Perspectives

Temporality of Empires: Reading *Einstein's Clocks, Poincaré's Maps: Empires of Time*

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Anyone hard-wired to be suspicious of any rendition of facts that seems overly coherent might feel guilty of enjoying this book by the renowned historian of science, Peter Galison, which is a neat narrative about a medley of incidents and a range of historical figures but which is also, to say the least, a fascinating read. If one could put on hold that suspicion, however, it would prove worthwhile as the overarching argument of the book is bold and thought-provocative.

In a nutshell, the book gives an account of the infrastructure, discourse networks, and institutional practices making possible or facilitating Albert Einstein's thinking of the relativity problem. The book is not intended to show how the young genius came up with the idea of relativity theoretically and how the physics community came to receive it. Rather, it seeks to show those nineteenth-century scientific and technological developments that were leading to the material conditions helping to foster Einstein's conceptualization of relativity, among them the most critical one being the measurement and unification of time.

The book begins with an explication of Einstein's 1905 paper, "On the Electrodynamics of Moving Bodies." This is the paper in which Einstein would introduce his groundbreaking notion of special relativity, overturning one of the foundations—or *the* foundation—of modern physics, Newton's idea of absolute time and absolute space. On one crucial point in the paper where Einstein attempts to explain relativity through the question of time, he uses the synchronization of clocks as an example:

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> If we wish to describe the *motion* of a material point, we give the values of its co-ordinates as functions of the time. Now we must bear carefully in mind that a mathematical description of this kind has no physical meaning unless we are quite clear as to what we understand by "time." We have to take into account that all our judgments in which time plays a part are always judgments of *simultaneous events*. If, for instance, I say, "That train arrives here at 7 o'clock," I mean something like this: "The pointing of the small hand of my watch to 7 and the arrival of the train are simultaneous events." (Einstein)[1]

In other words, Einstein believes that the real problem we need to unpack is time and that the question of time boils down to the question of simultaneity, which in turn could be illustrated by the coordination of clocks.

Einstein would criticize the then-prevailing understanding of simultaneity: the master clock would send a signal to other clocks, and these other clocks would set their times when the signal arrives (see Galison, *Empires* 20-21 for useful illustrations). Einstein says this is mistaken because in this model the secondary clocks are each located at a different distance from the central clock. The correct model, he contends, should be one in which the secondary clocks set their time not to the time of the master clock, but to the time of the master clock *plus* the time it takes for the signal to travel the distance from the master clock to each of the secondary clocks. This way, it does not matter which clock is designated as the master clock (Galison, *Empires* 14-22).

Premised on this reasoning process in Einstein's paper, Galison ventures to argue that the development in science and technology in the nineteenth century eventually leading to the standardization of time around the globe very likely might have furnished the material conditions for Einstein's theoretical thinking. Specifically, Galison refers to the reform of train schedules taking place in many countries (making time zones convenient for train passengers), the agreement on designating the Greenwich meridian as the prime meridian, and the universalization of time zones in the world—and these are only some of the numerous institutional efforts to standardize things in the nineteenth century.

According to Galison, the inspiration came to him when one day he was waiting for the train at a railway station in a north-European city, where he noticed several clocks on the wall all keeping the same time, all perfectly coordinated. Galison says it dawned on him right there that Einstein might have been

[1] The edition cited is prepared by John Walker, founder of the website *Fourmilab*, based on the English translation of Einstein's original 1905 paper which appeared in *The Principle of Relativity*, published by Methuen in 1923.

inspired in the same way. Without much hard facts at hand, Galison set out to argue for a technically-minded Einstein with the following circumstantial evidence:

1) When Einstein wrote his relativity paper, he was working as a full-time clerk in the Swiss Patent Office, six days a week. Galison, having poked into the archives of the Patent Office, found evidence about an immense industry in coordinating clocks at the turn of the century. These inventions would pass through the Patent Office, so it is fair to say that Einstein was well-informed of the newest time-synchronization technology.
2) The Patent Office was located in Bern, across the street from the train station where synchronized clocks were physically visible.
3) Switzerland had been the capital of clockmakers.
4) Einstein's father and uncle ran an electro-technical business and acquired quite a few patents on electrical clocks and measuring devices such as meters that measure the consumption of electricity.

Based on these facts, Galison suggests that the actual practice of synchronizing clocks might have been on Einstein's mind when he was pondering the relativity question.

By 1905, the world had pretty much agreed on how to live on uniform time. Before that could happen, however, the midcentury witnessed a series of debates and competition among different sectors in a country, among nations, and among fields of science—in other words, within and among various political and institutional forces. *This* is what Galison intends to articulate in the book. He hopes to show that the moves to standardize pretty much anything and everything in the nineteenth century were probably not merely a background against which thinkers like Einstein could revolutionize an entire field of knowledge; these standardizations in effect provided the infrastructure for Einstein's notion of simultaneity to materialize.

