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NINETEENTH CENTURY CRACKS IN THE CONCEPT OF DETERMINISM

BY IAN HACKING

*Déterministe: Nom d'une secte peu connue en Allemagne et qui y a peu d'influence. Déterminisme: Système, principes, doctrine des déterministes.*¹

During the nineteenth century we witness an event that I call the erosion of determinism. At the start of the period we read Laplace, confident that all the world is ruled with the same exact necessity as is found in celestial mechanics. At the end we find C.S. Peirce (1839-1914) asserting there is no ground for believing either such a doctrine of necessity or for holding that the laws of nature are rightly represented by precise numerical constants. What he called "tychism"—the idea that we live in a Universe of Chance, became a main theme of his philosophy. Concurrently Emile Durkheim (1858-91) says that the laws of society are probabilistic in nature, and are as inexorable as the laws of gravity. Like the cosmic laws of physics, they act on us from outside of us, and are not reducible to deterministic laws nor to facts about individuals. During this erosion of determinism the once unthinkable world of chance becomes subject to laws of nature. Chance could be allowed no real existence in 1800. Even those vitalists such as Xavier Bichat (1771-1802) who, in 1800, had thought that living processes could never be predictable nor fall under uniform deterministic laws, did not think that chance itself could be a real, law-governed, and intelligible ingredient of the world. Yet by 1900 chance had been tamed and the world of irreducibly probabilistic laws of physics lay near to hand.

The present paper has three parts.

1. It states a paradoxical thesis of Ernst Cassirer that far from determinism slowly being eroded after the time of Laplace, what we call determinism was not even stated until 1872. I shall show that there are some germs of truth in this unlikely suggestion.

2. I shall sketch a silly season for determinism that culminates about 1872: just before that time there was a zany intellectual ferment in discussion of determinism and free will.

3. I shall describe in more detail a problem of what was then called statistical determinism, much vexed in those days.

My point is to illustrate a whole series of conceptual confusions, false starts, and crazy responses. I believe there is a wide-ranging intellectual mutation to which the erosion of determinism is central.

¹ *Dictionnaire de l'Académie Française*, Supplément 1836, both entries quoted in full.

We normally and rightly emphasize the development of new forces of reason, which would here be exemplified by the growing ability to master probability mathematics and statistical inference. This does in fact occur after about 1872. But we should not forget the darker side of unreason that underlies the fragmentation of old concepts and their replacement by new ones.

The Cassirer Thesis.—Laplace's dictum is well known: "All events, even those which, by their insignificance, seem not to follow from the great laws of the universe, follow from them just as necessarily as the revolutions of the sun."² Cassirer says that when Laplace wrote these words, they were "hardly more than an ingenious metaphor."

The idea that the metaphor should be endowed with a wider meaning and validity, that it should be made the expression of a general epistemological principle, occurred in a much later period, and its date can be established quite definitely.³

The date is 1872, the source, a once famous speech by Emil Du Bois-Reymond (1818-96), German physicist, chemist, and neurophysiologist. It was delivered in Leipzig to a German scientific and medical association. He spoke "On the limits of the knowledge of nature." The lecture went through many editions and struck many a spark. It was intensely debated in German journals and daily papers. After quoting Laplace, Du Bois-Reymond gives his own sonorous rendition:

A mind which should know for a given very small period of time the position and movement of all the atoms in the universe, would also necessarily be in a position to derive from these, in accordance with the laws of mechanics, the whole past and future. It could, by an appropriate treatment of its world-formula, tell us who was the Iron Mask, or how the "President" came to grief. As the astronomer predicts the day on which, after many years, a comet again appears in the vault of heaven from the depths of space, so this 'mind' would read in its equations the day when the Greek cross will glitter from the mosque of Sophia, or when England will burn its last lump of coal.⁴

Du Bois-Reymond was a man of wide learning who contended that in the future the history of science must form the basis of human education and culture. He was a great pioneer who, with Brücke and Helmholtz (1821-94), held that the workings of the brain will be fully

² Pierre Simon de Laplace, *A Philosophical Essay on Probabilities*, trans. F.W. Truscott and F.L. Emory (New York, 1951), 3.

³ Ernst Cassirer, *Determinism and Indeterminism in Modern Physics* (New Haven, 1956; translated from the German of 1936), 6.

⁴ Emil Du Bois-Reymond, *Ueber die Grenzen des Naturerkennens* (Versammlung Deutscher Naturforscher und Aerzte, 14 August 1872) in *Reden von Emil Du Bois-Reymond* (Leipzig, 1886, Erste Folge, 105-140), 107.

understood by the theory of electricity. It was not unusual for him to go out on a limb. You may well imagine that once, when he dismissed Goethe as neither a great scientist nor a literary giant, he aroused some hostility. His 1872 lecture represented an opinion that had been forming steadily over 30 years. He had always contended that physiology and neurology are to be investigated by physical means, chemistry and electricity, but in the lecture he allowed that two matters transcend the realm of human knowledge: the nature of human consciousness and the freedom of the will. No amount of knowledge of the brain can in the end resolve either difficulty. Even the most perfect "Laplacian" science will fail to account for freedom, which yet remains a real felt fact. The grounds for controversy are evident. Materialists, vitalists and theologians were all offended in their own ways. According to Cassirer (see n.3 above) this is the first time in history that our modern concept of determinism was brought into the open and subjected to scrutiny.

Cassirer's claim is a veritable paradox. The great modern philosophical encyclopedias in English, German, French, and Italian all use their articles on determinism to take us back to the ancient world. Each has its own favorite list of determinists for the modern era. Hobbes is a regular member for the seventeenth century, while La Mettrie and Holbach star in the eighteenth. What with Laplace and such a long train of predecessors, how can Cassirer advance his thesis?

There are some feeble answers. For example the late English philosopher, J. L. Austin, was once asked, "There is more than one distinct doctrine of determinism, do you not agree, Professor Austin?" "No," he answered tartly, "less than one."⁵ Cassirer might be telling us that a particularly interesting kind of determinism becomes current in 1872. Or he might be saying that before 1872 there was never such a clear concept of determinism as is elucidated by Du Bois-Reymond. But I propose to treat Cassirer quite seriously, as holding that a fundamental transition occurred in 1872. Just when I say determinism was rapidly being eroded, he says that it is being invented or at least universalized and made literal for the first time.

