

Can Robotics help Environmental Sustainability?

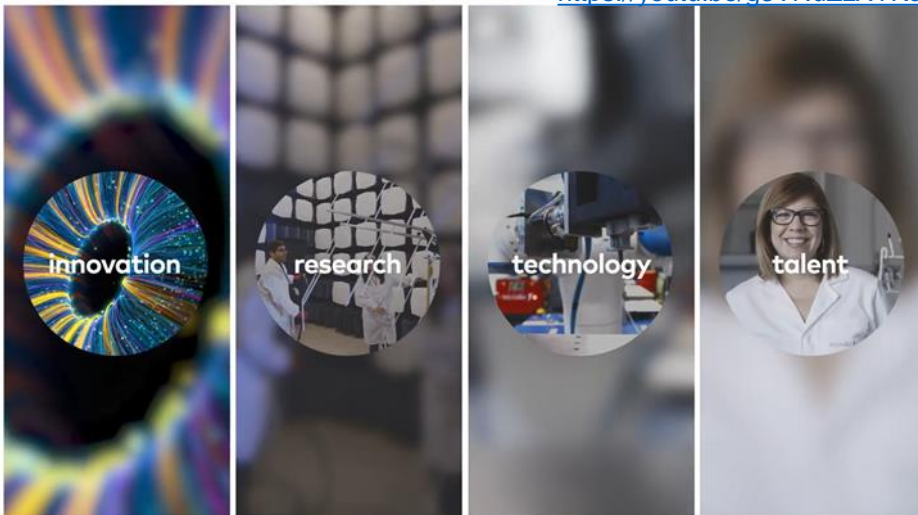
Damien SALLÉ

Coordinator of Robotics & Automation

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- **Largest Applied Research and Technological Centre in Spain**
- >120M€ Income: 47% Private contracts; +9000 clients
- 1464 People on Staff;
- A European benchmark: 1st Private organization in Spain in H2020
- Member of the Basque Research and Technology Alliance - BRTA.

<https://youtu.be/g3VNuZzXYKc>



**We transform
technological research
into prosperity**



ROBOTICS In TECNALIA: a KEY ENABLING TECHNOLOGY

Tecnalia + Robotics + Success Stories:

