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TRAINS OF THOUGHT: PIAGET, FORMALISM, AND THE FIFTH DIMENSION

Bruno Latour

PROLOGUE: A STROLL ALONG LAKE NEUCHÂTEL

It's sunny, this morning on Lake Neuchâtel, and windy and cold. What's that bright little shape out there? Ah, a sailboard in the wind. It's moving fast. How fast? I could use the lampposts along the quay to tick the time it takes him to pass behind each of them. With a good Swiss chronometer, a knowledge of how far the sailboard is from the land, an evaluation of the angle of its course—not an easy task, given the erratic moves of the board—I could come up with a speed; that is, a ratio of distance over time. Of course, I really couldn't because I'm pretty bad at calculating, even worse than at sailboarding. I can only play the observer on the margin. Oops, there he is in the water! Here he is again, back on the board, on a different tack, even faster along the waves now crested with the white foam triggered by the fiercer swerving wind. Now that he is closer to me, I see a broad smile on his face. The sailboarder seems to enjoy himself immensely. He does not see time passing. Strange to try to measure time while strolling along the lake, during the break between sessions of a conference on "Piaget and Time." Even stranger to play the outside observer. Of course, I could calculate the sailboard trajectory and obtain a ratio, a form, a speed, something that would neither be in time, nor in space. A timeless number. I too could reach, from safe and solid ground, the sure grasp of a formalism. But then, wouldn't something be missing? What, what exactly, would be missing? No hurry here. Take your time. The meeting is full of psychologists, of phenomenologists. They talk about "lived" time. Careful. They have an ax to grind. They want to criticize scientific time, the atemporal and

This paper is a version of the keynote address given at the symposium "Mind and Time," organized to celebrate the centenary of Jean Piaget's birth in Neuchâtel. The author wishes to thank Anne-Nelly Perret-Clermont for the invitation to this event and for her permission to publish it in *Common Knowledge*. A version will appear in *Swiss Monographs in Psychology*, vol. 4, ed. Anne-Nelly Perret-Clermont et al., 1998. © Hogrefe & Huber Publishers, Seattle Toronto Göttingen Bern. The author also wishes to thank Niels Viggo-Hansen, for commenting on the text, and John Tresch, for assistance with the English version, as well as to acknowledge intellectual debts to Geoffrey Bowker.

atopical coordinates of what they call science. (There, he's fallen again, brought down by a sudden gust. There he is again, darting away now.) Is the sailboarder moving like an arrow in "lived" time and space? Unlikely. "Lived," one of these empty words that have no opposite and are given a semblance of profundity because they appear to attack the cold and timeless and spaceless apparatus of dead reason. If I had managed to calculate the speed of that darting sailboarder, in what way would I have abandoned the "lived" world of this sunny day in Neuchâtel? I would have needed a watch, and a benchmark, and posts, and rulers, and a staff of helpers, and theodolites, the whole equipment and crew that Ed Hutchins describes so well when he shows the number of operations necessary to steer a dreadnought into San Diego Harbor.¹ In what sense are these operations not "lived"? In the end I would have obtained a speed—that is, a timeless, spaceless figure, a form, a ratio, on a piece of paper, held in my hand, inside my world, along the beach, under the sun, on the campus. So then, at no point would I have left the world. I would have added to Lake Neuchâtel another piece, another feature, an observer setting up apparatuses to calculate sailboard speeds. But the sailboarder (now barely a spot on the horizon) is not adding "fun" to the calculated speed. He is not adding the "lived" feeling of a sunny morning to the accurate definition of a timeless and spaceless instant and place. Why are all these psychologists comparing "lived" time to "real" time, "subjective" time to "objective" time? My calculation of speed, I mean my apparatus, my institution to extract speed from the sailboarder, is inside the world where he sails fast, and is not the depth feature on which his own psychological world would be built. How could I be so arrogant as to imagine that my calculation defines the primary quality of everything else? How could I be so forgetful of watches, and poles, and rulers, and crews, and staff, and compasses, and serious Swiss helpers? Especially here, just a few hours after having visited the Museum of Time in La Chaux de Fond? No, the watch is not the depth feature of the horizon but is added to the world, and so is this tenacious and ingenious industry cuddled in its mountain valleys, bringing so much wealth to this doll-house university. But then, if I am right, in what sort of world is the sailboarder moving? (Now, the dark speck and triangular wing are growing fast again, straight toward me.) No, no, he is not in a human, subjective, psychological, mental time-space. I want no part in painting this tableau, where the "lived" world adds false but warm colors to a real but bleak reality made of measurements. (He is still grinning, going fast toward the beach as if he wanted to skate-board onto the campus green, straight out of the lake—enjoying himself immensely. At the last second he briskly veers away and is gone again.) Enjoyment. That is the space-time in which he resides and moves. He is no more moving in space than he is in time. He is not adding a subjective morning to real mornings. Subjective lakes to

¹Edwin Hutchins, *Cognition in the Wild* (Cambridge: MIT Press, 1995).

real lakes. He explores the multiplicity of ways of being, he goes from some to many, from a little wind to a fierce gale, from a lower to a higher intensity. Yes, that's it, he is moving into enjoyment, intensity, ways of being, alterations; and if I want to calculate his speed, I can, but I won't define the depth of his world, the backdrop of all existence, I will simply add a color to the many colors there are already, maybe a grey, a dark color, but still a color. And thus, my dear psychologist colleagues, there is no need to turn toward the mind or subjectivity to escape from cold and objective time to find the rich "lived" world of meaning. To find richness, one only has to turn toward the world itself, to the wind, the foam, the sun, the snow-capped mountains in the background, the earnest miniature city behind the harbor. "Objective" time and "subjective" time are like taxes exacted from what peoples the world, they are not all that these multitudes do and see and mean and want. We are not forced to choose forever between losing either the feeling of time or the structural features of the world. Processes are no more in time than in space. Process is a third term, as if the sailboarding were moving into ways of being, exploring its alterity, its alterations. A third term! My God, aren't you tired of trying out third terms over and over and over, only to hear your audience object? ("Yes, but time is not a mere social construction!" Who said it was? Not I anyway, but nobody listens.) Their love-hate affair with science has blinded them to third possibilities. If it is not objective, then it is subjective. If it is not subjective, then it is objective. Chances are that if they understood that I am not a social constructivist, they would recoil in horror: "But this is abject metaphysics!" Well, too bad, I'm afraid it is. (The sailboarder is back now, folding his equipment, packing it up, seems happy.) Time to resume the session, to hear more about the many differences between the "lived" notion of time and "real" time. . . .

THE PARADOX OF THE TWIN TRAVELERS

To meet together in order to celebrate Jean Piaget's centenary, we need some *measure* of time—for instance, his birth certificate, issued by the well-organized Neuchâtel bureaucracy, the computing of hours and days and months calculated in the annals of astronomers and by various Bureaus of Longitude—and we also have to rely on a venerable Western tradition that stresses anniversaries and prefers nice round numbers like 100 or 1000 to more exotic ones like 88 or 133 or 666 and that puts special emphasis on someone's birthplace instead of, for instance, the city where his books were first published or from which his first grant was awarded. . . . Simply to gather at the right time, 1996, and at the right place, Neuchâtel, it is already clear that we need maps, institutions, recording devices, and traditions of ritual.

