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The perfection of analysis: extracts & commentaries

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Laplace: no more to be desired than the perfection of analysis (1796)

SOURCE

Pierre-Simon Laplace. *Exposition du Système du Monde*, Paris, 1796.

Translation of passage found in J. Lequeux. *Le Verrier: Magnificent and Detestable Astronomer*. Springer, 2013.

SETTING

Newtonian mechanics ruled the day and there were no experimental anomalies and confidence in its infallibility of a natural law was growing.

EXTRACT

In the midst of the infinite variety of phenomena that evolve continually in the heavens and on the earth, we have arrived at unraveling the small number of general laws that matter follows in its movements. Everything in nature obeys them; everything follows from them with the same necessity as the return of the seasons; the curve followed by the light atom that the wind carries away by chance is regulated in the same definite manner as the orbits of the planets…. Geometers … have at last reduced all of mechanics to general formulas that leave nothing to be desired but the perfection of analysis.

COMMENT

If you think we have all the fundamental laws of nature down and the rest is just a matter of perfecting analysis, you are not alone. Laplace was sure of that too … in 1796, as we saw in the above extract.

In contrast to this Laplacian outlook of naive and supreme confidence in the theory were views of people like Leibniz who 80 years earlier, in correspondences with Clarke [3], outlined his philosophical objections of Newtonian mechanics. In Leibniz's view, Newtonian theory assumed absolute spatial coordinates, whereas there can only be relational dynamics. The Leibnizian outlook, and criticism of Newtonian theory, was well grounded. It took about two hundred years for others to fully appreciate Leibniz's objections.

Newton himself had philosophical issues with his own theory too, in particular the implicitly assumed action-at-a-distance nature of Newtonian mechanics. In his letter to Bentley in 1692 he said,

"It is inconceivable that inanimate Matter should, without the Mediation of something else, which is not material, operate upon, and affect other matter without mutual Contact…That Gravity should be innate, inherent and essential to Matter, so that one body may act upon another at a distance through a Vacuum, without the Mediation of anything else, by and through which their Action and Force may be conveyed from one to another, is to me so great an Absurdity that I

believe no Man who has in philosophical Matters a competent Faculty of thinking can ever fall into it. Gravity must be caused by an Agent acting constantly according to certain laws; but whether this Agent be material or immaterial, I have left to the Consideration of my readers." [4]

And yet, we still had statements, like the one above from Laplace over a hundred years later, maintaining that Newtonian mechanics is nature's theory of mechanics, and you just have to get used to the fact that we are done. There is nothing else to do except perfect analysis. You can imagine the gallery of innocents saying, "Look, Newtonian mechanics is *RIGHT*. There is no experiment that shows it to be wrong, after more than a hundred years of observations. All your objections are just *useless and sterile philosophical objections*. You can drop more stuff from towers; you can smash more things together; you can watch more orbits; and you can say violations of the theory are 'just around the corner', but you're just wasting your time and our money."

We know that the first real experimental crack in the Newtonian standard model of mechanics came in 1859 [2], although it took much longer to be fully accepted as a problematic find within science. Newtonian mechanics held on. As we know, Einstein, who ultimately upended Newtonian mechanics, was devoted to investigating "philosophical soft spots" in the theory. He was not motivated by experimental anomalies, such as Le Verrier's anomalous perihelion precession of Mercury, which had more mundane interpretations, such as an unseen new planet, that did not threaten the underlying theory.

The Laplacian outlook that has confidence in the completeness of current basic science knowledge has never been a good bet in history, and I am not aware of any compelling argument that we live in a very special time where such confidence is suddenly warranted.

Besides the Laplacian Outlook and the Leibniz/Einstein Outlook, there is also a third kind of outlook. I will call it the Hamlet Outlook, calling to mind Hamlet's admonition to Horatio:

"There are more things in heaven and earth, Horatio,

Than are dreamt of in our philosophy." [5]

Hamlet, the ever dithering, ever ineffectual being, has no outlook except cowering in the face of fate and the mysteries of what might happen next. If Hamlet were a theoretical physicist today he would mope around, staring only at experimental web pages, maybe chasing a few anomalies here and there, drinking himself into a stupor when they turn out to be statistical fluctuations, yapping that we can never know anything except the pings and bings of experimental apparatuses (which, don't get me wrong, are *extremely* important), and having very weak opinions about what could be revealed by experiment in the future, which of course he takes no role in shaping or planning. Those with the Hamlet outlook are worse than those with the Laplacian outlook since they do little and create no new ideas. At least Laplacians do something, often doing impressive calculations within the standard theory of the day, even if they have the wrong overall outlook, and might accidentally contribute to progress.

Nevertheless, the Laplacian outlook will always lose, you can count on it. It might take ten years, it might take thirty years, or it might take more than two centuries, as was the case for Newtonian mechanics, but it will lose. And taking on the Hamlet outlook means you will never

contribute, but you might have some fun fighting others with swords. Now, wouldn't you rather be a Leibniz or an Einstein, even if it takes everybody else a decade or even a century to catch up, and even if you might fall short in the end?

