38th Meeting of the Global Science Forum

Item 11b
ROOM DOCUMENT

TRANSDISCIPLINARY RESEARCH: SCOPING OF KEY ISSUES FOR GSF

This document will be discussed under Item 11b of the Draft Agenda.

Transdisciplinary Research: Scoping of key issues for GSF

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March 2018

1.1. General introduction

1. This document aims at scoping some of the main issues relative to transdisciplinary research, from a policy perspective. Transdisciplinarity is increasingly cited as a concrete means to address global challenges such as climate change / environment sustainability and health. Facing such challenges implies thinking and acting beyond the individual disciplines of science, using innovative methods inspired from co-design and co-production. This means gathering not only the different disciplines of science, but also the various stakeholders outside the scientific community.

2. As described by Roland W. Scholz[1], "we are entering a new age which asks for research on coupled human-environment systems" (HES). Human is forming the environment and the environment is forming humankind. Hence, the concept of *Anthropocene*[2], as first popularized by Paul J. Crutzen[3] in 2002.

> *"Transdisciplinary science transcends disciplinary boundaries. The reasons to engage in transdisciplinary science are many and include the desire to nurture a more direct relationship between science and society, as well as the desire to explain phenomena that cannot be explained by any of the existing disciplinary bodies of knowledge in isolation. Both reasons also reinforce each other, as reality often features a level of complexity that demands and inspires the combination of scientific knowledge from various disciplines. The challenge in transdisciplinary science, however, is not so much to cross disciplinary boundaries, but to ensure an effective connection between disciplines"*[4] *and to go beyond the sole scientific field, by including the different stakeholders all along the processes, from thoughts to actions.*

[1] https://en.wikipedia.org/wiki/Roland_W._Scholz

[2] https://en.wikipedia.org/wiki/Anthropocene#cite_note-11

[3] Dawson, Ashley (2016). Extinction: A Radical History. OR Books. p. 19. ISBN 978-1944869014.

[4] Geophysical Research Abstracts Vol. 18, EGU2016-9435, 2016 EGU General Assembly 2016 © Author(s) 2016. CC Attribution 3.0 License. "Strategies for transdisciplinary research on peri-urban groundwater management in the Ganges delta", Leon Hermans, Wil Thissen, Sharlene Gomes, Poulomi Banerjee, Vishal Narain, Mashfiqus Salehin, Rezaul Hasan, Anamika Barua,

3. An editorial in the special issue on interdisciplinarity in Nature[5], in 2015 summarised things nicely "To solve the grand challenges facing society -energy, water, climate, food, health- scientists and social scientists must work together". Few scholars would disagree with this statement, but specifically, the collaboration between natural and social sciences, which is particularly crucial to tackling the challenges arising from global changes, remains "a challenging endeavor" (Ana Viseu, p. 342). If working together is the key to overcoming the major challenges of humankind, how can we improve it in the research area?

4. As expanded on in the rest of this paper there are a number of important questions that have to be addressed if transdisciplinary research is indeed to expand beyond a theoretical concept with a limited community of practitioners into a mainstream approach to the conduct of scientific investigation:

- How to define the relevant concepts and definitions in order to engage in a productive discussion around the opportunities, challenges and limitations of transdisciplinary research?
- How to enable and promote truly transdisciplinary research, including the establishment of productive research environments?
- How to adapt the current peer-review system for transdisciplinary research?
- How to incentivize and fund transdisciplinary studies?
- How to promote transdisciplinarity in science education?
- How to enhance, value, promote and achieve transdisciplinarity, both at collective and individual levels?

5. In this scoping paper, two societal challenges are taken as illustrative examples for the application of transdisciplinary research: sustainable development, specifically groundwater research, and improving global health, specifically the development of medical devices. However, these are just two of a number of critical areas, many of which are highlighted in the UN Sustainable Development Goals (SDG), where rigorous transdisciplinary research can be expected to generate new insights and accelerate the translation of knowledge into scientific benefits.

