Excellence and the new social contract for science

In search for scientific excellence in a changing environment

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“On the wisdom with which we bring science to bear against the problems of the coming years depends in large measure our future...”

[1] Vannevar Bush, 1945

The notion of “scientific excellence” has entered the vocabulary of scientists and funders and has embedded itself in the language of evaluation guidelines as part of a broader discourse about the new “social contract” for science. While excellence in science should be nurtured and rewarded, and while structures and practices that support excellence are important, the questions of what we mean by “scientific excellence” and how we can measure it remain open. The trend, at least in Europe, seems to be to apply “objective” numerical measures—that is, scientometrics—to identify excellence. However, the blind use of scientometrics could compromise scientific development if it is only used to apply an ill-fitting measure to what is an elusive concept.

It is interesting to note that this trend towards scientometrics and the quantification of scientific performance has not become *de rigueur* among some of the major scientific powers, most notably the USA. Our increasing immersion into quantification of scientific performance has also not been embraced by everyone; the San Francisco Declaration on Research Assessment (DORA) asserts that “It is imperative that scientific output is measured accurately and wisely” (<http://www.ascb.org/dora-old/files/>

SFDeclarationFINAL.pdf), and that using journal metrics as shorthand for the scientific quality of individual papers or their authors is not appropriate. The signatories of DORA—scientists, funding agencies, scholarly organizations and journals—also reinforced the strongly held belief that peer review is the only system that can properly evaluate research scientists, projects and institutions.

At the core of peer review is the careful analysis of individual scientists and their work to understand the nature and significance of their contribution. It is a process that cannot be reduced to simple numbers or metrics that, without knowing the proper context, fail to provide an accurate picture of reality. In fact, many ground-breaking observations that later gave rise to Noble prizes were not originally reported in top-ranking journals—as a proxy measure of excellence—such as the ubiquitin-dependent proteolysis system discovered by Aaron Ciechanover [2].

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Moreover, the recent rise in retractions of publications cannot solely be accounted for by an increase in scientific publications. While there are no clearly identifiable causes, it seems reasonable to suppose that

the increasing competition and pressure to publish in high-impact journals must be a contributing factor [3]. The recent highly publicized *Nature* papers from the RIKEN institute in Japan [4,5] took everyone by surprise when the work on stem cell reprogramming could not be reproduced, and the papers were eventually retracted. It highlights the peril of allowing high-pressure environments and the “be first or fail” culture of research publications to usurp the careful conduct and review of scientific research. The blind application of scientometrics and belief in its results, or the prestige of the journal in which a paper is published, are therefore by no means guarantees of scientific excellence.

As mentioned above, these developments are taking place in the context of a “new social contract for science” that aims to overhaul the basic premise of why nations invest into scientific research. Since the European Enlightenment of the seventeenth and eighteenth centuries, scientists have devoted much of their energy and efforts to the pursuit of knowledge—sometimes driven by a motivation to understand natural phenomena, sometimes driven by society’s needs, but always with the aim of finding answers to pertinent questions. Many of today’s young scientists still take on one project after another, sometimes with great personal investment, looking for that “Eureka!” moment when an experiment succeeds and reveals another bit of knowledge. As Vannevar Bush, the head of the US Office of Scientific Research and Development during World War II put it so eloquently: science’s mission is to explore

“the endless frontier” [1]. As such, technology, applications and other societal benefits should follow automatically from this endeavour. Has this somewhat romantic view of science changed in recent years, and if so, what challenges are we facing and where are we heading in terms of scientific excellence?