2022: <https://youtu.be/qLn6McBVPYw>

2021: https://youtu.be/UMLcb_h08mQ

2020: <https://youtu.be/n8H4Dx8mYvQ>

FLYING DRONES



COLABORATIVE ROBOTS



MOBILE MANIPULATORS



REHABILITATION DEVICES



MACHINES



AUTOMATED VEHICLES



INDUSTRIAL ROBOTS & SYSTEMS



CABLE ROBOTS



SERVICE ROBOTS



TESTBEDS



DUAL-ARM ROBOTS



MARINE ROBOTS



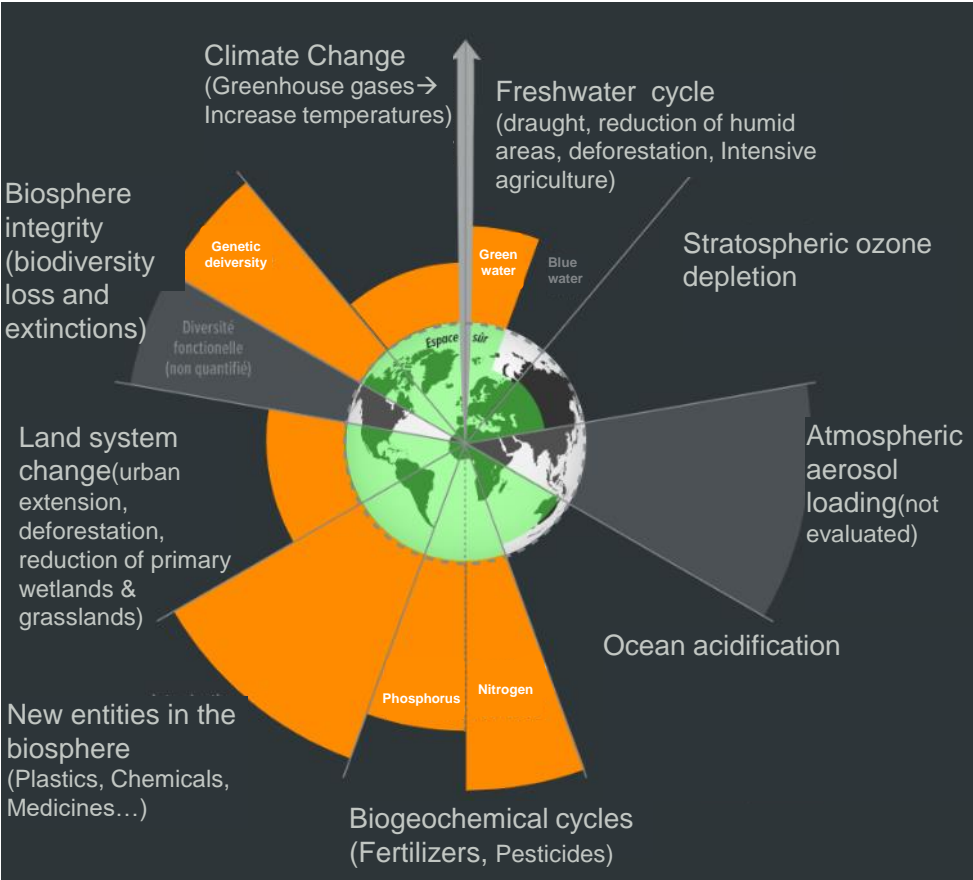
MEDICAL ROBOTS



02

Climate change...

It is urgent to do something!

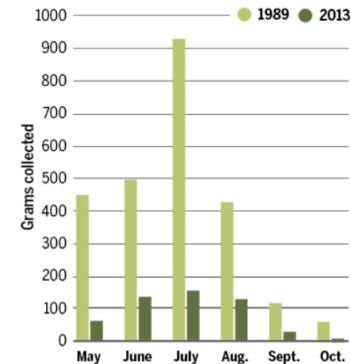


→ VERY HIGH STRESS ON THE BIOSPHERE DUE TO HUMAN ACTIVITIES

- Loss of 78% of insects in Germany in 24 years...
- WWF 2022: DECLINE OF 69% OF WILDLIFE POPULATION SINCE 1970

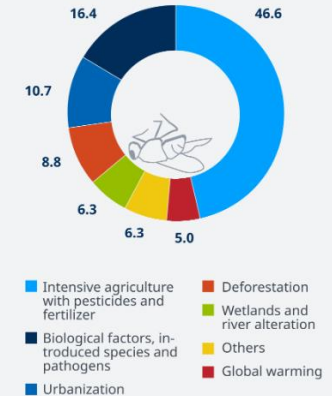
→ Main cause is our Way of life in Industrialized countries!!

The mass of insects collected by monitoring traps in the Orbroicher Bruch nature reserve in northwest Germany dropped by 78% in 24 years.



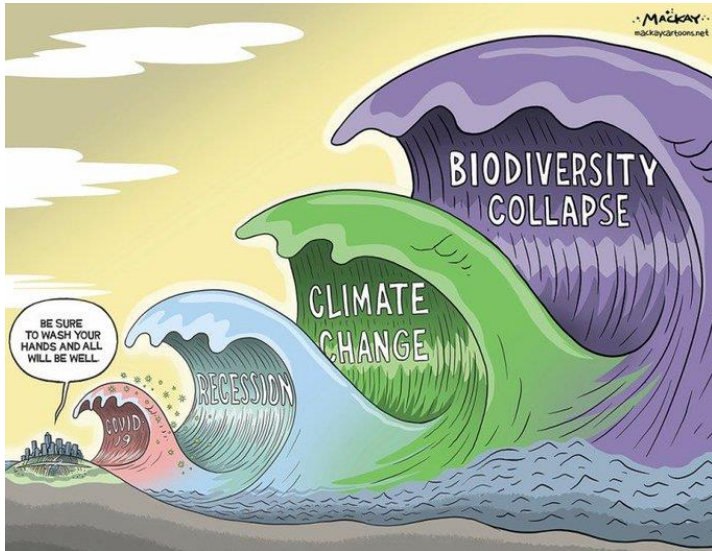
(GRAPHIC) G. GRULLÓN/SCIENCE, (DATA) M. SORG ET AL., MITTEILUNGEN AUS DEM ENTOMOLOGISCHEN VEREIN KREFELD 1, 1-5 (2013) © 2013 ENTOMOLOGISCHER VEREIN KREFELD