The Word "Determinism" — The article "Determinism" in the *Dictionary of the History of Ideas* begins by telling us that "the English word 'determinism,' like its French, German, and Italian counterparts, is of seventeenth- and eighteenth-century coinage."⁶

⁵ I owe the anecdote to G.E.M. Anscombe.

⁶ Alan Donagan, "Determinism," *Dictionary of the History of Ideas*, 5 vols. (New York, 1972), II, 18. The article rightly distinguishes "two different, but related doctrines. One, the doctrine that choice between different courses of action can, in all cases, be fully accounted for by psychological and other conditions. . . . The other . . . is the doctrine that everything that happens constitutes a chain of causation." The word is used in the first sense in the 1780s but I doubt that it is used in the second sense until the 1850s at earliest.

That sounds right because of our confidence that determinism is an old idea. But consider the curious quotation with which I began this paper, from the supplement to the dictionary of the French Academy, 1836. That is the first French dictionary entry for the word. It implies “determinism” is faring poorly in the French language even by 1836.

In fact the word first appears in German as *Determinismus*. The word is sufficiently known in 1789 to appear in the title of a philosophical tract.⁷ Kant first used the word in his book on religion of 1793; in a footnote he refers to it as a neologism and a bad one at that.⁸ He jeers at it as a *blindwerk*. He says that if the unnamed users of the word must invent something new, they should use *Praedeterminismus*. The concept which the word is intended to express concerns solely the domain of the mind and human choice. *Determinismus* is the doctrine that the will is entirely determined by its prior states and motives. Hence we are not free to choose what we do decide because earlier states of mind determine how we shall decide. Note that this has little to do with the Laplacian notion. To use the terminology of Cartesian dualism, Laplace speaks only of extended substance, of trajectories of the smallest particles moving in space. *Determinismus* is an idea about the operations of mental substance.

The *Oxford English Dictionary* cites the Scottish metaphysician, Sir William Hamilton (1788-1856), as first using the word in 1846.⁹ Hamilton was imbued with German philosophy and he explicitly contrasts determinism, which is necessitation by final causes (purposes or motives) and what he calls blind fate, or necessitation by efficient causes. Thus the Laplacian doctrine would, for Hamilton, be more like blind fate than “determinism.” Hamilton correctly represents the tenor of German use of the word in the 1830s, for example in Sigwart.¹⁰ The OED is not good on the first uses of philosophical words, particularly because it discounts works of translation or semi-translation. Roland Hall drew my attention to A.F.M. Willich, whose 1798 account of Kant’s philosophy for English readers includes a glossary with the entry:

⁷ Christian Wilhelm Snell, *Ueber Determinismus und moralische Freiheit* (Offenbach, 1789). The first citation in the new Grimm (6 Band, 5 Lieferung, Leipzig 1974) is the 1790 occurrence in George Foster, *Geschichte der Englischen Literatur von Jahre 1789*. Reprinted in *George Fosters Werke* (Berlin, 1967), VII, 87. Grimm has a 1788 citation for *Determinist*.

⁸ Immanuel Kant, *Die Religion innerhalb der Grenzen der blossen Vernunft* (Königsberg, 1793).

⁹ *The Works of Thomas Reid*, ed. William Hamilton (London, 1846), 87n.

¹⁰ H.C.W. Sigwart, *Das Problem von der Freiheit und der Umfreiheit* (Tübingen, 1839), 21. This would also be the standard style of definition in, for example, W.T. Krug, *Allgemeines Handwörterbuch der philosophischen Wissenschaften* (Leipzig, 1832).

Determinism is the principle of determining the will from sufficient internal (subjective) reasons. To obtain this principle with that of freedom, i.e., absolute spontaneity, occasions no difficulty.¹¹

In short, the word “determinism” does not occur in German or English until the very end of the eighteenth century, and then it is not used in the sense attached to it by Du Bois-Reymond. I am less confident about French. The word occurs in 1811 in a French version of Gall and Spurzheim’s phrenology.¹² The acerbic words of the 1836 supplement, quoted at the head of the present essay, make pretty plain that the word has not caught on.

All French scholars will immediately associate the word *déterminisme* with Claude Bernard, and in particular with his immensely influential 1865 *Introduction to the Study of Experimental Medicine*.¹³ Bernard certainly gave vigorous currency to the word. He used it in a rather active sense. Compare our English word “mechanism.” That has been used as the name of the doctrine that everything is caused by mechanical means. But we also speak of the mechanism of a watch, i.e., that which actually brings about the movement. “Déterminisme” for Bernard denotes that which actually does the determining, although he also holds, as a doctrine that came to be known as *Déterminisme*, that there is such a determining for every physiological event.¹⁴ This is in part an anti-vitalist opinion.

Bernard is not the first French writer to put the word into popular use. Indeed Bernard thought the philosophers used it merely to mean fatalism, thus ignoring the active element in his use of the word.

The word occurs often enough in the prolific work of Charles Renouvier (1815-1903), a philosopher of great energy. His house

¹¹ A.F.M. Willich, *Elements of the Critical Philosophy* (London, 1798), 154. On 159 “fatalism” is reserved for some version of Spinoza’s idea. Roland Hall has extracted many other philosophical neologisms from this text; see *Notes and Queries*, 212 (1967), 190-92.

¹² F.J. Gall and G. Spurzheim, *Des dispositions innées de l’âme et de l’esprit du matérialisme, du fatalisme et de la liberté morale, avec des réflexions sur l’éducation et sur la législation criminelles*. (Paris, 1811), 55. Incidentally many of the debates about statistical determinism were prefigured in the debates as to whether the various “penchantes” of the phrenologists limited freedom of the will. Gall and Spurzheim took a line similar to that pursued by Quételet thirty years later.

¹³ Claude Bernard, *Introduction à l’étude de la médecine expérimentale*, (Paris, 1865), *passim*.

¹⁴ For the first sense, “Le médecin expérimenteur exercera successivement son influence sur les maladies dès qu’il en connaît expérimentalement le déterminisme exact, c’est à dire la cause prochaine,” 376. For the second sense, “La critique expérimentale met tout en doute, excepté le principe du déterminisme scientifique.” 303. For a hostile account of Bernard’s claims to have introduced the word, and for a critique of his doctrine of *déterminisme*, see the article “*Déterminisme*” in A. Dechambre, *Dictionnaire encyclopédique des sciences médicales* (tome 28, 1883), 435-49.

journal, largely written by himself, was *La Critique philosophique*. It appeared almost weekly between 1871 and 1885 until it settled down to a more leisurely monthly publication. As the title indicates, it is French neo-Kantianism. He favored a *phénoménisme*, i.e., Kant purged of noumena.

