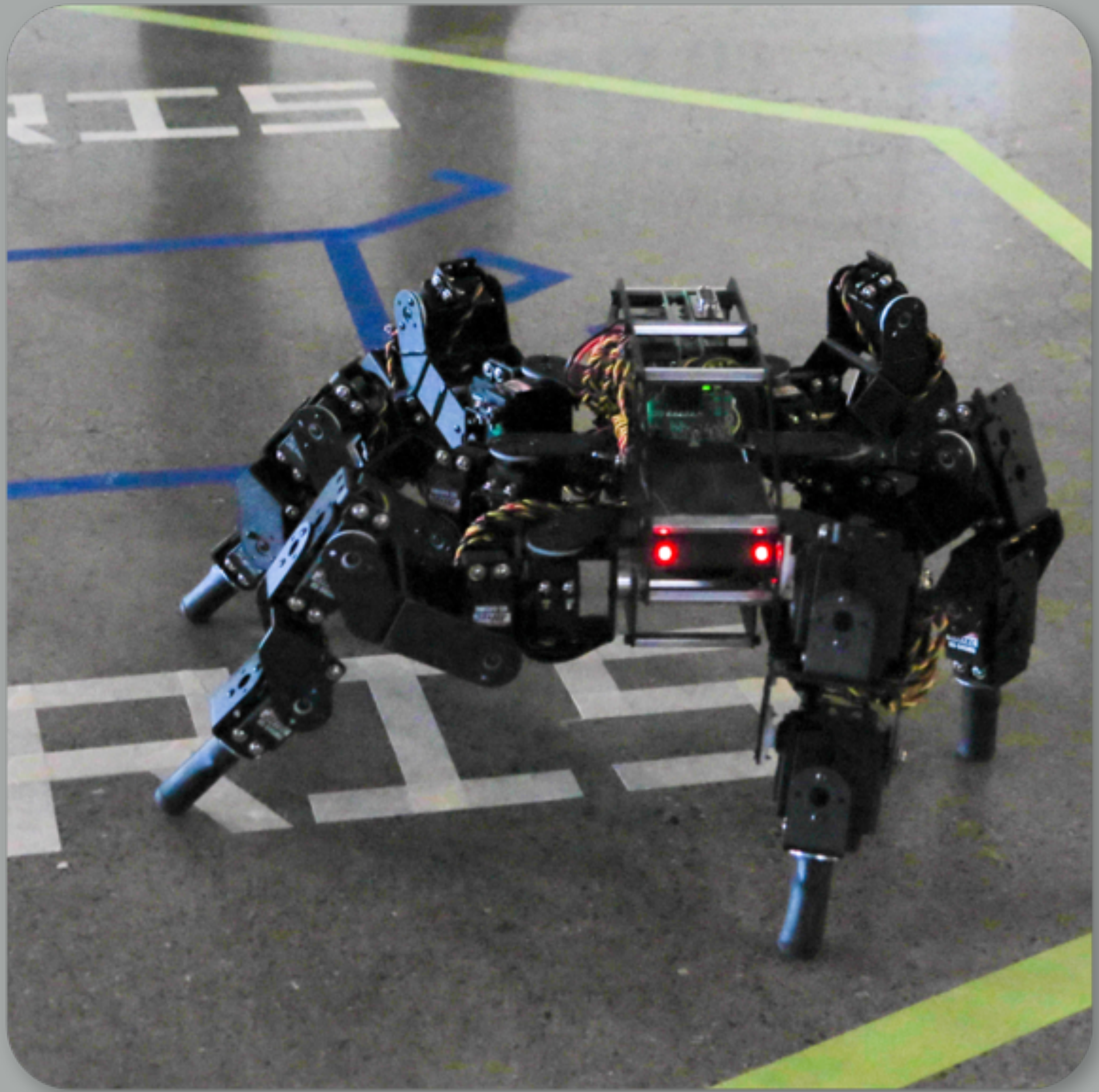


ROBOTICS CONTEST
5
20
50



NEGRA MODELO
ANCHOR
CALIFORNIA LAGER
Asahi
SUPER DRY
DRAKE'S
AMBER
SAN LEANDRO · CALIFORNIA

Jonathan Knowles



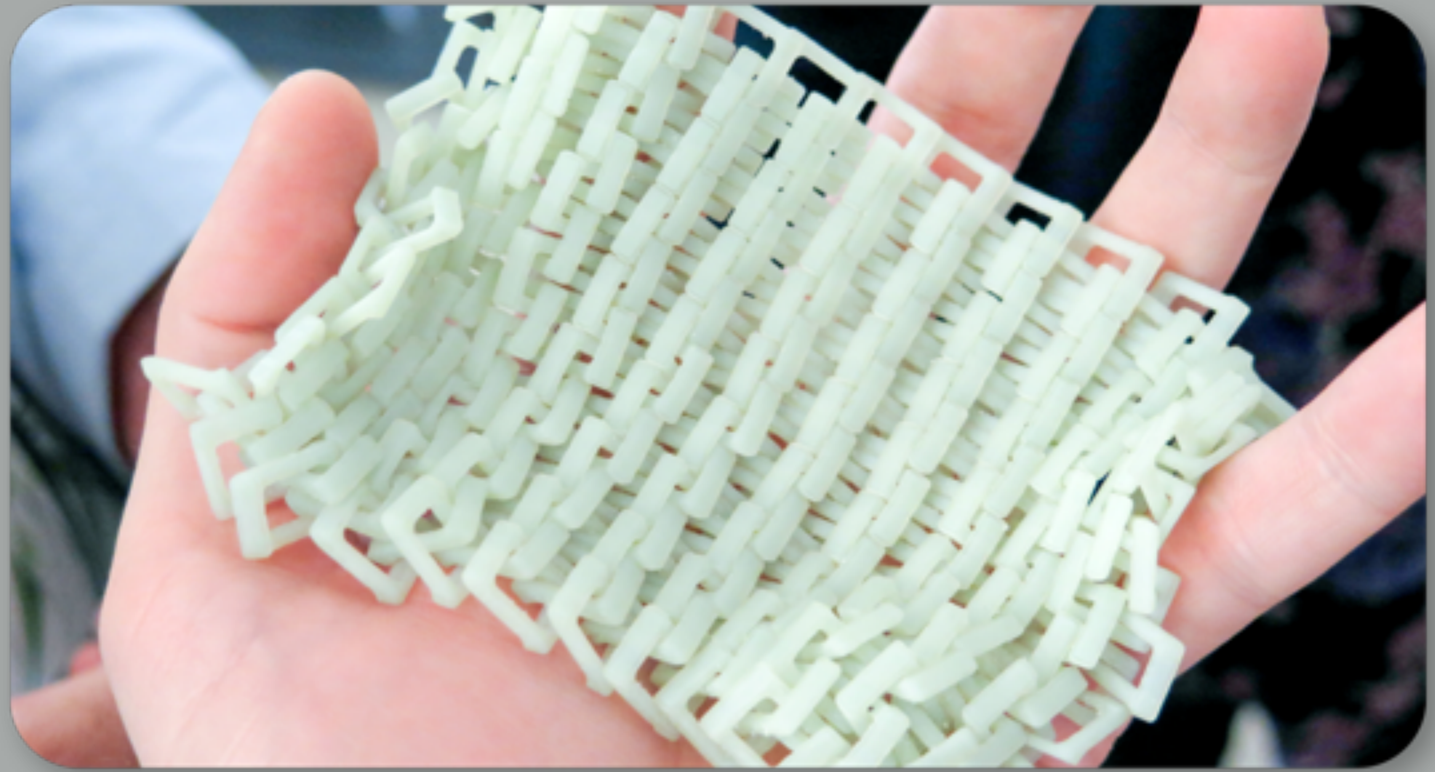
IDEAS

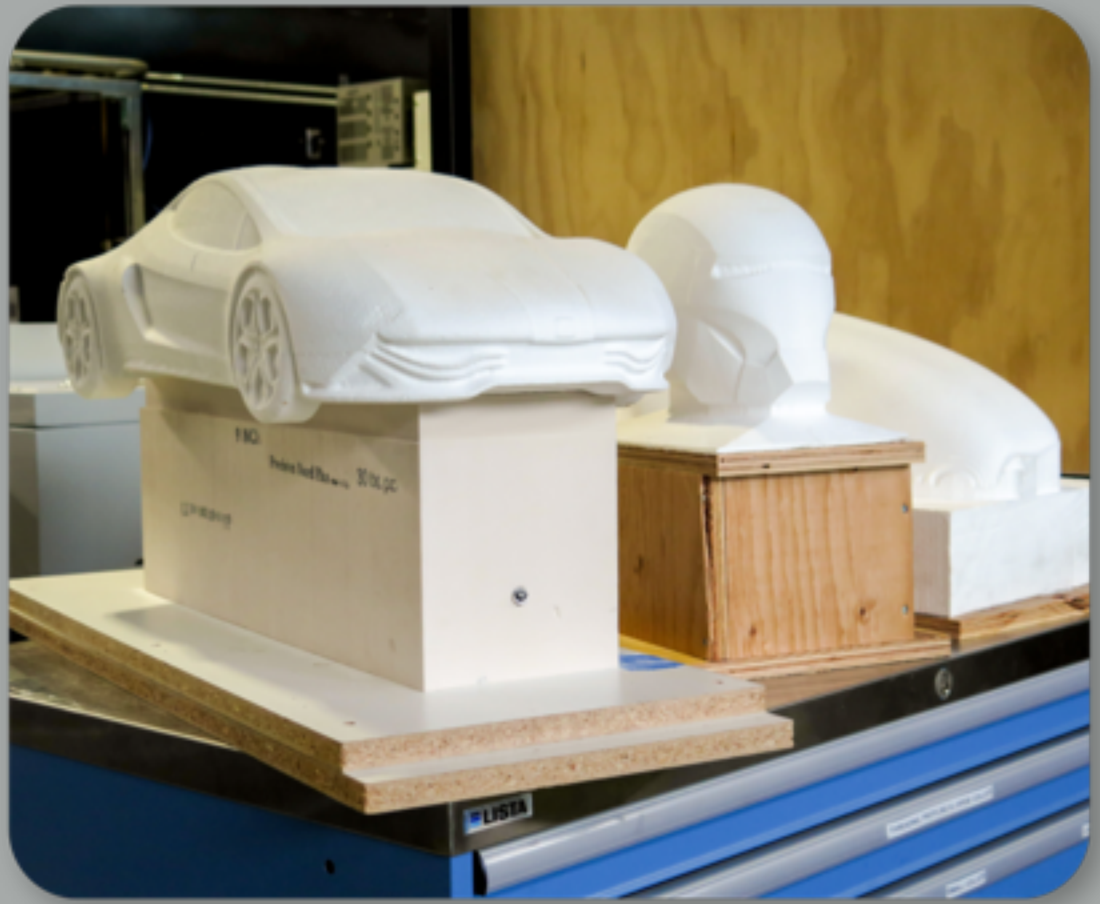

IDEAS_09
DINNER AT AUTODESK PIER 9

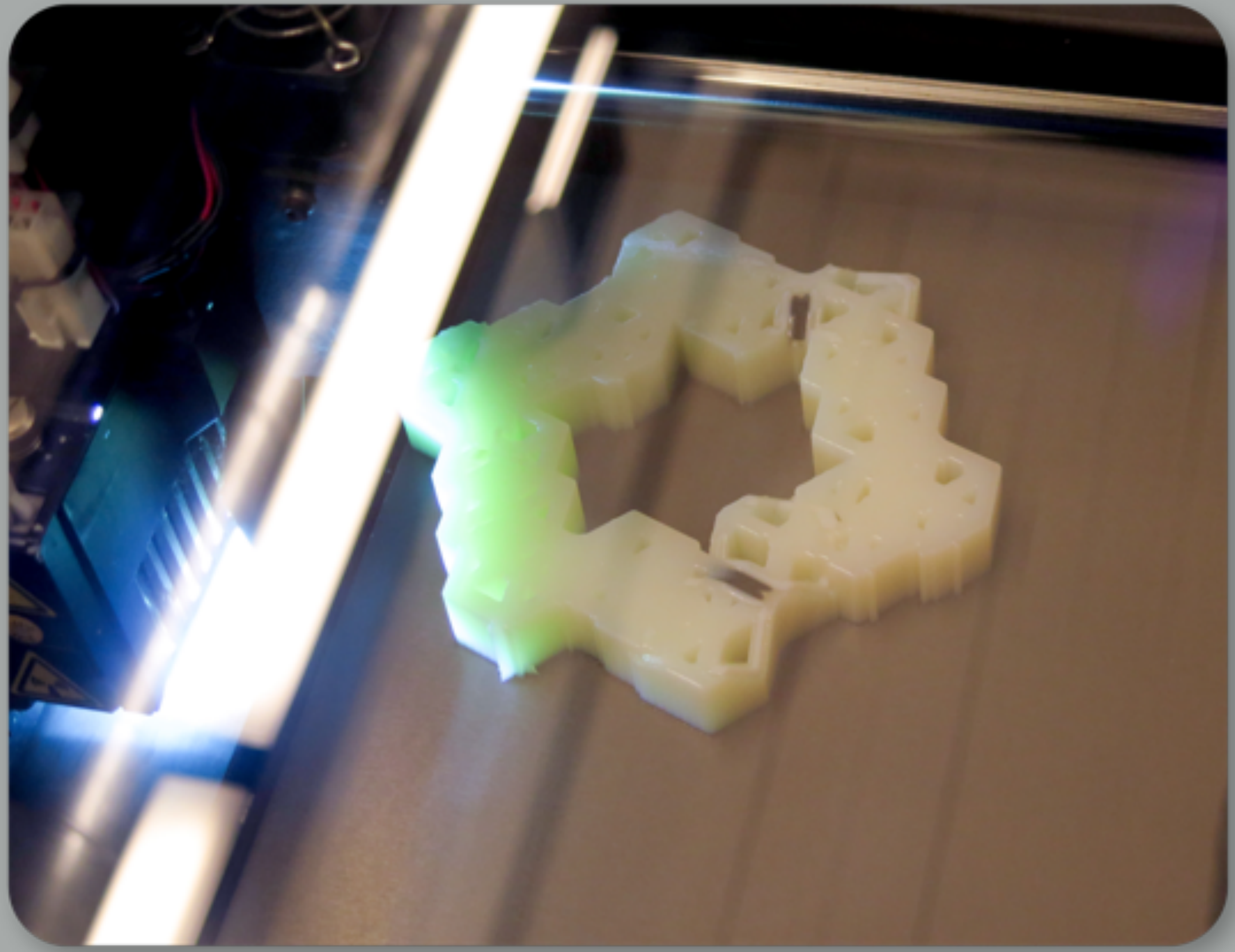
To conclude the first day of the IDEAS summit, participants joined Autodesk CTO Jeff Kowalski across the street from the Autodesk Gallery for a tour of Pier 9, the company's cutting-edge design and manufacturing workshop in downtown San Francisco.

Even dinner was manufactured on-site.





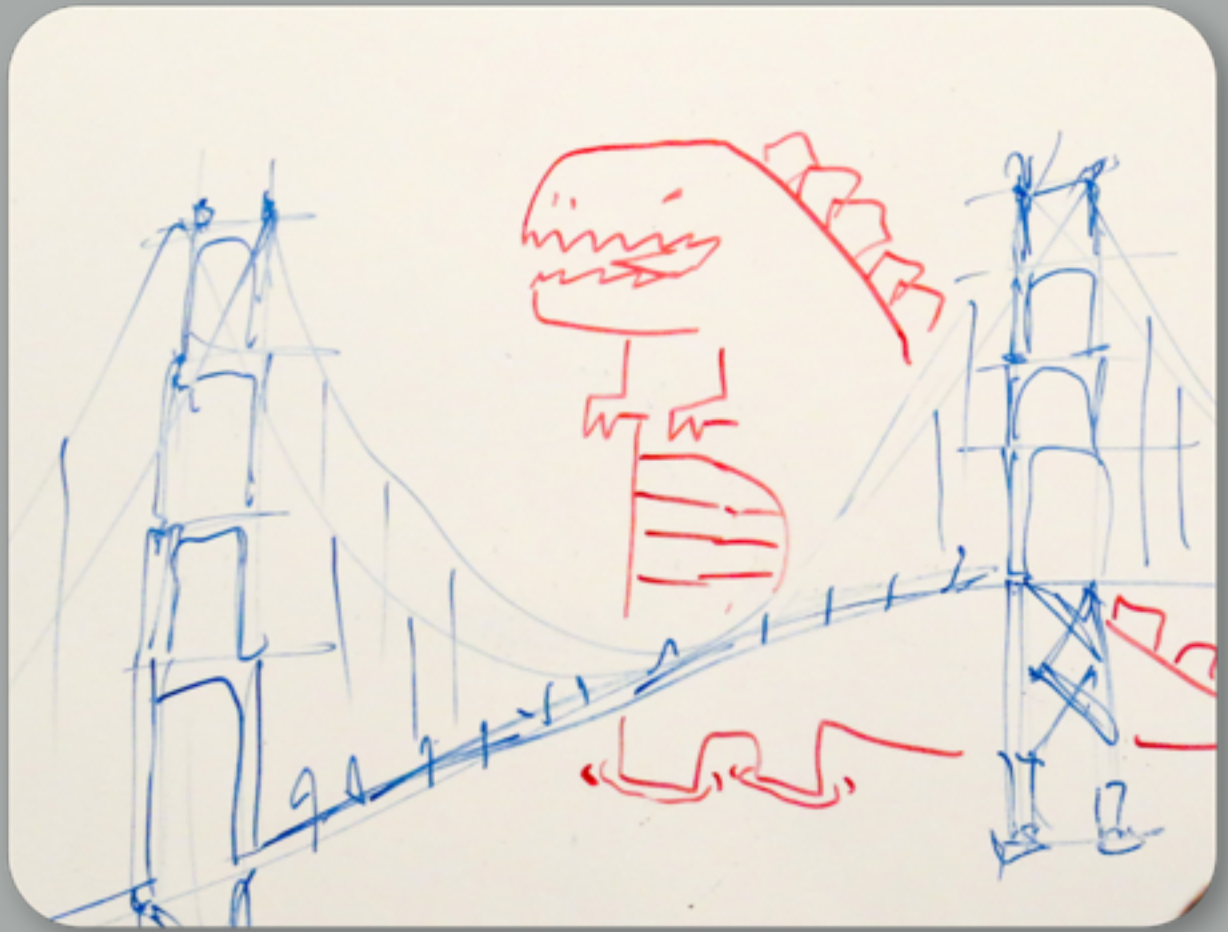















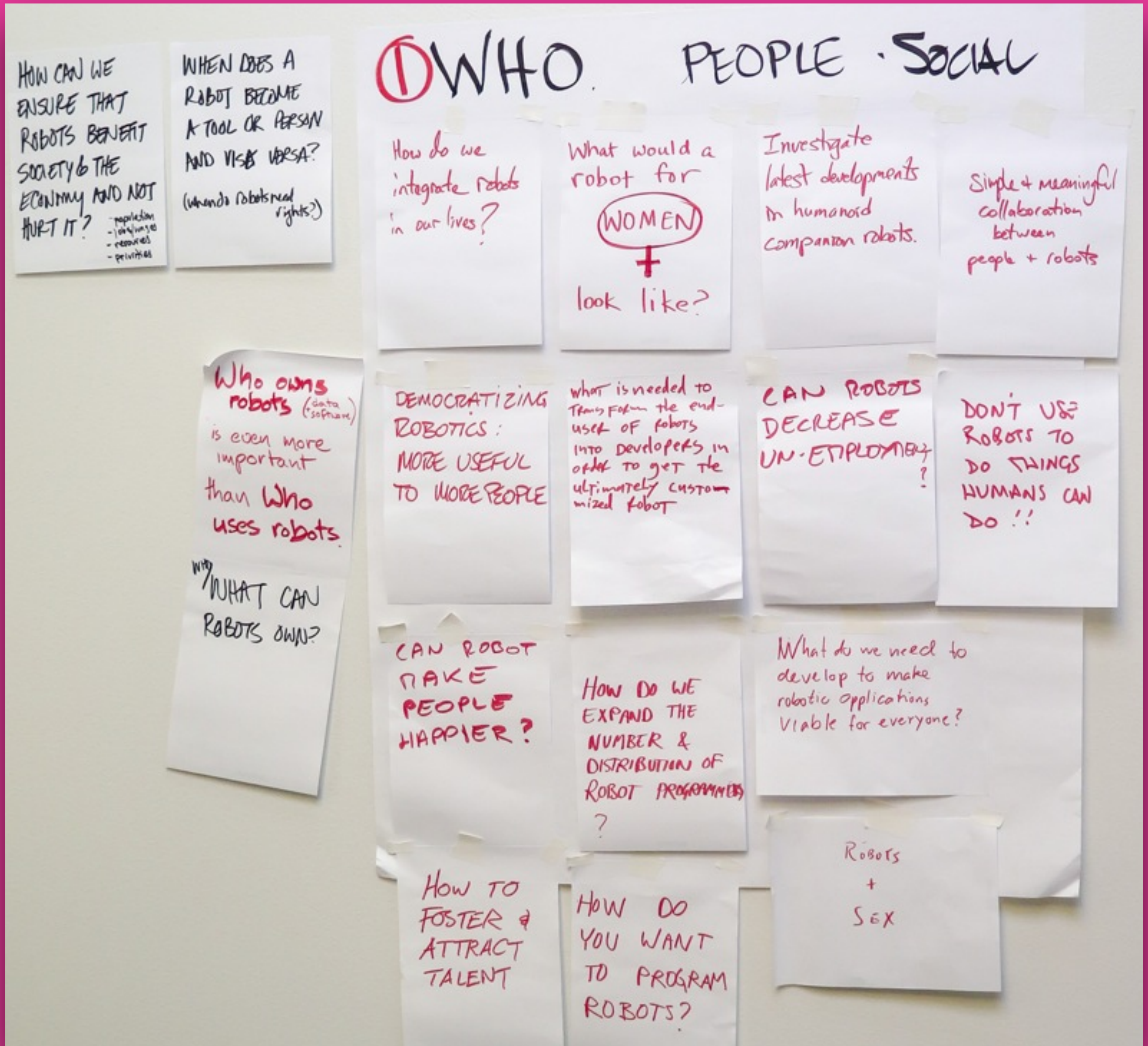
IDEAS_09
FRAMING THE BIG QUESTIONS

Tom Wujec clustered the stickies and questions that had emerged in response to participant presentations.

Out of these clusters came 5 major themes that the group felt important to answering the question of how we direct robots to do more interesting and important things.

Participants were broken off into groups — each group working to unpack the thematic area they had chosen, separating relevant questions and possible answers that had emerged during the summit.

TEAM_01
HUMAN-ROBOT RELATIONS



TEAM 01: Human-Robot Relations


IMPACT ON EMPLOYMENT / WORK
IMPACT ON POPULATION
IMPACT ON ECONOMIES
IMPACT ON RESOURCES
WHO ARE THE DECISION
ROBOTS?
COLLABORATION
ENT
WHO IS INVOLVED?
DAGOBAH TENNIS CLUB
DTC
CLAY COURT TOURNAMENT

TEAM 01: Human-Robot Relations

How can robots impact societal systems?