1.2. Definitions

6. The discourse on how different scientific disciplines and stakeholders from outside of science can work together is often confused by different definitions of science and different uses of ' X- disciplinarity' terminology. With reference to the literature, a working definition of some of the key terms is given below.

7. **Science** is an umbrella term that in its broadest interpretation encompasses all scientific disciplines - both natural sciences and social sciences. However, in many countries it is commonly used and understood as only including natural sciences. For the purposes of this paper the broader definition is adopted but nevertheless it is worth considering the range and breadth of disciplines that this includes as this has important implications for how we consider different levels of integration across disciplines.

Shah Alam Khan, Samir Bhattacharya, Remi Kempers, Parthasarathi Banerjee, Zakir Hossain, Binoy Majumdar, and Riad Hossain.

[5] Ana Viseu, *Why interdisciplinary research matters* (p. 305). Nature. 2015; 525(7569):305. doi: 10.1038/525305a PMID: 26381966

8. **Natural science** relies on the description, prediction, and understanding of natural phenomena, based on observational and empirical evidence[6]. Mechanisms such as peer review and repeatability of findings are used to try to ensure the validity of scientific advances. Life science as well as physical science use tools from formal sciences, such as mathematics and logic, converting information about nature into measurements which can be explained as clear statements of the "laws of nature". The parent natural science disciplines included physics, chemistry biology and the earth sciences, and each of these may be further divided into more specialized fields or disciplines.

9. **Social science** also uses systematic scientific methods but often relying more on qualitative research. Social science concerns society and the relationships among individuals within a society. Social science disciplines range from sociology and psychology to political science and economics [7]:

10. **Disciplines** in both natural and social sciences are characterized by objects and (core) methods.

11. **Cross-disciplinary** knowledge is that which explains aspects of one discipline in terms of another. Common examples of cross-disciplinary approaches are studies of the physics of music or the politics of literature.

12. **Multi- or pluridisciplinarity** implies juxtaposing different specialized points of view[8]. It aims at converging the results from various disciplines to an only examinee. The interest comes from the intrinsic complementarity of the different disciplines, each specialist considering the examinee through the specter of his own discipline. Insofar as the result is most often an assembly of fragments, this approach remains partially satisfying, thus difficult to implement operationally.

13. **Interdisciplinarity** sets up a dialogue and exchanges between the disciplines. Each discipline gets enriched from the contribution of the other disciplines. Inter-disciplinarity has several levels and may be limited to closely adjacent disciplines, e.g. different branches of physics, or fields with very different epistemiological basis and methods, e.g. anthropology and inorganic chemistry. A particular challenge in the context of science to address complex societal challenges, is bringing together disciplines from both natural and social sciences.

14. **Transdisciplinarity** deals with objects that are not fully part of one given discipline. It merges disciplines together, without any obligation, so to reach the same target through varied activities. Thus, this notion connotes “a research strategy that crosses many disciplinary boundaries to create a holistic approach”[9]. The

[6] https://en.wikipedia.org/wiki/Natural_science

[7] Economic and Social Research Council (ESRC): the UK's largest organization for funding research on economic and social issues. They support independent, high quality research which has an impact on business, the public sector and civil society.

[8] La pluridisciplinarité aborde un objet d’étude selon les différents points de vue de la juxtaposition des regards spécialisés. L’objectif est de faire coïncider le travail de plusieurs disciplines à un même objet, un même sujet. En se nourrissant de la complémentarité intrinsèque à plusieurs disciplines, chaque enseignant aborde l’œuvre selon sa discipline. Le danger risque d’être le morcellement des approches même si c’est une façon d’aborder tous les aspects. Évelyne Goupy, Les dossiers pédagogiques. Site du musée des Abattoirs.

9 https://en.wikipedia.org/wiki/Transdisciplinarity

transdisciplinary research approach integrates frameworks and methodologies beyond traditional academic disciplines and involves policy makers and other members of the community. Thus transdisciplinarity may be considered as the ultimate level of "-disciplinarity". In a nutshell, transdisciplinarity goes beyond sciences. The concept aspires efficient use of available knowledge (Thompson-Klein et al. 2000) by relating different epistemics (Scholz et al. 2006) and asks for integrating knowledge and values from practice in science.