If I remind the reader of these trifling details, it is not to be impolite and criticize the title of the conference to which I was invited—"Mind and Time"—but to stress that "time" is not something that is in the "mind" or that is "thought" by a mind, but

something rooted in a long material and technical practice of record-keeping, itself embedded in institutions and local histories. In philosophical discussions about time, the work of inscription and the fabrication of *times*—in the plural—is all too often forgotten. To recover time we need to delve into the machinery of measuring it, for which Neuchâtel and its region are known the world over. The amusing paradox of this international conference was to have chosen, in honor of the local hero, a theme—the measurement, recording, and fabrication of times—that is well known to the Swiss economy but that Piaget did his utmost to ignore, even repress, throughout his scholarly life. “How the Fabrication of Time *Never* Entered Piaget’s *Mind*” could be the title of my somewhat embarrassed eulogy. . . . I do not write here as a specialist on Piaget, which I of course am not, but as a philosopher of science interested in understanding why close attention to the practice of fabricating time and space in science and technology has not done more to renew the philosophy of time. Piaget, in this respect, stands as having expended more energy in the effort to ignore the fabrication of time and its consequences for philosophy than any other intellectual of the century.

Imagine twin travelers. The first sets off into a deep jungle and cuts her way with a hatchet along a trail that is barely visible. Each minute, as she opens a few centimeters of pathway, she ages more than one minute. She sweats. Her body bears the traces of her efforts: each meter can be read in the bloody scars made by thorns and broken brush. The path is cut as she advances, but she is cut as well. A suffering body strives among other suffering bodies, vines, grass, and woods. She will no doubt remember all her life every moment of this excruciating trip through the jungle. She will remember it because each centimeter has been won through a complicated negotiation with other entities, branches, snakes, and sticks that were proceeding in other directions and had other ends and goals.

For comparison, imagine the comfort of the other twin, her brother, who traveled to the conference, as I did, by TGV. He sat quietly in his first-class, air-conditioned passenger car and read his newspaper, paying no attention to the many places passed by the speeding train, all of which looked to him like landscapes projected on a movie screen. He did not age more than the three hours of the trip. He bears virtually no trace of the journey, except for a few wrinkles on his trousers and maybe the effects of a few cramps caused by not often enough stretching his long legs, and he will remember little else except having traveled by train instead of plane. Only the articles he read in the newspaper might be briefly recalled. All the atoms of steel, all the electrons, all the gates and switches, all the efforts of the train companies, SNCF and CFS, were *aligned in the same direction*, going fast through space in time, complying to the millisecond with the world-famous Swiss exactitude and with the almost as famous French TGV quality of service. No negotiation along the way, no event, hence no memory of anything worth mentioning. “An uneventful trip,” as he says to his friend when getting off the train.

Why compare these twins and how they age? To direct our attention to a phenomenon that is logically prior to the fabrication of times—the relation between *transportation* and *transformation*.

With each move, the woman traveler is modified and ages; she may even lose her life en route. The male traveler remains unchanged by his smooth and speedy trip, which only an anonymous bomb or, as we shall see, a strike could interrupt. Thus, the woman traveler will equate transportation (or displacement) with modification, aging, history, transformation, metamorphosis. The male traveler will differentiate two apparently different phenomena: moving through space in time, on the one hand, and aging, living, suffering, participating in events on the other. Since the relation between transportation and transformation differs in the travelers' cases, the production of times and spaces, I want to argue, will be *entirely* different. The first traveler will not differentiate space, time, and aging; we will call her indifferenciation *processual*.² Her twin brother will find no difficulty in distinguishing what is displaced from the immutable framework *in which* it is displaced.

The separation between time and space on the one hand and entities, beings, or events on the other, is *not* a fundamental distinction, but one made by *some* travelers in some very specific and historically situated means of transportation.³ Hence, in discussing time, we might not have to pay exclusive attention to the two major relevant positions that have occupied modern philosophers. Time and space are not the Newtonian *sensoria* in which events occur and planets fall along ellipses. But neither are they forms of our perception, the universal a prioris that our mind has to use in order to frame or accommodate the multiplicity of beings and entities. Far from being primitive *terms*, they are, on the contrary, *consequences* of the ways in which bodies relate to one another. We must therefore link our meditation on time to a third tradition, the Leibnizian, which considers space and time as expressing some relation between the entities themselves. But instead of a single space-time, we will generate as many spaces and times as there are types of relations.⁴ Thus, progressing along jungle trails will not produce the same space-times as moving smoothly along networks.⁵ It makes an enormous difference if that body is a suffering body among other suffering bodies or a relaxed air-conditioned executive on a bullet train.

²"Process" is of course taken from Whitehead's philosophy. The present paper is a meditation complementing a previous piece of mine, "Do Scientific Objects Have a History? Pasteur and Whitehead in a Bath of Lactic Acid," *Common Knowledge* 5 (Spring 1996): 76–91. To escape the narrow limits of social constructivism, it seems that the history of science requires more and more ontology.

³It is, for instance, hard to express this in Chinese thought, according to François Jullien, *The Propensity of Things: Toward a History of Efficacy in China* (Cambridge: Zone Books, 1995).

⁴Niels Viggo-Hansen, "Process Thought, Teleology, and Thermodynamics" (a paper presented at the conference on "Time, Heat, and Order," Aarhus, September 1997), and his Ph.D. diss. (forthcoming).

⁵On the notion of trails, see Adrian Cussins, "Content, Embodiment, and Objectivity: The Theory of Cognitive Trails," *Mind* 101 (October 1992): 651–88.

What is this difference? Can we make it more precise? Yes, if we take into account the number and nature of the others with which each traveler is involved. In spite of his smooth trip—I neglected to mention this earlier—something marked and shocked our male traveler, and made his trip memorable. The train passed at 150 kilometers an hour without stopping at Culoz, the place where all trains bound for the Alps and Switzerland used to stop until a few years ago. He remembered Lake Bourget, with its decks and buffet, to which the stop at Culoz gave his family access when he was a child. What used to be an important *place* had become a nonexistent, undifferentiated *instant* along the train's route. For this traveler, the event was the very fact that nothing in the station could make this place eventful, memorable, markable, in passengers' lives any more. Further, the natives of this little town no longer had the dignity of being able to stop the train, to board it or alight from it. The natives' ties to the station had earlier resembled the lianas of our female traveler, blocking the pathway, forcing passengers to make detours, accept delays, wait for later trains; those ties having been cut as the twin had cut her lianas, the tracks at Culoz now resembled the open path that she had left through the jungle. This little station had counted, it no longer counts. It interrupted passengers' trips, it no longer interrupts them. It was a station, it is no longer a station. The rails, well aligned, now run in only one direction, from Paris to Geneva.

