THE SPECTACLE OF THE GROWTH OF KNOWLEDGE AND SWIFT'S SATIRES ON SCIENCE

BEAT AFFENTRANGER

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Let others censure, let others laugh, I will not.

Richard Jackson in defence of the Royal Society, 1669

The Spectacle of the Growth of Knowledge and Swift's Satires on Science

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Beat Affentranger
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ABSTRACT

This is a revisionist study of seventeenth- and eighteenth-century satires on science with an emphasis on the writings of Jonathan Swift and, to a lesser degree, Samuel Butler and other satirists. To say, as some literary commentators do, that the satirists attacked only pseudo-scientists who failed to employ the empirical method properly is to beg a crucial question: how could the satirists possibly have distinguished the genuine scientist from the crank? By a failsafe set of Baconian principles perhaps? No, the matter is more complicated. I read the satiric literature on early modern science against a totally different understanding of what science is, how it came into being, and how it developed.

Satire has a decided advantage over scientific discourse. It can rely on common sense; scientific discourse often cannot. There is always a counter-intuitive element in the genuinely new. New knowledge is in some ways always at odds with received assumptions of what is possible, reasonable, or probable. Satire on science, I suggest, can be seen as a systematic exploitation of that gap of plausibility. Natural philosophers of the late seventeenth- and early eighteenth-century were keenly aware of their discursive disadvantage and at times even hesitated to publish their material. They feared the satirists and the wits, who they knew would find it easy to debunk their work on commonsense grounds. But commonsense and laughter are unreliable yardsticks for measuring scientific merit.

Ironically, the satirists and the natural philosophers *shared* some of the most fundamental epistemological assumptions of early English empiricism, for instance, the stereotypical Baconian assumption that knowledge about nature would come to us unambiguously once the mind was freed from preconception and bias. It is an assumption about scientific method that is decidedly hostile towards speculative hypothesising. Indeed, the motto of the day was not bold speculation and learning from error, but *avoiding* error at all costs. Yet in practice, error (or what appeared to be erroneous) was of course frequent; for science is an essentially speculative enterprise. Natural philosophers of the early modern period, however, were embarrassed by their failures and tried to explain them away. The satirists, on the other hand, could prey on

these mistakes and conclude that the work of the natural philosophers was purely speculative. The reason for this rigid, anti-speculative epistemological stance, I argue, was a religious one, having to do with the conception of nature as a divine book that could be read like Scripture.

This conflation of the epistemological and the theological is especially obvious in Swift. In both his satirical and non-satirical writings, he is obsessed with proposing proper standards of interpretation, and with criticising those whom he thought had corrupted these standards. Dissenters and religious enthusiasts are taken to task for their misreading of Scripture, for their corrupt religious doctrine which they erroneously claim to be based on Scripture and reason. The natural philosophers are accused of some similar hermeneutic sin; only, they have committed their interpretive transgressions against the proper interpretive standard of the book of nature. Where the natural philosophers claim to have found a new, more accurate way of reading the book of nature, Swift, I argue, sees only *mis*-readings. Rhetorically, Swift's satires on religious dissent perpetuate the typically Tory High-Church insinuation of sectarian and heretical sexual promiscuity. In his satires on science, Swift makes the same insinuation with respect to natural philosophers, most vividly so in *A Tale of a Tub* and the flying island of *Laputa.* The study concludes with a fresh look at Swift's rational horses in part four of *Gulliver's Travels*.

INTRODUCTION

SCIENCE, SATIRE, AND THE ARGUMENT OF THIS STUDY

There have been a number of attempts to come to grips with Swift and science, starting with Marjorie Nicolson's most memorable contribution, "The Scientific Background of Swift's Voyage to Laputa," in the 1930s. But despite of three hundred years of hindsight, commentators disagree on what these texts can offer in terms of criticism on science. For Miriam Starkman, for example, they are now only of "antiquarian interest to us."[1] In the same vein, Clive Probyn diagnoses in Swift a "self-indulged myopia" towards "the practical aims and values of the natural sciences of his day."[2] Others are more positive and see in Swift's alleged enmity towards the new thinking a visionary almost prophetic anticipation of all the evils of Modernity: Swift "foresaw the ruin to come, Democracy, Rousseau, the French Revolution; that is why he hated the common run of men...."[3] These are words of W.B. Yeats's "Swift student" in the play *The Words Upon the Window-Pane*. For other commentators Swift even foresaw the specific evils and problems of present-day science and technology. Kenneth Craven tells us that Swift's satires on science were "satires of modern information technology."[4] For many scholars, however, Swift's chief object is not science as a whole. Ehrenpreis's list of potential targets of *A Tale of a Tub* (1704), for instance, comprises a wide range of activities he self-consciously subsumes under the name of pseudo-sciences.[5] The real thing (i.e. genuine science), Ehrenpreis assumes, is not at stake. Almost two hundred years earlier, in 1755, Deane Swift made a similar observation: "DR. SWIFT has laughed egregiously in the voyage to *Laputa*, and exerted a vein of humour, not against the whole tribe of chymists, projectors, and mathematicians in general; but