The second volume of Renouvier's *Essais critiques générales* was first published in 1859 and has for its proposed topics, "reason, passion, liberty, probability and moral certainty." It is full of occurrences of our word.¹⁵ It is less common in the first volume of 1854, but there we do find mention of the famous problem "du libre arbitre et du déterminisme."¹⁶ Moreover in a somewhat different context, later in the book, Renouvier explicitly quotes Laplace.¹⁷ Now Renouvier's statement of the forms of determinism, to which I shall return, is less explicitly "modern" than that of Du Bois-Reymond. But the very quotation of Laplace refutes Cassirer's suggestion that Laplace's determinism was completely ignored until 1872. On the other hand, I think Cassirer has directed our attention to a curiosity. Somewhere, let us say between 1854 and 1872, the concept of determinism acquired its modern sense in all the European languages. This adds some credibility to the improbable claim of Cassirer that the very concept of determinism comes into being at that time.

A more modest statement of what was happening may be found in William James, who gave us the nice terms "hard" and "soft" determinism. The soft determinist thinks that free will and determinism may be reconciled, while the hard determinist rejects free will. James began his famous lecture, "The Dilemma of Determinism" by saying that "*We see in the writings of Renouvier, Fouillée and Delbouef how completely changed and refreshed is the form of all the old disputes*"¹⁸ about free will. One of his early essays was a review of the second edition of Renouvier's *Essais critiques*,¹⁹ so in 1876 James is using the word "determinism" in his review. Renouvier published James in his house journal. In his 1904 presidential address to the American Psychological Association, James declared his debts to

¹⁵ Charles Renouvier, *Essais de critique generale*. Deuxième essai. *L'Homme: la raison, la passion, la liberté, la certitude, la probabilité morale*. Paris, 1859; e.g., 190f, 335ff, 347ff, 397, 461.

¹⁶ *Ibid.*, Première essais (Paris, 1854), 247.

¹⁷ *Ibid.*, 589.

¹⁸ William James, "The Dilemma of Determinism," first published in *The Unitarian Review* of 1884, and reprinted in *The Will to Believe and Other Essays in Popular Philosophy* (New York, 1897), 10. In a footnote for the latter printing, after Delboeuf he adds, "And I may now say Charles S. Peirce; see *The Monist* for 1892-93" (cf. my note 32 below).

¹⁹ William James, in *Nation*, 22 (1876), 367-69; reprinted in *Collected Essays and Reviews* (New York, 1920), 26-35.

Renouvier.²⁰ One debt is surely his usage of the word "determinism."

The *OED* gives 1876 as the first occurrence of this modern use, defined as "the doctrine that everything that happens is determined by a necessary chain of causation." This is doubtless too late. In a discussion of 11 February 1873, to which I shall return, James Clerk Maxwell (1831-79) used the word in its modern sense.²¹ By 1870 it seems to have become fixed in the language, but it was not so in 1860. In 1865, J.S. Mill grudgingly made use of the word which he took from Sir William Hamilton.²² Such clusterings around a date do no harm to the Cassirer thesis. Of course, absence of a word never proves absence of the corresponding idea. In his 1873 discussion Maxwell spoke interchangeably of "the opinion of Necessity" and "Determinism." That name, "The doctrine of necessity," is a standard phrase of eighteenth-century discussions of free will. Moreover Holbach called himself a "materialist" and La Mettrie a "mechanist" and I would not discount those authors as propounding versions of "modern" determinism.

Finally there is the fact that cognates of the word "determinism" do occur even in the seventeenth century. This is strikingly illustrated by the fact that Erdmann's 1840 edition of Leibniz includes the word "determinism" in the index. Now the word does not occur in Leibniz's texts themselves, but we do find ample use of "determination", "déterminé", and the like, in contexts connected with fatalism. I believe the case can be made that these usages are different from the modern sense of the word distinguished by the *OED* and implicitly noticed by Cassirer. They have more to do with the idea of definiteness, of something having a determinate value, than with a necessary chain of causation. Full exploration of such niceties of language would lead us further afield. We are, in the light of these complex verbal

²⁰ William James, "The Experience of Activity," *The Psychological Review* XII (1905); reprinted in *Essays in Radical Empiricism* (New York, 1912), 155-88. "I should like to say that such an interpretation of the pages I have published on Effort and on Will is absolutely foreign to what I meant to express. . . . I owe all my doctrine on this subject to Renouvier." For an acknowledgement of James's general indebtedness to Renouvier, cf. *Some Problems of Philosophy* (New York, 1911), 164f. This last book was dedicated to Renouvier, "feeling endlessly thankful as I do."

²¹ James Clerk Maxwell, "Does the progress of Physical Science tend to give any advantage to the opinion of Necessity (or Determinism) over that of the Contingency of Events and the Freedom of the Will?" A talk given 11 February 1873 to the Eranus club (of former members of Cambridge "Apostles"). Printed in L. Campbell and W. Garnett, *The Life of James Clerk Maxwell* (London, 1882), 483-89.

²² J.S. Mill, *An Examination of Sir William Hamilton's Philosophy* (London, 1864), Chap. XXVI. Mill is rude about Hamilton's alleged confusions of Necessity, Materialism and "the fairer name of Determinism" which is, for Mill, evidently a neologism. See *Collected Works of John Stuart Mill* (Toronto, 1979), IX, 439n. and 463n.

facts, entitled only to the modest proposition that Cassirer has enunciated.

But even if we do not quite agree with Cassirer, let us grant that he has directed our attention in an unexpected direction. At the very least we shall say with James that in the 1860s the old discussions are completely changed and refreshed. Yet I am not so sure "refreshed" is quite the right word. Just at that period very serious and clever people start producing a whole range of completely queer but new arguments about determinism. I believe this to be another aspect of Cassirer's thesis.

