Einstein Rewired

Peter Galison, Einstein's Clocks, Poincaré's Maps. Empires of Time (New York / London: Norton, 2003)

By Antonio Lafuente[*]

The Muses always catch you when you are at work, say those who see no incongruity between genius and perseverance. But Peter Galison, accustomed as he is to shunning clichés and to dealing with heavyweight scholars, would say that this expression is confused and conformist, unless we go deeper into the meaning of the word work. For Galison, professor of physics and history of science at Harvard, the Muses must be scared off by contemplative, antisocial, and technophobic attitudes, since what they find when they come to the aid of a scientist, says this historian, is somebody manipulating things, tinkering with objects, moving terms around, negotiating meanings and plugging in apparatus.

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The process of thinking, no doubt, is more manual than cerebral, and always involves a host of professional gadgets, from tabulations and computers to formulae, instruments and libraries. Our histories, however, still insist on describing science and culture as a battle of words, a sort of seepage from the brain and devoid of all the accessories which form the ecosystem of the scientist. It is not that there are few references to machines, for they account for a large part of the time spent on an activity which is of an experimental nature; but rather that laboratory life has completely disappeared. Scientists are often regarded as writers, people who publish things, although their writings have very rarely been analyzed in terms of rhetorical artifacts: after all, their texts are the translation into word and language of what has been done with the hands and visualized by way of machines.

The fact is that Peter Galison sees things in a different way, and to demonstrate it he has chosen the most difficult of all cases: Einstein, the best-known scientist of all time, the most prodigious human mind. Indeed, Einstein's brain is still a cult object. Many think it is incredible that once again others are trying to find a direct relationship between morphology and intelligence.[1] But after applying the most sophisticated analytical techniques, a couple of very extraordinary peculiarities have been discovered in his parietal lobes. Steven Pinker, a well-known neurologist from the Massachusetts Institute of Technology was delighted, and

[1] S.F Witelson, D.L Kigar and T. Harvey, "The Exceptional Brain of Albert Einstein", *The Lancet*, 1999, *353*:2149-2153.

announced his delight to the world in a series of well-turned phrases: "Still, it is strangely fitting that the brain that unified the fundamental categories of existence — space and time, matter and energy, gravity and motion — should now be helping us unify the last great dichotomy in the conceptual cosmos, matter and mind."[2] And if we can do such exquisite physiological things with his brain, why not take advantage of his name to get into the politics of science? Lee Smolin, an expert on quantum gravity at the Perimeter Institute for Theoretical Physics (Waterloo, Ontario), has just joined in the commemoration of the centenary of Einstein's "Miracle Year" with the question Why No "New Einstein"? [3] in the influential journal Physics Today. Irrespective of the answer to this question, the point is that anything referring to Einstein acquires this aura of mysterious genius, the mystique surrounding a solitary disinterested scholar, whose every movement is to satisfy his innate curiosity and to work towards the public good. Smolin's article is excellent. He begins by stating that, while great discoveries come from independent minds, like Einstein's, our system has evolved in the opposite direction to what is most appropriate. It is not only incapable of harnessing what little revolutionary drive may still exist, but it is threatening the existence of the necessary spirit of criticism: Einstein

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[2] Steven Pinker, "His Brain Measured Up", *The New York Times* (June 24, 1999), http://pinker.wjh.harvard.edu/articles/media/1999_06_24_newyorktimes.html

[3] Lee Smolin, "Why No 'New Einstein'?" *Physics Today*, 2005, *58*:56-57 This text, which is being hotly discussed, is freely available on various blogs, such as http://waltf007.mindsay.com/

would be impossible in a world where scientists are squeezed by the pincer movement of pressure for research into practical subjects, and the obligation to publish in influential journals. The consequence, according to Smolin and the many other scientists who are singing the Big Science "blues", is that democracy itself is in jeopardy. Not only are the creativity and independence of researchers being cut back, but we are seeing the liquidation of the old ideals which made science, according to Merton, into a disinterested, community-oriented, cosmopolitan and skeptical undertaking.

