

The Role of the State in the Funding and Shaping of Science

How Big Science Created a New Model for Private Research

The debate on whether science should be funded and secured by the State or shaped by private foundations and institutions is not at all new. However, public dispute on this topic emerged again at the dawn of the 21st century, triggered by the decoding of the human genome accomplished by Craig Venter and his corporation Celera Genomics, during which the public and nationally (mostly through the National Institutes of Health) funded Human Genome Project was also pursuing the same goal. This controversy was thoroughly reported in the article *The Genome Warrior* by Richard Preston, in which he tracks the tensions and discomfort that Celera caused among the scientific community where Venter had many enemies (including the Nobel prize laureate James Watson) and was seen as an “idiot” and an “egomaniac” (Preston, p. 66). Well beyond the genes, what was troublesome about Celera is that it became an integration of science and business – as Venter himself puts it, “Celera is more than a scientific experiment; it’s a business experiment” (Preston, p. 81)

The Preston piece thus brings us to the question: is Celera an unprecedented model of scientific research? In this essay I will study this question by placing it into a historical context and seeing how the funding and the pursuits of science have evolved together through time. I will focus on three historical moments to study the development of the methods and motivations behind scientific inquiry along with its type of funding: The

Royal Society of London and Francis Bacon, the Industrial Revolution in Britain and Germany, and the rise of Big Science and post-war research policies in the United States.

One of the main figures who analyzed scientific knowledge and its funding was Francis Bacon in 16th century England. Bacon, who hugely influenced the creation and the values of the Royal Society of London, claimed in his book *The Advancement of Learning* that science is a public good that ought to be funded by the State in order to ensure scientific progress and discovery. However, his arguments did not exactly portray a “pure” scientific pursuit – discovering for the sake of intellectual discovery – but rather followed the so-called linear argument. To Bacon, funding pure science led to technological improvements which in turn led to wealth, power, and strength for the Nation. These ideas hugely influenced the formation of the Royal Society of London in 1660, whose doctrines were transmitted by Thomas Sprat. As described by Sprat, the Royal Society was a public body formed by “free and unconfined” gentleman (Sprat, p. 3) supporting basic research, which reflects Bacon’s understanding of independent science, because “knowledge still degenerates to consult present profit too soon” (Sprat, p. 3). The Royal Society also subscribed to Bacon’s idea that scientific research would ultimately strengthen the Nation, as Sprat mentions several times the benefits that their organization would have for the English Nation. In conclusion, the Royal Society and Francis Bacon supported a State-funded model for basic scientific research which followed the linear model.

Nonetheless, this linear interaction between science and industry was critically challenged in Britain during the Industrial Revolution, and the industrialization of the country raised many questions about the relationship between scientific progress and technological inventions. 19th century Britain and Germany witnessed how major scientific inventions and discoveries took place in the textile industries and breweries

rather than in academia or in scientific institutions (Bowler and Morus). The efficacy of the industry as the framework and motivation for scientific progress during that period is unequivocal – Joule, Watt, Carnot, Helmholtz, and countless others made significant scientific discoveries in this industrial setting, especially in the topic of conservation of energy. However, it is clear that this type of science and the motivation behind it is significantly different than that of the Royal Society: first, it was *not* State funded and independent from the government, and second, it was exceedingly motivated by profit. As Helmholtz describes in one of his lectures, the strong interest that many scientists had at the time building a perpetual motion machine was to “produce work inexhaustibly”, and thus “fabricate money out of nothing” (Helmholtz, p. 3). Therefore, the role that physics played in the Industrial Revolution shows a shift in the conception of scientific knowledge, motivations, and its relationship to the State and the industry.

