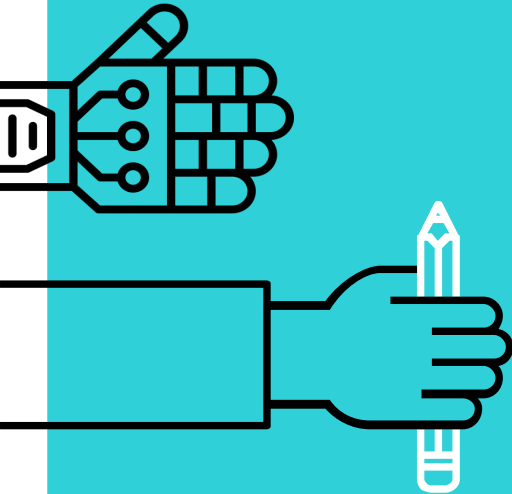




NOVA SCHOOL OF
SCIENCE & TECHNOLOGY

Responsible technology assessment: an inclusive and anticipatory process

8th Doctoral Conference on Technology Assessment
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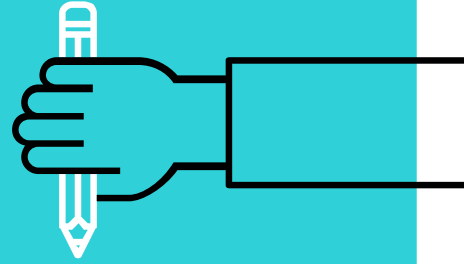
Sofia Romeiro

Supervisor: Professor Andoni Ibarra,
Universidad del País Vasco

Agenda/Structure

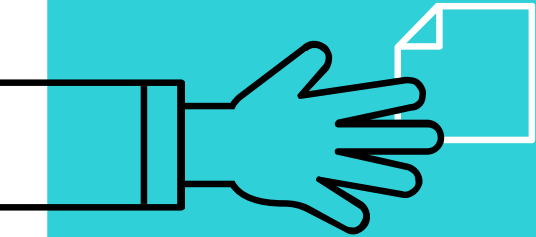
- ▶ 1. Introduction
- ▶ 2. Theoretical framework:
 - ▶ 2.2. Case: Exoskeleton technology as a tool for human enhancement; demands & expectations -a complex diversity
 - ▶ 2.1. RRI: a framework for responsible innovation guidance
 - ▶ 2.3. Pre-RRI responsibility applied to exoskeletal technology processes
- ▶ 3. Methods: Survey; Literature review
- ▶ 4. Results:
 - ▶ 4.1. Guidelines for an RRI-responsible evaluation of exoskeleton technology
 - ▶ 4.2. Operationalization of Anticipatory governance
- ▶ 5. Project Progress





1.

INTRODUCTION

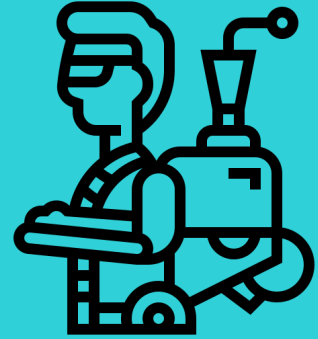


Exoskeleton

Learning from nature, the robotic exoskeleton takes advantage of the design of zoology and is based on its natural functions and capabilities, to translate into an accessory that protects the bone and muscle structure and increases the physical capabilities of the human being.

Applied in various sectors:

- ▶ Therapeutic;
- ▶ Industry;
- ▶ Civil construction,
- ▶ Sports;
- ▶ Military



Exoskeleton: segmentation

By Component	Hardware Software
By Type	Powered exoskeleton Passive exoskeleton (exosuit)
By Mobility	Stationery Mobile
By Body Part	Lower Upper Full Body
By Industrial Vertical	Healthcare Defence Industrial
By Geography	North America Europe Others (Asia; Latin America; Middle East)

Source: <https://www.fortunebusinessinsights.com/industry-reports/exoskeleton-systems-market-100205>

market

The influence of news and economy on the exoskeleton producers (USA)



Source: <https://www.google.com/search?q=ekso+bionics+stock>



Europe

At least 24 exoskeleton development projects funded by Europe funds, like Horizon 2020 – since 2015