15. The Belmont Forum[10] elaborated that a transdisciplinary approach is enabling inputs and scoping across scientific and non-scientific stakeholder communities and facilitating a systemic way of addressing a challenge. This includes initiatives that support the capacity building required for the successful transdisciplinary formulation and implementation of research actions. In the CIRET[11] approach, transdisciplinarity differs radically from inter- and pluridisciplinarity. As the prefix "trans" indicates, transdisciplinarity concerns that which is at once between the disciplines, across the different disciplines, and beyond each individual discipline. Its goal is the understanding of the present world, of which one of the imperatives is the overarching unity of knowledge[12][13].

16. Roland Scholz[14] summarized the essence of transdisciplinary processes, in a sketch (below) where actors from the science community, public at large, and legitimized decision-makers are involved in research processes, public discourses or stakeholder activities, and decision processes, respectively. When the actors leave their primary processes (action lines – bold gray) and join in a **collaborative, power-balanced effort**, we can call this a "transdisciplinary process".

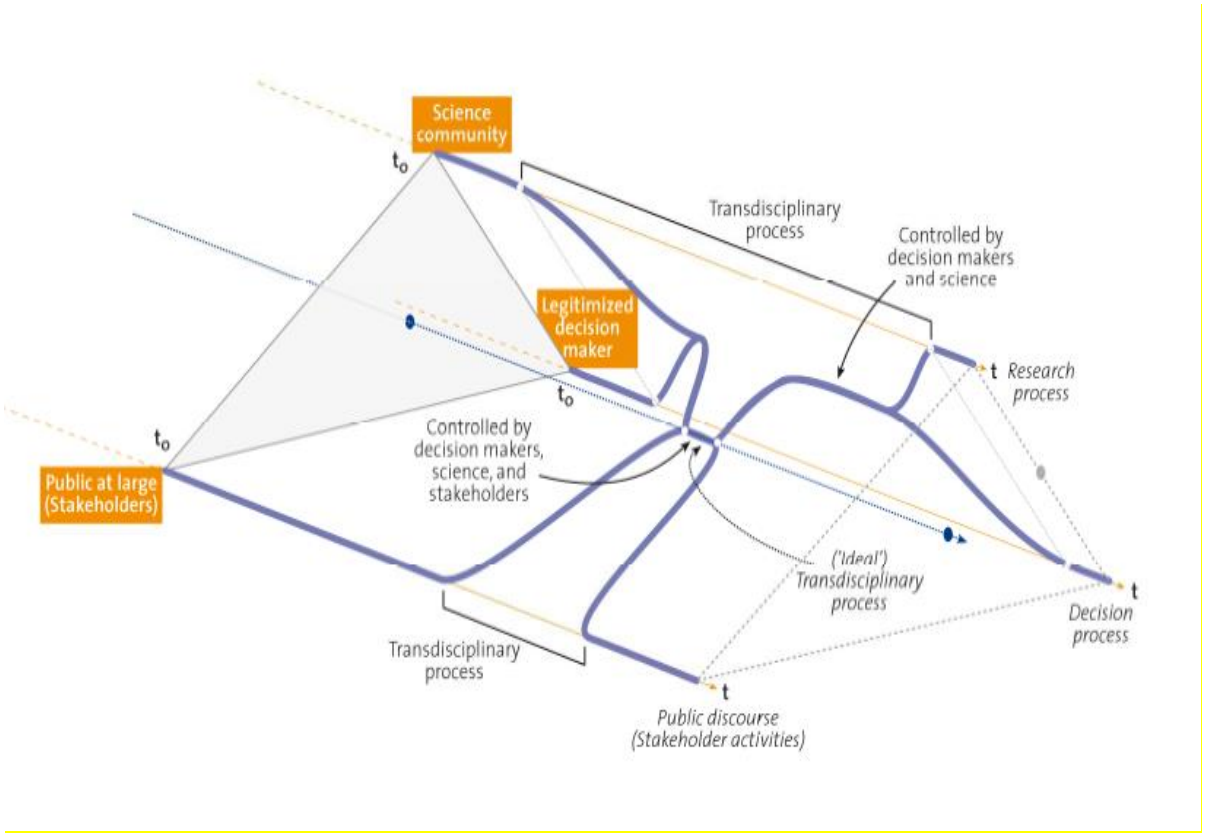
[10] Established in 2009, the Belmont Forum is a partnership of funding organizations, international science councils, and regional consortia committed to the advancement of interdisciplinary and transdisciplinary science. Forum operations are guided by the Belmont Challenge, a vision document that encourages International transdisciplinary research providing knowledge for understanding, mitigating and adapting to global environmental change.