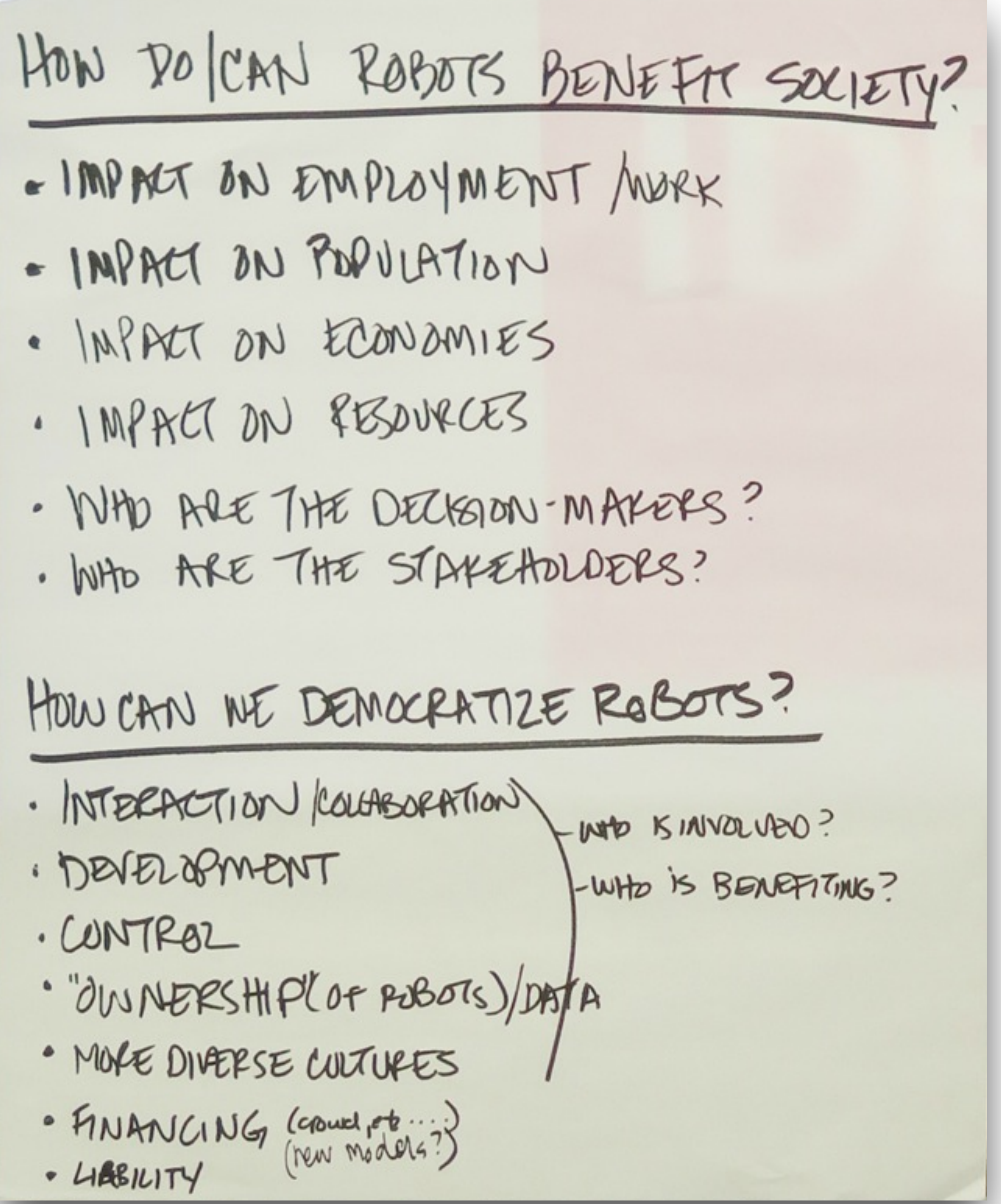
Employment / Work
Population
Economies
Resources

Who are the decision-makers about robots?

Who are the stakeholders? Who benefits?

How can we democratize robots?

Interaction / Collaboration
Development
Control
Ownership of Robots/Data
Financing (New Models?)
Diverse Cultures
Liability



TEAM 01: Human-Robot Relations

Who / What IS a Robot?

Animal
Person
What / who can THEY own?
Tool / Machine

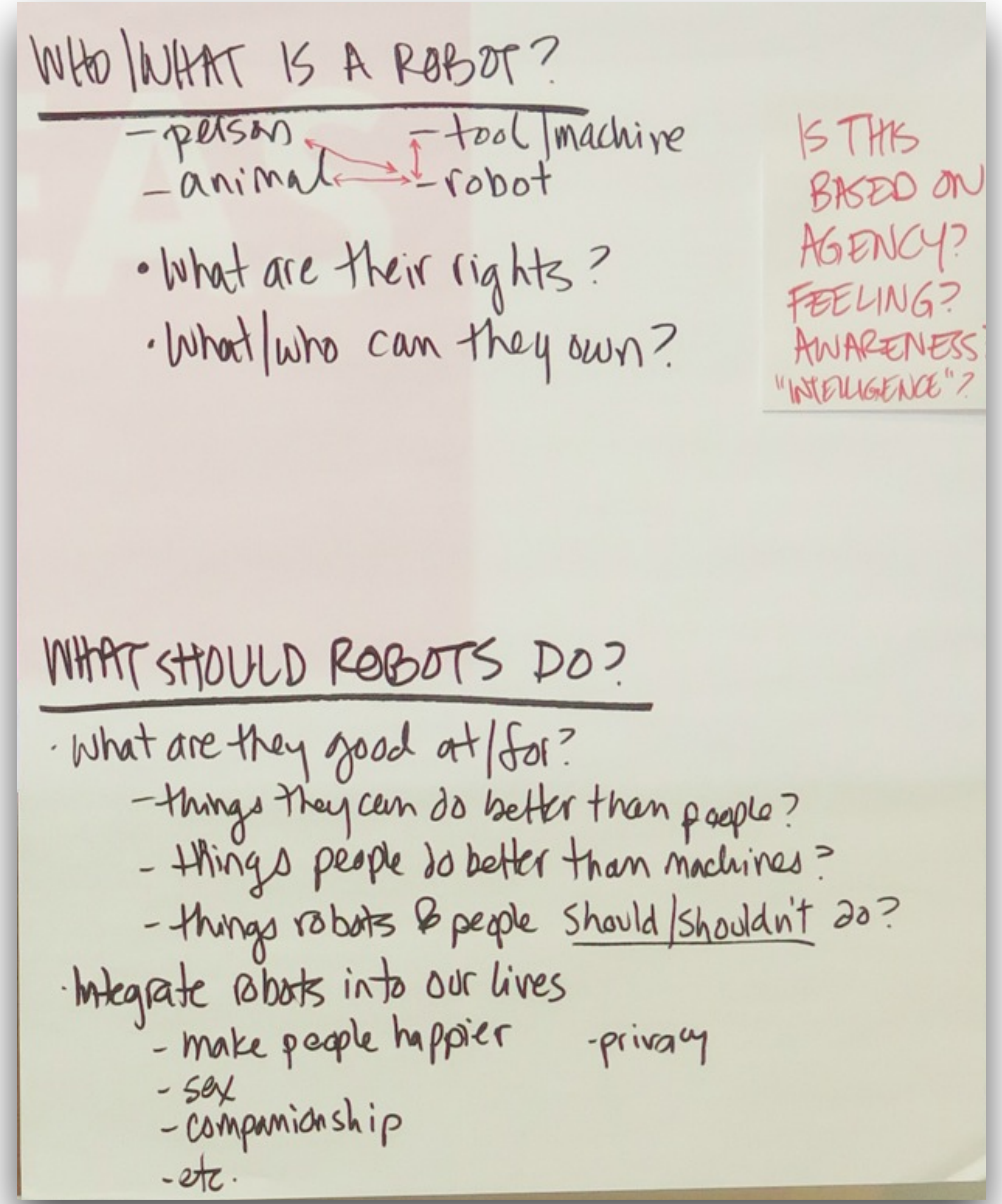
What should Robots DO?

What are they good at / for?

What can THEY do better than people? *What can WE do better than robots?*

How can we integrate robots into our lives?

Happiness
Sex
Companionship
Privacy



TEAM 01: Human-Robot Relations

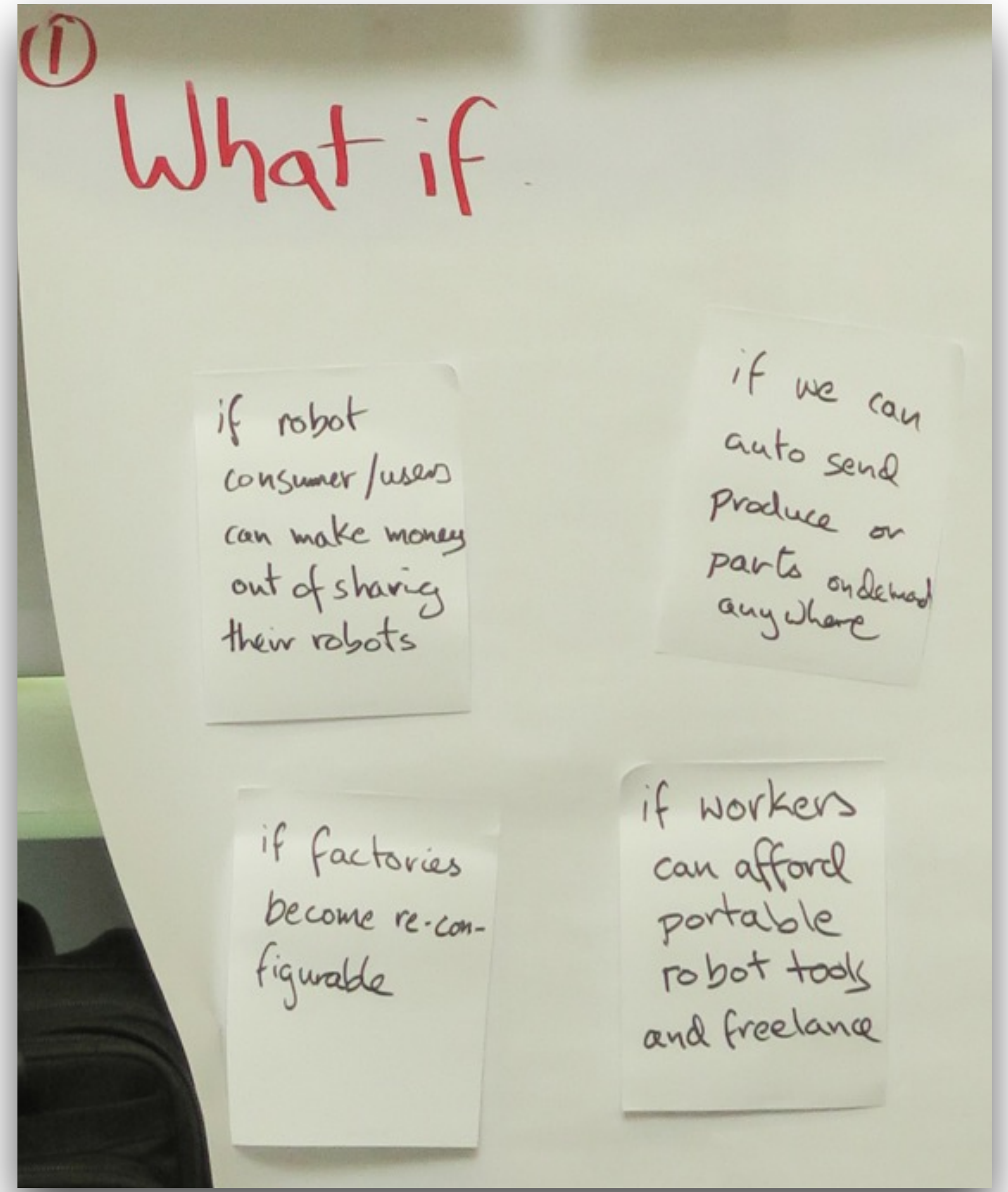
"What If" Questions

What if robot consumers / users could make money out of sharing their robots?

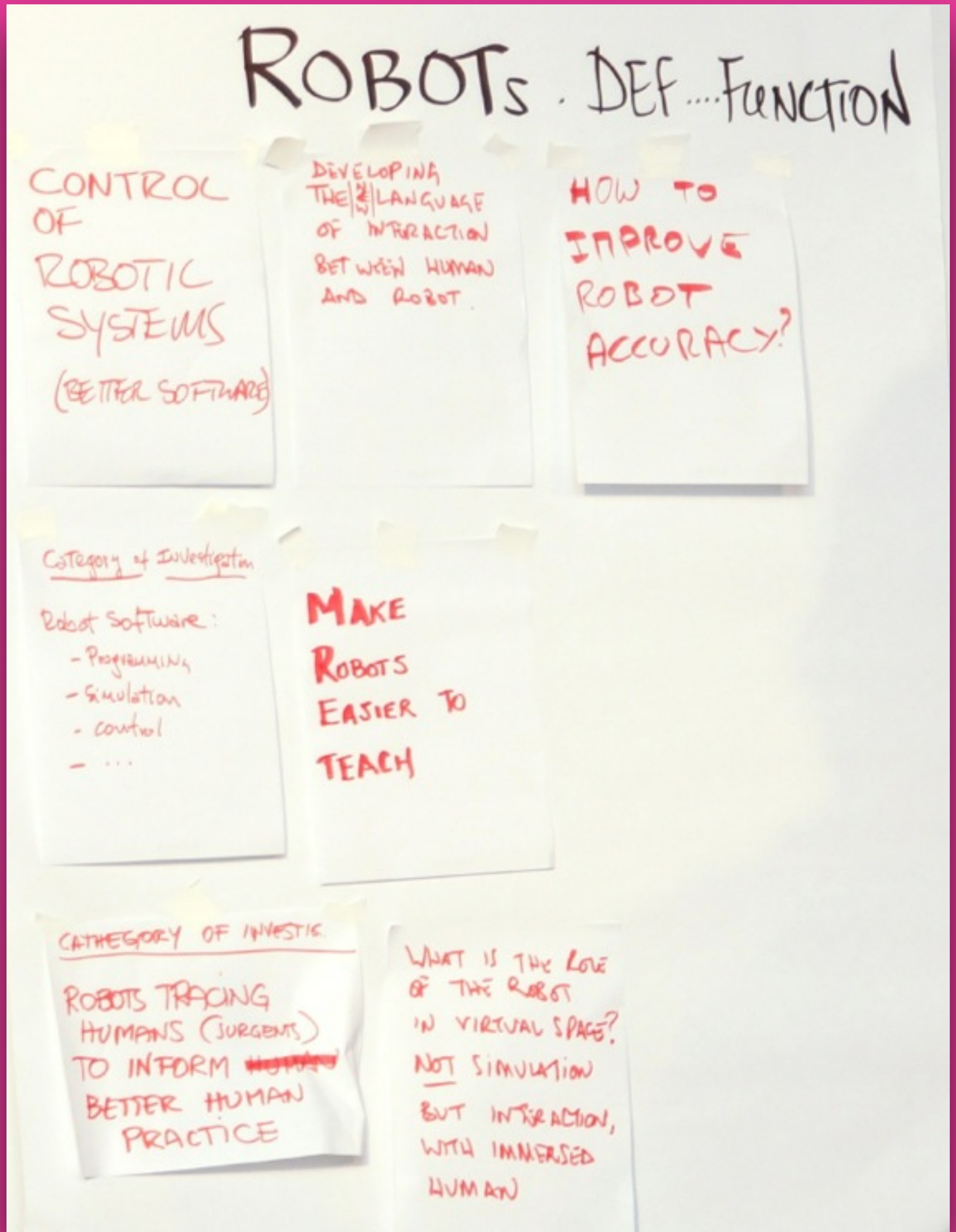
What if we could automatically send/produce robot parts on demand, anywhere?