1 Starkman, *Swift's Satires on Learning* (1950), 86.
2 Probyn, *Jonathan Swift*: *The Contemporary Background* (1978), 145.
3 Yeats, *Plays by W.B. Yeats*, 942.
4 Craven, *Jonathan Swift and the Millennium of Madness* (1992), 11.
5 Ehrenpreis, *Swift* (1962-83), I,192.

against those, and those only, who despise the useful branches of science, and waste their lives in the pursuit of aerial vanities and extravagancies."[6] And in *Swift's Anatomy of Misunderstanding* (1981), a book dedicated entirely to epistemological aspects of Swift's writings, Frances D. Louis solves the problem of Swift's satiric intent once and for all: In *A Tale of a Tub* and in *Gulliver's Travels*, she claims, Swift attacks all "unreasonable" forms of thought and behaviour both religious and scientific. As in Ehrenpreis, true science remains unharmed.[7] For Louis, it is not Bacon that is up for discussion but the crank pretending to be Bacon, a "booby playing Bacon," as she puts it.[8]

I do not here want to weigh the blessings of science against its curses, or to determine where Swift and other satirists were right, and where they were wrong. It is simply anachronistic to blame the satirists for not having foreseen the good in the progress of science. It is, however, equally anachronistic to give them credit for what we think has gone wrong, or to claim that they had foreseen the evil and troubles that have come to us in the wake of scientific progress down to the very problems of present day information technology. Some of the essays and chapters dealing with seventeenth and eighteenth-century satires on science are based on an understanding of science and its history that is either simplistic or downright wrong.[9] Furthermore, I am not engaged here in what Marjorie Nicolson herself once called 'source hunting'. A tremendous amount of work has been done in this field, work I can gratefully rely on. What is original about my approach to satire on science is not primarily literary but

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[6] Deane Swift, *An Essay upon the Life, Writings, and Character of Dr Jonathan Swift*, 214.

[7] Louis, *Swift's Anatomy of Misunderstanding*, xv.

[8] Louis, *Swift's Anatomy of Misunderstanding*, 52.

[9] I am aware that there is something anachronistic in the very use of the word 'science' here, or 'satire on science.' A crucial point of this study is precisely that science as we understand it today did not exist in the seventeenth century. Nor would 'natural philosophy' be a term unproblematic here. For practices referred to under this or some similar name were in the process of change, only gradually approaching what we now call 'science.' Following common practice, I shall use these terms often and almost interchangeably, "meaning in both cases nothing more than the endeavour to understand, describe or explain the workings of the physical world," Henry, *The Scientific Revolution*, 5. By 'satires on science,' consequently, I mean texts that refer in a satiric way to such endeavours.

philosophical. I read these texts against a totally different understanding of what modern science is, how it develops, and how it emerged in the seventeenth century. And as to Swift the satirist, I deny him the epistemological vantage point most commentators have been prepared to grant him.

The understanding of science and its history informing this study may be illustrated in theatrical terms. Traditionally, science has been compared with the notion of tragic fate in Greek dramatic literature; more recently—and more accurately, as I shall try to show—with Brecht's notion of 'epic theatre.' These two ways of looking at science stand for epistemologically entirely different conceptions of science.