Main drivers of insect decline Worldwide, in percent



Source: Sanchez-Bayo & Wyckhuys, Biological Conservation, 2019

We don't have much options...



SOBRIETY → DO LESS

Decide wiser how to use our reduced “budget” of Co2 if we want to keep the objective of 2°C.
→ Stop buying stuffs, stop doing things, make decisions based on “less”, give-up on some habits...

EFFICIENCY → DO BETTER

electrification, hydrogen, zero-waste, **Circular economy**...

RESILIENCE → ANTICIPATE

Prepare our agriculture, social system, companies to the cycles of events and crises that will come...

03

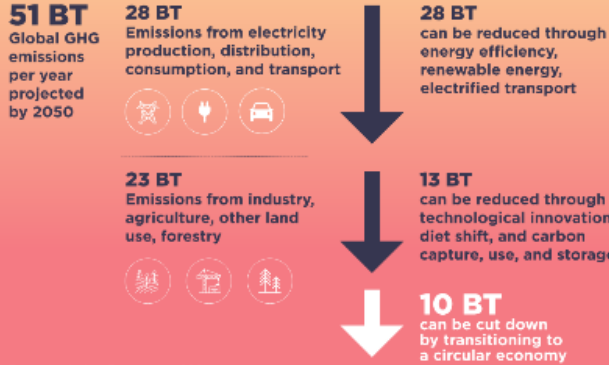
Can Robotics & AI Contribute to Environmental Sustainability?

→ **Robots4Green: TECNALIA CIRCULAR ROBOTICS**

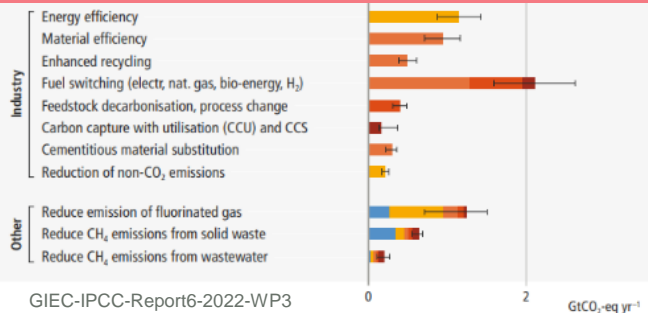
Why focus on Circular Economy?

- ➔ Because Circular Economy has an impact on CO2 and material extraction (~20% ➔ Not enough alone, but in complement to Sobriety and all the other initiatives...)
- ➔ Because as roboticist, it appears to be the alternative of higher potential impact for our technology