[11] International Center for Transdisciplinary Research (CIRET): a non-profit organization, located in Paris and founded in 1987. The aim of this organization is to develop research in a new scientific and cultural approach - transdisciplinarity - whose aim is to lay bare the nature and characteristics of the flow of information circulating between the various branches of knowledge.

[12] https://en.wikipedia.org/wiki/Discipline_(academia)#Cross-disciplinary

[13] New Horizons: environmental and sustainability sciences, Roland W. Scholz, 2007. Perspectives for environmental literacy, Cambridge University Press.

[14] Figure 15.1, Scholz, R. W. (2011). Environmental Literacy in Science and Society: From Knowledge to Decisions. Cambridge: Cambridge University Press.



The terms co-design and co-production are frequently associated with transdisciplinary research and reflect the inclusion of relevant stakeholders in key stages of the research process rather than limiting them to their more traditional position as 'end -users'.

2. Obstacles to realizing transdisciplinary research

17. Whilst the need for more transdisciplinary research to address complex societal challenges is generally accepted there are a number of significant obstacles that need to be overcome if such research is to be more widely implemented. These obstacles reflect the structure of the academic research system as a whole including it institutions, funding, review and reward structures as well as science education and training.

2.1. Institutional arrangements

18. Academia and academic structures, including University departments and public research centres are traditionally based around scientific disciplines. This can be an obstacle to working across disciplines. Whilst individual students and motivated staff may work more between and connect different 'silos' to carry out multi- and inter-disciplinary research, it can be difficult to establish substantive trans-disciplinary initiatives. One response to this has been to establish inter- and trans- disciplinary research centres out-with the traditional university structures. Trans-disciplinary research networks that bridge individual institutions and nations are also present in some domains, with EC funding mechanisms being well adapted to support such networks at the European level.

19. **Key question:** What are the key characteristics of successful transdisciplinary research environments (teams, institutions and networks)?

2.2. Funding

20. In most countries, the funding mechanisms for science are aligned with academic structures. Whilst top-level missions for research funding agencies or priorities in national strategies may imply the need for interdisciplinary and transdisciplinary research, this can be difficult to map on to operational mechanisms and processes. Research assessment and competitive grant awarding processes invariably depend on peer review that focuses on scientific excellence and is organized along disciplinary lines. Furthermore, emergence of new type of research teams for interdisciplinary and transdisciplinary research needs not only competitive grants, but also space and time for incubation of ideas between different actors.

21. **Key question:** How can research funding mechanisms be adapted to promote inter- and trans-disciplinary research?

2.3. Peer-review

22. The traditional system of publications is founded on academic peer-review processes and may need to evolve so that papers dealing with transdisciplinary approaches are fairly and rigorously reviewed.

23. Roland Barthel and Roman Seidi[15] demonstrated that:

- Journals publishing interdisciplinary research have lower impact factors on average
- Interdisciplinary papers are cited much less than mono-disciplinary ones, at least in the shorter term.

24. **Key question:** How to review funding proposals and make the research support system adaptable to a transdisciplinary approach?