In the middle of the 20th century, the world saw a new transformation in the conception and development of science with the making of the atomic bomb during the Second World War. Known as the rise of *Big Science*, an unprecedented integration of the science and the State took place in the US during the construction of the bomb, which caused the emergence of the State as the main patron of science (Kevles). Los Alamos project distinctly contrasted with the research of the Royal Society and of the Industrial era – not only was it State funded, but it was essentially unified with the government and its guidelines and targets during the war. When the worldwide conflict was over, the American engineer Vannevar Bush (who had been a major figure in this big national scientific organization during the war) actively worked in ensuring that the State would continue to fund scientific research. In 1945, Bush wrote a report to President Roosevelt entitled *Science, the Endless Frontier*, to advise him on the post-war scientific policies that he believed the United States ought to follow. Bush advocated for the creation of the

National Science Foundation to support basic and applied scientific research and freedom of inquiry. Following our historical study, we realize that Bush's proposal has many arguments in common with Francis Bacon and with the spirit of the Royal Society: the linear model (emphasis on basic research so that it can be later applied), the emphasis of freedom of pursuit of the scientist, and the importance of science towards the Nation's strength and power in relation to the rest of the world. However, it differs from the Royal Society in other aspects, mainly those related to the Big Science model which settled in the US after the war, as it is reflected in the Moon Landing in 1969 during the Cold War and in the Human Genome Project, among other main scientific developments. Therefore, although Bush's idea of the NSF shared many points in common with Francis Bacon's conception of science, the role that the State played in its shaping and conception was extraordinarily higher.

The post-war research policies and the appearance of Big Science in the scientific paradigm bring us back to our initial topic that generated this discussion: Craig Venter and Celera genomics. We again ask the question that we posed in the introduction: is Celera an unprecedented model of scientific research? After reviewing several historical moments, we argue that the answer is yes. This is not because Celera is privately funded and driven for profit. Indeed, we have seen how scientific pursuit simply for the sake of intellectual discovery has not quite been the case throughout history. Even in the arguments of Francis Bacon in defense of pure science, he set ultimate profitable goals for research such as the power and wealth of the Nation. There are many examples that show how basic science was also used for commerce and profit, such as the so-called Garden of Global Commerce owned by Carl Linnaeus (described by Koerner as "the garden as a miniature mercantile empire within a European state") or the trading endeavors of the Dutch East India Company. In this essay we saw an even more

unequivocal example of science for the sake of profit: the scientific discoveries that occurred during the Industrial Revolution, which were very clearly ignited by a desire to improve efficiency and profit in the industrial setting.

But Celera is much more than research for profit: it is a new model because it is an unprecedented integration of science and business, which can be understood as the parallel of Big Science in the private setting. It is not only the case that Celera intends to use its research findings to generate profit, but rather that the entire institution is plainly a corporate firm that behaves like any other in the New York Stock Exchange. Craig Venter is thus dangerously reshaping and redefining research institutions into a new model that raises many concerns and ethical dilemmas. If we examine it closely, we see that in fact Celera shares many similarities with the Big Science model: huge impact on society, ambitious and very influential research objectives, a large and massively organized group of scientists, and famous and influential scientific personae (not only within Celera – this model is rapidly spreading with the appearance of figures such as Mark Zuckerberg or Elon Musk). However, it does all of this *completely separately from the State*. Celera is the integration of science and business in the same way Big Science is the integration of science and the State. As noted above, these models of scientific and technological discovery consisting of highly influential and monopolies, with no regulation from the State, and that have a huge amount of power over people's lives – in short, what I identify as *Private Big Science* – have become increasingly popular all around the world. Private Big Science is particularly noticeable in areas like computer science, engineering, and the pharmaceutical industry with companies such as Facebook, Google, SpaceX, Pfizer and many others.

This is why we conclude that while private funding of science does stimulate the process of scientific discovery, the presence of State funding and public support of science is imperative. In the recent rise of companies such as Celera, which merge business and science in an unprecedented way, we see a new scientific model that combines the profit-driven character of the Industrial Revolution with the structure of Big Science, but without the State. This type of science is insufficient in a society that recognizes the importance of research that is not necessarily profitable and the essential need for transparency and accountability in scientific research. Private Big Science is threatening precisely because it is big, and thus has great power in our daily lives. While the existence of Private Big Science is not detrimental to scientific progress, the State must continue to fund scientific research in order to ensure that science continues to be transparent, accessible, and beneficial to society.

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