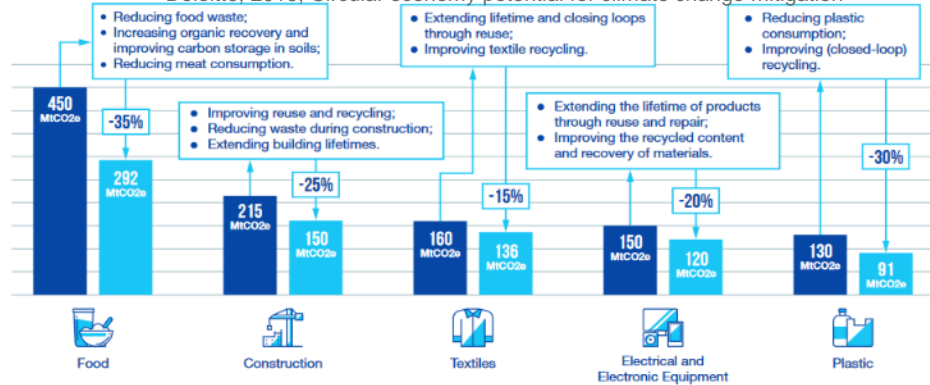
THE CIRCULAR ECONOMY IS NEEDED TO GET TO NET ZERO EMISSIONS



© Elon MacArthur Foundation 2021



Deloitte, 2016, Circular economy potential for climate change mitigation



A retreaded tyre enables saving...

- 70%** Resource extraction (ore, oil, L, mainly because of the avoided consumption of steel castings)
- 29%** Land use or growing heavy
- 24%** CO₂ emissions
- 21%** Air pollution (as measured by particulate matter emissions)
- 19%** Water consumption

...compared to a low-end non-retreadable tyre

Source: Ernst & Young report: The socio-economic impact of truck tyre retreading in Europe

Savings through recycling :



Energy 20%

Downgraded Materials 50%

Savings through Remanufacturing :



Transformed Materials 70%

Energy 80%

Knowledge 90%

Our claim : ROBOTICS CAN BE AN ENABLER FOR A RAMP-UP OF CIRCULAR ECONOMY

A massive transition towards circularity requires many hurdles to be faced and solved:

- Price
- Quality
- Trust and Traceability
- Efficiency
- Low environmental impact of the process...

The good news: Robotics has proven to be a champion at:

- Cost-killing
- Constant quality
- Guaranteed traceability.

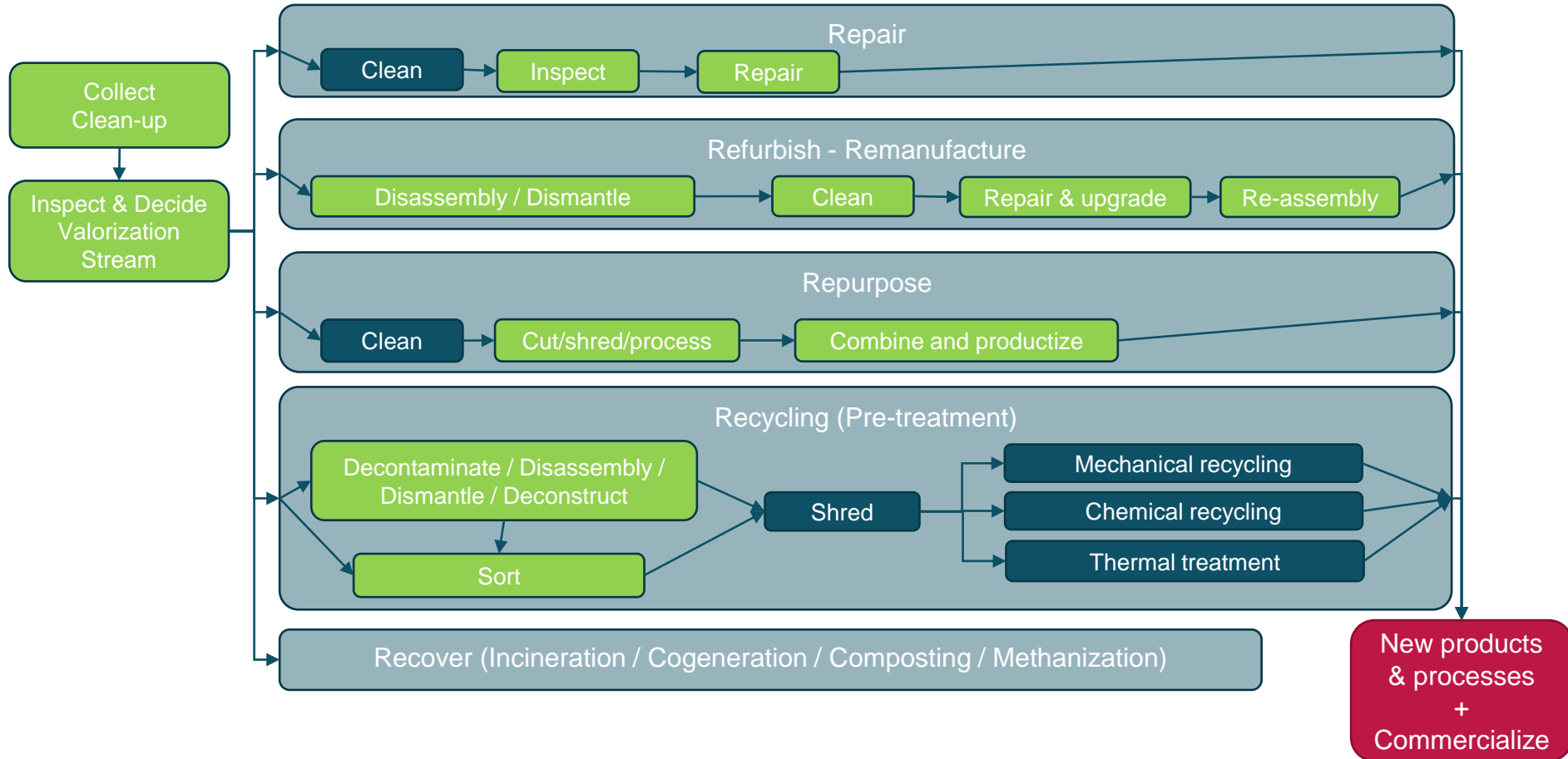
→ We believe that we can transfer these benefits to the circular economy.

