News

How universities shape global science through the world and decades

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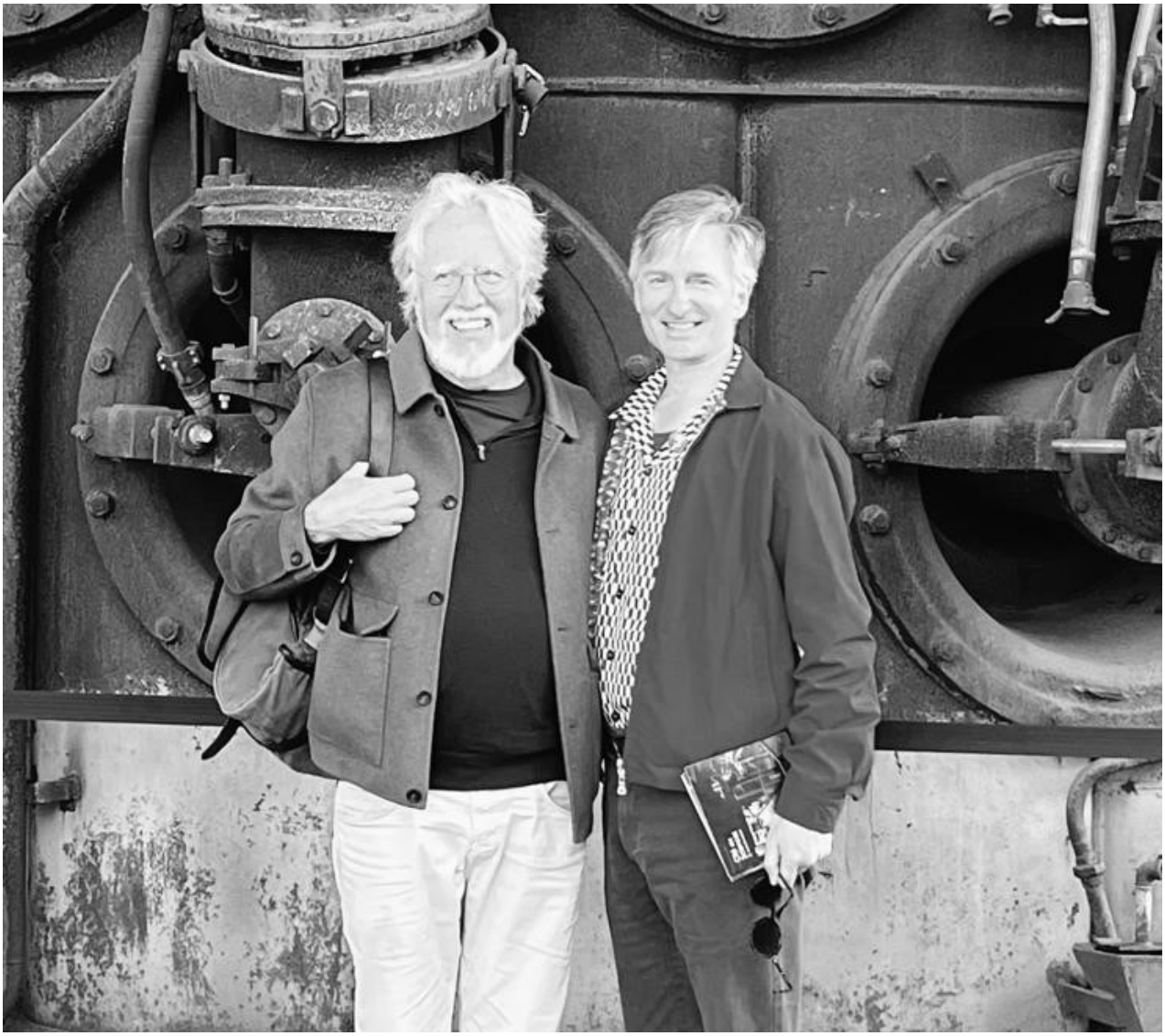
Category

Research

The book *Global Mega-Science: Universities, Research Collaborations, and Knowledge Production,* edited by Profs. Justin JW Powell from the University of Luxembourg David P. Baker from Pennsylvania State University, explores how cutting-edge scientific research, driven by research universities and global collaborations, profoundly shapes our world.

Its relevance is clear: scientific advancements not only yield breakthroughs in medicine, technology, and environmental sustainability but also influence policies that improve public health, education, and social well-being. The book showcases how universities have historically propelled scientific progress, supported by the continuous rise of education. As we face unprecedented global challenges, understanding the evolution of science, and its relationship to education, equips us to harness its transformative potential for a better future.

