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PERSPECTIVE

Applied Research

How science creates impact: A comment

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Abstract

Addressing the grand societal challenges is a task for science. To get this done, innovation needs to be the focus of all research institutions together with industry, as discussed in the following comment by Dr. Arik Willner.

KEYWORDS

impact, innovation, innovation ecosystems, technology solutions, technology trends, transfer

INTRODUCTION

As the IPCC report[1] recently extrapolated once more: The climate catastrophe is uncontested the biggest challenge that mankind is facing and will be facing in the years to come. To manage ensuing challenges and to thrive despite massive implications, societies need new technological solutions and breakthrough discoveries, which can be put to the fastest possible use.

Research—basic and applied—is at the forefront of discovering and fostering adequate solutions and supports the much-needed sociotechnical transformation of our societies, no matter the field of study or technology. We need insights and solutions for tackling climate change. New approaches to decarbonizing mobility and industry, technologies for saving and treating water, or new recyclable materials are a few examples. Furthermore, addressing the challenges of aging societies requires a strong focus on health-related research, from drug discovery to cancer treatments or new imaging methods. The list can go on including key technologies, which are important for all fields from disruptive quantum technologies to 3D and 4D printing and the development of new functionalized materials.

This alone is reason enough for basic research institutions to become consistently and purposefully intertwined more closely with applied research, transfer, and innovation. In Europe and especially now in Germany with the new coalition consisting of the Social Democrats, the Green Party, and the Liberal Democrats, this trend is widely encouraged. As made explicit through the EU missions and national frameworks like the Hightech Strategy[2] in Germany, we need bold and ambitious goals that follow a strong narrative of change. Mission-oriented innovation policy[3] that is in line with the universal Sustainable Development Goals[4] as defined by the United Nations calls exactly for those systemic solutions, which cut across different policy domains and different areas of the science and innovation system.

At DESY, a national lab for basic research in physics and related disciplines in natural sciences, we address these issues and accommodate this shift. One example is to open our very own systemic expertise and competence, which can address a multitude of the outlined problems at different levels, for example through the best use of our large-scale infrastructure, such as our synchrotron light source PETRA III.

A PARADIGM SHIFT

The ivory tower is long gone, and all research institutes are acutely aware that their solutions and competencies matter to society and that they need to deliver solutions with real impact. The thought of interdisciplinarity has been embraced. This is reflected by researchers

[1]The Intergovernmental Panel on Climate Change (IPCC): https://www.ipcc.ch/

[2]High-tech Strategy 2025 in Germany: https://www.hightech-strategie.de/hightech/de/home/home_node.html

[3]Mission-oriented innovation policies in Germany (Missionsorientierte Innovationspolitik): https://www.isi.fraunhofer.de/content/dam/isi/dokumente/policy-briefs/policy_brief_mission-oriented-innovation-policy.pdf

[4]The 17 Sustainable Development Goals: https://sdgs.un.org/goals

from different fields meeting around a topic in an already institutionalized environment. Examples of this approach are the Centre for Structural Systems Biology (CSSB),[5] with its focus on infectious diseases, or the Centre for Molecular Water Science (CMWS),[6] about understanding water at a molecular level, both nestled into the DESY research campus in Hamburg. Next to interdisciplinarity, the focus on transdisciplinarity is a major shift in how academia, research, and innovative companies are interacting. Every participant along the complex path to innovation needs to be well aware of the responsibility in that regard. This includes accommodating the needs for challenge-oriented research as well as industrial solution-seeking on top of the mandate to carry out basic science when it comes to a national lab anchored in basic research such as DESY. As we have witnessed throughout the pandemic: Speed is a decisive factor in getting insights from research translated into products or services.

However, this kind of cooperation and transfer cannot be left to happen by chance. It requires attention, time, and resources. Successes are the result of a deliberate and often very long process, from the first identification of new developments until market entry. That said, transfer today is way more than the management of the intellectual property. It's about providing excellent scientific methods and experts for proactive joint solution-seeking with partners from industry, while being receptive to the needs and abilities of those different spheres.

For a research institute such as DESY, this means that we need to anticipate technological trends and scientific challenges. This translates into more than reacting to requests from staff or partners, but deliberately focusing on strategic topics that enable the prioritization of future initiatives, partnerships, and developments. The aim is to generate relevant ideas and paths to innovation that provide answers to the pressing societal problems that ultimately benefit society and each individual.

Technology trends, which need to be addressed by research and pushing toward technological solutions, respond largely to the grand societal challenges we are facing today, including all areas of energy harvesting, storage and transport, mobility, management of water, health-related topics from individual gene therapies to bio-printing, additive manufacturing, artificial intelligence and all technologies that influence and play an important role in digitalization.