It is becoming clear that the new social contract for science is changing the relationship between society and science. David Demeritt, Professor of Geography at King's College, London, UK, has written critically about some of the ideas that now populate the discussion of the value of science to society and the recent changes in policy that aim to make research more publicly accountable and relevant. He notes that “the relationship between public sector funding bodies, academic researchers and the wider public is

being reorganized in terms of **customer-contractor relations**” and concludes that “Fetishizing the outcomes of research, in terms of new findings and results, the new social contract for science favors those ways of practicing science most likely to generate immediate commercial and economic benefits and discounts other reasons for engaging in academic inquiry and conversation” [6]. These changes, he argues, are designed to make academic research more responsive “to the demands of research customers in government and industry”. The new social contract is therefore not only changing the nature of the scientific enterprise itself, but is also revising how we define the social value of science: research projects are becoming customer-contractor relations in which funding agencies play the role of paying customers on behalf of the public. An example is the

EU's new Horizon 2020 EU Framework Programme for Research and Innovation, which states on its webpage that: “It promises more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market” (<http://ec.europa.eu/programmes/horizon2020/>). While this model to commercialize science can be effective in some circumstances, it is not clear whether it will always deliver more or better results to make social progress. Indeed, it poses three major challenges to the future of the scientific endeavour: it requires that the scientific research agenda be aligned explicitly with societal problems, concerns and preferences; it requires that investment into science lead reliably to technical innovations within a short time frame; and it calls for the increasing use of scientific expertise in societal decision-making.

What are the consequences of these changes and challenges for scientific research and excellence? History is littered with examples when science was hitched to the fulfilment of societal wishes, beliefs and ideology. The results were not particularly pleasant, neither for science nor for society. The period of Lysenkoism in the Soviet Union from the 1930s to the 1960s held Soviet biological science back by decades and led to the execution of leading Soviet geneticists. In the 1980s, the USA banned fatty acid-rich tropical oils based on the unfounded premise that such oils increase the risk of coronary heart disease. The same advocacy groups later campaigned to ban hydrogenated vegetable oils, which replaced tropical oils and which contain higher amounts of *trans* fatty acids that actually increase the risk of arteriosclerosis much more than tropical oils [7].

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Given that we ought to learn from the past, it seems risky to once again try to align scientific research with societal expectations to the detriment of science’s prime mission of discovery. Therefore, the questions of which societal problems can be turned into well-defined and achievable scientific goals, and when and how these can be delivered, should be a matter for debate among the various actors who know realistically what is achievable and in what time frame. On the other hand, it could also be argued that because virtually all scientific research elevates our understanding of human nature and of the natural world, the relevance for society from any scientific project is fundamentally at a higher level than simple, practical applications. Even then, it is still just a matter of time until nearly all knowledge becomes useful and can be applied to new technologies: innovation is well entrenched in scientific practice.

Another lesson from history is that much of our understanding of nature and new technologies were unexpected, which means

that we must keep looking for the unexpected to create the conditions for discovery. Helga Nowotny, the former President of the European Research Council, said in a recent lecture at the Central European University in Budapest: “The beauty of science is that it constantly plays with uncertainty. What the scientist is really trying to do is to discover something that he or she is not looking for, but is clever enough to recognize its importance when it appears” (<https://www.youtube.com/watch?v=4vQd3pdH8tM>). While the public likes certainties and turns to science for answers and the truth, science thrives in uncertainty.

Can we expect that investments into science should generate technical innovations in the short term? It is clear that the answer to this question has to be “no”: it is simply impossible to turn every scientific advance into technological innovation because the requirements of discovery or innovation are different and sometimes even opposite. Instead, we should heed the idea that inspired some of the world’s strongest economies for more than 50 years, eloquently described by Bush in 1945: “Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn [...] Today, it is truer than ever that basic research is the pacemaker of technological progress [...]” [1].

We must also consider the role of our leading characters in this play: What about scientists? Can a single scientist be expected to simultaneously drive scientific discoveries, identify their potential commercial use, manage a laboratory, teach students, apply for grants and contribute to peer review? I do not think it is possible or even realistic to expect that scientists can do all these things single-handedly—each one of these tasks has its own requirements for time and expertise. With this in mind, how much of the endeavour of an individual scientist should be recruited to directly solving societal problems? The answer to this question requires input from society, scientists and industry, since all these stakeholders are involved in the equation that we are trying to solve.