Laplace — Before proceeding to the silly season for determinism, we must reconsider the case of Laplace. Was his celebrated determinist dictum only a metaphor, as Cassirer has it? I think not. It occurs, of course, in the work on probability, not the celestial mechanics, but it is used on quite a few different occasions throughout the whole of Laplace's creative life. The purpose, I believe, is to assert that in the physical realm there is no such thing as chance. Chance, as Hume had put it, is a matter of hidden and secret causes. Indeed that philosopher is at one with the applied mathematician, writing in his *Treatise* of 1739:

'Tis universally acknowledged, that the operations of external bodies are necessary, and that in the communication of their motion, in their attraction and mutual cohesion, there are not the least traces of indifference or of liberty. Every object is determin'd by absolute fate to a certain degree and direction of its motion.²³

As in the case of Leibniz, we note even the very verb "determin'd." But Hume quite explicitly writes of external bodies in this connection, and not of mental events. Likewise Laplace implicitly refers only to external bodies. If we are to save the thesis of Cassirer, we should not hold fast to his feeble claim that Laplace wrote only metaphorically. Instead let us guess that Laplace was not fully dissociated from a kind of dualism. In the world of extended substance, of external bodies, everything is "determined." That entirely leaves open the question of mental substance. Even Kant found his place for freedom in the world of mental substance, although he uses the terminology of noumena. Perhaps that is why he was so offended by the

²³ David Hume, *A Treatise of Human Nature* (London, 1739-40), Book 2, Part 3, Section 1. I owe this reference to Thomas Baldwin. My distinction between determinism in extended substance, and determinism or *Prædeterminismus* in the mind is not anachronistic but was discussed early in the nineteenth century, for example in James Gregory, *Letters from Dr. James Gregory in defence of his essay on the difference of the relation between motive and action and that of cause and effect in physics, with replies by the Rev. Alexander Crombie* (London, 1819).

neologism of “Determinismus” which, he said, ought to be “Prae-determinismus.” *Determinismus* was invoked for a prior determination of motives in the mental realm, parallel to that of causes in the physical realm. Now Laplace did write about human freedom, but few of his ideas seem to have survived. It is possible that current research by Professor Roger Hahn of Berkeley will tell us Laplace’s views on freedom. In the meantime we can let the Cassirer thesis fit the available phenomena. It was possible for Laplace, like Kant and Hume, to be a determinist about external bodies but not about the mind.

At this juncture Du Bois-Reymond’s own branch of science becomes of central importance. He was an electroneurologist, a member of the 1847 Berlin group that proclaimed it would never allow merely mental causation in the study of the brain. The 1872 lecture was a confession of doubt, of limitation about that program. Central to the program was an out and out materialism: everything mental is to be understood in terms of the material. Du Bois-Reymond was no dualist. Nor, to all intents and purposes was his French counterpart, the physiologist Bernard, who gave our word prominence in French. It is precisely the explicit materialism and the medical investigation of the human mind and body by chemical and electrical means which generated the new form of determinism.

Indeed, let us recall that the hegemony of determinism had never been absolute. There were always those students of the human body, and of living matter in general, called vitalists. They rejected the Laplacian dictum from the start. In 1795 Laplace gave his famous introductory lectures on probability that became his *Essai philosophique sur les probabilités*. Laplace told his audience that for a being with sufficient knowledge of general laws, and a temporal slice of the universe, everything else would be completely predictable. In lectures in the School of Medicine across the street, Xavier Bichat (commonly called the founder of histology) was to reject all of that:

We calculate the fall of a heavy body, the motion of the planets, the course of a river, the ascension of a projectile, and so forth: the rule being once found, it is only necessary to make the application to each particular case. Thus heavy bodies fall in a series of odd numbers; attraction is in the inverse ratio of the squares of the distances, and so on. On the other hand all the vital functions are susceptible of numerous variations. They are frequently out of their natural state; they defy every kind of calculation, for it would be necessary to have as many rules as there are different cases. It is impossible to foresee, predict or calculate anything with regard to their phenomena.²⁴

Bichat and other vitalists deny calculation more than determinism. Du Bois-Reymond speaks of calculation only as a corollary of deter-

²⁴ X. Bichat, *Anatomie générale appliquée à la physiologie et la médecine* (Paris, 1801), 51; my translation.

minism, but it is a materialist, anti-vitalist determinism that embraces atoms, stars, body and brain. Although having a different perspective, antivitalist Bernard is also in the same camp. For Du Bois-Reymond, the mind works by electrical forces acting on parts of the brain. Hence Laplace's words become directed to mental as well as to physical substance.

That is a speculative vindication of the Cassirer thesis. It must remain only a partial thesis because earlier mechanists and materialists had surely prefigured many aspects of the determinism of 1872. All the same, the appearance of the word "determinism" (in common use for the first time in French and English) and with its new sense in German add weight to the Cassirer thesis. So too does the sudden flurry of new arguments which I shall now describe.

Saint-Venant and singular solutions—Adhemar Jean Claude Barré de Saint-Venant (1797-1886) was in his day thought to be one of the greatest of mathematicians. He was a great atomist, and worked on the theory of point forces. Karl Pearson (one of the founding fathers of the biometric approach to statistics and author of among other things the chi-squared test for goodness of fit) was when young charged with posthumously editing Isaac Todhunter's *History of the Theory of Elasticity*. (In 1865 Todhunter [1820-84] had done a comparable history of probability, which remained the standard for a century, and is still a good reference.) Pearson rebelled against and to some extent changed the planned structure of Todhunter's text. He also decided to devote a separate volume to the work of Saint-Venant, because he thought the work would prove so fundamental to physics.²⁵ Saint-Venant, for example, was on the verge of solving the mathematics which would bear on the central issue of the day, whether the aether is rigid or elastic. His wide range of ingenious results turned out never to be at the forefront of science, but they are still remembered in various applications, for example in fluid dynamics.

Saint-Venant may have been riding the wrong horse, but he was a man of genius. He and his pupil Boussinesq were fascinated by the investigation of singular solutions of certain fundamental equations. Very roughly speaking, by inserting different values arbitrarily close to zero, one would produce enormously different effects. This, said Saint-Venant, is how free will intersects with a completely mechanistic universe. (There is more than a whiff of catastrophe theory in this research.)