1. DexROV
2. RETRAINER
3. WALKEr
4. HUMEXE
5. SPEXOR
6. XoSoft
7. HANK
8. ERXOS
9. S.D.S.
10. An.Dy
11. EURECA
12. NEPSpiNN
13. e-walk
14. HUMEXE
15. PRO GAIT
16. MEMMO
17. NGBMI
18. iHand
19. REHO
20. Simecos
21. Chairless Chair
22. SYMBeetle
23. ABLE
24. ReHyb

Source:<https://www.fabiodisconzi.com/open-h2020/per-topic/exoskeleton/list/index.html>

Forecast: "Exoskeleton Market Size Worth \$4.2 Billion By 2027"

GrandView Research says



RRI (Responsible Research and Innovation) is an European Union strategy that seeks to open the entire innovation process (expressed in terms of demands, values and motivations) to collective decision, creating a vision of responsible innovation as inclusive innovation (Eizagirre, Rodríguez & Ibarra, 2017).



4 dimensions of RRI

(Owen et Al, 2013)

antecipation

Bring to the present the solutions for the future

inclusiveness

Involve all the society

responsiveness

Capability to answer

openness

alternatives and transparency of their approach

Exoskeleton – survey questions

1. How old are you ?
2. What is your professional activity ?
3. Sex,
4. Level of education,
5. Do you know what exoskeletons are ?
6. Are you familiar with the use of exoskeletons for rehabilitation?
7. What do you think are the main advantages (technical, social, economic, ...) of these technologies?
8. In your opinion, do you think this technology has negative aspects? If so, which ones?
9. In your opinion, what aspects should be taken into account in the design of this type of solution?
10. Do you think that the development of these technologies should "listen" to users and others social actors? If so, which ones?
11. How do you consider that the demands and opinions can be integrated in the design and development of exoskeletons?
12. How do you see the future of this technology in terms of technological evolution? What scenarios do you see as possible in the next 10 years?



Exoskeleton – positive & negative aspects: Survey results

Positive:

- They allow the user to regain mobility and empowerment lost during physical rehabilitation
- They promote greater autonomy during the recovery process
- They bring improvements in social inclusion and the maintenance of mental health
- They improve the quality of life of users

Negative:

- They are expensive products
- Difficulty of adaptation to each user / customization to each morphology and case
- The possibility of deviating from the initial purpose and using the equipment to impose superiority over other human beings or for war purposes
- May imply reduction of jobs

Exoskeleton – development:

The development of exoskeletons is so far based in 3 main points:

- 1 – Functional (Almenara et al, 2015)
- 2 – Users – UX design (Shore, 2019)
- 3 – Markets (Søraa e Fosch-Villaronga, 2020; Linnane, 2020)



Exoskeleton – Pre-RRI responsibility

Pre-RRI responsibility applied to exoskeletal technology processes

Currently based in:

- ▶ Safety regulations: ISO norm (13482:2014 -Robots and robotic devices) - Safety requirements for personal care robots
- ▶ Health: FDA – Food & Drugs Administration – Certification required to be sold as a medical device.
- ▶ Data and information security: ISO 27001 & GDPR
- ▶ Access regulations and insurance



Exoskeleton – what aspects should be taken into account in the design of this type of solution?

- Comfort for the user, aesthetics from the point of view of better social acceptance, usability, user-centered solution, quality of materials
- Possibility of its use to prolong the quality of life in older ages
- The type of clinical approach and consultation with rehabilitation specialists and the people who will use that equipment
- Cost and ability to adapt to various scenarios

Exoskeleton: How do you see the future in the next 10 years?

- In the orientation of the digitization it is observed with neuro-interface, muscle-neuro-interface and augmented reality;
- Simplification of the equipment - and, therefore, cost reduction -, they are seen in the future much simpler, with new materials and accessible on the public network.
- With increasing general acceptance, these devices may become part of everyday life, even outside of the therapeutic setting, in order to facilitate daily activities, which in turn further increases their acceptance.
- Concerns about the future: the possibility that exoskeletons end up replacing people in their jobs and / or evolve too much, which would pose a risk to humanity.

Exoskeleton – needs; expectations; complexity

- Survey Online: No participant was selected, made available online and shared on social media. The responses analyzed (35) correspond to people between 20 and 71 years of age, 67% women and 33% men; 75% with higher education. 25% of the respondents -from Portugal and France- are health professionals (doctors or nurses).
- The results show the **heterogeneity of views, demands and concerns** of the actors in relation to this technology. It is reasonable to argue that a larger universe of actors would still make the set of responses to the questions raised more diverse and heterogeneous.