Consider first the tragic notion of history. One of the most fundamental premises for the development of modern science was, according to Alfred N. Whitehead, the assumption of the predetermined order of nature, the assumption that nature is governed by immutable laws which are (in principle at least) intelligible to human beings. Without this trust in the order and scrutability of the physical world, it is difficult to see how people could have found it worth their while to engage in natural philosophy. Historically, then, the idea of order cannot be a product of empirical science but must have existed before it. In *Science and the Modern World* the analytic philosopher Whitehead (1861-1947) identifies two sources from which western science inherited this idea of a predetermined natural order. One source of this deterministic bias he sees, paradoxically perhaps, in the notion of tragic fate in Greek dramatic literature.[10] In the great tragedians of ancient Athens, Aeschylus, Sophocles, and Euripides, he sees the precursors of modern scientific spirit:

> Their vision of fate, remorseless and indifferent, urging a tragic incident to its inevitable issue, is the vision possessed by science. Fate in Greek Tragedy becomes the order of nature in modern thought. The absorbing interest in the particular heroic incidents, as an example and a verification of the working of fate,

[10] This is somewhat paradoxical because, following Whitehead's own argument, one should think that the notoriously wayward and capricious gods of Greek mythology would have made it impossible for the scientific spirit to emerge.

> reappears in our epoch as concentration of interest on the crucial experiments.[11]

Whitehead compares the development of science with the unfolding of the merciless chronology of events in a predetermined world. Human interference with such a rigid order is impossible in principle; if it is attempted, it ends tragically and leads necessarily to human suffering:

> Let me here remind you that the essence of dramatic tragedy is not unhappiness. It resides in the solemnity of the remorseless working of things. This inevitableness of destiny can only be illustrated in terms of human life by incidents which in fact involve unhappiness. For it is only by them that the futility of escape can be made evident in the drama. This remorseless inevitableness is what pervades scientific thought. The laws of physics are the decrees of fate.[12]

He then illustrates this "remorseless inevitableness" of scientific inquiry with an episode from a meeting of the Royal Society in London at which he was present. Einstein had predicted that rays of light would bend as they pass in the neighbourhood of a powerful centre of gravity such as the sun, a phenomenon which could not be accounted for within the framework of Newtonian physics. Years later, Einstein's speculations were verified by Astronomers of the Greenwich Observatory. In the following passage, Whitehead describes the moment when the Royal Society officially acknowledged Einstein's findings:

> The whole atmosphere of tense interest was exactly that of the Greek drama: we were the chorus commenting on the decree of destiny.... There was dramatic quality in the very staging:—the traditional ceremonial, and in the background the picture of Newton to remind us that the greatest of scientific generalisations was now, after more than two centuries, to receive its first modification. Nor was

[11] Whitehead, *Science and the Modern World*, 12.
[12] Whitehead, *Science and the Modern World*, 13.

> the personal interest wanting: a great adventure in thought had at length come safe to shore.[13]

The tradition of comparing scientific inquiry to the development of tragic fate has been very influential. Some people seem always to have found comfort in the idea of an absolutely immutable physical world; others, though, felt threatened by that sort of determinism. Already Epicurus warned that "It would be better to follow the myths about the gods, than to become a slave to the physicist's destiny. Myths tell us that we can hope to soften the gods' hearts by worshipping them, whereas destiny involves an implacable necessity."[14] Epicurus' warning has not been heeded, as we all know.

For a long time, propagandists and historians of science, as well as scientists themselves have perpetuated a very dramatic notion of science. For a long time, the history of science has been depicted as if indeed it was a series of inevitable discoveries, discoveries that were destined to happen with "implacable destiny" after the true method of scientific investigation had been invented in the seventeenth century. Once the "soil, the climate, the seeds were there," Whitehead writes, "the forest [of science] grew" steadily.[15] For the historian of science George Sarton, the "history of science is the only history which can illustrate the progress of mankind;" for "progress has no definite and unquestionable meaning in other fields than the field of science."[16] Such a view of science implies that every particular discovery is bound to be made sooner or later and that it would always be exactly the same discovery. Had, for example, gravitation not been discovered by Newton, the relativity of space and time not by Einstein, they would have been discovered by someone else, in exactly the same way. In the immensely influential tract *Science: The Endless Frontier* (1945), the physicist Vannevar Bush talks of

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[13] Whitehead, *Science and the Modern World*, 13. To be sure, Whitehead's understanding of Greek tragedy owes more to his understanding of science than vice versa. But Whitehead's (mis)readings of Greek tragedy is not my concern here. What is at stake is the dramatic conception of science he so eloquently endorses.

[14] Passmore, *Science and Its Critics*, 29.

[15] Whitehead, *Science and the Modern World*, 20.