Finally, one might ask what is the role of scientists in decision-making? I think that if the inclusion of expertise in decision-making were done on a regular basis involving the natural and physical sciences, the arts,

humanities and the social sciences, maybe we would be in a somewhat different position. However, there is a risk that the voice of science in particular tends to be lost in a sea of arguments and counter arguments, expertise and opinion. Nevertheless, scientists are conscious of their role as informed citizens and are willing to contribute to the identification and study of societal problems to find solutions.

So what about the role of excellence in the new social context of science? How do we integrate these challenges with scientific excellence, merit, individual freedom and the need to create and maintain institutions and processes that foster excellence? Does fair competition always lead to excellence and can excellence reinforce itself in some sort of virtuous cycle? While the fundamental answer is probably yes, reality has many nuances. Many outstanding scientists are lost in the process, and many others fade away when their star no longer shines. While the identification of existing excellence can be accomplished with some common sense, it is much more difficult to predict whether any given excellent scientist will solve a societal problem, carry out technology transfer and contribute towards public policy in future. In any case, excellent scientists are only a relatively small minority at the tip of a pyramid, which is supported by a broad base of competent scientists. The larger the base, the stronger the pyramid and the more successful the top group will be; a success that will eventually benefit all who are involved in the construction and maintenance of the pyramid.

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Which brings us back to the question: How do we measure excellence? What parameters can be applied to predict from past performance whether excellence will appear, be maintained or eventually disappear? In this context, an important question would be excellence for what? To push the frontiers of scientific discoveries and develop new conceptual frameworks that

allow a better understanding of the world and of human nature? To push technology so that solutions to practical problems can be developed, tested and implemented? To identify the market opportunities of a particular technology or idea? To train the next generation of scientists? There is not just one excellence, there are many different types of excellence for the many different parts of the scientific ecosystem. In order for the overall project to succeed, all the individual areas have to perform at the highest level, and the individual players have to be allowed to play to their talents.

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A culture of fostering excellence, which has now permeated science, was absolutely necessary to break away from old habits and overcome the complacency that restrained the old system. However, what about those at the other levels of the pyramid? How do we appreciate and support individual scientists and institutions in countries that are not yet “established” research-based economies? What about gender equality to give women a fair chance of making it to leading positions? What about people with unusual biographies or unconventional career paths? In other words, how can we ensure social inclusion and cohesiveness while at the same time support and foster excellence?

The base from which top research institutes recruit their scientists is the entire scientific enterprise, and without it, these institutions would struggle to secure their most valuable asset: human talent. Excellence can be achieved by many

scientists who work hard enough, and by institutions that find ways to foster it. Yet, it is also a dynamic state that can slip away easily if it is not supported and maintained. We need to develop ways to create diversity in order to maintain a continuous flux of motivated and committed scientists; otherwise, the base will dwindle and no longer be able to support the institutions at the top. All who do not reach excellence but still work hard and contribute to it deserve our respect.

In a country like Portugal, where the publicly funded infrastructure for research and technological innovation is relatively new, excellence was interpreted as a long-term goal of a process that took more than 20 years. However, recent years of “excellence-focused” science policy-making are threatening the sustainability of the system. A severe reduction in the number of PhD and postdoctoral scholarships, followed by irregular calls for funding projects and a systematic disinvestment into research, has made it extremely hard for the majority of Portuguese research institutions to achieve excellence, even if they now produce very good and solid science in many fields. At our institute, we have reached some modest level of excellence, but it took us 18 years and a long-term commitment to support scientists by developing and strengthening the infrastructure needed. This success is now being threatened if the new social contract for science focuses only on short-term results at the expense of scientific excellence.

In concluding, I would like to stress three points: first, we must take a close look at what we mean by excellence, how this concept conditions our choices, and whether these choices will favour merit and contribute towards scientific progress; second, we must openly discuss the new social contract for science, its implications and assumptions, and how it is implemented, so that creativity does not suffer but is instead fostered to promote further social progress; third, we

must harmonize the pursuit of excellence with social cohesiveness, inclusion and diversity, which will be essential for the development of new and unexpected solutions to social problems.

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Conflict of interest

The author declares that he has no conflict of interest.

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