Of course, automating these complex and highly versatile processes is **clearly a greater challenge** than automating production in Linear Economy where everything is under control...

But robots are also getting more Agile, more Versatile and more adaptable with AI...

So, Let's fight for it...

CircularRobotics impact on some of the 9R





Removal

H2020 MAELSTROM for Marine Litter

Accurate control of Position & Orientation (6 dof)
20m depth; 130Kg marine litter removal capacity



H2020 MAELSTROM for plastics in Marine Litter HEU RECONMATIC for Construction waste



Dismantling

H2020 HR-Recycler for WEEE HEU Smart-Handle & REINFORCE (EV Batteries)



H2020 PARADDISE - EIT MOLDAM + Industrial clients



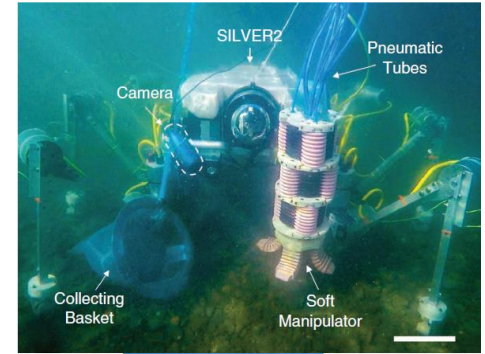
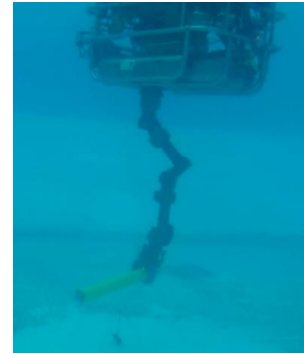
04

WASTE Removal

REMOVING Legacy Waste and Marine litter from the coastal seabed

→ Plastics are invading in the Oceans, they fragment from MacroPlastics to Micro and nano plastics and contaminate the complete food chain

→ Cleaning-up the environment is a cost and recovered materials have low value...
Labour intensive and potentially dangerous task → use robots for that?