[16] Sarton, *The Study of the History of Science*, 5.

science euphorically as an "edifice" whose form "is predestined by the laws of logic and the nature of human reasoning. It is almost as though it [science] already existed," he notes.[17] Bush's view of science is dramatic because it implies that the temporal unfolding of our knowledge of the world is fixed and inevitable. Methodologically, this means that the logic of scientific research is pre-given, too; and that research is scientific and successful to the degree researchers apply that pre-given logic. In Bush's terms, a conclusion that is scientifically sound is logically always compelling; it owes nothing to the scientist's personal deliberation but is guaranteed by the "predestined" laws of logic applied to empirical evidence. In the same vein, false science or pseudo-science is seen as a result of non-adherence to the logic of genuine science. Error in science, according to this view, is always intellectual; it always betrays a lack of mental discipline and as such is, in principle at least, always avoidable.

The second source from which modern science has inherited its deterministic bias is, according to Whitehead, medieval theology with its insistence on an all-rational God. A belief in an arbitrary, irrational, or otherwise unreliable God would not have allowed for modern science to emerge. Whitehead argues that with such a God "Any definitive occurrence might be due to the fiat of an irrational despot, or might issue from some impersonal, inscrutable origin of things."[18] In such a world natural philosophy—the attempt to discover universal laws of nature—would be pointless; hence the assumption of order and scrutability was logically necessary for the development of science. But the logician Whitehead hastens to add that this assumption was an irrational one: "I am not arguing that European trust in the scrutability of nature was logically justified even by its own theology." Whitehead, writing in the 1920s, is embarrassed that science seems never to have shaken off this irrational bias. Science "has remained predominantly an anti-

[17] Quoted from Horgan, *The End of Science*, 22. Horgan argues that "Bush's essay served as a blueprint for the construction of the National Science Foundation [U.S.A.] and other federal organisations that thereafter supported basic research on an unparalleled scale."

[18] Whitehead, *Science and the Modern World*, 16.

rationalistic movement, based upon a naive [religious] faith,"[19] he writes. Whitehead's worry is not that the assumption of order is wrong, but that it is logically not compelling and therefore wholly unsuitable as a rational basis for a logically consistent scientific rationale. Hence his urgent appeal to subject the epistemological foundations of science to thorough philosophical criticism lest science "deteriorate into a medley of *ad hoc* hypotheses."[20] Unfortunately, Whitehead does not explain why a rational unity or consistency of nature (independent of God) should guarantee a firmer ground for the steady progress of science than the "anti-rationalistic" medieval assumption of an all-rational God. What, if not the assumption of an all-rational Creator, can guarantee that the world is created in a way that is amenable to the "laws of logic and the nature of human reasoning?" Nothing. Or, if there is no rational God (or no God at all), what reason is there to believe that the future form of the "edifice" of science "is predestined by laws of logic and the nature of human reasoning?" None.

Despite Whitehead's dismissive gesture, the assumption of predetermined order behind his (dramatic) conception of science

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[19] Whitehead, *Science and the Modern World*, 20. Whitehead alludes to the physico-theologians of the seventeenth and eighteenth century, who conceived of scientific investigating largely as an uncovering of the preestablished divine order. We shall touch upon English physico-theology repeatedly in chapter 3. Physico-theology is not only an English phenomenon. For a comprehensive survey of the staggering scope of seventeenth and eighteenth-century physico-theological writings in England, Scotland, and the Continent, see Philipp, *Das Werden der Aufklärung* (1957). Many scientists were physico-theologians of sorts, throughout the eighteenth and way into the nineteenth century. So for example the Swedish taxonomist Linnaeus, who writes in 1754: "If the Maker has furnished this globe, like a Museum, with most admirable proofs of his wisdom and power; if this splendid theatre would be adorned in vain without a spectator; and if Man the most perfect of all his works is alone capable of considering the wonderful economy of the whole; it follows that Man is made for the purpose of studying the Creator's works that he may observe in them the evident marks of wisdom....;" quoted from Brook, "Why did the English Mix Their Science and Their Religion," 58. Today, traces of the physico-theological assumption mentioned by Whitehead are clearly discernible, see Hacking, "The Disunities of the Sciences."