2.4. Training and education

25. The current education approach, mainly based on building expertise and turning out students able to deliver a high quality level of contribution in prescribed field in science, will need to be adapted to accommodate the need for more trans-disciplinary research. There is a balance to be achieved between researchers with substantive disciplinary knowledge and trans-disciplinary 'openness'. Training of (at least some) researchers must transcend individual academic disciplines.

26. **Key question:** How to prepare students to be more receptive to inter- and trans-disciplinary approaches? How to enhance, value, promote and achieve the concept, both at individual and group levels?

2.5. Data integration

27. Scientific data is largely organized in disciplinary or domain-specific fields. Each community of researchers takes care of the research data that is generated and used in their particular field. They develop their own infrastructures, standards and processes that are optimized for usage by their specific communities. The challenge then comes when new research communities wish to access and use data from other fields, e.g. use of biodiversity data for health research. Whilst it is commonly recognized that many of the most important opportunities for exploiting open research data are at the interface between disciplines, there are very significant (technical and cultural) obstacles to realizing this in practice.

28. **Key question**: How can the move towards Open Research Data accommodate the future needs for inter- and trans-disciplinary research?

[15] *Interdisciplinary Collaboration between Natural and Social Sciences – Status and Trends Exemplified in Groundwater Research*, Roland Barthel, Roman Seidi, 2017 01 27 (Research. PLoS ONE 12(1): e0170754; doi:10.1371/journal.pone.0170754)

3. Cases Studies

29. For this preliminary scoping, illustrative examples have been taken from two very different research fields:

- Human-environment systems (HES) and groundwater
- Health and emerging technologies

3.1. Human-environment systems

30. Today's environmental problems cannot be managed without incorporating analysis of human systems that affect many processes on all levels, from molecular up to global biogeochemical processes of the material–biophysical environment[16]. This asks for redefinition of the environment system, integration across different disciplines and engagement with relevant societal stakeholders.

31. "We, along with these scientists, have to leave our travel route and step into real-world cases to gain valuable additional information from directly talking, interacting, collaborating with, and getting first-hand information from the people and human actors who are directly experiencing, benefiting from, and interacting with the environment".

32. In his landmark work, Scholz selected four very different cases, in order to look at the challenges and threats of human-environment interactions. These were: 1.epidemic and pandemic threats; 2. Market and the environment in Switzerland; 3. Basic supply services and natural resources in Sweden; 4. Recycling and minerals

33. Using a HES trans-disciplinary framework, Scholz demonstrated that each case could be addressed by means of decision and game theory. "Decision and game theory incorporate two potentials essential for the study of HES. One is a capacity to precisely describe the decision situation; that is, the range of potential actions at the disposal of human systems. The other is the capacity to incorporate models about the decision process, referring to the cognitive, mental or epistemic processes involved as well as to the social rule systems representing the situation. This allows assessment of what environmental awareness human decision-makers have about their interaction with the environment."

34. Scholz argues that "transdisciplinarity offers a new type of framing, learning, and coping with complex, tangible environmental problems. […] Transdiciplinarity relates human wisdom with analytic scientific rigor for dealing with the right problem in an adequate manner".

[16] Environmental Literacy in Science and Society, Roland W. Sholz, Cambridge University Press, 2007.

3.1.1. Groundwater research

35. Groundwater—"the world's largest freshwater store"[17]— is a life-sustaining resource that supplies water to billions of people, plays a central part in irrigated agriculture and influences the health of ecosystems. Groundwater comprises 97% of the world's usable fresh water resources. About 3±4 billion people rely on sufficient and clean groundwater for drinking on a daily basis.

36. There are a wide range of applied environmental questions related to sustainability of water resources, and the role of groundwater in the context of biodiversity, environmental hazards, and environmental change. The fields of groundwater research can be divided into at least 11 distinct areas each with their own dedicated research and stakeholder community[18] Such a diversity of areas highlights the need for transdisciplinarity in the way of addressing the issues: "An overwhelming consensus among scientists and practitioners in the water sector is that the pressing problems in water resources management can only be solved in an interdisciplinary way, specifically by the collaboration between natural and social sciences".