REMOVING Legacy Waste and Marine litter from the coastal seabed

- Cleaning-up the environment is a tedious and costly task + recovered materials have low value...
→ Use robots to do it? And assess they don't create more negative impact → LCA analysis
→ Marine Litter removal from the seabed using Underwater Cable Robotics:

**Accurate control of Position & Orientation (6 dof)
20m depth; 130Kg marine litter removal capacity**



MAELSTROM

Smart technology for Marine Litter Sustainable
Removal and Management

<https://youtu.be/16k3-Bp4FCI>



05

Waste Sorting

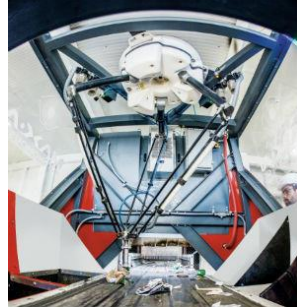
Robot increases the purity of the streams to increase usability and value, and reduce dull and dirty jobs

Maybe the most mature field for Packaging & municipal waste; a bit for CDW

Optical sorters by Airjet



PKM & Cartesian robots

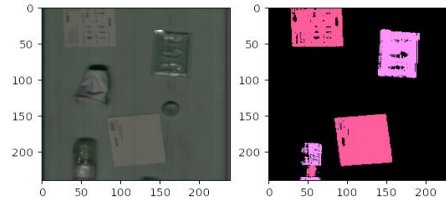


Industrial and Collaborative robots



SORTING: AI-driven Robotic system to segregate waste material and increase purity, recyclability and value

➔ **Focus on streams not treated now:** Plastics from Marine Litter, Construction waste, Electronics, Textile...



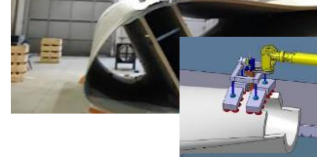
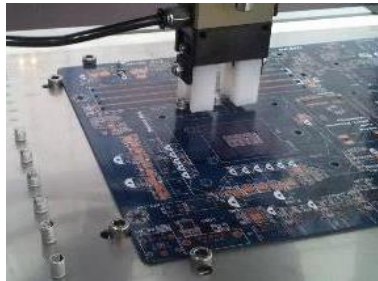
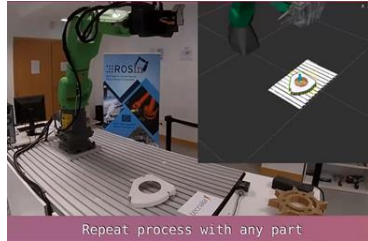
06

Dismantling, Remanufacturing, Deconstruction

Equipment Disassembly, Dismantling, Deconstruction

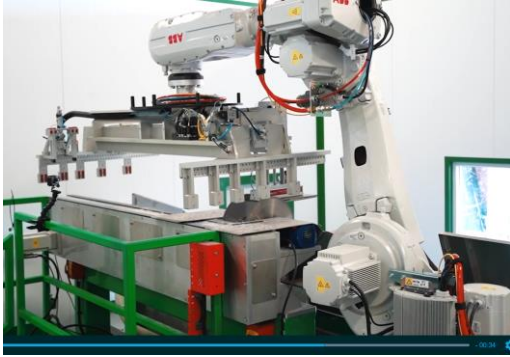
Enable or Improve the efficiency and quality of raw material recovery from recycling processes, by dismantling/dismantling and removing undesired materials/covers before shredding and recycling

Targeting Batteries, Electric motors, WEEE, PCB chips...
But also Selective deconstruction of buildings, dismantling of textile etc...