Who, then, is Henri Poincaré, who shares the spotlight (or equation) in the book? This French scientist trained at a polytechnic college and later became a respected mathematician-physicist in French academia and also a premier participant in various practices of standardization representing the French techno-bureaucracy. Poincaré was a member of the Academy of Sciences, worked at the French Bureau of Longitude (and later became head of it for several years); he was also the head of a committee giving recommendations to the French government about decimalizing everything aside from the length and weights.

Galison brings Poincaré in for at least three important reasons. First, he wants to emphasize that Poincaré stands for the intersection of science and technology, of theoretical thinking and hands-on practice that is a salient feature of the standardizations he was part of. It is this kind of crossing that Galison takes pains to foreground in order to suggest that in some sense Einstein should be thought of in a similar light: Einstein's daily dealings with countless patent applications were not for nothing; that experience must have put a stamp on his thinking. Second, Poincaré's relevance lies in the fact that, in many ways, he was ahead of Einstein in thinking of simultaneity *by* thinking of synchronized time. If Einstein thinks that the synchronization of clocks should take into account the transmission time of the signals, prior to him, Poincaré was already thinking that and putting it into practice. Third, Galison is keen to argue that in either theoretical thinking or practical approaches to the meaning of time on the part of both Poincaré and Einstein, time is treated not as a given, but as a convention, as the result of conventionality. Since Poincaré was involved in institutional efforts to decide what time is and how time should be read, revisiting those events revolving around him would be key to Galison's argument.

In brief, what Galison wishes to present in the book is "the daily world of 1900 in which it became usual, and not just for Poincaré and Einstein, to see time, conventions, engineering, and physics as of a piece"; this is a historical juncture when "it made perfect sense to mingle machines and metaphysics" (*Empires* 38).

If Poincaré's and Einstein's careers marked a time eager to synchronize time, at the heart of that eagerness was an intellectual, cultural, and political climate encouraging, if not obsessed with, standardization on many fronts. For instance, the French had been promoting the use of the metric system following the Revolution. That enthusiasm did not really catch on until 1875, when the French held the Convention of the Meter in Paris; over a decade later, in 1889, a solemn ceremony was held to sanction the meter by "burying" it in a basement vault in Breteuil. Eventually, more and more nations were adopting the metric system. For the French, the decimal character of the system epitomized the kind of rational thinking the French had prided themselves on (*Empires* 84-91).

Aside from the decimal metrology, other international agreements on standardization included the World Postal Union, as well as agreements on electrical standards, protection of intellectual and industrial property, etc. (*Empires* 145).

The effort to standardize time would prove much trickier in that other agreements were more or less predicated on the understanding that they were arbitrary conventions set up for a sensible life, in particular for convenience in commerce—and the French would probably add, for rationality, above all. But the sense of time seemed intuitive. How could we unify time?

Galison's argument is that if ultimately the world managed to unify time toward the end of the century, the turning point was the changed conception of time. The primary actors in time reform showed that they were pushing for an understanding of time as a convention, instead of something intuitive or absolute—and Poincaré would be a prominent figure along this line of thinking.

Galison points out that *convention* in fact carried three senses in this context. First, it invoked "Convention of Year II" of the French Revolution, that is, the Convention held in 1793 deciding on the promulgation of the decimal system. Second, it meant "the international treaty, *the* diplomatic instrument that the French, more than any other country, pushed to the fore in the second half of the nineteenth century." Third, it indicated "a quantity or relation fixed by broad agreement" (92).

What is noteworthy is that in the context of the craze over standardizations, the practice of setting up conventions ended up leading to a proliferation of conventions—that is to say, conventions would generate more conventions. For instance, the French triumph over the meter would prompt them to push for more decimalizations: the decimalization of money, of time, etc. In 1897, Poincaré was tasked with leading a group of scientists to decide whether it was worthwhile for France to further decimalize everything. The commission came up with all sorts of proposals, and eventually Poincaré pushed through a plan to decimalize time (to divide an hour into 100 minutes) and to break a circle into 400 units. Their recommendation was not well received and did not come through within the government.

So, who would want to see time unified? What was the prevailing understanding of time in day-to-day life in the mid- and late nineteenth century? The idea of "meridian" had been around since the mid-eighteenth century, but it was in 1851 that Britain set up a meridian at the observatory of Greenwich. Several other nations would set up their meridians and promote their own as the standard, but Greenwich proved to be the most popular: by the early 1880s, nearly three-quarters of ships in the world were using maps set to the Greenwich meridian.