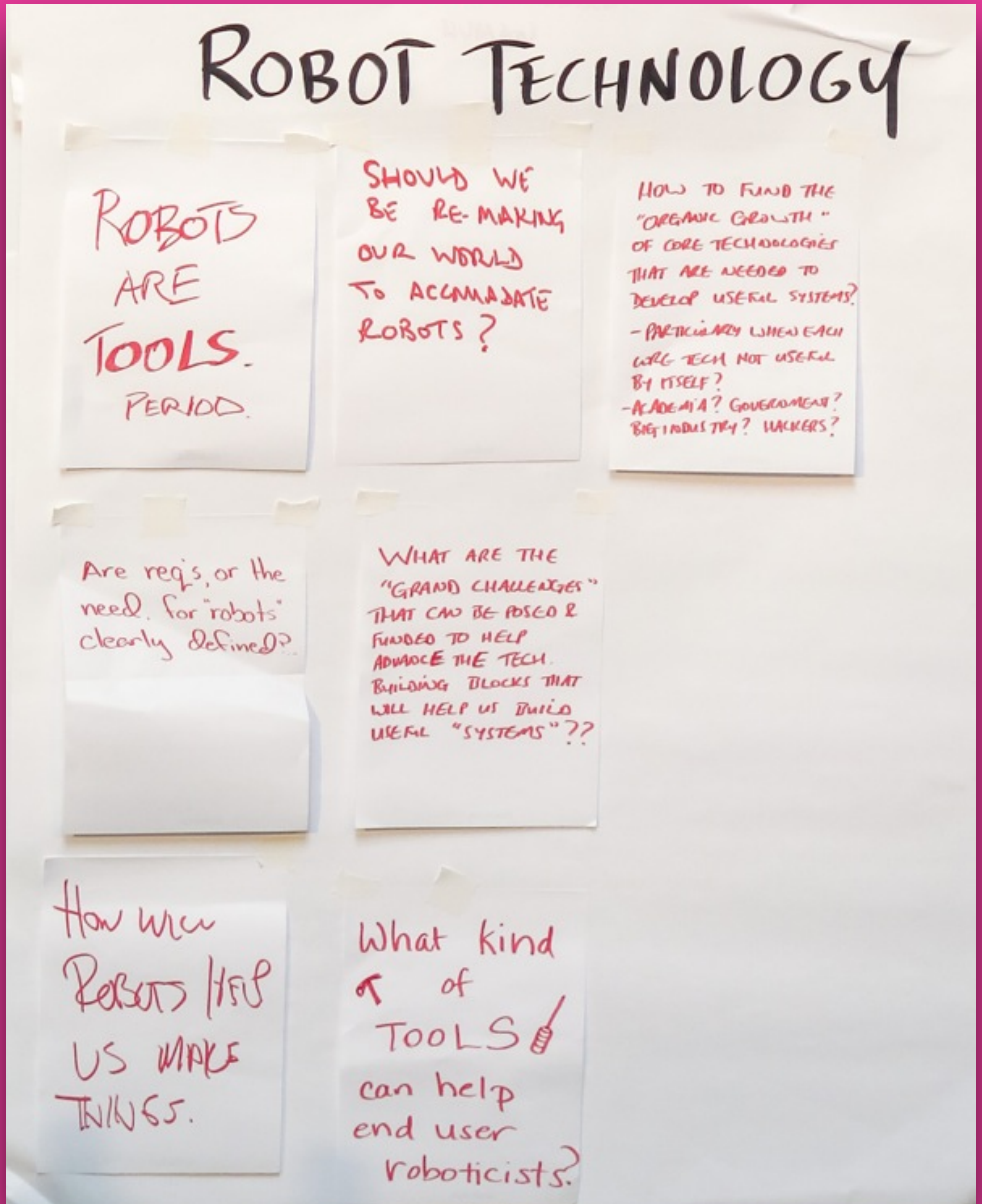
What if workers could afford portable robotics tools for freelance work?

What if factories could become reconfigurable?



TEAM_02
ROBOT FUNCTION + TECHNOLOGY





TEAM 02: Robot Function and Tech

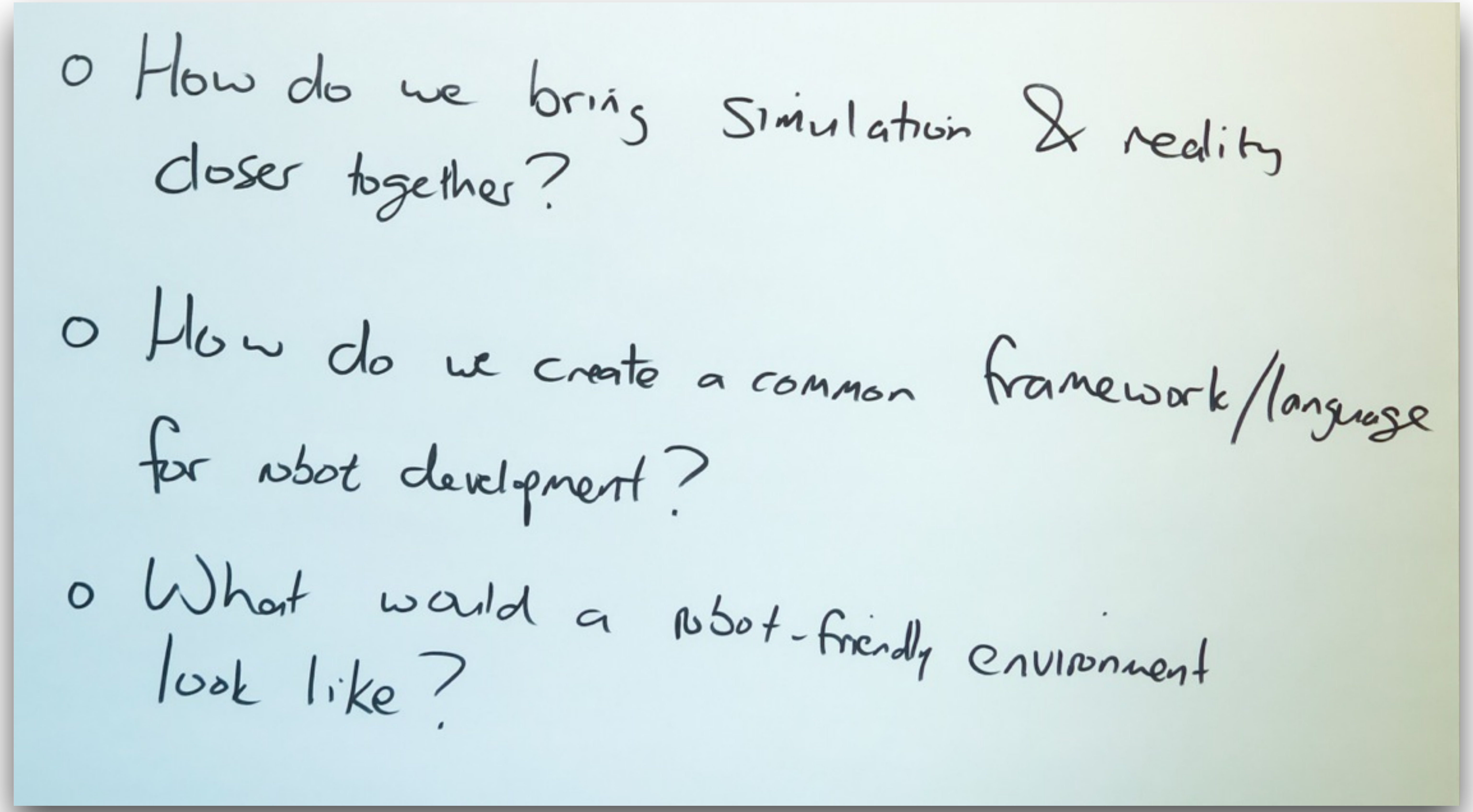
2 ROBOTS . ~~DEF~~ CONTROL ~~FUNCTION~~
How to promote development of more robot-friendly environments?
What changes to the environment will make robots easier to control?
CONTROL OF ROBOTIC SYSTEMS (BETTER SOFTWARE)
DEVELOPING THE NEW LANGUAGE OF INTERACTION BETWEEN HUMAN AND ROBOT.
HOW TO IMPROVE ROBOT ACCURACY?
MAKE ROBOTS EASIER TO TEACH
Category of Investigation
Robot Software:
CATEGORY OF
RE-MAKING OUR WORLD TO ACCOMADATE ROBOTS?
What kind of TOOLS can help end user roboticists?
HUMAN-CENTRIC?
Simon DiMaio
Intuitive Surgical
USA

TEAM 02: Robot Function and Tech

How do we bring simulation and reality closer together?

How do we create common frameworks / languages for robot development?

What would a robot-friendly environment look like?



TEAM 02: Robot Function and Tech

How can we eliminate / minimize differences between simulated and real robots?

How to stimulate advances in simulation and virtualization?

How do we improve robot accuracy?

How to connect / map robot accuracy to task accuracy? (And by what measures?)

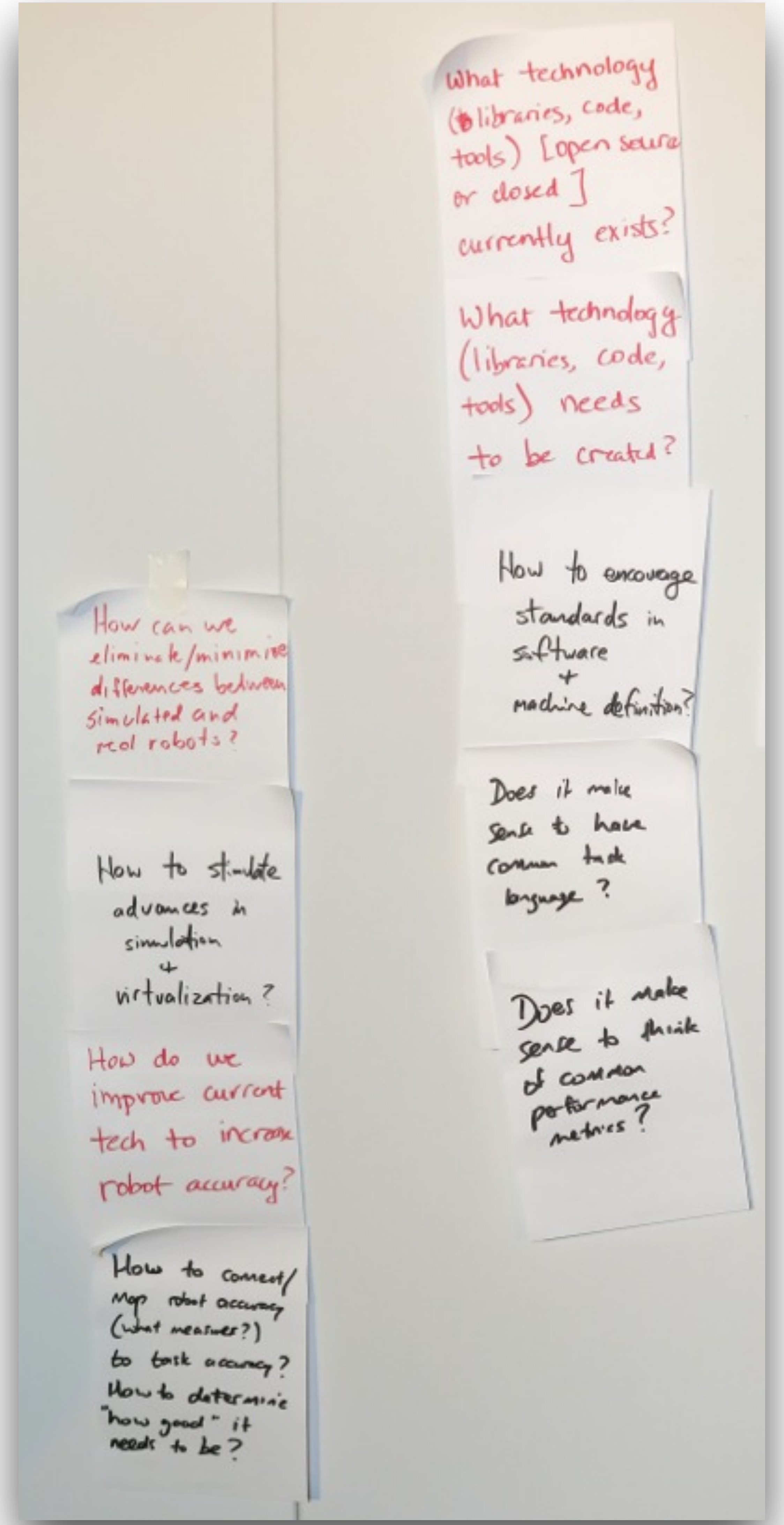
What technology (libraries, code, tools - open source or closed) currently exists?