So the difference between the trips that our twins took comes from the *number of others* one has to take into account, and from the *nature* of those others. Are they well-aligned *intermediaries*, making no fuss and no history and thus allowing a smooth passage, or full *mediators* defining paths and fates on their own terms? Are they really others—that is, mediators—or are they more of the same—that is, intermediaries? Timing depends on that sort of ontological difference, not on the mind's apprehension. If other entities are necessary for our existence (and surprise us), then times and spaces will proliferate. In the opposite case, times and spaces will rarefy to the point of becoming *one* time-space, or even, as we shall see, *no* time and *no* space, only *forms*.

We can now situate our twins along one dimension that takes into account the ratio of transformation over transportation or else the number of mediators compared to the number of intermediaries. But if we want to escape the usual opposition between subjective and objective time, we can go further and imagine a second dimension that will obtain for us a richer grid to develop our discussion of time-space fabrication. To define this second dimension, we may connect our twins' biographies in one scenario and insist now on the *labor* necessary to reach one position from the other. Imagine, for instance, that the female twin is a surveyor sent by a company to explore the future path of a bullet train, a path that will in a few years be planned, designed, funded, built, successfully completed, and eventually used by her forgetful brother wearing his pin-striped suit. Each locus, each site that, before, had blocked or slowed his sister's progress, aging her and causing her pain, has now been turned into a well-aligned

intermediary that lends its force, goal, will, or end to the path of the rushing train. Each tree, house, hut, vine in the path of the bullet train has been rent; hence the train's speed—nothing interrupts it or slows it down. Speed crucially depends on the number of intermediaries relative to the number of mediators. The speed of the train and the uneventful trip of the passenger are entirely dependent on the complete *obedience* of the places traversed—and also of course on the smooth functioning of the train company's organization running, as the saying goes, "like clockwork."

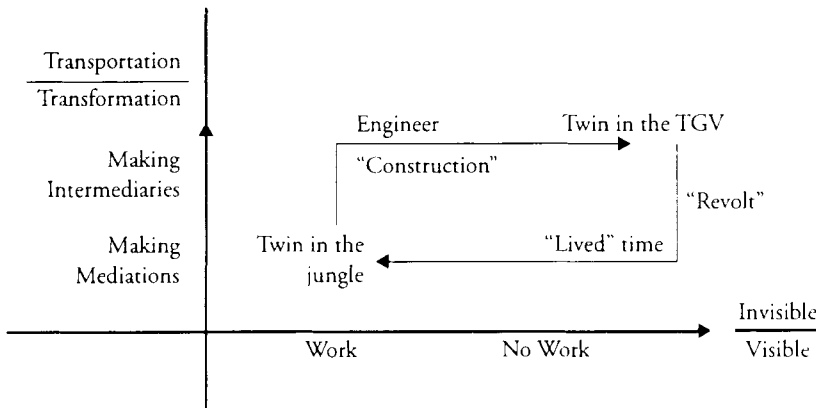
However, our story could also go in the other direction. The inhabitants, whose city has been divided by the line, may decide to protest by sitting on the tracks or even putting logs on the rails and setting them on fire (not in Switzerland, of course, that would be unthinkable; but let us say in the French section!). Then what would happen? The passengers on the train would start to age. The train blocked, they would be stuck in this to them meaningless hamlet, which has, because of the protest, become a meaningful place, a site, an event-producing *topos*. Hostages of fortune, the passengers will start remembering this trip. They will begin to feel the passage of time and to feel time going slowly or fast. They will begin to have the impression of a "lived" time and space that they did not have when the train was moving quickly, uneventfully. Buses will have to take them away from the station and they will lose hours because of the angry demonstrators who, for their part, will have been "making history," taking pride in their strength, and knowing once again that they are not living in a no-place that can be traversed at high speed as if it were a route to someplace else, but a memorable spot to be reckoned with, negotiated with. To use another cliché, angry demonstrators will be proud of having put their little village "on the map."

Let us pursue our story to its end. Imagine the revolt happening at each station along the railway and also on each road that the buses are using to get around the blockades. We would then be back in the jungle we started with. Each centimeter would have to be negotiated, and it would be impossible for anyone to go straight ahead without being deeply and durably modified. Each transportation would be paid for with a huge transformation, a durable and memorable metamorphosis.⁶

My little story, which consisted originally of the woman traveler in her jungle and her male twin in his bullet train, has been enriched by the addition of a progressive *passage* from the trail to a high-speed railway network and a *reverse* passage from network to jungle where every move has to be discussed and won the hard way. Thus we now have two dimensions to take into account in discussing space and time construction: one that defines the ratio of transformation over transportation and one that defines the relative *visibility* of the work to be done in order to obtain a displacement.

⁶Although my story is a thought experiment, in the Amazon I have seen a former highway taken over by a jungle even more impenetrable than the original trail where Indians feared to tread.

This gives us the following diagram:



The first twin produces mediations, she sees and feels the work of transformation and is unable to differentiate space and time on the one hand, and moving bodies on the other; nor does she differentiate her own suffering body from all the others through which she is slowly drudging. The engineer is aware of the mass of work necessary to produce calculation, frames of reference, smooth transit; but his energy is invested in making sure that the routine institutions on which transportation depends are running "like clockwork." The second twin sees no difficulty in distinguishing a moving body from a circumscribed frame of reference, since the work of the others has become invisible and since no transformation forces him to pay for his transportation—except of course the price of the ticket. For him, as for all the angelic philosophers of physics who play the role of Queen of the Night, "time is like nothing." The passenger whose train has suddenly stopped because of the riot does not see more of the work of mediation than the Newtonian philosopher. But he feels the passage of time and the importance of space. Aware that something was wrong in his previous sense of timelessness and spacelessness, he concentrates attention on his "lived" time and space, as if this phenomenon were psychological, human, subjective. Most of the debates in the philosophy of time, faced with our ever more complicated story, would oppose the two train passengers on the right side of the diagram above: the one for whom there is no time, the other who harbors a subjective feeling for time. But if we alight from the train and direct our attention also to the institutions responsible for making sure that trains arrive on time, to the revolts en route where space and time are determined on the spot, and to the processes through which those institutions are built or those movements are

¹Most of the work of Isabelle Stengers with and then without Ilya Prigogine has been done on this puzzle: how to understand that for physicists "time is like nothing." See Isabelle Stengers, *Power and Invention* (Minneapolis: University of Minnesota Press, 1997), and *L'Invention de la mécanique: pouvoir et raison. Cosmopolitiques*, vol. 2 (Paris: La Découverte, 1996).

quashed,⁸ we should be able to add another dimension to the debates. What are the lessons that we can draw by thinking in two dimensions instead of one?