Equipment Disassembly, Dismantling, Deconstruction

Flat screens & laptops



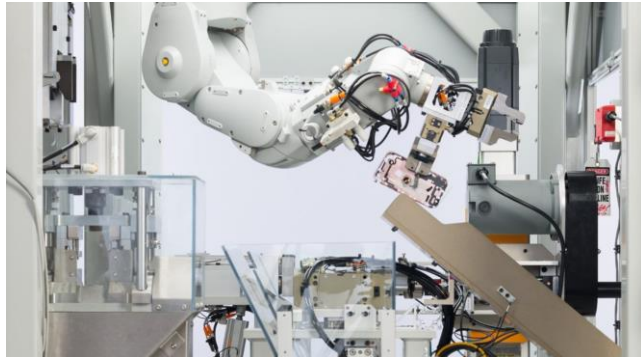
Disassembly for remanufacturing
of automotive components



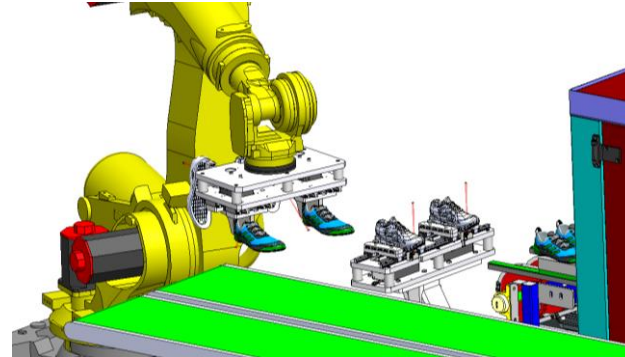
Rare Earth in electronics chips



Daisy Apple iPhones



Shoes and Textile dismantling



Robotic Disassembly, Dismantling, Deconstruction

Increase purity of material pre-treatment, prior to recycling
→ Improve efficiency of recycling process & quality of recovered material
Targeting Batteries, Electric motors, WEEE, PCB chips, Buildings, Textile etc...

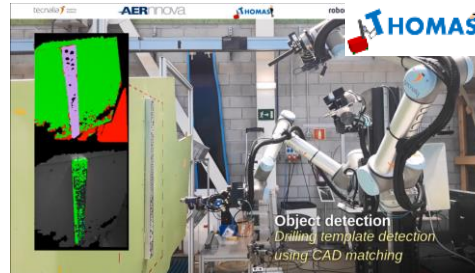
Complexity:

High diversity of reference and condition of the incoming products
+ High mix – Low volume



Need Agile and Flexible robots with AI, capable to adapt and be easily programmed:
Skills, Vision, Path planning, Teaching by demonstration, force-control, Teleoperation...

Agile Robotics is one of the key technologies developed by TECNALIA during the past 10 years in numerous projects



04

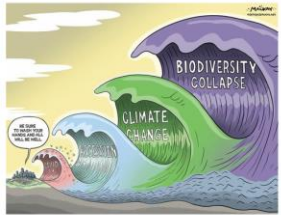
It's good to use robots to preserve the environment!

But are their impact worse their environmental cost?

→Green4Robots: Lower impact of Robotics & AI

What is the real Environmental impact of using robots?

We don't have much options...



- ➔ **SOBRIETY → DO LESS**
Decide wiser how to use our reduced "budget" of Co2 if we want to keep the objective of 2°C.
→ Stop buying stuffs, stop doing things, make decisions based on "less", give-up on some habits...
- ➔ **EFFICIENCY → DO BETTER**
electrification, hydrogen, zero-waste, Circular economy...
- ➔ **RESILIENCE → ANTICIPATE**
Prepare our agriculture, social system, companies to the cycles of events and crises that will come...

I started by saying we should, as humanity, start doing less... and I presented very nice but complex devices and technologies...

So we should at least ask ourselves if it is worth it...

And the short answer is: it is not easy to say!

Robots4Green have an impact during manufacturing and use... so that we can try to have an impact on the ecosystem...

→ So we should evaluate if the output really makes sense... but it also means to compare CO2 emissions with biodiversity and ecosystems preservation, and with social and economic sustainability...

One tool to do this is the Life Cycle Assessment LCA.

It is not an easy process because databases are not prepared for robotics and AI, and that we engineers are not trained to it!