What still needs to be created?

How to encourage standards in software and machine definition?

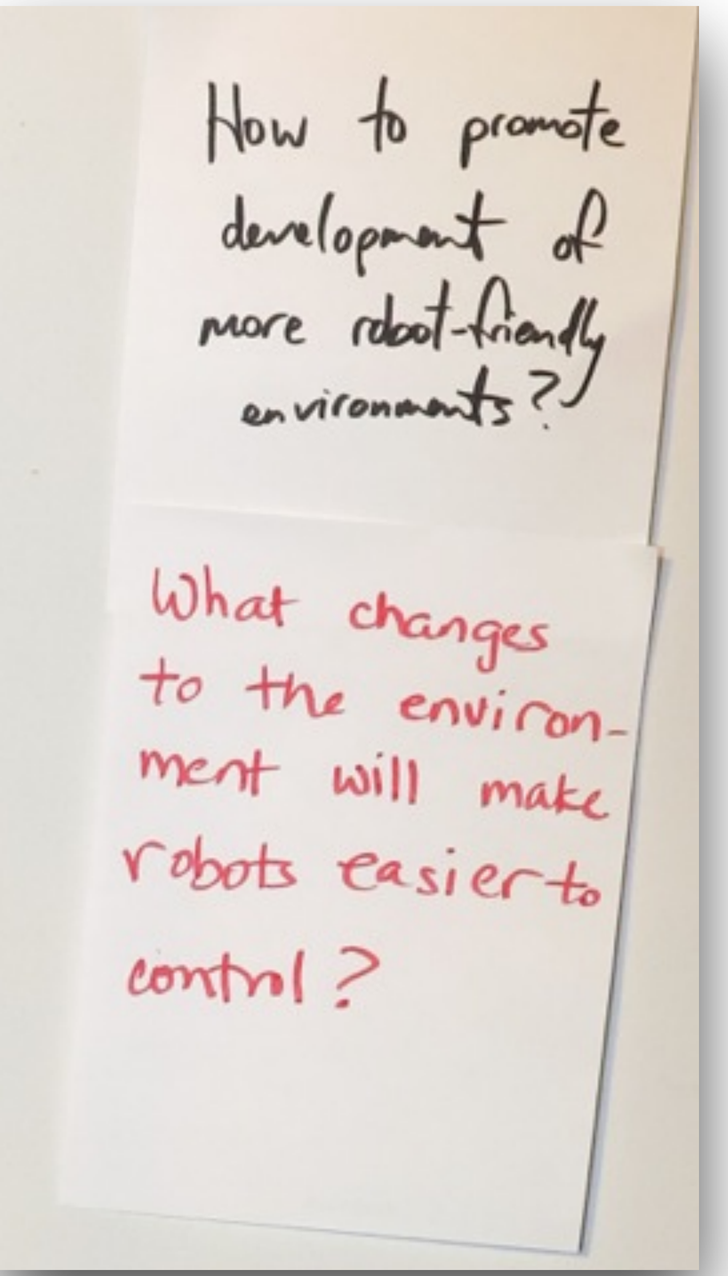
Does it make sense to have a common task language?

Does it make sense to think of common performance metrics?



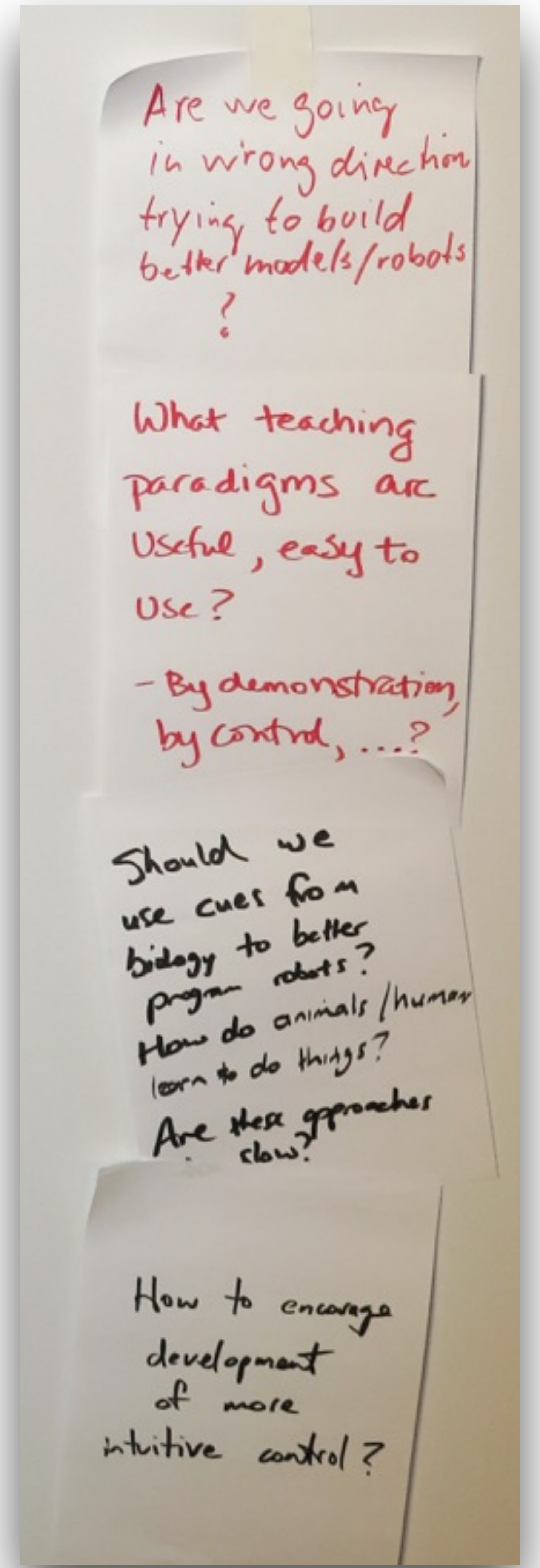
TEAM 02: Robot Function and Tech

Are we going in the wrong direction trying to build better models / robots?



How to promote development of more robot-friendly environments?

What changes to the environment will make robots easier to control?



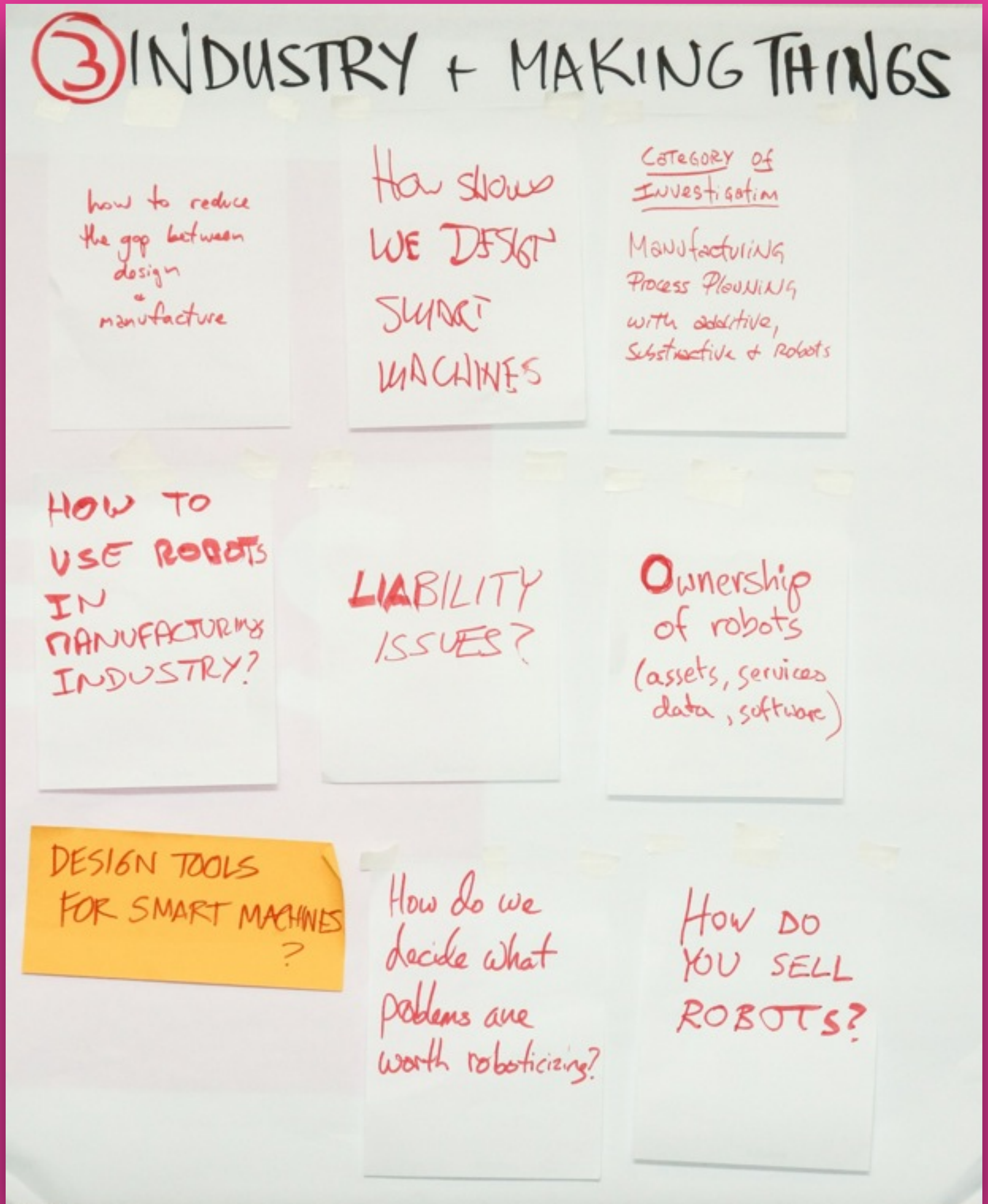
What teaching paradigms are useful / usable?

Demonstration? Control?

Should we use cues from biology to better program robots? *How do animals and humans learn?*

How to encourage development of more intuitive controls?