Around the midcentury, the concept of longitude was also gaining currency, though it was still a challenging task to decide the longitude of a place. Longitude is different from the latitude: to decide the latitude, we locate the north point and the south point, and get the equator. But to decide longitude, we need to be able to compare two places and calculate the time difference and distance between the two places. The most effective practice, which was what the nineteen-century surveyors figured out after countless trials and errors, was the following. Astronomers or geodesic surveyors in two different places would decide to observe the same celestial phenomenon (such as the position of the moon when it reaches its highest point) on the same night, and inform each other of the time difference. Since they already knew a day consists of twenty-four hours, if they could know the time difference, they would be able to decide the distance—hence longitudinal difference—between the places. But the lack of reliable machines to transmit in real time the time difference made the process extremely difficult. At the beginning, the surveyors would carry clocks set to the time of their point of departure on their expeditions, but these clocks proved to be unreliable when traveling on the sea, affected by climate factors such as humidity. It was not until the technology of electric telegraphy was matured and widespread that precise determination of longitude became possible, now that the scientists could send signals to one another through electric time transmitters. The year 1867 saw the installation of the first underwater telegraphic cable across the Atlantic; by the year 1880, 90,000 miles of underwater cable had been installed (*Empires* 130-44).

If deciding a local longitude was imperative for sailors and explorers at sea, the most influential actor in time reform at the time was the railway industry, as their decision would bring about a widespread transformation of the concept of time for anyone who would like to benefit from modernization. In the mid-nineteenth century, with the growth of train travel came the need for a universal timetable. The American railway industry introduced new zone standards in 1883, and Britain and other countries soon followed suit. As Galison puts it, an acute awareness of "modernist time sensitivity" would grow rapidly wherever the railroad reached (*Empires* 109).

The world eventually came to agree on global time zone standards at a conference held in Washington D.C. in October 1884, where delegations from twenty-four nations would nominate the Greenwich meridian as the prime meridian. It was, however, not a smooth discussion: France famously objected to the proposal of the majority spearheaded by the Britain-U.S. alliance. The differences could not be more remarkable. The British-American side were thinking of their "clients" (the actual word used by one of the delegates) (*Empires* 148) whereas the French held steadfast to their glorious history in rational science. The French delegation first insisted that the Paris meridian be used as the standard, and later compromised and proposed to choose a neutral spot, which means anywhere but Greenwich—if they could not prevail by selling their crowning achievement in science and technology, they would fight for neutrality. Yet this rhetoric of neutrality was quickly dashed by the other side. The advocates of Greenwich were ready to concede that choosing a prime meridian was never something natural and that neutrality was but a myth.

Anyhow, we now know how that chapter of history unfolded, though by the year 1897 France was still resistant to complying with the Greenwich standard, and 1897 was the year when Poincaré was assigned the job of supervising the group of scientists investigating the benefits of decimalized time.

In what way is all this relevant to literary studies today? Elsewhere, Galison makes it clear that the methodology he is attempting at in this book is "a philosophically informed and historicized material culture," a project that, he hopes, would lead us out of the binary oscillation between idealism and techno-determinism, two predominant trends in twentieth-century history of science ("Place of Time" 388). This kind of opposition may not be at play in literary criticism; there is, to be sure, a distinct hierarchy when it comes to techno-determinism, one in which techno-determinism is often dismissed as the worst kind of determinism. Nevertheless, literary critics may gain by attending to the fact that Galison foregrounds the role of the infrastructure in intellectual and institutional developments. For instance, the advances in telegraphy proved to be pivotal in scientists' pursuit of precision, in their attempts to determine a longitude. Unsurprisingly, the British had dominated the telegraphic technology by being the main supplier of telegraphic cables. This could turn out to be a helpful footnote, however minor, to our reconsideration of the British empire's domination of the world at that time.

Finally, what Galison sees in the time standardization movement in the nineteenth century is a conception of time as a convention. It is this rhetoric of conventionality, and of arbitrariness, that would pave the way for Einstein's thinking of relativity. As Galison argues:

> Time was a convention, an agreement like any other that would, depending on the accord, unify cities, lines, zones, countries, or the world. Inscribing that arbitrariness into the collective language was as great a transformation as the acquisition of a regularized time awareness. (*Empire* 125)

This passage brings to light the gist of Galison's book nicely insofar as we take it literally: what was important was for the public to gain a modern time sensitivity, that is, precision; what was equally important was to materialize the rhetoric of arbitrariness and conventionality into the collective *language*.

This echoes the opening of the book where Galison argues, "Amidst the cacophony of voices, this book aims to show how the synchronizing of clocks became a matter of coordinating not just procedures but also the languages of science and technology" (*Empire* 40).

The moral we have learned from this account of time unification resonates with many other monumental accounts of measurement in the science of history and technology—measurement in modernity is always already a metanarrative, about nation-building, about the triumph of capitalism, and about the very conception and materiality of modernity. Thus, with measurement comes a metalanguage, even with something as natural as time.

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