First, the distinction between subjective and objective time is only part of the story. The distinction concerns only train passengers. With the notion of objective or scientific time, two entirely different phenomena are lumped together: the routinized work of engineers inside huge institutions is taken as though equivalent to the feeling of a "user" who, because the engineers are watching day or night over his safe passage, is allowed to forget the work of making time. Similarly, with the notion of subjective or "lived" time, two entirely different questions are confused: first, the surprise felt by a "user" when the smooth running of time machinery is interrupted—top right of the diagram, and second, the labor of those engaged in processes so little routinized that the difference between subjectivity and objectivity cannot even be recognized—bottom left of the diagram. Those of us who explore the intensity of multiple beings cannot be accounted for by relying on a subjective definition of an internal state of surprise.

Second, time is not in itself a primary phenomenon. Time passes or not depending on the *alignment* of other entities. In a world made of intermediaries, of displacement without transformation, there is a time separated from space, an immutable frame to measure displacements and, by definition, no process. In a world made of mediations, of transportation by deformation, there are a lot of times and places. Deeper than time is the question of the obedience and disobedience of humans or nonhumans.⁹

Third, the notion of *event* cannot be differentiated into spatial and temporal components. If a place counts as a no-place it also counts as a non-event. Place is not a feature easier to understand than time. When a place counts as a *topos*, it also counts as a *kairos*. Deeper than time and space there is another question about who or what counts. Which actants can interrupt, modify, interest, or interfere with which others, thus producing as many *topoi-kairoi*?

Fourth, to talk like the semioticians, there are always, simultaneously at work in each account, a shift in space, a shift in time, and a shift in actor or actant, the last of these always forgotten in philosophical or psychological discussions. My story of the woman traveler in the jungle, for instance, sent you, the reader, along the three different axes at once: at another time, in another place, but also in someone else's character.¹⁰ Deeper than the question of time and space is the very act of shifting—delegat-

⁸Jacques Lolive, "La Mise en oeuvre controversée d'une politique de réseau: les contestations du TGV Méditerranée" (thèse de doctorat, Université Montpellier I, 1997).

⁹Human/nonhuman is a technical expression that does not replace subject/object but makes the latter do another philosophical job. See my article "On Technical Mediation—Philosophy, Sociology, Genealogy," *Common Knowledge* 3 (Fall 1994): 29–64.

¹⁰*Semiotics and Language: An Analytical Dictionary*, ed. Algirdas Julien Greimas and Joseph Courtès (Bloomington: Indiana University Press, 1982).

ing, sending away, translating. We should not speak of time, space, and actant but rather of temporalization, spatialization, actantialization (the words are horrible) or, more elegantly, of *timing*, *spacing*, *acting*.

Fifth, and finally, the question of spacing, timing, and acting should always be combined with that of their *intensity*. What has occurred—an event or a non-event? Process is not in itself associated with time more than with space. Process is not the fourth dimension, but a *fifth*. That is well known, as far as time is concerned, since we have used (at least since Husserl) the notion of “historicity” in order to differentiate process from the “simple” passage of time—as measured by the watch (more on this later). But the same should be true for space, though there is no spatial term as widely accepted as “historicity” is for time. To differentiate the intensity of being in a space, a *topos-kairos*, from simply being located on a map, we would need a term as clear-cut as “historicity.” When, as in my narrative of the twins, a no-place becomes a master place, a *chef-lieu*, a *topos*, we should be able to say that it gains “spacifcity” or “situatedness.”¹¹ The same goes for the shift in actantiality. We should have a word that differentiates the move from one actant to another—extensive repetition—from the modification of all the actants—intensive repetition. Unfortunately, there is no such term. Since we do not have the requisite triad of concepts, I have chosen to use the simple contrast between trail making and network following, between transportation *with* transformation and transformation *without* deformation, and am using the word *intensity* to trace this fifth dimension.

Writers like Bergson with his distinction between spatialization and duration, Péguy with his contrast between the history of historians and the history of events,¹² Whitehead with his insistence on process, Deleuze with his early work on difference and repetition, were obsessed by the question of the intensity of time as opposed to its *expansion*. The difficulty in using their insights to trace the fifth dimension of process is that they were engaged in a battle with what they saw as a scientific definition of time and space. The difficulty also comes from their unfairly favoring time over space in order to avoid what they saw as the inherent spatialization produced by science, as if process were in any way more easily connected with time than with space. So that my burden now is to shift attention to the labor that goes into the fabrication of spaces and times—we are shifting from right to left in the diagram above—in order that we not take scientific practice regarding space and time as objective time and space; I also want to redress the imbalance between space and time by using work recently done in technology studies.

¹¹“*Médiance*” has been proposed by Augustin Berque, *Du geste à la cité: formes urbaines et lien social au Japon* (Paris: Gallimard, 1993).

¹²Never translated into English, Charles Péguy is probably the greatest French prose writer and no doubt the deepest philosopher of time. See especially “*Cliv: dialogue de l’histoire et de l’âme païenne*,” in *Oeuvres en prose, 1909–1914* (Paris: Gallimard, 1961).

PROCESSING TIME AND SPACE

If I have taken the case of a train for my paradox of the twin travelers, it is not only because I am a fan of the TGV and a great admirer of the "Ratische Bahn" leading to the Nietzschean valley of the Upper Engadine, but also because I wish to honor that most famous Swiss engineer from Zurich, Albert Einstein, obsessed by bullets, trains, and clocks. What I am going to argue should be obvious to La Chaux de Fond clockmakers, to Geneva train company managers, to Zurich bankers: the fabrication of a certain type of space-time-actor crucially depends on our ability to measure intervals by relying on bodies that have the strange peculiarity of remaining fixed through motion: planets, falling stones, pendulums, bullets, scales, geometrical shapes, and of course trains, cars, satellites, bank accounts. As many scholars have made clear,¹³ there is in our civilization a fixation on how best to transport something without deforming it, an infatuation with what I have called "immutable mobiles." To the search for constants (that is, for what can be carried around and resists deformation in spite of transportation), anything will be sacrificed—even, as in the case of Einstein's relativity theory, the very definition of Euclidian space and clockwork time. Piaget of course shares this obsession, to the point of having turned the ability to conserve constants through transportation into the very definition of intelligence (and into the best way to distinguish its successive stages).¹⁴ As we will see, anything will be sacrificed by him, really *everything*, to this conservation of constants.

Instead of taking displacement without deformation as an obvious feature of what the world is like, as so many philosophers of time and train passengers tend to do, I simply want now to use the rich literature on the fabrication of time and space to free the fifth dimension of time from both its subjective and objective interpretations. How is the discussion changed when the work necessary to construct scientific facts and technical artefacts is again becoming visible? The first thing to do is to elevate spacing to the same philosophical dignity as timing.