But Galison does not agree. The question is wrong because it is redolent of that ideology which has always contributed to the construction of the myth of old-fashioned science, a science tucked away into small spaces, protected from the public gaze, buttressed by brilliant minds, made up of paradigms without frontiers, and where money, machines, public, administrations, publishers and ministers were only incidental matters, secondary actors, mere props in a theatre blazing with concepts, theorems, crucial experiments and Nobel prizes.

Science, says Galison, should be put into a new context. The history of scientific ideas, together with the frame surrounding them (a bit of institutional history, dressed up with dashes of politics, philosophy and prosopography), ignores what is decisive and gives substance to what is purely anecdotal or even traditional. What Galison has done is to document himself better than his predecessors and then not to reject any facts. Thus he has taken seriously some of the circumstances of Einstein's life which hitherto have received no academic attention: for example, the importance of forming part of a family involved in the development of electrical equipment. It was very important for Galison to have a grandfather who had worked with Edison, and who had an experimental workshop at home which would be the envy of any handyman of the time or any nerd of today[4]. It would be wrong to think that Einstein was not happy while he worked in the Patent Office in Bern where, by the way, he spent between 10 and 12 hours a day, six days a week. And, what is most important, it would be a great mistake to think that his work with electromagnetic devices, watches and dynamos was purely a way of making a living and contributed nothing to his concerns as a theoretical physicist.

Clocks in about 1900 were what computers are today. The synchronization of clocks at that time was a task with as much technical, philosophical and political importance as interconnecting PCs and designing communication protocols and distributed calculations are now. Strange though it may seem, this was really the case. And nothing shows this better than a look at another key figure of the science of the time, a polytechnicien, in other words, a product of the École Polytechnique of Paris, the emblematic institution of French republicanism whose engineers were something between the pupils of the MIT and the students of West Point. We refer to Poincaré, the most popular and most prestigious scientist in France, a character as decisive for the development of the

[4] "Einstein and Poincaré: A Talk with Peter Galison", http://www.edge.org/3rd_culture/galison03/galison_p3.html

Theory of Relativity as he was a key figure in the process of techno-scientific consolidation in the French empire. The point which makes this book such an exceptional work is that it manages to connect one case with the other: for Poincaré did not pass into the history of relativity in spite of his responsibilities for the mapmaking of the colonies in the Bureau de Longitudes, but precisely because of them. And the same may be said of Einstein, for it was his work with those devices for measuring time which taught him to treat it as a purely technical excrescence.

In order to make maps you have to know the longitude of the places which are to be connected topographically. To draw them on the map you have to compare the differrence between two times, local and distant: one, for instance, in Senegal and the other in Paris, the capital of the Empire through which the reference meridian would obviously pass. The first is obtained by in situ observation of some astronomical phenomenon, and the second from a distance, when a signal transmitting the time from Paris arrives in Dakar. The precision of maps, consequently, depends on the quality of the transmissions, first using the telegraph wires and then undersea cables. The organization of the railways also posed problems of coordination, for signals were not instantaneous and they took a certain amount of time to cover distances. For engineers, the notion of local time was absurd and, rallying to the cause of efficiency, they imposed the dictum that a country should choose not only a metric system but also a national time. In short, to find out the time, city dwellers, priests, engine drivers and mapmakers stopped looking at the sky and began to consult the clocks installed in the cities, including those installed in many palace towers and belfries. Bern inaugurated its system of time synchronization in 1890, and it would have been an insensitive person indeed who would fail to be impressed by the spectacle of the hands of all of those clocks moving together, never missing a step. Precision was laudable, but the most important thing was coordination. This book is peppered with fascinating stories. In 1883, for example, the division of the United States into time zones was imposed. Each zone was exactly an hour different from its neighbor. The agreement was reached "railocratically", for each delegate voted according to the number of miles of railroad track he represented, and the result was thus 79,041 miles to 1,714. Our modern, and now century-old, habit of seeing the second hands in Ferrol, Marseilles and Naples all moving in unison not only reflects the conventional nature of time but also the technological challenge called for to maintain time — that is to say, our world.