37. The scientific aspects of groundwater range from purely physical, chemical and biological ones to economic, political, social and cultural dimensions. Where, if not here, should interdisciplinarity flourish?" [19] However, in the groundwater area, despite the need for transdisciplinary collaboration being expressed frequently in the research community, "it remains unclear to what degree such collaboration actually takes place, what trends and developments there are and which actors are involved."[20]

38. Using bibliometric analysis, Roland Barthel and Roman Seidi, come to the conclusion that "the overall percentage of multi- or inter-disciplinary articles in groundwater research was in the low single-digit range, with only slight increases over the past decades. The interdisciplinarity of individuals plays a major role compared to interdisciplinarity involving two or more researchers. If collaboration with natural sciences takes place, social science is represented most often by economists. As a side result, they found that journals publishing multidisciplinary research had lower impact factors on average, and multidisciplinary papers were cited much less than mono-disciplinary ones."

39. There are a number of initiatives to promote more transdisciplinary approaches to groundwater research, either through support for dedicated infrastructure or novel funding mechanisms (see box 1).

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[17] http://blogs.egu.eu/network/water-underground/category/research/

[18] The British Geological Survey is a public sector organization responsible for advising the UK government on all aspects of geoscience as well as providing impartial geological advice to industry, academia and the public.

[19] Source: Interdisciplinary *Collaboration between Natural and Social Sciences – Status and Trends Exemplified in Groundwater Research*, Roland Barthel, Roman Seidi, 2017 01 27 (Research. PLoS ONE 12(1): e0170754; doi:10.1371/journal.pone.0170754).

[20] Idem.

Box 1. Dedicated infrastructure and funding for groundwater research

Best practice on boxes: see page 20 of the OECD Style Guide. Do not forget to delete or replace this text. In Australia, the National Center for Groundwater Research and Training (NCGRT)[21] is composed by 12 partner universities, a growing list of more than 19 government and industry partners, and formal linkages with some of the world's leading groundwater research organizations. The NCGRT brings together nearly 200 Australian and international researchers to pool their knowledge and expertise. The structure is supported by the National Collaborative Research Infrastructure Strategy (NCRIS)[22], which is the Australian government program funding the development of scientific infrastructure. Since 2004, the Australian Government has invested over $2.5 billion to enable the Australian science community to develop critical infrastructure that will enable quality research for years to come.

The NCGRT's[23] role is to advance the understanding of the country's groundwater resources, and to train the next generation of groundwater researchers. They have also supported vital research infrastructure across the country as part of the Australian Government's NCRIS Groundwater Infrastructure fund. The data available from this infrastructure underpins the research efforts and will be available to groundwater researchers for many years to come. The NCRIS set aside $15 million to develop a series of world-class groundwater infrastructure sites. This NCRIS Groundwater Infrastructure fund was administered by the Department of Education and managed by the University of New South Wales.

Settling up a transdisciplinary funding approach for groundwater research is apparently a core issuefor quite a number of countries. In the USA, for example, the NGWA[24] Foundation funds leading-edge activities that stimulate new knowledge, information, programs, and products to advance groundwater science and technology. The aim is to enhance the future effectiveness of the groundwater professions and maximize groundwater's benefit to society. The NGWA Foundation solicits research applications that support groundwater sustainability. Inter- and trans-disciplinary proposals can cover scientific, engineering, environmental, socioeconomic, legal, political, and any related aspects of groundwater sustainability.

[21] http://www.groundwater.com.au/about-us

[22] http://www.groundwater.com.au/groundwater_infrastructure

[23] The National Center for Groundwater Research and Training was established in 2009 by the Australian Government as a Centre of Excellence co-funded by the Australian Research Council and the National Water Commission.

[24] National Ground Water Association, a community of groundwater professionals working together to advance groundwater knowledge, based in the USA.