Far from being obvious commonsense terms, "spacing" and "timing" are in fact quite difficult to tell apart. Through what sort of labor do we produce the distinction between space and time? The question is not as trivial as it seems. For instance, the legendary wandering Jew cannot distinguish the two, every spot along his way being

¹³ Among many others, I found particularly relevant Geoffrey Bowker, "Second Nature Once Removed: Time, Space, and Representations," *Time and Society* 4.1 (1995): 47–66; David S. Landes, *Revolution in Time: Clocks and the Making of the Modern World* (Cambridge: Harvard University Press, 1983); Otto Mayr, *Authority, Liberty, and Automatic Machinery in Early Modern Europe* (Baltimore: John Hopkins University Press, 1986); Daniel R. Headrick, *The Tenthets of Progress: Technology Transfer in the Age of Imperialism, 1850–1940* (Oxford: Oxford University Press, 1988); Simon Schaffer, "Babbage's Intelligence: Calculating Engines and the Factory System," *Critical Inquiry* 21 (Fall 1994): 202–27; Wolfgang Schivelbusch, *The Railway Journey: The Industrialization of Time and Space in the 19th Century* (Berkeley: University of California Press, 1986); Eviatar Zerubavel, *The Seven Day Circle: The History and Meaning of the Week* (London: Collier Macmillan, 1985).

¹⁴ Jean Piaget and Rolando Garcia, *Psychogénese et histoire des sciences* (Paris: Flammarion, 1983).

also a date. Since he never retraces his step, never stays in the same place, never settles, never comes back, there is no meaning for him in the notion of "place" differentiable from "date"—except, of course, in the case of the City of Jerusalem, which he will reach "next year." His itinerary is made of "date-places." It is only because we come *back* to the same place over and over that we generate the notion of a place, of a *topos*, that lasts and stays the same, while we have moved. The size of the castle of Chatelperron diminishes irreversibly in the distance as the wandering traveler moves away from it. It is thus as much part of time as the hour spent walking by. Only if the walker stops and reverses his steps does the castle size reverse itself and grow again, and only then can the voyager conclude that this is a place rather than a date. It is in comparing the irreversibility of his aging body with the reversibility of the castle's size that he is able to make sense of the expression "space and time." Following the usual definition of space as the "series of coexistences" and of time as the "series of successions," he deduces: "I have changed and the castle has not; thus there is a space, a somewhat longer lasting landscape, inside of which I move and age"—space offering the measure for time, and time the measure for space.

Thus, we cannot say that the castle is "in" space since we claim that times and spaces—right side of the diagram—are generated by a type of work, and by the displacement of kinds of bodies, that tend to remain invisible. We should say that the traveler's displacement, by his returning, has put the castle into space instead of time, that this move has, so to speak, "spaced" it. But why does the castle exist intact after the traveler has descended the mount? Certainly this too has to be accounted for. "Castles in Spain," "castles in the air," would not have this ability. If everything changed at the same *tempo* as the traveler, he would never be able to measure the changes in shape, even if he could retrace his steps: he would have aged, but the castle too would be so different that he could never be sure that it was not another castle, another date-place. Even Heraclitus's proverbial river does not flow at the same speed as its embankment. We now encounter the importance of techniques that I will define as a very peculiar way of *folding* times and actants of different qualities and *tempos*.¹⁵

The castle of Chatelperron, across the foot of which the traveler passed two hours ago, was renovated four years before, was built eight centuries earlier on an earth mound elevated two hundred years previous to that, with stones generated hundreds of millions of years in the past—leaving aside momentarily the question of measurements on these different timescales. In other words, what makes the traveler encounter a place, a *topos*, is the connection of actions taking place in various sites and times by various actants. The hard labor of feudal villeins hewing huge stones and putting them in place is present today, as much as the labor of the ancient seas and telluric activities of the geological past, and as much as the more recent work by the courageous owner

¹⁵See my "On Technical Mediation" (n. 9 above), and "On Interobjectivity," with discussion by Marc Berg, Michael Lynch, and Yrjö Engelström, *Mind, Culture, and Activity* 3.4 (1996): 228–45.

who fixed the roof and consolidated the walls—not to mention the Neanderthal cave-men who placed Chatelperron on the paleontologists' mental map. Far from being a point in an isotropic space, the "specific," "situated" site met by the traveler who returns becomes a *connection* of interactions dispersed in time, space, and action, and reassembled, kept up, instituted in an event-producing *topos*. Because of the ancient, enormous, and continuous mass of work connecting various interactions over ages, the castle still holds, makes space, makes history, breaks the continuity of vision, bends attention, interrupts the travels of voyagers, creates hierarchies, and thus the wanderer at its foot rightly feels that it differs from his own fast-aging flesh. He passes, and the castle does not. The castle holds its ground, occupies space, creates a landscape, becomes a *chef-lieu*, whatever the proper expression, not because it is a spot "in" space, but because it is itself the event connecting interactions on a large spread of space-time-actants. Here history was locally made and traditions kept the castle continuously in place. Hence, there is *a* place.

It might seem strange to define techniques as what connects interactions from different times, places, and actants, but it is necessary when we attend to delegation and shifting. Take the very simple example of a mousetrap I set up to deal with the many mice that live in my house at the foot of Chatelperron. It took ten minutes for Korean workers to make them last year in their sweatshops, a minute for the import/export trade company to order them by fax, three months to carry them in a container across the East Asian trade routes. It took me a few minutes and a few francs to buy them at the local hardware shop last week; I am presently putting Swiss cheese on the nail and, cautiously, setting the spring, making sure it is not my finger that gets snapped by the miniature guillotine. . . . Tonight, the kinetic energy of the spring set in place by my action will be unleashed in my absence as soon as a mouse starts sniffing the cheese. How many actors are present at once?—Korean workers, French traders, wood from the mountain, cheese from the Alps, my action of yesterday delegated to the spring of this oldest of techniques, the trap. More primitive, more basic than a point in an isotropic space is this subtle weaving together of interactions among many places, times, and types of material: the week-old mouse body, the month-old cheese, the age-old trap, the five-year-old wood, the night-old action of the exasperated kitchen owner, all of them contributing to this very humble *topos-kairos*, to an event-producing spot—and it is certainly an event for the mouse who will meet its death, I am hopeful, tonight.

We never encounter time and space, but rather a multiplicity of interactions with actants that have their own timing, spacing, goals, means, and ends. Nothing in the mind, nothing, but a lot in the know-how of those who, by clever technical action, can weave together types of actants that were immiscible a moment before. What could be farther apart than Korean sweatshops and Swiss cheese? Yet these are now connected by the shortcut of a mousetrap. Long before we can talk of space and time,

it is these sorts of connections, short circuits, translations, associations, and mediations that we encounter, daily.