A review of key findings with authors David P. Baker and Justin J.W. Powell.



Profs. David P. Baker and Justin JW Powell

What do we understand by mega-science, and what are the key take-away notions?

Baker & Powell: Mega-science refers to exponential growth of scientific publications, especially since the mid-20th century as well as massive scientific research projects that require substantial investment and collaboration across multiple institutions and countries. Think of projects like the Large Hadron Collider (CERN) or the Human Genome Project or, as in our book, the astrophysics IceCube Collaborative. These endeavors aim to tackle substantial scientific challenges and push the boundaries of our knowledge and technology.

The key take-aways are the sheer scale of and necessity for international teamwork, the significant and long-term financial and infrastructural investments required, and the profound impact these projects have on scientific advancements

and addressing global issues like climate change and health, such as COVID-19 vaccines, which were developed in record time but on the basis of decades of groundbreaking basic research.

Analysing bibliometric information of over a century of scientific publications brought out a rich map of the journey leading to what we call mega-science. Can you give a rough outlook of this map?

Baker & Powell: Absolutely. We've been able to chart the incredible and sustained growth and evolution of mega-science to become a truly global phenomenon.

Today, nearly all countries have universities devoted to advanced education and cutting-edge research. One of the main findings is the exponential increase in scientific publications, with university-based scientists contributing to 80-90% of more than 3 million articles published per year. We also observed a significant trend towards international and interdisciplinary collaborations. However, there are notable funding disparities, with universities often being underfunded despite their substantial contributions to scientific output.

Which real challenges to global science do you identify, those that institutions and countries should prepare for?

Baker & Powell: There are several real challenges that global science faces today. One major issue is the chronic underfunding of universities, which hampers their research capacity, though luckily in Luxembourg we are able to continue developing our research and teaching programmes.

There's also the increasing global competition for scientific talent and resources, which can create disparities in scientific output and innovation.

> *"Simultaneously, the extraordinary mobility of global talent is crucial for the diffusion of scientific ideas and their intercultural transmission."*

Prof Justin J W POWELL

Full professor

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The University of Luxembourg attracts and trains advanced talent from around the world, significantly providing for the country's high-skill, knowledge-based economy.

Another challenge is the sheer volume and diversity of scientific publications, which makes it difficult to absorb and utilise new knowledge effectively: here, more emphasis on replication, on translation, and on synthesis will be driven by AI tools that are increasingly adept at such tasks. Given its multilinguality and international recruitment, Luxembourg has an advantage in an era of global scientific collaboration.

Public engagement is also crucial; science needs to be more accessible and relevant to the public, necessitating efforts in outreach and communication. Lastly, addressing the scientific capacity of regions with less developed research infrastructure is essential for equitable scientific progress. If collaboration is the key to scientific advance, the networks should be globe-spanning and not only amongst a few countries and scientific communities.

To understand the evolution of science through the world and decades, one has to consider the cultural shift that came with the education revolution. Can you expand on this?

Baker & Powell: Certainly. The evolution of science is deeply intertwined with the cultural shift brought about by the education revolution. The massive expansion of higher education has led to an ever-larger pool of scientists and researchers, which in turn has fueled the growth of scientific knowledge.

The so-called Humboldtian model, which integrates research and teaching in universities, has been adopted and adapted globally, creating environments where education and scientific inquiry thrive together. This revolution has also facilitated the globalisation of science, with more countries investing in higher

education and research, leading to a more interconnected and collaborative scientific community.

Late nineteenth century European universities gave the world the original idea and later took advantage of the collaboration dividend. For example, European universities twice played a pivotal role. First in the late 19th century, supporting the growth of universities that blended teaching and research missions. And then, from 1980 becoming the world's second major hub facilitating global scientific collaborations and, as a region with strong mid-sized and smaller systems, surpassed the United States in publishing scientific research articles.

How are universities going to move forward in this dynamic? How is the balance between education and research going to move?

Baker & Powell: Universities will need to strike a balance between their educational responsibilities and research activities.

This means ensuring that both areas are adequately supported. Public outreach and lifelong learning are becoming increasingly important, as they help modernise skills given continuing and rapid scientific advances. Despite increasing specialisation, science must also strive to become more accessible to a broader audience. Facilitating collaboration between universities and research institutes and increasing overall funding for universities, especially for collaborative research projects (such as numerous research funding instruments in the European Union) can significantly enhance research capacity and innovation of countries, regions, and the world.

Global Mega-Science: Universities, Research Collaborations, and Knowledge Production can be purchased on the Stanford University Press website.

Buy the book

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