TEAM_03
INDUSTRY + MAKING THINGS



TEAM 03: Industry and Making Things

APPLICATIONS
o WHAT ARE THE REAL METRICS?
o WHO DO THE ROBOTS SERVE?
WHO ARE YOU DESIGNING FOR?
o SHOULD ROBOTS BE HUMAN-CENTRIC?
o NOT COST OR STRENGTH BUT QUALITY
o IN RESPONSE TO PROBLEM
OR
IN SEARCH FOR APPLICATION
③ INDUSTRY + MAKING:
· Are Robots tools?
· Difference from Machines?
· Customized out-put?
· Lego'ization of manufacturing
· Can we conceive of production as something other than sequential additive assembly?
scale
tiny
HUGE
Number
individual ↔ swarm
Intelligence strategy ↔ instructions
autonomy ↔ collaboration
Robot = Tool
Sharing info
Learn from building
Tangible learning
FIRST ROBOT
TEAM WORK
- WATCHING
ELDERLY
Exploration -
"Go where no man has gone before"

TEAM 03: Industry and Making Things

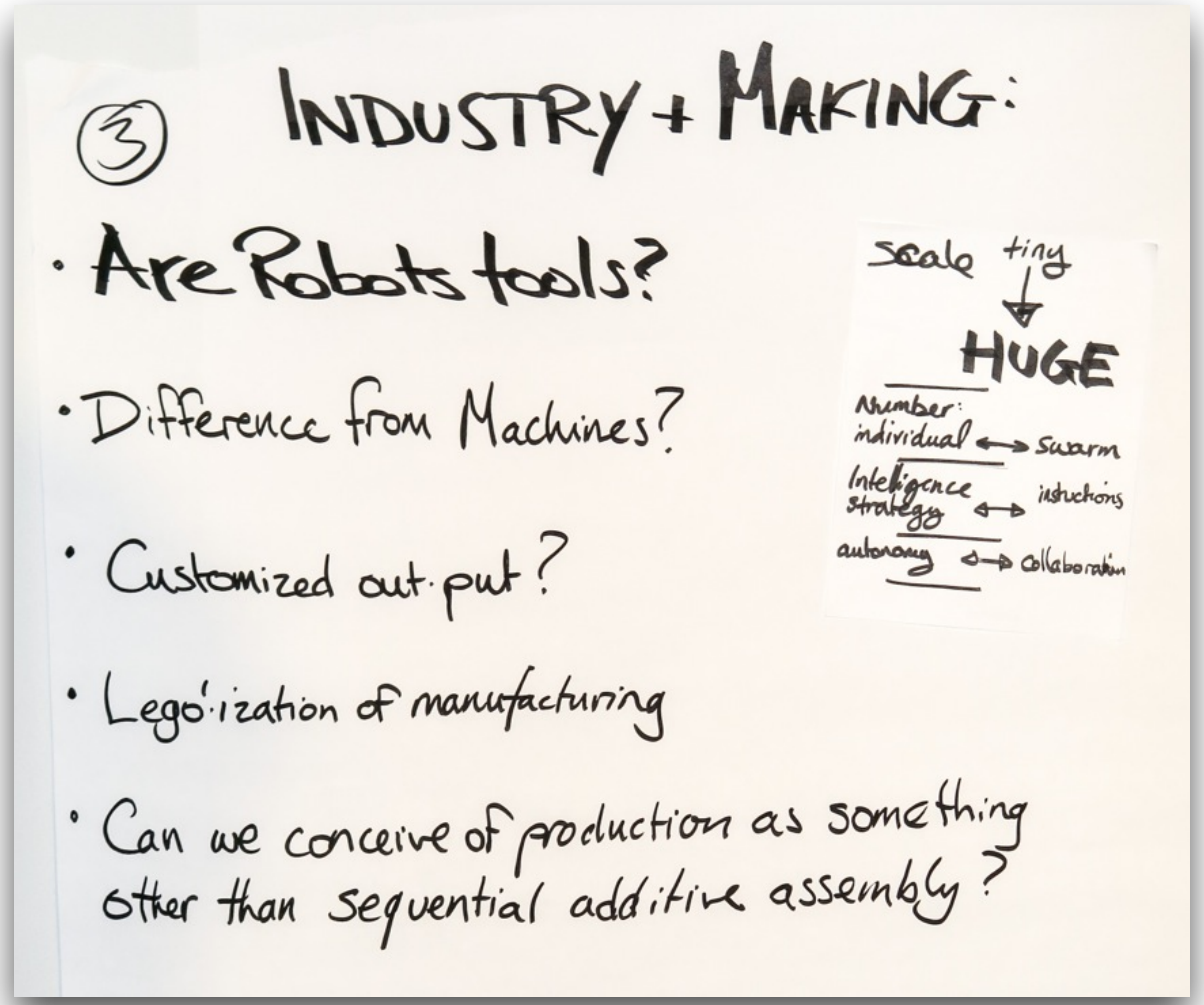
Are Robots Tools?

How are they different
from machines?

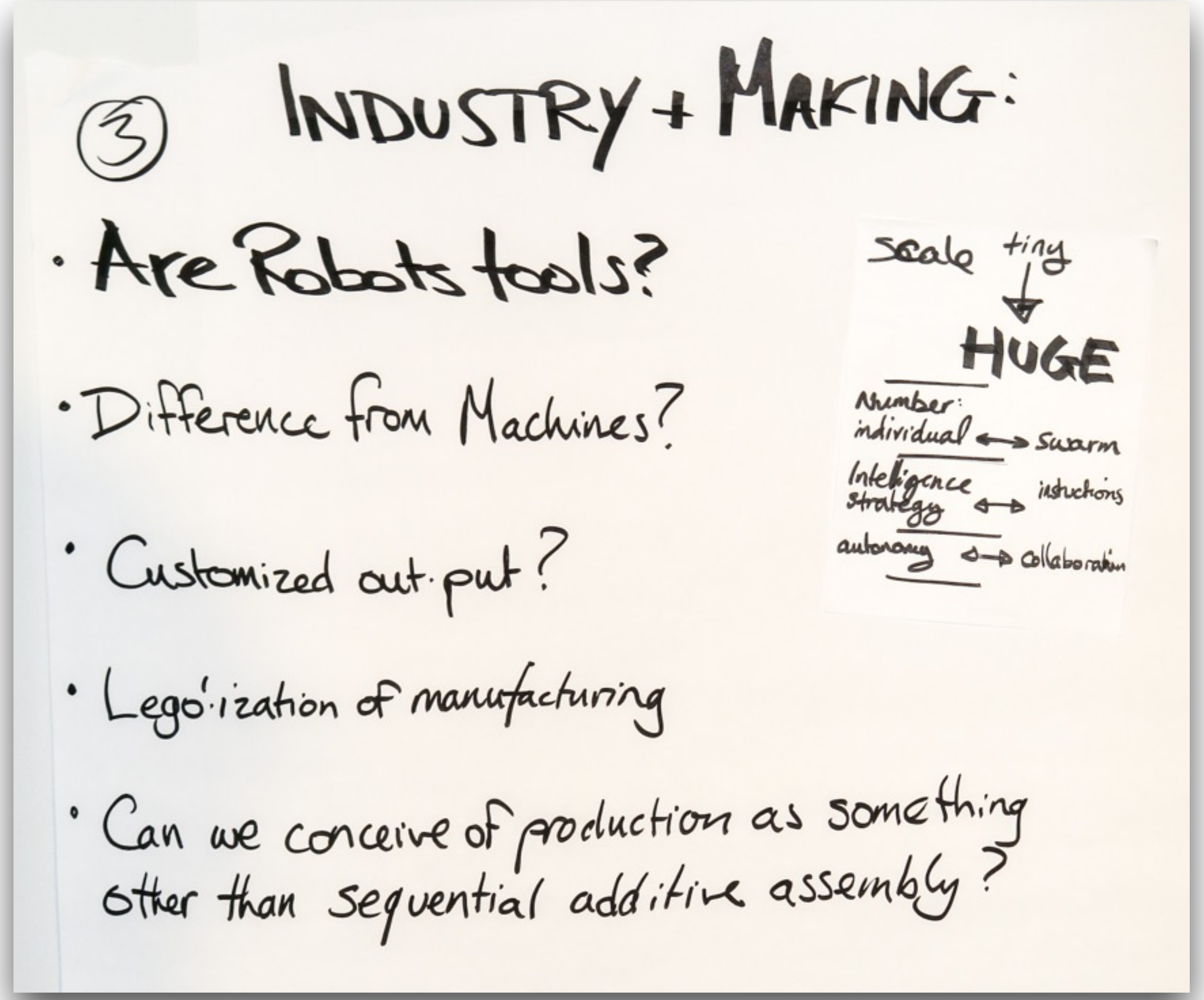
Customized output?

Lego-ization of Manufacturing

Can we conceive of production as something other than sequential additive assembly?



TEAM 03: Industry and Making Things



ROBOTIC SPECTRA

How do Robots "Scale?"

Tiny → **HUGE**

Individuals → **SWARMS**

Instruction-driven → **STRATEGIC**

Autonomous → **COLLABORATIVE**

TEAM_04
EDUCATION AND ROBOTS

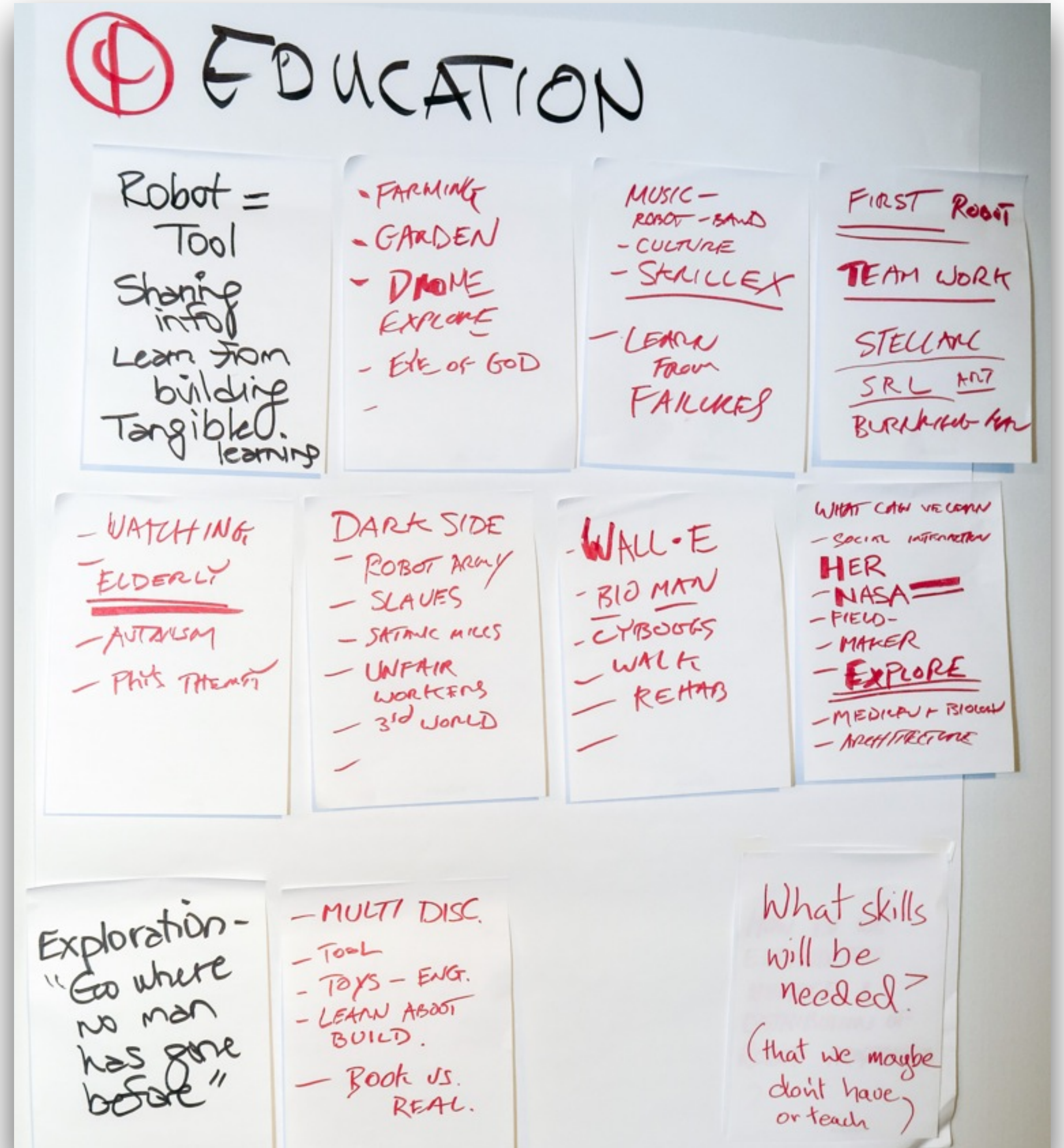
TEAM 04: Education and Robots


EDUCATION
Robot = Tool
Sharing info
Learn from building
Tangible learning
FARMING
GARDEN
DRONE
EXPLORE
EYE OF GOD
MUSIC
ROBOT - BAND
CULTURE
SKRILLEX
LEARN FROM FAILURES
FIRST
TEAM WORK
SRL
WATCHING
ELDERLY
AUTISM
DARK SIDE
ROBOT ARMY
SLAVES
SATANIC MILLS
UNFAIR WORKERS
3rd WORLD
WALL·E
BIO MAN
CYBORGS
WALK
REHAB
Exploration -
"Go where
MULTI DISC.
TOOL
TOYS - ENG.
AUTODESK

TEAM 04: Education and Robots

Robots = Tools for...