We register these many differences in timing and relative resistance through the various instruments invented by scientific disciplines (in the largest sense of the word) to record and document them, and it is at this point that we must shift from technology studies to science studies. In what may be the most unfair account of science given by any philosopher, Bergson criticized scientists for being unable to pay attention to duration, to "*la durée*," because, according to him, scientists always turned it into meaningless and timeless spatial delineations. An extravagant claim, since scientists are the ones who made it possible to speak of the "*longue durée*," of the eons of biology and geology out of which Bergson could make his "creative evolution." Without Linnaeus, without Cuvier, without Lamarck, without Darwin, there would be no long history of life for Bergson to pit against the obsession for geometry and space. The very idea of an evolution unfolding over billions of years emerges out of the natural history museums and the collections of geologists. What Bergson puts aside when he poses his vain opposition between the warm and rich duration of time and the poor and cold spatialization of mind is the work of registering differences, the work of the clever scientists, another labor that philosophers have ignored as much as they have the work of the able engineers.

Of the instruments overlooked by philosophers, perhaps the most interesting in this context, because it is a trap for time, not mice, is the photographic gun of Étienne-Jules Marey, a contemporary of Bergson and Einstein. Marey invented his gun in order to visualize the precise motions of doves in flight. He was certainly not attempting thereby to "geometrize" the passage of time; he was attempting to produce time *as much as space*.¹⁶ More exactly, his labors produced something entirely different from either, which we may call *synopticity*. In the same way as attention to technical know-how completely subverts the defining of a time and space, since it wreaks havoc on interactions by creating events and *topoi*, attention to synopticity, to what can be seen right away by a scientist, completely redistributes the ability of scientists to know, to see, to imagine, to think anything at all.¹⁷ What is important about Marey looking at the successive images (of the dove in flight) impressed on the circular silver-coated plate is not, in spite of Bergson's condemnation, that he has lost the *passage* of time, of duration—it is precisely to lose it that he set out to invent his photographic gun.

¹⁶Marta Braun, *Picturing Time: The Work of Étienne-Jules Marey* (Chicago: University of Chicago Press, 1992); François Dagognet, *Étienne-Jules Marey: A Passion for the Trace* (Cambridge: Zone Books, 1992).

¹⁷For entry into what is now a huge literature, see *The Right Tools for the Job: At Work in Twentieth-Century Life Sciences*, ed. Adèle Clarke and Joan H. Fujimura (Princeton: Princeton University Press, 1992), and *Representation in Scientific Practice*, ed. Michael Lynch and Steve Woolgar (Cambridge: MIT Press, 1990), 19–68; see also my article, "The 'Pédofil' of Boa Vista: A Photo-Philosophical Montage," *Common Knowledge* 4 (Spring 1995): 144–87.

Marey was utterly fed up with *durée*, with invisible, obscure, and uncontrollable patterns of flight that are not seizable, fixable, catchable.¹⁸ The flying dove did not live "in time" before being killed by a gun "in space." The photographic gun does not kill, and what was important for Marey is that the events in the sky can now recur, hundreds of times at will in the *Station physiologique* of the Collège de France. Marey is not reducing the lived and rich *durée* of the dove for a poor and cold geometry. On the contrary, he is *adding* to the flight of the dove, adding something never experienced on earth before, the enrapturing contemplation of the dove's successive motions transformed, on the plate, into coexisting shapes. He has not "degraded" time into space, as Heidegger would say; the leap is much more innovative and daring than that: the fleeting seconds of the dove's flight have been transformed into a permanent silver photograph that can be contemplated for hours or quickly scanned by scientists again and again, in search of structural features that will explain the muscles' position and the energy balance.

For someone who observes scientists or engineers at work, there is not merely one time and space. The phenomena observed are much more surprising; they rely on the subversion, disjunction, displacement, rescaling, crossing-over of relations between spatial, actorial, and temporal features.¹⁹ Science does not withdraw time from the world, it adds many spaces and times to the world by constantly modifying scales, lengths, and units in those strange sites, the laboratory, the institute, and the archive, which are utterly different from "a mind."

If this is the case, then, where does the obsession for a time-space frame "in which" entities would reside, or a frame that the mind would "impose on" things in order to apprehend them, come from? No amount of labor will ever produce that sort of space and time—not the work of engineers or scientists, nor even that of our anecdotal trail-blazer. It is useless to oppose, as is so often done, the "lived world" of human subjectivity apprehending space and time and all the rich colors of intentions and affectivity with, on the other hand, the scientific and technical objective world ceaselessly cutting a meaningless space-time into isotopic and isochronic units. The scientific and engineering practice of subverting spaces and times through maps, charts, digs, traps, tricks, and knacks exceeds by far any subjective time and space described by phenomenologists. The subjectivity of space and time is not what is left when the objective space-time has been thoroughly described. It is only in some very peculiar circum-

¹⁸This is why, by the way, he did not come to invent the movie camera; what Marey wanted was to invent the *anti*-movie camera—an instrument for turning movement into a succession of images synoptically, and not successively, visible.

¹⁹Michael Lynch, "Science in the Age of Mechanical Reproduction: Moral and Epistemic Relations Between Diagrams and Photographs," *Biology and Philosophy* 6 (April 1991): 205–26. For a much more complicated scientific case, see Andrew Pickering's beautiful meditation on what sort of scientific practice is necessary *before* phenomena begin to appear: *The Mangle of Practice: Time, Agency, and Science* (Chicago: University of Chicago Press, 1995).

stances that the two can be differentiated. Only the man in the TGV can distinguish transport and transformation, not his sister opening the trail with her ax, not the engineers of the train companies making sure trains do not run out of synch,²⁰ not the scientists watching over the coordination of atomic clocks, and not Marey trembling at the idea that his photographic gun might give fuzzy, blurred, or overlapping images.

But surely, space-time, our imaginary frame for all events, has to come from somewhere? Its origin seems to be in the peculiar nature of the *objects* used in the scientific disciplines to build their measuring instruments. Whitehead once quipped that it is all very well to praise Galileo for his study of the inclined plane, but what if he had tried with bags of wheat instead of spherical billiard balls? Try to distinguish a seven-year-old "conserving" child from "nonconserving" children who use calabashes instead of beakers, the latter of course controlled by metrology and standardization—inspectors and instruments and institutional bodies are necessary here, as much as in the case of trains and clocks, to hold them "up to standard" and to coordinate action and certification.²¹ Still, in Africa, away from their laboratories, most Piagetian testers would probably qualify as "nonconserving": there is an inordinate number of rigid bodies in the paraphernalia of laboratories, but that does not mean that scientists are *themselves* rigid bodies or have rigid geometrical minds. It simply means that, in the laboratory, in order to detect differences, they use benchmarks.

The circulation of those rigid bodies will locally generate a specific type of space-time, as the circulation of any other body with different properties will generate additional spaces-times-actants. This does not mean that we are *in* an isotopic space and an isochronic time, but that locally, *inside* metrological chains, there are *effects* of isochrony and isotopy produced by the carefully monitored and heavily institutionalized circulation of objects that remain relatively untransformed through transportation: high-speed trains, rulers, standards, cannons, weights, constant relations, bullets, ballistic missiles, falling stones, accounts, and various other rods, hands of clocks, gears, and structural isomorphies. None of that instrumentation—though very practical, very clever, very material, very local—at any point says anything about the mind's inner workings, nor does it explain the ways by which no-place becomes event or events become non-event. The building of metrological networks for space and time is a crucial feature of Western history. It has to be documented, to be sure, studied and

²⁰Philosophy being an empirical science, I had the luck, coming back from Neuchâtel after giving my talk, to sit next to three Swiss railway engineers going to Paris to meet their French counterparts and to overhear their conversations. In charge of buying carriages, they were heaping price tags and technical controversies onto each of the types of moving material we encountered. Although a passenger in the top right of the diagram, I moved, by listening, closer to the top left.