Local time, as we can see, was a tricky subject not only technically but also theoretically. Lorentz, the greatest living physicist of his time, was the first to observe that the equations of electromagnetism would be much simplified if they were not referred to a fixed external frame (the ether, which ensured the metaphysical validity of absolute time and space), but to another, linked to the movement of the system. And so it was that he introduced the notion of local time, a sort of mathematical device with no basis in fact: it could be deduced but not measured. But Poincaré, who had already simplified these metaphysical questions by translating them into technical problems, resolved the problem in

1900 by showing that time changed according to the velocity of the reference frame. The consequence was clear: Lorentz had not invented a fiction, but had unwittingly discovered the relativity of time and space. After all, absolute space and absolute time, like Euclidian geometry itself, “did not exist”, said Poincaré, “before mechanics, any more than the French language logically existed before the truths we express in French”.

Local time was as real as the theory of the ether was unpredictable. Down with absolutes! Poincaré knew it before Einstein, but fell short of the mark by not rejecting the theory of the ether, that fluid which for centuries was said to be necessary for the transmission of light rays (like water for waves, or air for sound). Einstein was younger, and refuted the need for this intangible fluid; in exchange he proposed two new laws which changed our way of looking at the world: that of the constant speed of light, and that of the invariability of the laws of physics. Both of them would hold true in all frames, no matter what their velocity or their motion. The theory of relativity, as we can see, should really have been called the Invariantentheorie, and Einstein himself several times requested that this name be used. However the media opted overwhelmingly for a name which helped them to understand the direction in which the other vanguards of the early twentieth century were heading (and the crises they would face!).

Let me borrow a metaphor that Galison frequently uses to explain what he is trying to do. In Paris, the Place de l’Étoile is not in Avenue Foch, nor in the Avenue Victor-Hugo: it is precisely the intersection which makes it into a city landmark. The same applies to Relativity, which appeared to be on the crossroads of powerful technological traditions, ancient metaphysical enigmas and unexpected problems of physics. Relativity, contrary to popular opinion, was not the work of one isolated genius, nor was it born in any out-of-the-way location (technologically, culturally or economically speaking). Einstein was right at the centre of science at the time. His greatness is not to be found in his brain, but it comes from his strategic position in the network. This is the reason I have called this review "Rewired Einstein", because it puts him into a new context, showing him as the focal point of a network of interchanges, and as someone who thoroughly enjoyed playing with cables and artifacts. But it also shows him as a person able, like Poincaré, to site himself right at the intersection of many disciplines, whose traditions, protocols, instruments and sources of authority were immeasurably huge. Who could foresee then, in about 1900, that the booming business of selling electrosimultaneity would join forces with that of the railways and of colonialism, to interweave with the dilemmas of Lorentz, the duties of Poincaré and the verdicts of Einstein, and jointly give birth to Relativity?

The subject has always concerned Galison: the "disunity of science", the need to explore the border areas (trading or Creole zones, he calls them) between different disciplines. He has already done it in his previous two works, How Experiments End (Chicago University Press, 1987) and Image and Logic: A Material Culture of Microphysics (Chicago University Press, 1997). In the first, all of 18 years ago, he was interested in the problem of how scientists, with their sophisticated artifacts, know that they are producing facts and not mere artificial effects, and also how they know that they have enough facts, in other words one or more proofs. To put it another way, he was concerned with the way material machines (made of nuts and bolts, cables and glass) interact with theories and concepts. The second book followed up these concerns and dealt with the development of subatomic physics linked to the two generic types of machines (or instruments) each designed to produce differrent types of image (or representations or simulations): analog, like the bubble chamber or the techniques of nuclear emulsion, and logical which, like the Geiger counter, give us an image made of figures which count impulses. The message of all three books is the same: there is a great deal of technology behind every theory and, of course many concepts spring into motion every time we turn a little wheel or press a button. To separate science from the technologies which produce it, to opt for the history of ideas, is to condemn the discipline to a spiral of idealization which is as common as it is destructive. Worse still, to separate our ideas from the machines with which we produce them and realize them is tantamount to refusing to understand how the world in which we live was created. The last two lines of the book say it forcefully: “We find metaphysics in machines, and machines in metaphysics. Modernity, just in time.”