3.2. Health and emerging technologies

40. There is a particular challenge for the health care and medical devices industry in integrating emerging technologies with the latest knowledge from relevant research fields and patient and carer expectations[25]. One example, form France, of an organization dealing with this question is Clinatec.

41. Clinatec is an innovative, trans-disciplinary structure based in CEA that promotes less invasive and better targeted medicine. The structure is based around a technological platform where breakthrough technical devices are designed in a hospital setting (cf. illustration[26]). This brings a multifaceted team, which includes robotics engineers, mathematicians, physicists, electronics engineers, computer scientists, biologists, neurologists, surgeons and nursing staff, directly to the patient's bedside.

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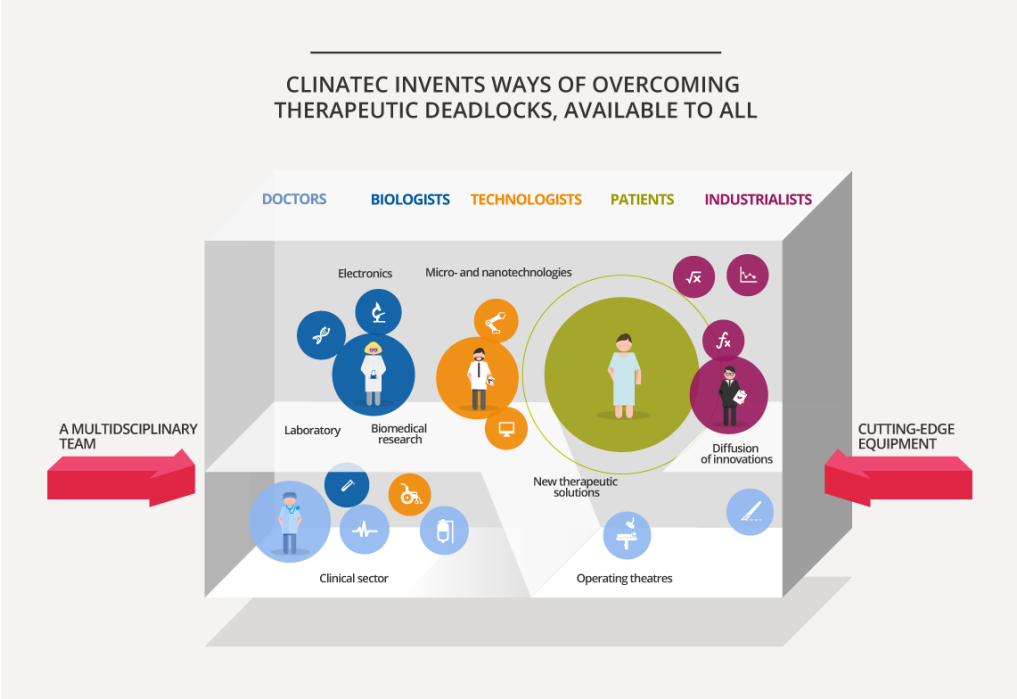

42. The main focus of Clinatec is on neuroscience - "the scientific study of the nervous system. It is a multidisciplinary branch of biology that deals with the anatomy, biochemistry, molecular biology, and physiology of neurons and neural circuits. It also draws upon other fields, most notably physics, pharmacology, psychology, and medicine."[27] The scope of neuroscience has broadened over time to include different approaches that are used to study the molecular, cellular, developmental, structural, functional, evolutionary, computational, psychosocial and medical aspects of the nervous system. And Clinatec goes a step further by directly involving patients and carers in the design and implementation of its research (see box 2).