In the 1873 paper alluded to above, Clerk Maxwell states just this

²⁵ Isaac Todhunter, *The Statistical Researches of Barré de Saint-Venant*, (Karl Pearson, ed.) Cambridge, 1889. This is Chap. X of *A History of the Theory of Elasticity and the Strength of Materials from Galilei to the Present Time* (Cambridge, 1893), vol. II, Part I, 1-287.

solution to the problem of free will. He adds, however, that “singular points are by their nature very isolated, and form no appreciable fraction of the continuous course of existence.”²⁶ C.W.F. Everitt, the experimental physicist and Maxwell scholar, suggested to me that Maxwell had in mind his great personal difficulty in choosing which of two women to marry: a singular point in his life, but a rare one. In the recently published lectures on the history of probability which Karl Pearson gave 50 years ago, Pearson says, “I hold a letter of Clerk Maxwell in which he states” of Saint-Venant and Boussinesq “that their work on Singular Solutions is epoch-making” on account of its being “the great solution to the problem of freewill.”²⁷

This story exemplifies several things. First, here is a completely new idea. Secondly, it is embraced by some of the most powerful minds of the age. Thirdly, it appears to involve mind and matter in a new and intimate way: singular solutions about atomic point forces will create just the empty spot at which to locate human freedom. Fourthly, this idea is completely crazy: it tries to fit a square peg of human freedom into the round hole of singular solutions. When great minds took to a new but crazy idea, we may suspect their very thinking about a concept was undergoing a lot of stress. I contend that the stress in the concept of determinism was as widespread as could be. Indeed in his fascinating discussion on that evening of February 1873, Maxwell laid before his friends his own worries about the relation between the statistical and the dynamic conception of both human being and of matter, referring alike to statistical mechanics and to Henry Buckle, the great proponent of statistical determinism in history, whom I discuss at the end of this essay.

Renouvier and the law of large numbers — The name “law of large numbers” is still used loosely in probability theory, although there are now so many different theorems that one needs better names, which usually clump around what we now call the central limit theorem. S.D. Poisson introduced the name “law of large numbers” in 1835, and it plays a major role in his probability analysis of decisions by jury.²⁸ He reminds us of the theorem of James Bernoulli, published in 1713. It tells us the connection between the probability of a kind of event, and the probable results of repeated trials. For example, the

²⁶ *Op. cit.*, 444, note 21.

²⁷ Karl Pearson, *The history of statistics in the 17th and 18th centuries against the changing background of intellectual, scientific and religious thought*, ed. E.S. Pearson (London, 1978).

²⁸ S.D. Poisson, “Recherches sur la probabilité des jugements principalement en matière criminelle,” *Comptes rendus hebdomadaire des séances de l’Académie des Sciences* (Paris, 1835), I, 473-97, “Note sur la loi des grands nombres,” (*ibid.*, II, 1836), 377-82. *Recherches sur la probabilité des jugements en matière criminelle et en matière civile, précédés de règles générales du calcul des probabilités* (Paris, 1835).

relative frequency of occurrences of that kind of event on repeated trials tend to p with probability approaching 1. That explains one kind of statistical stability, as when we model throws of a die as having a constant probability $1/6$ of giving an ace. But in real life we have statistical regularities in which the probability of an event on repeated trials is not constant. I shall elaborate towards the end of this paper how, with the blossoming of published statistics after 1820, people were much impressed by the regular stability in rates of crime, suicide, divorce, as well as the old familiars of birth and death. Poisson tried to model mathematically how one could have stable probabilities of mass phenomena even when the probabilities for individuals are not constant. It took a long time for his work to be properly understood, but he did indeed prove that under certain restrictions, even when the probability at repeated trials is variable, in the long run the average relative frequency does converge on p , the average probability for individual trials. It is one of the tricks that probability plays on our intuition, that in fact the tendency to stability is greater when p is variable than when p is constant.²⁹ Thus, as was also noticed empirically by mid-century, rates of crime and so forth are more stable in a smaller population than are rates of mortality.

Our industrious friend Renouvier writes of the law of large numbers,³⁰ but exemplifies something different from Saint-Venant. Renouvier is a philosopher of very modest mathematical ability attempting to lift from current mathematics something to use in his epistemology and metaphysics. In fact he did not understand the point of Poisson's law of large numbers. He is to be forgiven this. Even Bienaymé, a distinguished probabilist and interested in the same problems as Poisson, failed to understand Poisson's theorem, and, after Poisson's death, said the grand old man had simply made a mistake.³¹ Renouvier's use of the law of large numbers remains instructive to the philosopher interested in crackpot ideas.

Renouvier's overall strategy was to show what we might call an antinomy between free will and determinism. The idea is that any argument for determinism can be turned into one for free will, and vice versa. Renouvier gave a large number of examples of this, but I mention only one.

The determinist says that there manifestly are fixed natural laws all around us, to which the indeterminist can say that these may be only the consequence of the law of large numbers applied to a collection of

²⁹ For an excellent brief historical and mathematical survey of this work, see C.C. Heyde and E. Seneta, I.J. Bienaymé, *Statistical Theory Anticipated* (New York, Heidelberg, and Berlin, 1977), Chap. 3.

³⁰ *Op. cit.*, notes 15, 16 above. For example, in the 1854 essay, 246; in the 1859 essay, 344.

³¹ I.J. Bienaymé, "Sur un Principe que M. Poisson avait cru découvrir et qu'il avait appelé loi des grands nombres," *Comptes rendus de l'Académie des Sciences Morales et Politiques* (Paris, 1855), XI, 379-89.

free acts. This is because viewed externally, a free act is indistinguishable from a ticket in a lottery. The law of large numbers teaches that absolute regularity emerges in a long run of draws. Hence deterministic regularity can be explained on the basis of freedom.

Renouvier next attacks the determinist who holds that there must be a deterministic explanation of each alleged free act, based on a multiplicity of complex causes. I have remarked that Renouvier quoted the Laplacian dictum on determinism as readily as Du Bois-Reymond. His attitude to it is, however formed from this philosophical position of antinomy. Laplace's "exposition of principles," he wrote, "entirely conforms to the spirit of science, or, perhaps better, to the spirit of scientists, all or almost all of whom are quite ready to avow or reproduce this principle. You find a clear and concise notion of probability (the same that I develop in my categories) but disfigured by a profession of faith in necessity, which seems to me, at the very least, useless and in consequence arbitrary."³² He then made the standard positivistic move, saying that just as final causes have been eliminated from science, so must we eliminate efficient causes too.