- Exploring (where no *human* has gone before)
- Sharing information
- Learning through building
- Tangible learning
- Watching the elderly
- Farming
- Gardening
- Music
- Culture
- Learning from Failure



TEAM 04: Education and Robots

Robots as Toys for Learning

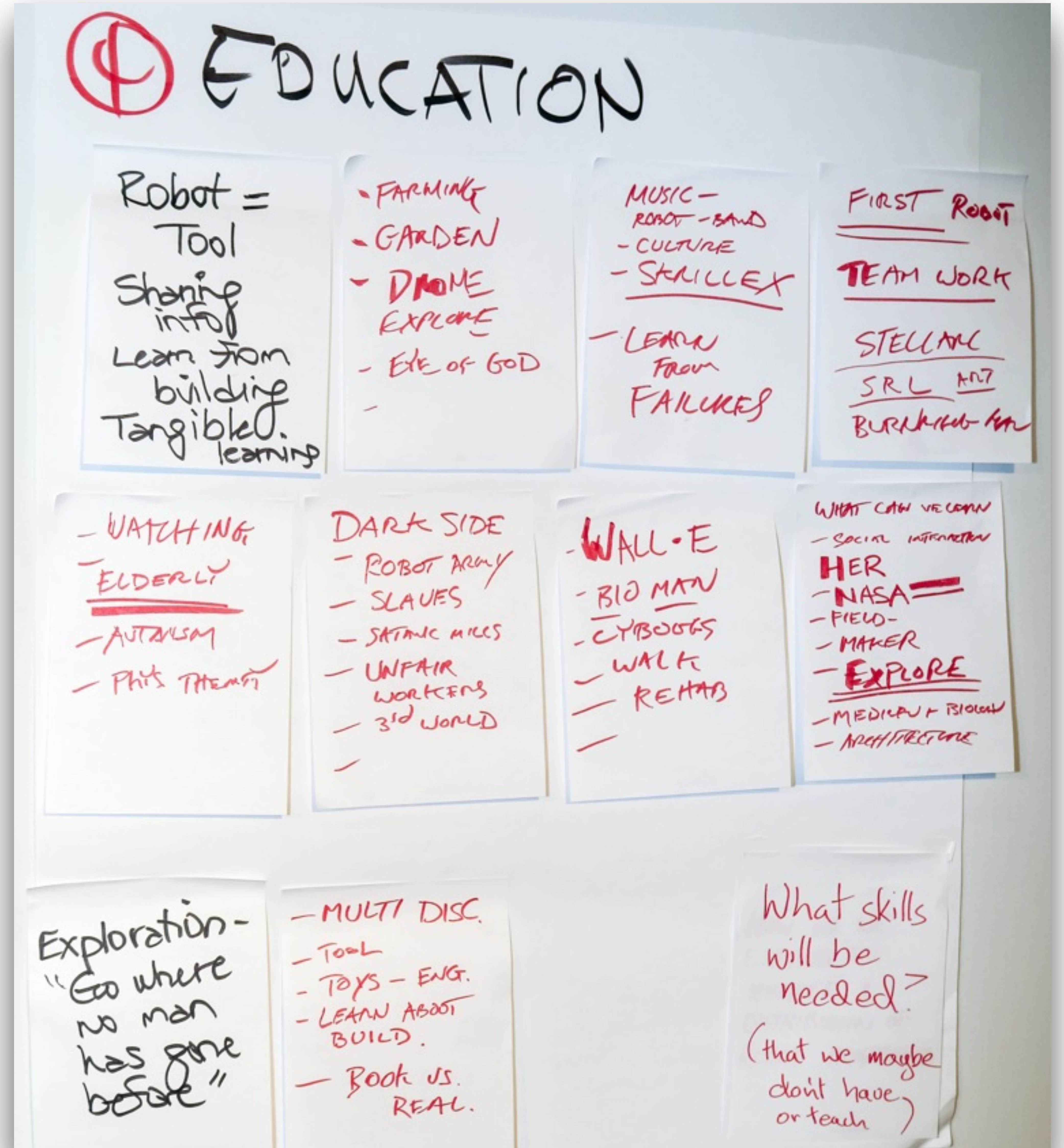
What skills will be needed that we don’t yet have or teach?

For working with robots

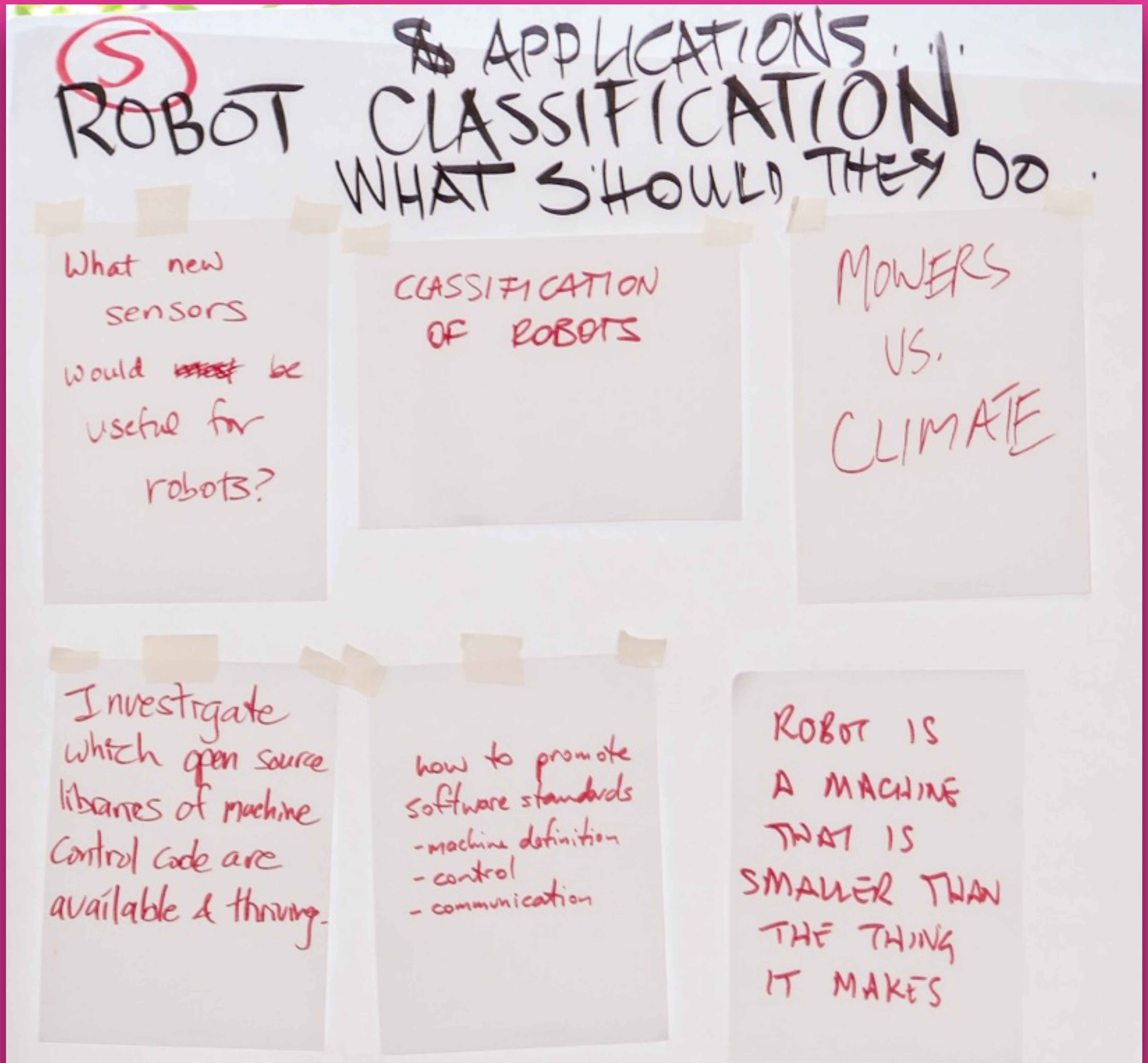
For designing and making robots

Is there a DARK SIDE to Robots?

- Robots as Armies
- Robots as Slaves
- Robots in/as Satanic Mills
- Robots in the 3rd world