[25] "*Top health industry issues of 2017: A year of uncertainty and opportunity"* PWC study https://www.pwc.com/us/en/health-industries/top-health-industry-issues.html

[26] http://www.clinatec.fr/en/clinatec_/what-is-clinatec/

[27] https://en.wikipedia.org/wiki/Neuroscience

Box 2. Clinatec transdisciplinary medical device projects

The BCI (Brain Computer Interface) project[28] aims at demonstrating that it is possible to drive an exoskeleton[29] thanks to a brain implant[30] that records cortical signals[31], opening up the prospect of a better future for people with motor function disabilities. The project is based on the fact that when we imagine making a movement, we trigger the same electrical activity in the motor cortex of the brain as when we actually perform that activity. The project aims at recording these electrical signals, known as ElectroCorticoGrams, and decode them to drive the limbs of an exoskeleton. To achieve this, transdisciplinary teams have been working for over 8 years: surgeons, electrical engineers, mathematicians, roboticists, biologists, psychiatrists, industrialists, patients and nurses. The first tangible results from this work were presented during the last annual WSSFN Congress[32] (World Society for Stereotactic and Functional Neurosurgery) in Berlin.

The overall objective of the Near Infra Red (NIR) project is to develop a new treatment for Parkinson's disease, thanks to a chronic intracerebral implant that provides near-infrared light with neuro-protective effects. Given that it is difficult to diagnose Parkinson's at an early stage, this new surgical strategy is designed to present very low risks, since it is targeted at patients who have little or no motor problems. Drawing on their previous and current developments, the Clinatec teams have developed implants and are currently conducting preclinical tests to obtain accreditation for a clinical trial on humans.

Setting up transdisciplinarity in this kind of technology-oriented research organization implies building a research model that is able to renew itself frequently. Organisations and funding mechanisms have to be committed and flexible in order to make this work.

[28] http://www.clinatec.fr/en/research/projects/bci-project/

[29] *EMY: a dual arm exoskeleton dedicated to the evaluation of Brain Machine Interface in clinical trials*, Morinière, A. Verney, N. Abroug, P. Garrec, Y. Perrot, 2015 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS): 5333-5338

[30] *CLINATEC BCI platform based on the ECoG-recording implant WIMAGINE and the innovative signal-processing to control the exoskeleton* EMY: preclinical results, Eliseyev, T. Aksenova, C. Mestais, A.-L. Benabid, et al., EMBC, 36th Annual International Conference of the IEEE 2014:1222-1225

[31] *WIMAGINE: Wireless 64-Channel ECoG Recording Implant for Long Term Clinical Applications*, Mestais, G. Charvet, F. Sauter-Starace, M. Foerster, D. Ratel, and AL. Benabid, IEEE Trans Neural Syst Rehabil Eng. 2015 Jan;23(1):10-21.

[32] http://www.wssfn-congress.org/en/programme/dynamic/

43. Clinatec has faced a number of difficulties in adapting the traditional way research is organized to the new needs of transdisciplinary health research:

- Infrastructure problems, solved by building a little hospital in a nanotechnologies research center having partnerships with universities and a health research institute
- Governance issues are just now being solved after several years of existence
- Organization is being adjusted through the set-up of operational task-forces able to transcend the different disciplines and solve the staff issues (key opinion leaders rounded by high-level specialists per discipline, having to work together beyond the disciplines)
- Growth stays effective but slow, even if the early results are promising.

44. The organization is working together with associations such as CORTICO (COllectif pour la Recherche Transdisciplinaire sur les Interfaces Cerveau-Ordinateur)[33] in order to make transdisciplinarity in scientific and clinical research more effective

[33] http://www.cortico.fr/journee-de-lancement-de-lassociation-africo/

4. Concluding comments:

45. There are a number of creative initiatives underway to bring together a critical mass of researchers from different natural and social science disciplines, with other stakeholders, to address complex societal challenges. Many OECD countries are establishing inter- and tran-disciplinary centres and networks with the aim of bridging the divide between social and natural sciences to address grand societal challenges.

46. One of the options for future GSF work would be to develop a framework to carry out and analyze what makes a successful inter and trans-disciplinary research environment, exploring issues such as institutional structure (e.g. relationship with Universities), mission and governance, material structure, influence of the international connections / networks, funding, staff training, missions and impact assessment/KPI/outputs. Such a project could build on previous OECD-STI work on centres of excellence and research governance but would have a specific focus inter- and trans- disciplinarity.