BASIC RESEARCH IS KEY TO THE INNOVATION PIPELINE

All that said, basic research is and still needs to be open-minded to any results. Here is where limits in different technological fields are pushed and insights lead to new products or services. For everyone working in transfer and having knowledge of innovation management, this is a time- and labor-intensive process to make the way from first insights or developments stemming from basic research into applications.

Key factors within research centers or institutes influence this, but external factors play an equally important role.

High-risk funding instruments for early-stage inventions

Will an idea or development work out? Can it be scaled from a lab-based solution to an industrial scale level? Only two short questions showcase the need for early inventions for processed ideas and new technology solutions to be supported, especially when the clear outcome has not been clarified yet.

And this support can't end after a short time period: Validation projects between research and industry partners are not set up and done within 6 months. It is not easy to scale a new technology from a lab to an industrial scale. In addition, early interventions and technology screenings need to be supported and carried out in basic and applied research. A lot of research centers and institutes have gone a long way to create instruments that can support, if not fund, additional work to refine inventions and ideas toward publications. However, consistent funding is needed and cannot be realized by research institutions alone. Adequate instruments need to be put in place by legislators and continued by venture capital.

Funding, continued interest, and support are key so that any invention makes it from basic research to application and doesn't get lost in the valley of death (Figure 1).

Creating the mindset

Making innovation happen requires a cultural shift as well, especially in basic research. Everyone who is working in this field needs to embrace the idea that innovation matters and it is more than just creating new insights: Ideas, inventions, and solutions need to make their way to the market so that society can benefit from them. That means as well that support for innovation activities needs to be more than just lip service by the management.

Creating a framework to support innovation activities can include for example acknowledging IP and patents far more than before—one option which is fairly standard in technology transfer activities. At the same time funding, time, or support with grant application plays an important role. Last but not least: There needs to be positive visibility for activities geared toward innovation. This requires often a real culture change and thus a change management process in institutes, universities, and research centers.

At the same time, the professionalization of transfer is a significant aspect of the acceptance of transfer within research institutions and universities. Degrees, for example in Innovation Management, or possibilities for further education in this field by bodies such as ASTP,[7] the European association for knowledge

[5]CSSB is a joint initiative of three universities and seven research institutes: https://www.cssb-hamburg.de/