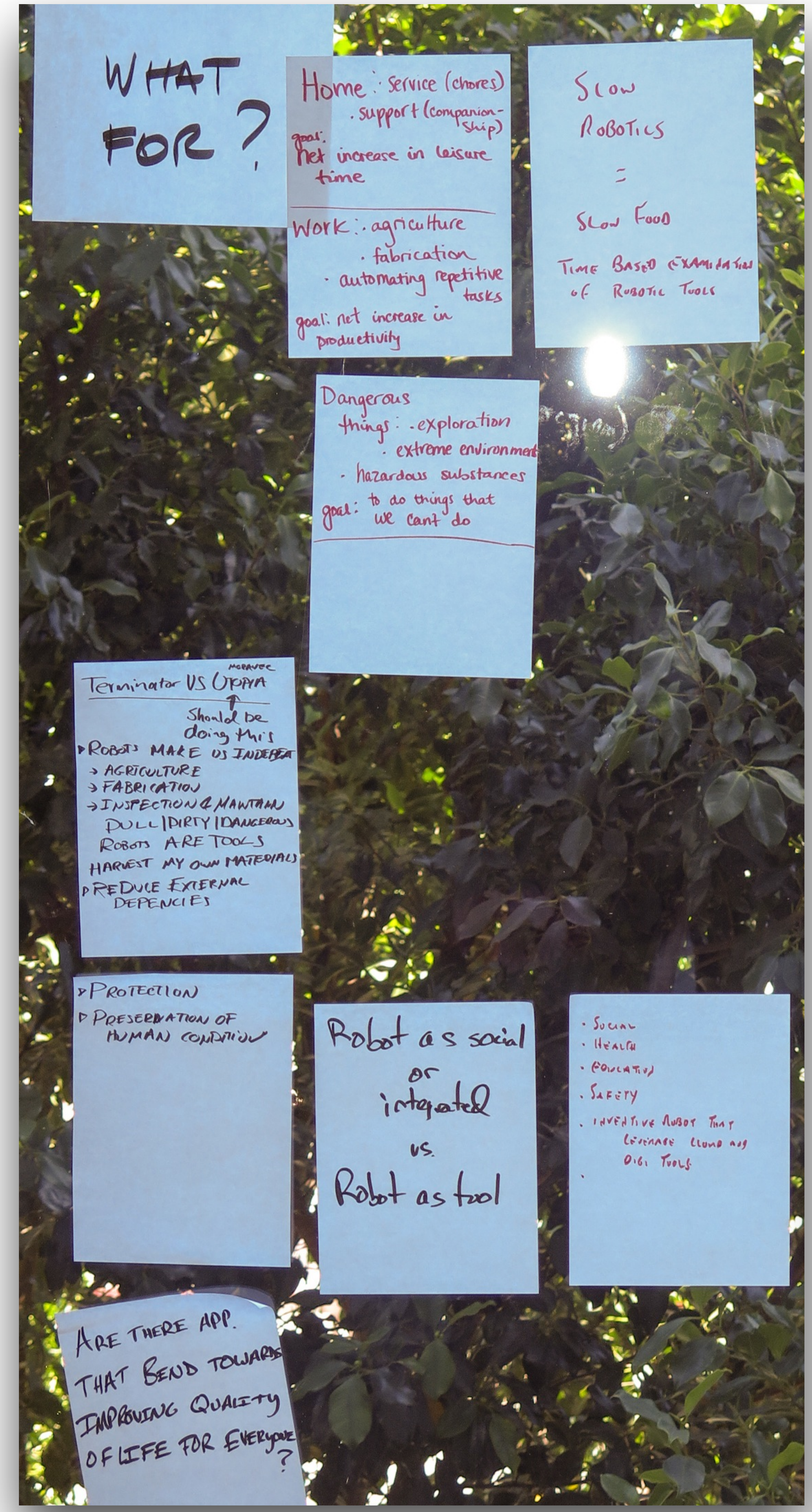
TEAM_05
CLASSIFICATION + APPLICATION

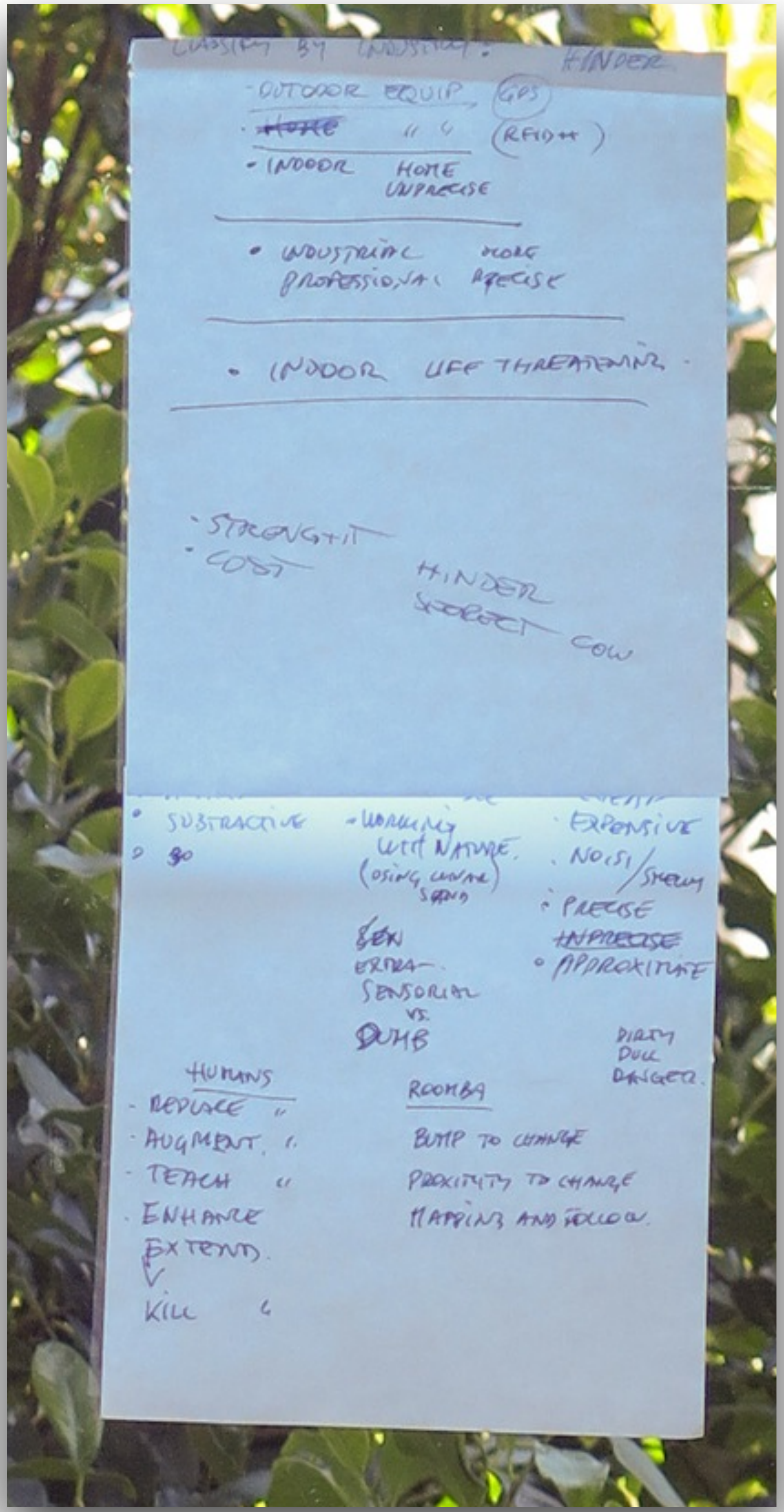


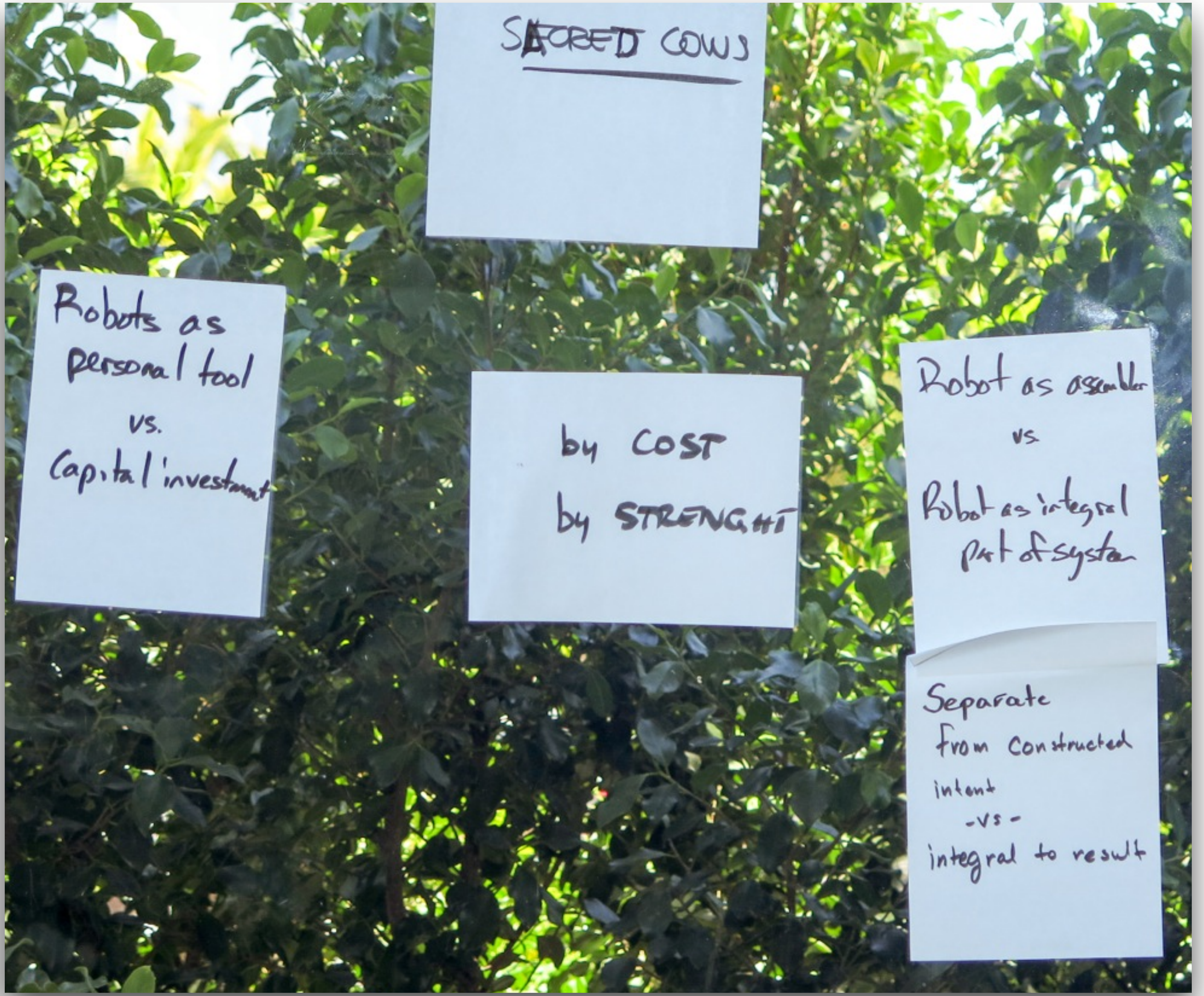
TEAM 05: Classification + Application

Robot Classification
+
Applications
o What are the real metrics?
o Not cost or strength but quality
o Who do the robots serve?
Who are you designing for?
o In response to problem
~~NOT~~ OR
In search for application
o Should Robots [redacted] be human-centric?
③ Industry + Making:
· Are Robots tools?
· Difference from Machines?
scale tiny
HUGE
Number:
individual ↔ swarm
Intelligence

TEAM 05: Classification + Application

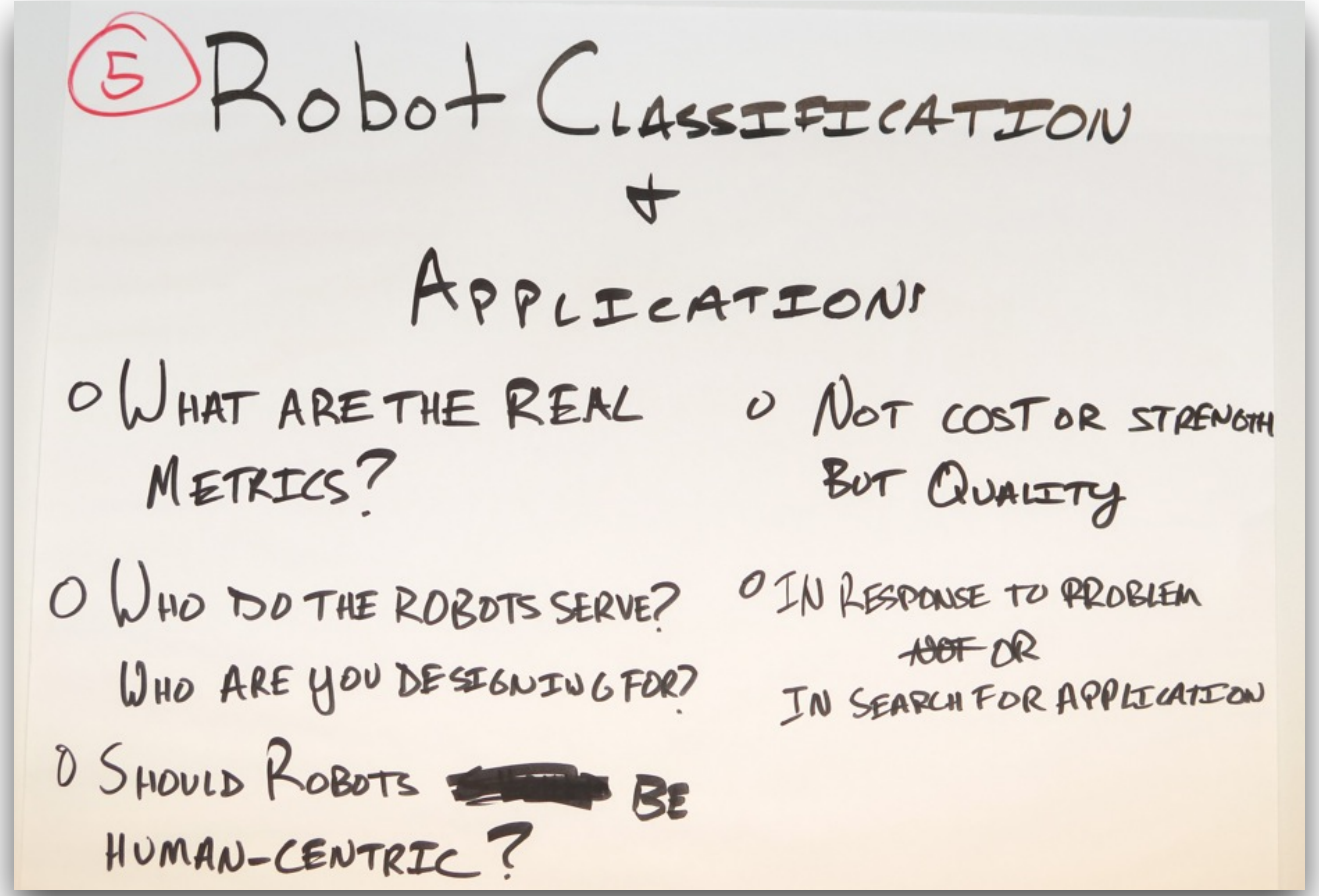






TEAM 05: Classification + Application

TEAM 05: Classification + Application



BIG QUESTIONS AND SPECULATIONS

What are the REAL metrics?

Who do the robots serve?

Who are you designing for?

Not cost, or strength... but Quality

Should robots be designed in response to a problem, or in search of applications?

Should robots be human-centric?

A VISIT TO OTHERLAB

Following the conclusion of the IDEAS summit, participants enjoyed a visit to OtherLab!, the San Francisco headquarters of Saul Griffith and his myriad of startup companies connected to robotics and sustainable energy.


VOICING
A
HINGES
CORKS
CORD PARTS
GARDEN
Pipe Fittings
Balls
KNEX
SANDPAPER SHEETS
OTHER CUTTER
Conduit Parts
BOLTS (misc) SCREWS
Wallace
DREMEL TOOLS


sunfolding
Solar Power for Pennies
AIR DRIVEN
PLASTIC
robust
lightweight
inexpensive
PIPE ORGANS
ESTABLISHED 1877
3101