Guidelines for an RRI-responsible evaluation

Currently the responsibility in the development is traduced in the strict compliance with the applicable regulations in each case and the production of exoskeletons following the UCD (“user centered design”) approach.

It’s dynamics are guided by the logic associated with the market in **two directions**:

1. improving the human-machine interface, making it lighter, more “suitable” and
2. making it increasingly profitable for manufacturers.

Pre-RRI Responsibility

These two considerations do not sufficiently account for the complexity of the innovation processes associated with exoskeleton technology, in particular they do not account for the diversity of interests, goals and objectives, values, expectations, ... linked to this technology!

Integrate this:

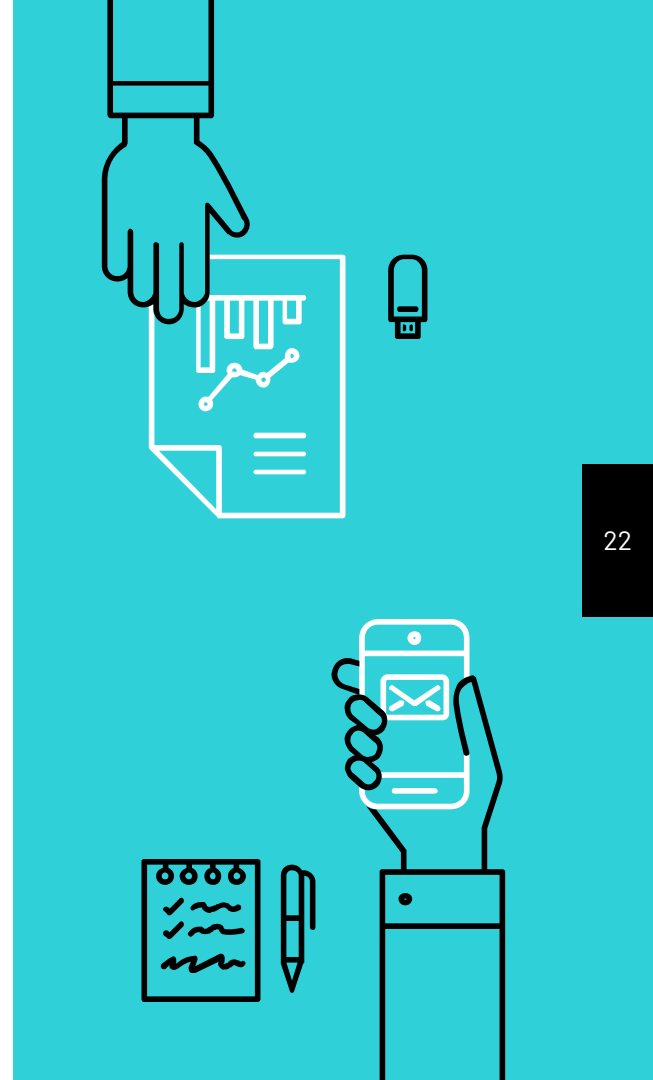
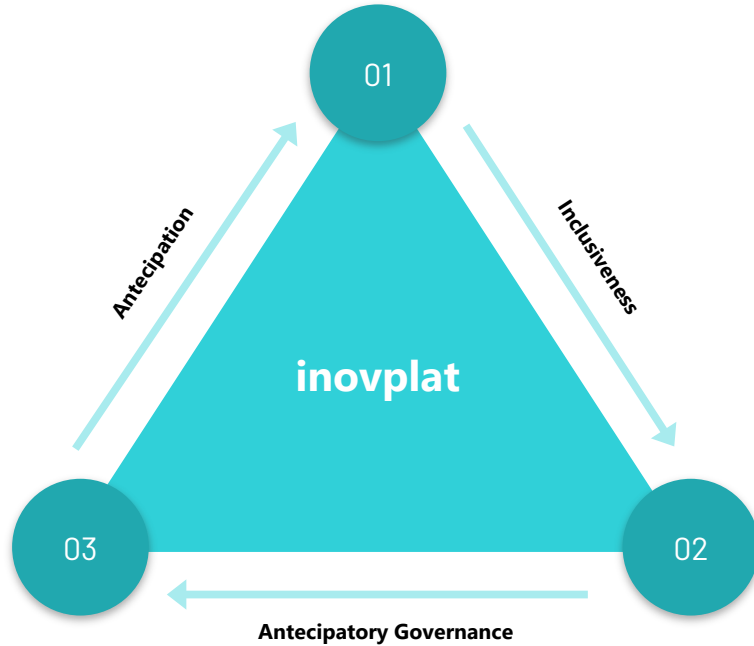
Anticipation

Anticipation is a construction of the future, based on certain methods that allow evaluating or determining in real time (Guston, Sarewitz, 2002).