²¹"Conserving" and "nonconserving" are technical terms in Piagetian psychology to describe the result of experiments when children are able or not able to grasp constants through transformations. See the classic work of Anne-Nelly Perret-Clermont, *La Construction de l'intelligence dans l'interaction sociale* (Berne: Peter Lang, 1979). On transcultural "deconstruction" of Piagetian theory, see Jean Lave, *Cognition in Practice: Mind, Mathematics, and Culture in Everyday Life* (Cambridge: Cambridge University Press, 1988).

respected, but it does not have to be confused with an account of how our mind evolved, or with the understanding that other civilizations may have of time, or with the ontology of world making.

I am well aware that we have reached the turning point, or perhaps it is the breaking point, of this line of argument. Since an interest in the shift in times and spaces practiced by technical means and scientific laboratories, and the attention paid to instruments and their making instead of to their results, cannot be justified by demonstration, we have a choice to make between philosophies. The first would consider space and time in their isotropic and isochronic nature as being what the universe is made of or, alternatively, what the mind needs to impose on the universe in order to make sense of it. Moreover, as an afterthought, this first position might save for human subjectivity some other sort of relations that would explain how we relate emotionally to events and orient ourselves concretely in space, but all of this subjectivity would be understood in contrast to objective space-time. Affectivity and effectivity would be clearly contrasted. Only the right side of our diagram would be considered, and the left side taken as a purely instrumental aspect of no philosophical consequence for the elaboration either of the world or of the mind.

A second solution would be to start from a phenomenon that is not in itself connected with either subjectivity or objectivity, one that ignores the quarrel between space-time as *sensorium* or as mind-set and that begins with the *other entities* that are necessary for maintaining us in existence. It is this quality of otherness and the "number" of others that are, in this second philosophy, the crucial features; and its central problem is that of knowing if a transport, a displacement, a translation, a trajectory is "paid for" by a small or a large deformation, transformation, metamorphosis.

The major difference between these two philosophies is that the normal case of the first is the rare exception of the second. That a mobile travels without mutating is so rare, so miraculous, so expensive a phenomenon, it has to be explained in detail. And indeed, to explain the man in the TGV who does not age more than three hours going from Paris to Neuchâtel, one would have to take into account several huge bureaucracies, enormous networks, many clocks, flags, signs, and standards, a lot of electrical plants, labor relations, and so on. Similarly, to account for Einstein's travels without deformation at the speed of light, in spite of the acceleration of frames of reference, one would have to count the whole establishment of physics, huge laboratories, most of astronomy, and quite a few trains and embankments of the Swiss railway authorities. In this second sort of world, the measurement of times and spaces *makes* spaces and times, whereas in the first, the instrument plays no role other than that of a practical means to reach space and time, which themselves exist independently, whether objectively or subjectively. In the second sort of world, instruments are mediators and shifters; in the first, simple means and intermediaries (they could, in theory, be discarded). The role of the mind, of ethics, politics, and religion, is entirely different in these two

worlds, and that difference will be my concluding focus. Why is the fifth dimension of time-space so difficult to register?

FORMALISM: A PROFESSIONAL HAZARD

What happens if, instead of attending to instruments (circulating rigid bodies, laboratory sites, changes of scale, institutions in charge of time and standards, and the know-how that goes into experimental trials) we attend only to the results of a smooth displacement? To continue with my favorite example, what happens when the man in the first-class compartment of the TGV ignores not only the famous "man on the embankment" but also the inhabitants of the string of aligned stations and cities, the whole machinery and administration of train companies? He really will think that there can be something like a displacement in time-space that does not require any aging, any transformation—something that is "paid for" nowhere by costly network-building. He may even come to think that isochronic time—measured by his watch in relation with the train's clock—and isotopic space—signaled by the number-bearing milestones that flash regularly along the track—are normal features of the world. This will not happen if he boards an Italian train, let alone an Indian train, and it will not happen either, recall, if there is a strike or other incident, or even if the air-conditioning malfunctions slightly. But if all goes smoothly, this traveler will take the *result* of the railway companies' labor—smooth travel across space in time—as its normal *cause*. After having discarded as irrelevant the tracks, the trains, the switches, the bureaus of standards, the clockwork, the regulations, the timetables, and the whole attendant menagerie, he will then be tempted decisively to believe that this system of isochronic and isotopic coordinates can be located *in his mind*! That is the real great danger of train trips; they are too comfortable (at least in Switzerland). Epistemology is a professional hazard of first-class, air-conditioned train travel.

Science is both praised and attacked for what it cannot possibly provide: timeless formalism. There are of course scientists working on forms, on rulers, on maps, on coordinates, on structures, but their work is not itself formal, ruled, mapped, coordinated, structured. Formalisms circulate inside scientific networks with the regularity, efficiency, elegance, and economy of trains circulating on the "Ratische Bahn." But in the same way as no one could even imagine trains keeping regular schedules without railway companies, no one should imagine that formalisms could go on circulating smoothly without the costly institutions known as Research and Development. It is as strange to turn isochrony and isotopy into mental or natural categories as it is to turn the work of establishing constants into what the mind would be particularly good at. The unequipped mind of a desocialized scientist would be unable to prolong the life of any constant. This is why researchers, well aware of these practical constraints, ceaselessly devise instruments, time- and space-subverters, data traps, and scale-inverting

inscriptions, and in the process produce a fabulously interesting history for their own sciences. Those researchers resemble worried train company managers, not careless, well-fed, ignorant travelers. Even Einstein, in his Machian account of general relativity, deployed very explicitly the engineering work that goes into shifting from one accelerated frame to the next without losing information on the way.²² His proverbial “mollusk of reference” generates an absolute space-time but cannot itself be seen as *in* absolute space-time.

The idea that a mind could *make* formal reasoning is as bizarre as imagining that a solitary scientist could make a discovery or a naked male traveler’s body (not Flash or Superman’s) could move by itself at 300 km/h from Paris to Neuchâtel. Yet the very idea of “genetic epistemology” goes further than this thought experiment, imagining not only that the mind undertakes formal reasoning through formal means, but also that the whole history of biological life, from the earliest pre-Cambrian ferns to the superior cortex of primates, obsessively seeks nothing but the conservation of those formal relations.²³ Thus formalism is taken as the pinnacle of human reasoning, and life itself is said to aim at nothing else. Here Piaget, the immanentist, appears to take the opposite position from that of Bergson, the spiritualist, for whom life must remain forever foreign to *Homo faber*’s urge for geometry. In effect, however, Piaget’s position starts from the same principle: time and space can be said, unproblematically, to pertain to life itself.