Renouvier thus illustrates the philosopher taking snippets of current science and weaving them into a thoroughly new form of a traditional free will antinomy. In terms of direct influence he is important. He rehearsed many of the arguments that appear, in more cogent form, 35 years later when Charles S. Peirce re-examined the doctrine of necessity. But whereas Renouvier was attempting a philosophical construct, a Kantian antinomy derived from contemporary science, Peirce is content to use one side of the arguments to demolish determinism.³³ I cannot positively assert that Peirce got these ideas from Renouvier. We do know that William James was the only person who well recognized the genius of Peirce, and was his chief Cambridge supporter. I have remarked already on James's close contacts with Renouvier. Another French contact is Émile Boutroux, a younger man whose doctoral work was published in 1875.³⁴ This study on the contingency of laws of nature is one of the better elaborations of the notion that laws of nature are themselves in evolution. The laws that shall organize a higher level of organization shall not be determined entirely by what has evolved for a lower one. The atoms may not fix the laws for organic compounds. The laws for those compounds may

³² *Op. cit.*, note 17 above.

³³ C.S. Peirce, "The Doctrine of Necessity Examined," *The Monist*, II (1892), 321-37. Reprinted in *The Collected Papers of Charles Sanders Peirce*, eds. C. Hartshorne and P. Weiss (Cambridge, Mass., 1960), VI, 28-45.

³⁴ Émile Boutroux, *De la Contingence des lois de la Nature* (Paris, 1874). Cf. Mary Jo Nye, "The Boutroux Circle and Poincaré's Conventionalism," *Journal of the History of Ideas*, 40 (1979), 107-20. She tells me there also remains an ample correspondence between Boutroux and William James.

not fix the laws of biology, for the biological forms evolve only later. The biological may not determine the psychological, nor the psychological the social. Precisely this form of emergentism is cast into sharper form in one of the central ideas of Peirce, who used the fact that laws of nature of any complexity are not predetermined by laws of nature for simpler structures.³⁵ He put emergentism together with ideas of statistical mechanics, to form a new and vigorous indeterminism.

Statistical indeterminism—Having provided two examples of the way in which scientific results were somewhat zanily imported into the free will debate, I now pass to a longer-lived example that is far closer to the evolution of probability. There was a confused idea in circulation in the 1930s that quantum indeterminacy would provide room for free will. Statistical determinism is the exact opposite: when the laws of the world turn statistical, the elbow room for free will is diminished, if not eliminated.

The idea of law-like regularities in the ratios of birth and death is an old one, widely known after the publication, for example, of John Graunt's 1662 analysis of the London Bills of Mortality. What of regularities in the moral domain, where we appear concerned with the choices freely made by individuals? The eighteenth-century French economists were sure that there must be economic laws as rigid as Newton's celestial mechanics. It was increasingly understood that this must have something to do with probability, and it was foreseen that stable empirical frequencies would be essential to any study of law in the moral sciences. This became the popular wisdom of the intelligentsia. Thus by 1790 Madame de Staël noted the stability of divorce rates in certain Swiss cantons and inferred that these indicate laws in the moral realm.³⁶ Yet any such reflections are patchy until there are systematic published data. Only in the 1820s did Paris and the department of Seine begin to publish statistics for the hospitals, suicides, crimes and so forth. In 1825 the French department of justice began its judicial statistics, counting and classifying kinds of crime and rates of conviction. Then began an avalanche of printed numbers. Before then, only Scandinavia had any systematic tabulations of social facts, and although the data collected by Lutheran pastors have proven a godsend for twentieth century historians of demography, their potential was hardly realized at the time. But after the 1820s Belgium, England and Wales, France, Holland, Scotland and the Italian and German states arose in a frenzy of counting and publishing numbers about the moral order: crime, suicide, marriage, divorce, prostitution.

³⁵ C.S. Peirce, "Evolutionary Love," *The Monist*, III (1893), 176-200, Reprinted in *Collected Papers* (op. cit. n.32), VI, 190-215.

³⁶ Madame de Staël, *De l'influence des passions sur le bonheur des individus et des nations* (Lausanne, 1796), reprinted in *Oeuvres*, (Paris, 1820), III, 10.

After a few years it looked as if there were remarkable stabilities. Even if the quantity of deviancy was increasing at a terrifying rate, its distribution was uniform, so that the proportion of Frenchmen who committed suicide in the several months followed a sinusoidal curve; the proportion who used carbon monoxide inhalation as opposed to swallowing a poison was stable. The ratio of the different methods of suicide in different countries was equally striking. The English, for example, preferred hanging and drowning to the French poisoning.

By 1828 Adolphe Quételet announced a theme that would exercise even the popular imagination for fifty years: "The terrifying exactness with which crimes reproduce themselves."³⁷ Quételet was to become the most influential popularizer of the bureaucratic practice and the systematic science of statistics. We know in advance, "how many men will bloody their hands with violent murders, how many will be counterfeiters, how many poisoners, just as one can enumerate in advance the births and deaths that will occur in a given year."³⁸ Or again in 1832:

We have a sort of French national budget of the scaffold, whose regularity is, without doubt, more reliable than the French financial budget.³⁹

Ten years later it was realized that there was more stability in the moral domain than in procreation and mortality, and, as I have remarked, it was beginning to be suspected that there might be a mathematical reason for this. There was a fascination with the fact that although "nothing would seem more to escape foreknowledge than murder,"⁴⁰ in fact the frequency distribution of kinds of murders, and instruments used, is amazingly stable. It was inferred that "the annual crime rates are a necessary consequence of our social order,"⁴¹ and could be changed only by amending the social order itself.

Society prepares the crimes and the guilty person is only the instrument . . . the victim on the scaffold is in some way an expiatory victim of society.⁴²

³⁷ A. Quételet, "Recherches statistiques sur le Royaume des Pays-Bas" (1828), 27. Reprinted in Quételet's *Journal*, *Correspondances mathématiques et physiques* (1829), V, 117-87. Quételet published prodigiously and often repetitively. A truly definitive summary and synthesis of his work is in Joseph Lottin, *Quételet, Statisticien et Sociologue* (Louvain and Paris 1912).

³⁸ A. Quételet, *Ibid.*, 35.

³⁹ A. Quételet, "Recherches sur le penchant au crime aux différents âges, *Nouveaux Mémoires de l'Académie Royale de Belgique* (1832, presented 1831), VII, 20.

⁴⁰ *Ibid.*, 79.

⁴¹ A. Quételet, "Sur la possibilité de mesurer l'influence des causes qui modifient les éléments sociaux." Lettre à M. Villermé, *Correspondances mathématiques et physiques* (1832), VII, 344.

⁴² *Ibid.*, 346.