[20] Whitehead, *Science and the Modern World*, 21. To establish such a rationalistic basis was the ambitious goal of logical positivism (e.g. Vienna Circle) in the twenties and thirties of this century—a vain enterprise, as it turned out.

can ultimately only be justified theologically with the divine book of nature. Historically, the importance of the notion of nature as a book can hardly be overestimated. Without a thorough understanding of its epistemological and methodological implications, as we shall see (chapter 3), the seventeenth and eighteenth-century debates about empirical science cannot be comprehended. Here, I am interested in the metaphor for its illustrative qualities. The idea has, as in the case of Whitehead, possessed people even in our century, tacitly at least. In one way or another, the idea of nature as a text with a coherent rationale inscribed is behind all claims to the unity of science, irrespective of the emphasis of the kind of unity that is postulated: metaphysical, logical, methodological, etc.. A famous instance of this is when Galileo writes that God wrote the book of nature in the language of mathematics. But the metaphor is also present in Vannevar Bush. For Bush the book of nature seems to be written in a language that can be deciphered by the "laws of logic and the nature of human reasoning." And for Whitehead, as already mentioned, it is the logic of a yet to be discovered scientific rationale that answers to the building plan of nature. These are all variations of the same assumption: one book, one language, and one Author. In the metaphor of the book of nature, unity is built in, even if the Author is absent. Ian Hacking, who makes this point eloquently in "The Disunities of the Sciences," suspects "that many atheistical admirers of metaphysical unity [of science] have, *au fond*, a thoroughly theological motivation." He illustrates it with the claim often made by scientists, that theories and laws are better if they are simple. On what grounds if not on religious one, Hacking asks, are we to assume that preferences founded upon aesthetics or ease of computation are more likely to be true? We would be hard put to come up with a straight answer to this question; but "Leibniz had a ready answer, that God preferred the simplest theory with the most diverse consequences; it was elegantly economical."[21]

The point here is not that in science assumptions of consistency and harmony are wrong, or bad, or that they have not proved fruitful. Historically, unification has been a success story,

[21] Hacking, "The Disunities of the Sciences," 63.

particularly in physics. But diversification of science is a fact, too. The metaphysical assumption of one book, one language, and one Author has clearly not been vindicated. In the natural sciences especially, traditional fields of study splinter into ever more specialised fields. Despite of what names like Molecular Medicine or Molecular Biology suggest, the process is clearly one of fragmentation and diversification, not of unification. Disciplines subsumed under the name Molecular Biology, for instance, do not unify chemistry and biology, nor do the different types of biologies or bio-sciences form a united superdiscipline, even though a university campus may for administrative or political purposes be structured in such a way.[22] Yet it is not only science policy or the sheer bulk of (specialised) knowledge that brings new disciplines into being or makes it necessary for traditional disciplines to be broken up in sub-disciplines. The diversification of science is also motivated by practical and methodological considerations. Research questions referring to different organisational levels of nature call for different methods, different equipment, and different research strategies—perhaps even different types or styles of reasoning. And the findings in one field cannot in any straightforward way be transferred to and integrated into the body of knowledge of other fields. To make matters worse for a proponent of a strong thesis of unity, there are fields which seem to be cut off hermetically from what would, in a reductionist sense, appear to be their neighbouring discipline. A case in point is high-energy physics and condensed matter physics. In an essay by now almost legendary, P.W. Anderson, one of the foremost condensed matter physicists, acknowledges that considerations of symmetry are of the utmost importance to physics: "It is only slightly overstating the case to say that physics is the study of symmetry."[23] But Anderson shows that in physics symmetry itself is discontinuous. There is no guarantee that symmetrical principles

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[22] See Hacking, "The Disunities of the Sciences."

[23] P.W. Anderson, "More is Different" (1972), 394. In physics, considerations of symmetry have a strong reductionist thrust: "By symmetry we mean the existence of different viewpoints from which the system appears the same. .... The first demonstration of the power of this idea may have been by Newton, who may have asked himself the question: What if the matter here in my hand obeys the same laws as that up in the sky—that is, what if space and matter are homogeneous and isotropic?" (394)

which hold on one level would hold true also on a higher or lower organisational level of matter: “a piece of matter need not be symmetrical even if the total state of it is;” or, “a really big system does not at all have to have symmetry of the laws which govern it.”[24] With respect to condensed matter physicists, this means that they cannot rely on the findings of the elementary particle physicists. “In fact, the more the elementary particle physicists tell us about the nature of the fundamental laws, the less relevance they seem to have to the very real problems of the rest of science, much less to those of society.”[25] On different organisational levels, then, matter is organised differently; on each level new phenomena may emerge which cannot be explained by reference to the properties of smaller units of matter. As a result, “High-energy physics and condensed matter physics have become essentially decoupled....”[26] Any strong reductionist hypothesis which reduces everything to simple fundamental laws (and then starts from these laws to reconstruct the universe) is therefore at least counter-factual; “the reductionist approach that has been the hallmark of theoretical physics in the 20th century is being superseded by the investigation of emergent phenomena, the study of the properties of complexes whose ‘elementary’ constituents and their interactions are [already] known.”[27] When studying such emergent phenomena, scientists may for good reasons be guided by assumptions of symmetry, simplicity, or harmony; but there is no longer the hope that such considerations can ultimately bring together fields that have become epistemologically “decoupled.”[28]

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[24] Anderson, “More is Different,” 395.