But if we have been right to locate the production of times and spaces in various types of circulation, registration, and instruments, then one cannot attribute to life itself the timing that is due in large part to the biologists’ and evolutionary theorists’ practice.²⁴ There is a huge difference between a snail in Lake Neuchâtel and the same snail inside Piaget’s collection. The first is more like the female traveler of my anecdote: it is a suffering body among suffering bodies, lacking instruments to register its suffering, its metamorphoses, its mutations, and all the risks it dares take to stay alive. It is only the second, inside a range of other snails of slightly different colors and shapes, that will begin to register, through the invention of a new form of synopticity, its mutations in relation to the changing environment, itself represented by colors, labels, lengths on millimetered paper. As Stephen Jay Gould has so beautifully demonstrated, one cannot explain the history of life without taking into account the history

²²Albert Einstein, *Relativity: The Special and the General Theory, a Popular Exposition* (London: Methuen, 1920).

²³Jean Piaget, *Biologie et connaissance: essai sur les relations entre les régulations organiques et les processus cognitifs* (1967; Neuchâtel: Delachaux et Niestlé, 1992).

²⁴See, for instance, the marvelous study of Robert E. Kohler, *Lords of the Fly: Drosophila Genetics and the Experimental Life* (Chicago: University of Chicago Press, 1994), and the examples gathered in *The Right Tools for the Job*, ed. Clarke and Fujimura.

of the life sciences.²⁵ The leap from archives and collections, instruments, and natural history museums to the aim of life itself is a sure route to failure—to the fallacy of granting all living organisms a “way of life,” an obsession with constancy, a mad search for structures, a fixation on conservation that might well be characteristic of Swiss watchmakers, train managers, record keepers, and bank collectors, but that cannot, at least without more research, be attributed to snails, stomachs, brains, children, and non-Swiss mathematicians. One can be allowed to forget, for a moment, that smooth displacement in time and space is paid for, somewhere else, by other people; but not forever. Time may “pass like nothing” inside a Swiss train compartment, but a good test of this notion’s validity outside the train might be to jump off the TGV at full speed.

The environment in which Piaget’s thought developed ought, as Fernando Vidal has shown, to have produced an entirely different kind of intellectual stance.²⁶ If naïve contextualists are to be believed, a biologist born in Neuchâtel, who worked for many years in the natural history collections of a rich country of bankers and clockmakers, crisscrossed by trains, cars, trucks, and planes, and who would become fascinated by the exploring behavior of children, by the extent of their material manipulations and their reliance on social interactions, *should* have come to argue that societies, children’s peer groups, and scientific disciplines are so many time-producing collectives. He should have seen how our concepts rely on material, social, and practical mediations, and how close children’s controversies are to scientific controversies. Struck by the extravagant ethnocentrism of most psychology, Piaget would have become the founder of “cognitive anthropology,” revealing the gap that exists between practical cognitive cultures (as Edwin Hutchins has recently shown in his important book),²⁷ and, going much further, he would have founded as well the study of what times and what spaces suffering biological bodies trace on their own terms. And yet, as we all know, Piaget’s heroic effort was to eliminate from the mind, from the production of science, from ontogenetic development, from the history of science, and finally, especially in *Biology and Knowledge*, from the history of life itself, any trace of history, of time-producing practice.

The constancy of Piaget, during a long career, in seizing any occasion, in all the many domains in which he worked, to turn virtualities into potentialities (in Deleuze’s and Isabelle Stenger’s sense)—his constant erasure of time and practice—is stun-

²⁵Stephen Jay Gould, *Wonderful Life: The Burgess Shale and the Nature of History* (New York: W. W. Norton, 1989)—the full title should not be overlooked.

²⁶Fernando Vidal, *Piaget Before Piaget* (Cambridge: Harvard University Press, 1994).

²⁷See Hutchins, *Cognition in the Wild*.

ning.²⁸ Potentiality is the realization “in time” of what was already there *in potentia*. Time unfolds determinations but nothing really happens, just as it is possible to calculate all the positions of a pendulum from its initial position without the actual fall of the pendulum adding new information. The same is true of development, if development is understood as the unfolding of potentialities: a problem that Piaget tackled twice, in regard to the growth of mollusks and with reference to child intelligence. Virtuality is something altogether different; it depends on the fifth dimension I defined above, which makes space and time dependent on process, on the intensity with which *other* types of surprising actants are connected. The question is thus to decide whether time is the realization of potentialities, or whether time emerges from the eliciting, the educating, of virtualities, of surprising differences.

Piaget's insistence on turning virtualities into potentialities requires an explanation that I am not equipped to find but that, I am sure, will interest social historians of ideas. My own guess is that theology must have played a major role. Piaget's theorizing has all the timelessness of a secularized Protestantism. Contrary to the general assumption, theologians are often more rationalist than epistemologists are, largely because theologians imagine that God has something to do with the same time and space as the one produced by immutable mobiles, except that He is “beyond.” But, since theologians (like train travelers and epistemologists) do not focus on the work of producing those mobiles but only on its result, they take isotopy and isochrony as features of the world. They commit, to use Heidegger's language, the sin of metaphysics. Thus, they have no alternative but to consider God as an entity beyond space-time, in a transcendent other world. If one wishes, like the young Piaget, to maintain the ahistoricity supplied by this God of beyond and above but wishes, at the same time, to distance oneself from the embarrassing baggage that accompanies Christian theology, one solution is to make certain that this world itself has all the constancy, formalism, and ahistoricity that characterize the world “beyond.”

That enterprise somewhat resembles the experiment by which absolute zero is to be reached by progressively slowing down the motion of atoms. The fusing of psychology, history, logic, mathematics, pedagogy, and life itself creates a confined space in which Piaget's extraordinary trial can take place: the slowing down of history, the slow replacement of virtualities by potentialities, the transformation of process into the actualization of constants—it is one of the most daring scientific enterprises of a century already rich in such endeavors, an attempt to ensure that nothing unanticipated or untoward happens, that every step is regulated according to schedule, that ontogeny recapitulates phylogeny, that this world is as well-regulated as the lost other world, that accounts and balances are always kept in spite of all imbalances, that constancy is forever maintained in spite of the turmoil of history and its world wars, that capitaliza-

²⁸Isabelle Stengers, *Au nom de la flèche du temps: le défi de Prigogine*, *Cosmopolitiques*, vol. 5 (Paris: La Découverte, 1997).

tion goes on for ever without either loss or expenditure. Piaget's timelessness is the paradoxical timelessness of clockmakers, ideal for an army of passive defense, for a world that runs smoothly like clockwork, where trains, colleges, and classrooms run on time, a world where nothing happens. *The mind without time*: a magnificent experiment to show in relief what has been missed so far in discussions about timing, spacing, and acting.