Inclusiveness

Inclusiveness does not refer to the mere participation of diverse societal actors, but to the inclusion of their perspectives and demands in the development and innovation process. Thus, inclusivity imposes a clear political challenge (Eizagirre, Rodríguez, Ibarra 2017): the construction of a space in which all societal actors -not only the most concerned or stakeholders- can participate, to propose their demands with the intention that these are heard by the other actors and that they can be deliberated on.

Operationalization of anticipatory governance

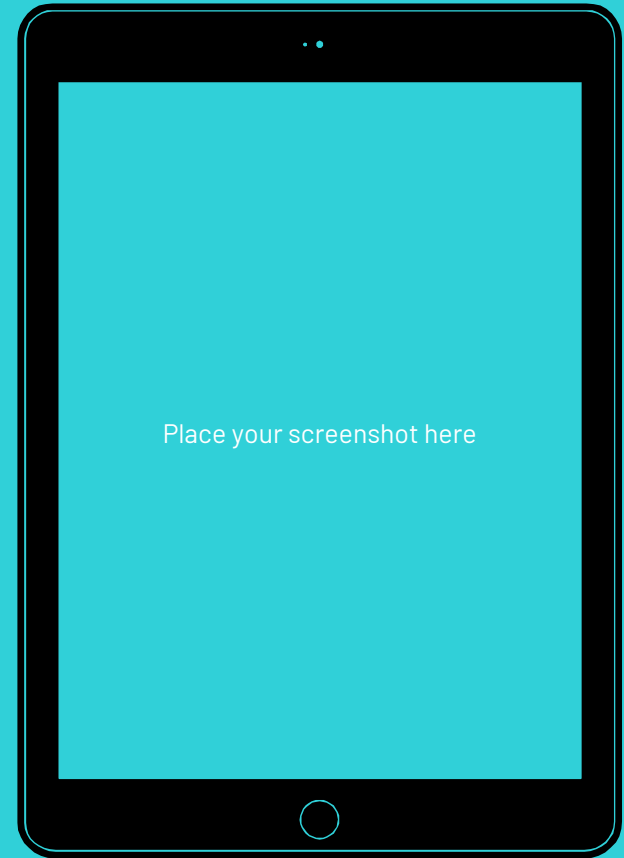


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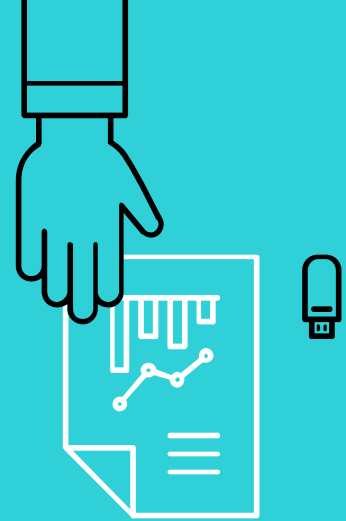
- ▶ an electronic space (web) to share demands, visions, scientific and technological knowledge, regulations, social experiences, uncertainties, ... as well as to favor responsiveness and deliberation among societal actors.
- ▶ allows all data and information to be centralized in one place, safely and ensuring accessibility to tests, as well as facilitating the exchange of information to favor inclusive anticipatory deliberation.
- ▶ It has a validation mechanism that allows assigning certifications of "responsibility" to the projects and products that are the object of the inclusive anticipatory evaluation exercise.
- ▶ In Inovplat a whole variety of such actors are summoned (inclusiveness); Likewise, the methodologies proposed by Popper (2008) (anticipation) are applied in a transparent and sufficiently complete manner.

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- ▶ Available anytime; everywhere
- ▶ Governamental features and integration with other services
- ▶ Voting systems;
- ▶ Clear indicators to be used and calculated.



THESIS PROJECT PROGRESS



THESIS PROJECT PROGRESS (next steps)



Replicate the methodology to other technology



Do larger scale surveys



Create a demo version of the platform online

Any questions?

You can find me at:
a.romeiro@campus.fct.unl.pt