→ Education + Need of helper tools to help in early phases of design to choose between alternatives → an AI ? → Decision to Not continue with the project/product...

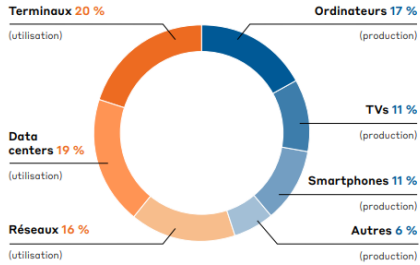
Even if Robotics is not a major contributor to CO₂, it still is a complex electrical machine... and we could improve them:

- **Optimize the energy used by robots:**
 - Lighter robots
 - Optimization of Base Placement and Motion Planning taking energy criteria in the computation of the best path. (FP7 AREUS: 35% of energy reduction)
 - Improve robot electronics to use motor as generator during braking and deceleration (instead of thermal energy dissipation: 30%)
- **Eco-design of robots, just like any other machine:**
 - Easy to maintain and dismantle to ease their recycling
 - Possibility to upgrade (gearbox, control unit) to allow retrofitting of older units for less intensive applications
 - Avoid non-recyclable materials in the robots (composites)
 - Integrate recycled and bio-sourced materials in the design

How about Digital and AI used in the robots?

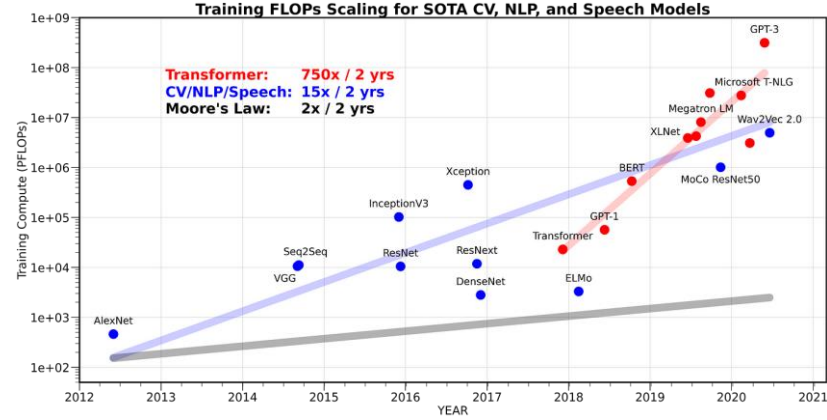
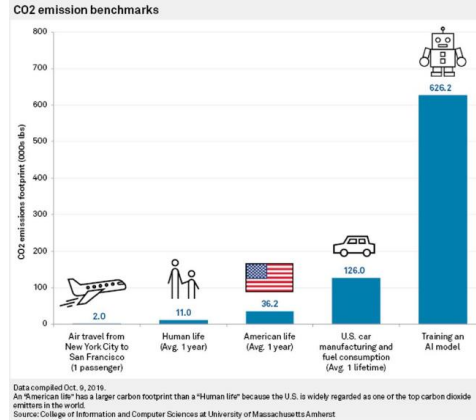
Energy used in Digital:

45% production – 55% use



Distribution de la consommation d'énergie finale du numérique par poste pour la production (45%) et l'utilisation (55%) en 2017

Source : Leon ICT, The Shift Project 2018



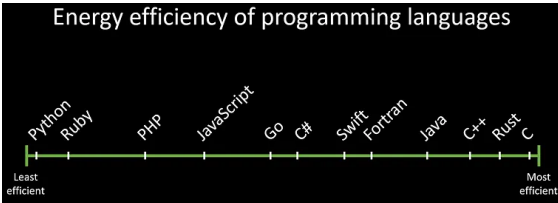
AI Training is really very energy-consuming → CO2

Raise awareness on the impact of AI / Deep Learning...

Better to use a standard algorithm if it does the job

Also, put code efficiency back in the ToDo of the programmers, just like when CPU power was limited...

Energy efficiency of programming languages





Interested?

Let's talk!

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