[6]Centre for Molecular Water Science: https://www.cmws-hamburg.de/

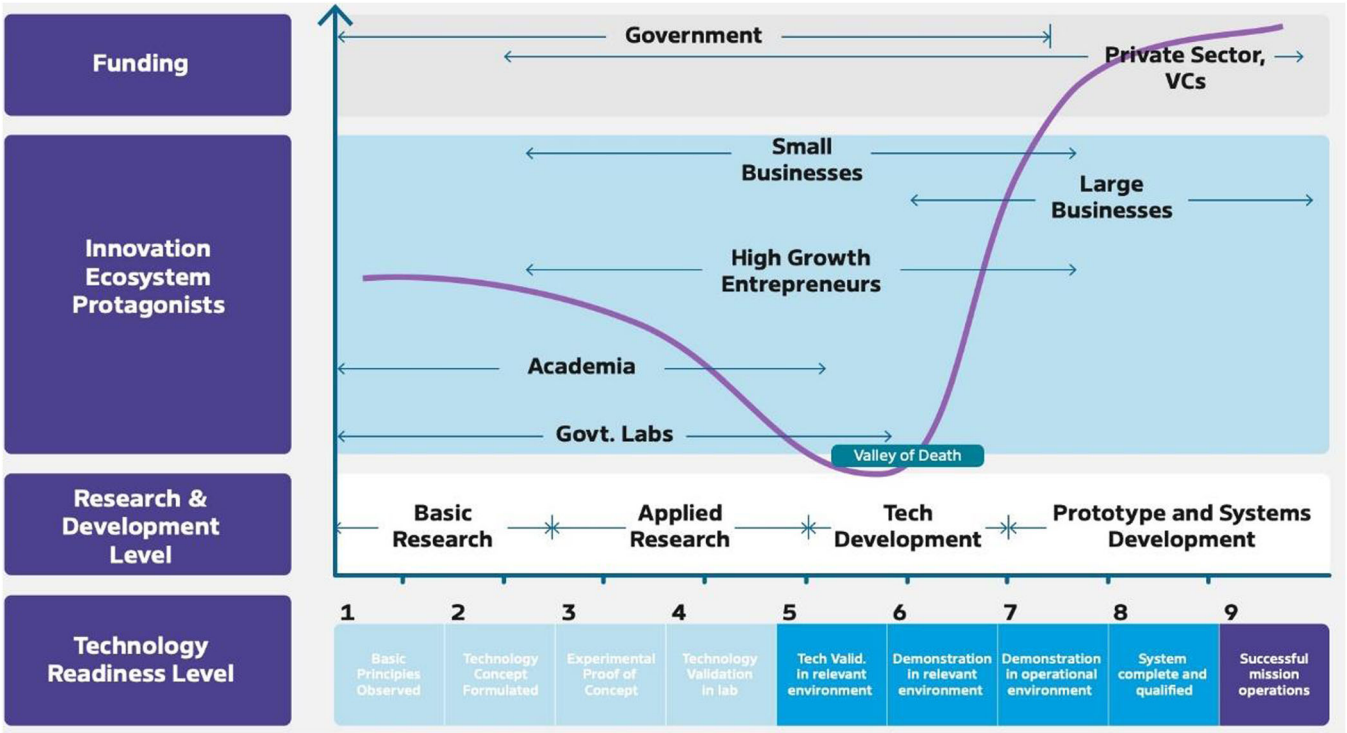

FIGURE 1 The interdependency of funding, players along the innovation chain, and the stages of research and development are usually reflected in the technology readiness level (TLR) of new developments and technologies. The so-called "Valley of Death" presents itself quite often due to a lack of funding, when governmental funding programs stop and these developments are often seen as too risky and unpredictable for private equity. ©DESY, own elaboration based on different sources. Source: Graphic: Own elaboration based on: http://philippleitner.net/technology-readiness-levels-impact-of-science-and-the-valley-of-death/, https://www.pwc.no/en/bridging-the-technological-valley-of-death.html, https://ars.els-cdn.com/content/image/1-s2.0-S2352938521001774-gr1.jpg

transfer, cannot be undervalued. Colleagues with a credible and knowledgeable background in transfer are and will be moving the whole field forward.

Innovation ecosystem

Innovation in the sense of new products or marketable ideas doesn't happen in a vacuum. Innovators need the resources to bring their ideas, inventions, or services to life. That includes funding, time, and—last but not least—workshops or labs, that is, possibilities to prototype, especially when it comes to deep tech. Digital ideas often need less equipment, except for the server power. Next to the infrastructural needs networks provide support, connect and create an information flow, which fosters innovation.

Creating these networks and facilitating knowledge exchange between scientists, founders, and industry representatives promote innovators and thus innovation. Other important aspects are education: start-up programs or accelerators, business school elements for students and scientists from the STEM-fields are just two best practice examples.

[7]ASTP: https://www.astp4kt.eu/

Research institutes and universities are very well suited to act as anchors for these ecosystems, as one important part of the mindset is prevalent in excellent science: precisely calculated risk-taking on the one hand and the desire to push technological boundaries.

Another important factor to establish a thriving innovation ecosystem is to build hubs or networks, where different actors meet: from basic research to applied researchers, industrial R&D. A functioning innovation ecosystem is not discriminating, rather it includes as many actors as possible, explicitly also working with and including small- and medium-sized companies who often don't have the possibilities to invest in research, but are for the Western European economies an important driver for innovation and bringing new products to the market.

ENABLING INNOVATION AND INNOVATORS

Above all driving and facilitating innovation requires courage to leave traditional paths and allow for cross-sectoral cooperation. Broadening the "comfort zone" of basic research might seem frightening at first, but if the bridge between heterogenous actors is strong and silos can be overcome, important disruptive innovations are possible. Systemic solutions cutting across different policy domains and leveraging mission-orientated innovation policy require close collaborations between all participants.

This collaboration will ultimately mean, that not only the willingness and mindset for innovation are there, but that instruments for public–private partnerships to close the gap between basic research and application are easily and readily accessible (Figure 1). The big goal: close or at least minimize the so-called valley of death for innovative products and services or new solutions.

At DESY, we have started this journey, appreciating what we can do best and trying to take it to another level: addressing grand societal challenges by scientific solutions seeking technological means. This includes as well that we invest in innovation and are willing to take risks and accept failures. Because only then we will be able to create and foster disruptive innovation, which we need to address the aforementioned challenges.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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Picture: DESY/Werner Bartsch**Arik Willner-** started his career as a consultant to the executive board at Deutsches Elektronen-Synchrotron DESY after receiving his Ph.D. in Physics from the University of Hamburg. Prior to starting his current position as Chief Technology Officer (CTO), he was a team leader in Business Development. In his role as CTO, he is officially authorized by the directorate for innovation activities since the summer of 2018 (Picture: DESY/Werner Bartsch).

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