This obsession with crime is not peculiar to the statisticians, for the great cities were more conscious of crime than today's New York. The new industrialized cities created not a crime wave but a typhoon. Nor was crime the only field in which statistical stability seemed to rise above individual horrors; there was suicide too, and sickness, epidemics, and death. Less terrifying, but just as stable, were the facts of marriage and divorce, so that there must also be an economy of love and hate.

Such observations created something of a crisis. To quote one author among many, d'Angeville wrote in 1836 that "the moral order falls in the domain of statistics . . . a discouraging fact for those who believe in the perfectibility of human nature. *It seems as if free will exists only in theory.*"⁴³ Quételet rightly replied that we do not have to deny that free will applies to individuals, so long as we agree that it has no influence when we consider social phenomena in a general way. His model came from mechanics, for he was himself first an astronomer. Statistical stability resembles the way in which changes internal to a system may leave its center of gravity unmoved. As the astronomers say, there may be perturbations in the system, but then it returns to equilibrium, a model which Quételet applied to the revolutionary periods of 1830 and 1848.⁴⁴ Such loose analogies were woven in with Poisson-style laws of large numbers and a conception of the Gaussian curve of errors (the so-called Normal law of probability much admired by Quételet) which was thought to be the product of a large number of irregular tiny causes smoothed out over the long run.

These conjectures [about the stability of crime and other social pathologies] which appear sinister to many people, are in fact deducible from the first principles of probability.⁴⁵

The project was to show that irregularity—and "hence" freedom for individuals—not only was consistent with but actually entailed large scale uniformity. No such deduction was ever published but it provided a standard source of problems. One required a mathematical explanation of the facts of stability in order to destroy the ogre of determinism. After all, suicide is a mortal sin, the worst, for it is the only one from which one cannot repent. If the proportion of suicides in an arrondissement is fixed, is it not determined that so many will kill themselves next year? How then can they be free? Quételet and

⁴³ A. D'Angeville, "Influence de l'âge sur l'aliénation mentale et sur le penchant au crime," *Bulletin de l'Académie Royale* (1836), III, 184-85. Compare his *Essai de la statistique de la population française, considéré sous quelques uns de ses rapports physiques et moraux* (Bourg, 1836).

⁴⁴ E. Gossart, *Adolphe Quételet et le prince Albert de Saxe-Cobourg* (Brussels, 1919).

⁴⁵ A Quételet, "Sur la constance qu'on observe dans les nombres des crimes qui se commettent," *Correspondances mathématiques et physiques* (1830), VI, 214.

the rest strove to prove they could be free, and yet the population necessarily would exhibit the statistical regularity. A great tradition of probability mathematics arises from this kind of problem: Poisson, Bienaymé, Lexis, Bortkeiwicz, Czuber, and even Poincaré. It provides an essential core for understanding a good deal of the history of mathematical probability, but here I reflect on the ramifications in social philosophy.

One of the most important books of the 1850s was Henry Thomas Buckle's *History of Civilization in England*, intended as a mighty introduction to the history of civilization which he never lived to complete.⁴⁶ Here was a man whose knowledge was deemed encyclopedic even by the highest standards of Victorian learning, who was the lion of the London Season when his book was published in 1857, when he was 36, and whose book instantly took hold in every European language. It is a massive work about historical determinism. I cannot excel the 11th edition of the *Encyclopedia Britannica* in summarizing one of the three chief theses in its entry on Buckle:

While the theological doctrine of predestination is a barren hypothesis beyond the province of knowledge, and the metaphysical doctrine of free will rests on an erroneous belief in the infallibility of consciousness, it is proved by science, and especially by statistics, that human actions are governed by laws as fixed and regular as those which rule the physical world.

Maxwell, in the discussion to which I have already alluded twice said that "The statistical method of investigating social questions has Laplace for its most scientific and Buckle for its most popular expounder."⁴⁷ The gentlest, wisest refutation of Buckle's statistical determinism is provided by John Venn, the logician, economist, and student of probability.⁴⁸ The most practical is briefly given by William Farr, the brain of the Registrar General's office for England and Wales, and architect of much modern statistical bureaucracy. In his introductory address to the International Statistical Congress held in London three years after Buckle had made his triumphal debut, he agreed that the laws are deterministic:

⁴⁶ H.T. Buckle, *History of Civilization in England* (London, 1857). There were, for example, German editions in 1859, 1864, 1868 and 1871. Quételet in turn quotes Buckle at length in his *Physique Sociale* (Bruxelles, 1869), I, 139-45.

⁴⁷ *Op. cit.*, note 21 above, 438.

⁴⁸ John Venn, *The Logic of Chance* (London, 1866), 355-70. After quoting Buckle's determinism, Venn writes, "The above passage as it stands seems very absurd and would, I think, taken by itself, convey an extremely unfair impression of the author's ability. But the views which it expresses are very prevalent, and are probably increasing with the spread of statistical information and study." What follows, an exposure of Buckle's fallacy in reasoning, is a noble triumph of logic over rhetoric. It does not bear abridgement here. It should be read by anyone tempted by statistical determinism.

Despite the accidents of conflagration, the unstableness of winds, the uncertainties of life and the variations in men's minds and circumstances, on which fires, wrecks and deaths depend, they are subject to laws as invariable as gravitation, and fluctuate within certain limits, which the calculus of probabilities can determine beforehand . . . This holds of crimes and other acts of the will, so that violation itself is subject to law.⁴⁹

Yet Farr, a resource man for the great philanthropic and utilitarian reformers, did not succumb to Buckle's fatalism.

Shall a system of fatalism be built upon this foundation . . .? No, for statistics has revealed a law of variation.

Thus far he speaks like Quételet. But in addition we, the good governors, can change the boundary conditions:

Introduce a system of ventilation into unventilated mines, you substitute one law of accidents for another . . . As men have the power to change the conditions of life, and even to modify their race, they have the power to change the current of human actions within definite limits which statistics can determine.

Our task as bureaucrats is to see how *we* can change the conditions under which *they*, the workers, or especially those called *les misérables*, shall fulfill the laws of their existence. Perhaps it took an artist to understand the nature of utilitarian philanthropic statistics. Dickens' finest novel, *Hard Times*, is a tract against utilitarianism and statistics ("stutterings" as the heroine wonderfully calls them in a great passage). The horrendous Gradgrind has taught in his school the doctrine of statistical law. By the end of his novel his horrid son, Tom, has become a thief.