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[3] Clarke, Samuel. *A Collection of Papers, which passed between the late Learned Mr. Leibniz, and Dr. Clarke, In the Years 1715 and 1716.* James Knapton Press, London, 1717.

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[5] Shakespeare, William. *Hamlet.* First Folio, 1623.

H.G. Wells: scientific people know that time is only a kind of space (1895)

SOURCE

H.G. Wells (1866-1946). *The Time Machine*. 1895.

SETTING

The “Time Traveler,” as he is referred to in the novel, is explaining to a group of esteemed acquaintances his conceptualization of time as a fourth dimension, which according to him is the first step toward understanding that going back and forth in time is no different than going back and forth in space.

EXTRACT

Filby became pensive. “Clearly,” the Time Traveller proceeded, “any real body must have extension in four directions: it must have Length, Breadth, Thickness, and Duration. But through a natural infirmity of the flesh, which I will explain to you in a moment, we incline to overlook this fact. There are really four dimensions, three which we call the three planes of Space, and a fourth, Time. There is, however, a tendency to draw an unreal distinction between the former three dimensions and the latter, because it happens that our consciousness moves intermittently in one direction along the latter from the beginning to the end of our lives.”

“That,” said a very young man, making spasmodic efforts to relight his cigar over the lamp; “that . . . very clear indeed.”

“Now, it is very remarkable that this is so extensively overlooked,” continued the Time Traveller, with a slight accession of cheerfulness. “Really this is what is meant by the Fourth Dimension, though some people who talk about the Fourth Dimension do not know they mean it. It is only another way of looking at Time. There is no difference between Time and any of the three dimensions of Space except that our consciousness moves along it. But some foolish people have got hold of the wrong side of that idea. You have all heard what they have to say about this Fourth Dimension?”

“I have not,” said the Provincial Mayor.

“It is simply this. That Space, as our mathematicians have it, is spoken of as having three dimensions, which one may call Length, Breadth, and Thickness, and is always definable by reference to three planes, each at right angles to the others. But some philosophical people have been asking why three dimensions particularly—why not another direction at right angles to the other three?—and have even tried to construct a Four-Dimensional geometry. Professor Simon Newcomb was expounding this to the New York Mathematical Society only a month or so ago. You know how on a flat surface, which has only two dimensions, we can represent a figure of a three-dimensional solid, and similarly they think that by models of three dimensions they could represent one of four—if they could master the perspective of the thing. See?”

“I think so,” murmured the Provincial Mayor; and, knitting his brows, he lapsed into an introspective state, his lips moving as one who repeats mystic words. “Yes, I think I see it now,” he said after some time, brightening in a quite transitory manner.

“Well, I do not mind telling you I have been at work upon this geometry of Four Dimensions for some time. Some of my results are curious. For instance, here is a portrait of a man at eight years old, another at fifteen, another at seventeen, another at twenty-three, and so on. All these are evidently sections, as it were, Three-Dimensional representations of his Four-Dimensioned being, which is a fixed and unalterable thing.

“Scientific people,” proceeded the Time Traveller, after the pause required for the proper assimilation of this, “know very well that Time is only a kind of Space. Here is a popular scientific diagram, a weather record. This line I trace with my finger shows the movement of the barometer. Yesterday it was so high, yesterday night it fell, then this morning it rose again, and so gently upward to here. Surely the mercury did not trace this line in any of the dimensions of Space generally recognised? But certainly it traced such a line, and that line, therefore, we must conclude, was along the Time-Dimension.”

“But,” said the Medical Man, staring hard at a coal in the fire, “if Time is really only a fourth dimension of Space, why is it, and why has it always been, regarded as something different? And why cannot we move in Time as we move about in the other dimensions of Space?”

The Time Traveller smiled. “Are you so sure we can move freely in Space? Right and left we can go, backward and forward freely enough, and men always have done so. I admit we move freely in two dimensions. But how about up and down? Gravitation limits us there.”

“Not exactly,” said the Medical Man. “There are balloons.”

“But before the balloons, save for spasmodic jumping and the inequalities of the surface, man had no freedom of vertical movement.”

“Still they could move a little up and down,” said the Medical Man.

“Easier, far easier down than up.”

“And you cannot move at all in Time, you cannot get away from the present moment.”

“My dear sir, that is just where you are wrong. That is just where the whole world has gone wrong. We are always getting away from the present moment. Our mental existences, which are immaterial and have no dimensions, are passing along the Time-Dimension with a uniform velocity from the cradle to the grave. Just as we should travel down if we began our existence fifty miles above the earth’s surface.”

“But the great difficulty is this,” interrupted the Psychologist. ’You can move about in all directions of Space, but you cannot move about in Time.”

“That is the germ of my great discovery. …”

COMMENT

This novel was written in 1895, well before Einstein's theories of relativity (1905/1916) and before Minkowski's 1908 formalizations of spacetime, with time being a fourth dimension on more or less equal footing as the spatial dimensions. However, there had been earlier discussions about the fourth dimension, and also thinking of time as that extra dimension, by others, including Lagrange, Kant, Riemann, and perhaps most relevant to H.G. Wells, the popularizing British mathematician Hinton. Wells does not mention any of these people in his novel, and he is of course too simplistic with the analogies. Nevertheless, it is a particularly eloquent and passionate advocacy for time being viewed as the fourth dimension by a brilliant novelist.