[25] Anderson, “More is Different,” 393. The last twenty years of physics have changed this statement “from a folk theorem into an almost rigorously proved assertion,” see Schweber, “Physics, Community and the Crises in Physical Theory,” 37.

[26] Schweber, “Physics, Community and the Crises in Physical Theory,” 38.

[27] Schweber, “Physics, Community and the Crises in Physical Theory,” 34.

[28] This is not to say that no fruitful exchange between two such distinct fields can take place. What is exchanged, however, is not factual knowledge that allows one field to be deduced from the other in a reductionist sense, but research strategies or analytical methods. Schweber, “Physics, Community and the Crises in Physical Theory,” 38, makes the point that today, “The commonalties of theoretical techniques used to address problems in what were different fields is a general phenomena [in science].... The interdisciplinary nature of the new communities studying these [emergent] phenomena is ... striking. The

Philosophically, the situation is messy, very messy; it is as if Whitehead's fear that science would "deteriorate into a medley of *ad hoc* hypothesis" had come true. For Ian Hacking, himself admittedly "an unabashed admirer of the great unifying physicists," "the scientific search for harmony [in physical nature] has been incredibly rewarding while the philosophical quest for [methodological and metaphysical] singleness [in science] has been in vain."[29] The kind of epistemological timidity implied in this statement is not untypical. Whereas Whitehead saw the task of philosophy in providing an universal, rational basis for all science, philosophers of science today usually resist such prescriptive attempts altogether and concentrate on the descriptive, on the analysis of how scientific arguments actually proceeded, rather than on how they ought to.[30]

If one considers the complexity and diversity of science, the notion of nature as a consistent text or book that can be read with one hermeneutic technique (the pre-given laws of logic and the nature of human reasoning that underlie scientific method) is totally inadequate. But let us, for the time being, keep the notion of nature as a book or text and turn to the question of consistency. What reasons do we have to believe that the (divine) author has written the book of nature in accordance with the laws of logic and the nature of human reasoning? None. "When I read a volume," David Hume's Demea says, "I enter into the mind and intention of the author; I become him, in a manner, for the instant, and have an immediate feeling and conception of those ideas which revolved in his imagination while employed in that composition." But with a

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communities are held together by tools: renormalisation-group methods [a mathematical tool], nmr machines, lasers, neural networks, computers and so on." Such "cross-fertilization" among different fields, as Schweber calls it, takes place in a largely unpredictable manner and must not be confused with methodological unity, "Tools and concepts are constantly being carried from one field to another in ways that are difficult to anticipate by any logical and structural analysis."

[29] Hacking, "The Disunities of the Sciences," 57.

[30] "Going beyond the ideal-typical investigations of earlier generations of pragmatist and ordinary language philosophers, contemporary philosophers of science are increasingly relying on historical and sociological investigations...." Micheal Lynch, *Scientific Practice and Ordinary Action*, xv.

divine author such a re-enacting of authorial intention is not obviously possible for a human being. As Demea aptly points out:

> Such near an approach we never surely can make to the Deity. His ways are not our ways. His attributes are perfect but incomprehensible. and this volume of nature contains a great and inexplicable riddle, more than any intelligible discourse or reasoning.[31]

Still, the "volume of nature" seems also to contain some lucid passages. We seem to have acquired knowledge in certain areas: we have, for example, learned enough about gravity and aerodynamics to build aeroplanes, or enough about the function and composition of blood to make blood transfusions. Yet our knowledge about the physical world has remained fragmented and incomplete; and there is no reason to assume that these islands of knowledge can one day be brought together to form a consistent whole. Scientists in different fields, it appears, are reading different pages of the same book. What if the book contains a collection of short stories rather than, as Whitehead would have had it, just one tragedy with a consistent and predetermined plot? Or perhaps it is not a book at all but a magazine with independent articles, as the physicist James Clerk Maxwell once suggested! Musing on the epistemological implications of the image of nature as a book, Maxwell writes to the bishop of Gloucester and Bristol in 1876:

> Perhaps the book, as it has been called, of nature is regularly paged; if so, no doubt the introductory parts will explain those that follow, and the methods taught in the first chapters will be taken for granted and used as illustration on the more advanced parts of the course; but if it is not a book at all, but a magazine, nothing is more foolish than to suppose that one part can throw light on another.[32]

Even if we accept a divine author and the assumption of the predetermined order of nature, "nothing is more foolish than to suppose" an internal consistency that answers to human

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[31] Hume, *Dialogues Concerning Natural Religion,* 26.
[32] Quoted from Hacking, "The Disunities of the Sciences," 61.

rationality. In the same vein one could ask: Why one language? Might the different episodes in the volume of nature not be written in different languages? Of course they might, some perhaps even in languages not intended for human understanding. It is therefore, perhaps, equally "foolish to suppose," as for example Rudolf Carnap did, that one could find a unified language of science, for that would mean to look for the best of all languages, namely that of God.

But there are aspects of science that even the image of nature as a multilingual magazine cannot capture. The development of science, we have come to realise, is potentially discontinuous, unpredictable, and contingent. How can we do justice to the epistemic and temporal intricacies of that process? Clearly, no straightforward narrative assuming steady progress along a pre-given line of development will do. We need new and less dramatic ways of telling the story of the growth of scientific knowledge. Since the 1960s, scholars of various disciplines have gradually come up with such different narratives.[33] An original case is Yehuda Elkana, who keeps the imagery of the theatre, though not that of Greek tragedy. He argues that science and its development could more accurately be described by the concept of 'epic theatre' as developed by Bertold Brecht and Walter Benjamin.[34]

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[33] On narrativity and the history of science see Golinski, *Making Natural Knowledge*, 186-206; also Clark, "Narratology and the History of Science." Clark offers a categorisation of some important recent works in the history of science along the line of Northrop Frye's narrative typology of Romance, Comedy, Tragedy, and Satire.

[34] Elkana, "Of Cunning Reason," 34. The point is also made in a less condensed form in Elkana, *Anthropologie der Erkenntniss*, 118-122. The problem with Elkana's reading of Brecht and Benjamin is similar to Whitehead's reading of the Greek tragedians: it tells us more about him then about them. As Fredric Jameson has pointed out, Brecht is an author that can easily be rewritten in terms of the concerns of the present. In any case, Brecht would have had very little to do with Elkana's conception of science; Brecht's science is not that of "Koyré, Bachelard and Kuhn." "For Brecht... 'science' is far less a matter of knowledge and epistemology than it is of sheer experiment and of practical, well-nigh manual activity. His is more an ideal of popular mechanics, technology, the home chemical set of the tinkering of a Galileo, than one of 'epistemes' of 'paradigms' in scientific discourse. Brecht's particular vision of science was for him the means of annulling the separation between physical and mental activity and the fundamental division of labour (not least that between worker and intellectual) that resulted from it...." See Jameson's conclusion in, *Aesthetics and Politics*

The main tenet of epic theatre is in startling contrast with the tragic view of history as evoked by Whitehead. In epic theatre, Benjamin holds, the order of events is not pre-given, "it can happen this way, but it can also happen quite a different way."[35] In epic theatre, "history's outcomes are never inevitable, always amenable to political intervention and transformation." The narrative in Brecht's epic theatre "does not imply any straightforward, unproblematic unfolding of chronology or other linear sequences.... the emphasis of Brecht's work is upon discontinuity."[36] Thus the question to be asked in history of science cannot be (as with Whitehead, Sarton and their ilk) "what were the sufficient and necessary conditions for an event to take place" or a discovery to be made; in epic theatre the historically meaningful question can only be, "what were the necessary conditions for the way things happened, although they could have happened otherwise."[37] It could always have happened otherwise, had the context been different, had people taken other decisions choosing other options at their disposal.

The metaphor of the epic theatre captures important and often neglected aspects of the history of science. It can show for example that the "edifice" of science has not, as Bush believed, always been there simply waiting to be discovered. Science as we know it today has been constructed and shaped by people who responded to the political, social, and cognitive environment they happened to live in. If we look at the world in the spirit of epic theatre, Elkana suggests, history is no longer simply the unfolding of the inevitable. With respect to science, this means that we are to some extent relieved from the burden of inevitability that determinist historians and other commentators of science have put upon us; and science is (in part at least) restored to human initiative and, most important perhaps, to human responsibility.