"If a thunderbolt had fallen upon me," said the father, "it would have shocked me less than this."

"I don't see why," grumbled the son. "So many people are employed in situations of trust; so many people, out of so many, will be dishonest. I have heard you talk, a hundred times, of its being a law. How can *I* help laws? You have condemned others to such things, Father. Comfort yourself!"⁵⁰

At a lower level, statistics had become a joke. Thus in a performance of 16 March, 1861, at the Paris Vaudeville:⁵¹

⁴⁹ William Farr, *The Fourth Session of the International Statistical Congress* (London, July 16, 1880), 4-5. In the text below I refer to "les misérables"—this is a standard heading for papers at these statistical congresses. The model is not Victor Hugo but Eugène Sue.

⁵⁰ Charles Dickens, *Hard Times* (London, 1854), Book III, Chap. VII.

⁵¹ Eugène Labiche et Edouard Martin, *Les Vivacités du Capitaine Tic, comédie en trois actes* (Paris, 1861).

Magis: Statistics, Madame, is a modern and positive science. It sheds light on even the most obscure facts. Thus recently, thanks to laborious research, we now know the exact number of widows that crossed the Pont Neuf during 1860.

Horace, rising: Bah.

Desambois: This is prodigious. And how many?

Magis: Thirteen thousand, four hundred and ninety eight, plus one doubtful case.

Magis, later in the play, offers a *Monographie de statistique comparée* in the standard style of this immense supposedly utilitarian literature.

In Germany the debate on statistical determinism was taken up by a series of writers, starting with Engel in 1852.⁵² In 1859, Wappaüs, in a book on general populations statistics, went through the whole Quételet debate on statistical determinism.⁵³ In 1864 the young economist, Adolf Wagner was sufficiently taken with these ideas to present a vivid version of such determinism.⁵⁴ His intent, I suspect, was only to repeat Farr's vision of the way in which the legislator will change the boundary conditions of the immutable statistical laws that govern the behavior of people. Wagner was, however, taken up by a generation of German philosophers who were discussing the free will problem anew, under the aegis of neo-Kantianism. Several minor figures did take the view that the new statistics was the final proof of philosophical determinism. So they had to be countered in turn, and they were met by a series of heated rebuttals, of which the most important was due to M.W. Dröbisch. He had already reviewed Quételet unfavorably for his mistaken philosophical assumptions, and in 1867 wrote a tract against Wagner and every other statistical determinist. There is however an unnoticed empirical difference between Dröbisch and Quételet. Quételet had some reason to think that human statistics betray an amazing stability. Dröbisch, writing later, and with more data, can see that this just is not true—there are many domains of wide variation. Thus it was that the German mathematicians of the late nineteenth century were the first to devise mathematical tests of dispersion and goodness of fit. This important mathematical work arises from the intersection of philosophical qualms and richer empirical data.

The French school of social statistics had tended to think of populations acted upon from the outside, subject to some law of nature which imposed itself on individuals. That seems to create some sort of a problem of free will. Durkheim's social realism, and his doctrine

⁵² G. Engel, *Die Bewegung der Bevölkerung in K. Sachsen* (Berlin, 1852).

⁵³ K.M. Wappaüs, *Allgemeine Bevölkerung Statistik* (Freiburg, 1859).

⁵⁴ A. Wagner, *Statistische-anthropologische Untersuchungen der gesetzmässigkeiten in den scheinbar willkürlichen menschlichen Handlungen* (Hamburg, 1864), cf. 44f.

of sociological laws, is the culmination of this tradition. But the subsequent German school proceeded from within, assigning variable probabilities to individuals, and providing mathematical models which show how large scale homogeneity is the result of local heterogeneity, Poisson and Bienaymé had begun this idea, but it was left for German mathematicians to complete it. An account of that work leads on to some central aspects of probability mathematics, and provides a curious example of how good mathematics can be stimulated by social and even moral problems.

Conclusion — Cassirer was wrong to say that our modern universal body-and-mind causal determinism reared its head for the first time in 1872, but he pointed to a remarkable ferment in the concept of determinism that reached a climax at about that time. The very word “determinism” became generally current in French and English just before then, and in German it attained Cassirer’s sense of the word during the same period. The literature has been full of zany arguments in which bits of mathematics of physics were pulled down from the shelf to make room for freedom of the will.⁵⁵ Buckle, whom we have largely forgotten, turned the whole of history into the evolution of statistical determinism. Exactly ten years later, a much more famous work by Marx would speak of “the natural laws of capitalist production . . . of these tendencies winning their way through and working themselves out with iron necessity.”⁵⁶ I believe that Cassirer almost inadvertently pointed to a period of tumult and chaos in thought about necessity and determinism. He was right to say that something new was afoot, but it was not merely a clear concept of determinism. It was an event that went hand in hand with the taming of chance. By the 1870s statistical workers were for the first time able to regard chance as an autonomous aspect of the world and subject to mathematical analysis. Chance could go into the regular modelling of aspects of the world, as well as become a tool of inference.⁵⁷ Instead of a blemish caused by ignorance, the most famous distribution of chances, the Gaussian or Normal curve, would be, in the words of Francis Galton, “the law . . . which reigns with serenity and in complete self-effacement amidst the wildest confusion . . . the supreme law of Unreason.”⁵⁸ Thus at the very moment that Cassirer’s concept

⁵⁵ M.W. Dröbisch, *Die moralische Statistik und die menschliche Freiheit* (Leipzig, 1867).

⁵⁶ Karl Marx, *Das Kapital* (Hamburg, 1867), Preface to the first edition.

⁵⁷ F. Galton, *Natural Inheritance* (London, 1889), 66.

⁵⁸ I. Hacking, “The Autonomy of Statistical Law,” *Pittsburgh Studies in Philosophy* (California, 1983), ed. N. Rescher, a volume of papers given in 1980-81. For an overview of the research of which these papers form a part, see my “How Should We Do the History of Statistics?” *I&C* no. 8, (Spring, 1981), 15-26 (A semi-annual magazine available from Burchell, *I&C*, Westminster College, North Hinksey, Oxford, England).

of determinism came into being, fully structured, chance was becoming tamed. If we understand determinism in a larger sense, so that it embraces Laplace, Holbach, La Mettrie, and perhaps Hobbes, then just when Cassirer's concept was fully definite, the erosion of determinism was fully under way, and we were about to enter a "Universe of Chance."

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