Nietzsche: blessed are the scholars (1882)

SOURCE

Friedrich Nietzsche. *The Gay Science* [*Die fröhliche Wissenschaft]*, 1882.

SETTING

The Gay Science is one of Nietzsche's most interesting books. It is mostly an ode to free thinking, the scientific mindset and rigorous intellectual approach to life.

EXTRACT

Almost always the books of scholars are somehow oppressive, oppressed: the "specialist" emerges somewhere—his zeal, his seriousness, his fury, his overestimation of the nook in which he sits and spins, his hunched back; every specialist has his hunched back. Every scholarly book also mirrors a soul that has become crooked; every craft makes crooked.…Nothing can be done about that. Let nobody suppose that one could possibly avoid such crippling by some artifice of education. On this earth one pays dearly for every kind of mastery.…For having a specialty one pays by also being the victim of this specialty. But you would have it otherwise—cheaper and fairer and above all more comfortable—isn't that right, my dear contemporaries. Well then, but in that case you also immediately get something else: instead of the craftsman and master, [you get] the "man of letters," the dexterous, "polydexterous" man of letters who, to be sure, lacks the hunched back—not counting the posture he assumes before you, being the salesman of the spirit and the "carrier" of culture—the man of letters who really is nothing but "represents" almost everything, playing and "substituting" for the expert, and taking it upon himself in all modesty to get himself paid, honored, and celebrated in place of the expert.

No, my scholarly friends, I bless you even for your hunched back. And for despising, as I do, the "men of letters" and culture parasites. And for not knowing how to make a business of the spirit. And for having opinions that cannot be translated into financial values. And for not representing anything that you are not. And because your sole aim is to become masters of your craft, with reverence for every kind of mastery and competence, and with uncompromising opposition to everything that is semblance, half-genuine, dressed up, virtuosolike, demagogical, or histrionic in litteris et artibus—to everything that cannot prove to you its unconditional probity in discipline and prior training.

COMMENT

Most of the serious experts in the world have zero tolerance for the wide-ranging generalists ("polydexterous men of letters") in the world. Their inadequacies are too transparent to them. Generalists are often the ones put in charge of companies, universities, and governments — in other words, the bosses — which brings additional scorn and resentment. Great scholars are crooked, and damaged, and mistreated, but they have something the generalist will never have: the incomparable satisfaction of attaining "mastery and competence" and of belonging to the

proud guild of scholars who see and understand what few others ever will. Well, I think there is some exaggeration by Nietzsche with these sentiments, since it takes a lot of different types of people to make this big world of ours, but it does let off a little “scholarly steam” for those feeling under appreciated at times.

Gaddis: historians are more like natural scientists than social scientists

SOURCE

John Lewis Gaddis. *The Landscape of History*. Oxford University Press, 2002.

SETTING

While on sabbatical at Oxford, the eminent Cold War historian from Yale, John Gaddis, decided to give lectures on the methods of historical research. The resulting book is somewhat philosophical in nature. One of the key points he makes is that historians are more like natural scientists than social scientists, in that natural scientists and historians share the same conviction that there is no such thing as a big independent variable that must be found to account for the phenomena, but rather an ecology of variables that jointly feed into a complex system that may even be chaotic. As part of this argument he mounts several attacks on reductionist-oriented social scientists. The extract below is one such volley.

EXTRACT

Students in the social sciences are often told to proceed “as if” these anomalies had not happened. Saving the *theory* is what’s important: it doesn’t matter if doing so “smooths out,” or even flattens, the facts. What this means, though, is that the social sciences are operating — by no means in all instances, but in many — at roughly the level of freshman physics experiments [with idealized, artificial set-ups]. That’s why the forecasts they make only occasionally correspond with the reality we subsequently encounter.

…. Hence, when social scientists are right, they too often confirm the obvious. When they don’t confirm the obvious, they’re too often wrong.

COMMENT

From the perspective of a distant scientist there might not seem to be a whole lot of light between an historian and a social scientist. However, as the extract above suggests, there can be deep divisions between the two once you get closer. The attack on social scientists fits into Gaddis’s larger picture that historians are much more like natural scientists (especially cosmologists, paleontologists, etc.) than social scientists.

More broadly speaking, the book is interesting reading in that he explains the methodologies of natural science in order to make a more positive likeness argument that historians are more similar to natural scientists. I do not agree with all the characterizations, but it is quite clever and fascinating nevertheless.

Finally, another relevant point Gaddis makes in the book is that reflection on the methods in one’s field (what are your deeper goals and how do you propose get there) is a necessary exercise that all should do. I believe this to be true among physicists as well. There needs to be more reflection on goals and especially methods within physics — not just on short-term goals

and the tactical methods to get there, which is rather easy, but also on the long-term grand goals and the strategic methods needed to get there, which is very hard, but critical to long-term success.