(1977), 204. I am interested here in the illustrative capacity of Elkana's comparison of science and theatre, not in Brecht's or Benjamin's conception of history and science.

[35] Benjamin, *Understanding Brecht* (1973), quoted from Elkana, "Of Cunning Reason," 34.

[36] Hollington, "Epic Theatre," 77.

[37] Benjamin, *Understanding Brecht* (1973), quoted from Elkana, "Of Cunning Reason," 34.

In this study, I endorse a more radical view with respect to the epistemological and temporal intricacies of science. The image of science as epic theatre breaks down as soon as we step down from the lofty pinnacle of hindsight and look at science in the making. The metaphor works fine as long as we refer to the past, to the history of science. It works because the story of science is, like epic theatre, deterministic and non-deterministic at the same time: The history of science is *non-deterministic* in that its outcome is always contingent; all could have happened otherwise, had circumstances been different, had people taken other decisions at their disposal. Yet any historical narrative is in an important sense also *deterministic*, for by the time it is told, history's outcome *is* determined and therefore no longer amenable to human intervention. Both these aspects are enacted in epic theatre: the non-deterministic element is comprised in the epic narrative of the play, which may be discontinuous and contingent; the deterministic (and with it the tragic) is enacted in the theatrical setting, which does not allow for the audience to interfere with the pre-given plot. No matter whether a play is epic or tragic, its plot is always predetermined by the author.[38]

Most relevant for a study of satire and science are precisely the moments in history in which new episodes in the development of science are being plotted. For moments of 'science in the making' are also moments that give rise to public discussions about science. New ideas may be greeted with disbelief by both the scientific community and the public. It is at such moments that our notions of the possible are stretched to their limits and humorous or satiric debunking of science occurs. The debates over the possibility of cold fusion or gravity shielding are recent and vivid

[38] Brecht's audience was quick to realise this. If measured against its own claims, Brechtian theory of theatre must be said to have failed. This may count towards an explanation why, in spite of its anarchistic and revolutionary potential, Brecht's technique could be so easily domesticated; why Brechtian theatre, in other words, could offer so little resistance to world-wide dissemination and painless consumption by the masses. It may also explain why Brecht in his later years abandoned the concept of epic theatre in favour of dialectical theatre, in which the traditional distinction of stage and audience became blurred. See Hollington, "Epic Theatre," (77).

examples of that.[39] In what terms are we to talk about such moments? How can we do justice to the temporal and epistemic intricacies of science in the making? I suggest another theatre metaphor, the spectacle. The growth of scientific knowledge bears features of the spectacular in that it evolves in a largely unpredictable, often counter-intuitive fashion. Also, it is a spectacle in that it knows no clear line of demarcation between audience and characters. As we shall see in Chapters 1 and 2, the plot of this spectacle is the outcome of a complex dynamics between the shaping (conceptualising) attempts of the people (scientists and non-scientists alike) involved in the making of science, and the constraints imposed on these conceptualizing attempts from the physical or material world 'out there.' Not anything goes in the spectacle of the growth of knowledge; our predictions and our shaping attempts may very well be frustrated. Even if we acknowledge that social factors from within the scientific community and from society at large influence the course of science in a lasting way, we have, I think, to accept that there are also rigid constraints to be taken into account, constraints from the material world that manifest themselves as resistance to human intentionality and theorising. Nature may lend itself to different conceptualising attempts, but not to all. "In the physical sciences [especially], nature places strong constraints on our experiments and means of observation and plays the role of an arbiter."[40] A crucial feature of the conception of science as a spectacle is, again, that there are no predestined laws of logic that determine its course. The plot of the spectacle of the growth of knowledge does not follow a pre-given rationale, it emerges in time. Logical consistency is something that is imposed on the course of science only retrospectively, once the outcome of an episode is known. Only with the benefit of hindsight is it possible to conceive of the development of science as inevitable. Logical consistency in the history of science, in other words, is always anachronistic; as long as we move with time and resist the temptation of hindsight we are faced with uncertainty, discontinuity, and paradox. What I am trying to capture with 'the

[39] See for instance Pinch, "Rhetoric and the Cold Fusion Controversy;" and Platt, "Breaking the Law of Gravity."
[40] Schweber "Physics, Community and the Crises in Physical Theory," 40.