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TEXTUAL TRADITIONS AS BIOSOCIAL SYSTEMS¹

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A TEXTUAL TRADITION IS A BIOSOCIAL SYSTEM formed through the successive copying of a text, during which alterations are continually made to the original wording. My own first-hand experience of such traditions has been with manuscripts of late-seventeenth-century libertine and satirical verse; but I hope that most of what I am going to say would also apply (with suitable qualifications) to the great ancient and mediaeval traditions. Such a system is structured at three levels, the macroscopic, which is the tradition as a whole, the intermediate, which is the level of the individual source-text of the work concerned, and the microscopic, which is that of the individual variant reading.² The macroscopic system is usually described as a pattern of lines of transmission and their meeting points, which may be either nodes of divergence, nodes of convergence or a combination of both. (Further attention will be given to these terms shortly.) However, it may also be conceptualised as the sum of the similarities and differences between individual readings at the microscopic level. In an ideal world the second of these descriptions would provide evidence permitting us to determine the first, but there are a great many cases in which this does not hold.³

We now need to consider the causes of change in the system. A textual tradition originates in the interaction between a written record and a human nervous system engaged in the activity of copying. A copy which is identical with its exemplar is of no interest to the editor, since textually (though not bibliographically) it counts as the same entity; but in practice most copying introduces changes, and some copying quite a lot of changes. These changes can be divided into those intrinsic to the psychology of copying (which will be incident to *all* textual traditions — with adjustment for medium) and those that are specific to the given culture or subculture in which copying takes place, or to the individual scribe. The first class arise from eyeskips, misreadings of letters

or combinations of letters, metathesis, anticipation, perseveration and a general tendency to replace the anomalous with the expected.⁴ The other class covers all matters which reflect the scribe's specific social attitudes and language preferences: revisions to grammar and idiom (whether conscious or unconscious), deliberate omission and interpolation, censorship, and all aesthetically-motivated changes, including the metrical. For completeness I should also refer to changes which might occur to the record after copying — as, for instance, alterations made by readers or loss of text as a result of physical damage. However, while change, whether of this or other kinds, marks the development of a tradition, it does not initiate or sustain it. This is the effect of the succession of copying, something which, in order to happen, demands both interest on the part of scribes and the availability of exemplars.

The simplest kind of tradition is that in which, as a manuscript becomes worn out, it is replaced by a single copy of itself. (In India the old manuscript might then be thrown into a sacred river; in the West it was often reused for bindings, kites or pie-crusts.) However, most traditions contain junctions where a particular manuscript has served as the exemplar for two or more copies, or received readings from more than one immediate source. In the first case motion is divergent and in the second convergent. Under the influence of divergent motion, a tradition will radiate graphically out into a series of subfamilies which in theory should all preserve the changes introduced during the copying of their exclusive common ancestor. These sub-families will then generate further internal sub-families whose characteristic readings can be used to determine the history of the tradition to that point. The reconstruction of this history is the object of the branch of textual criticism known as stemmatology. The other form of motion, which I call convergent, is regarded as an embarrassing obstacle by stemma-builders, since its tendency is to merge subfamilies which they require to be kept distinct; but, in conceptualizing the textual tradition as a system, we need to see convergent motion as just as characteristic and inevitable as divergent, with the proviso that it is more likely to predominate in the latter stages of the growth of the tradition. In fact the model on which I wish to concentrate (one of several that might be studied) is one of two phases, the first dominated by divergent and the second by convergent motion.

Open and closed systems

Here I need to digress for a moment to consider a distinction, which I hope will be familiar, between open systems and closed systems. Closed systems are those which, like the dynamic systems of Newtonian physics, are complete in themselves and can be described mathematically without reference to what lies beyond them. Open systems are those which, like non-isolated thermodynamic systems, are in a state of continuous interaction with their environment. In scientific terms, the first kind are reversible and the second irreversible. One of the meanings Ilya Prigogine and Isabelle Stengers give to these (somewhat elastic)

terms in their well-known study of thermodynamic systems is that the first kind preserve a knowledge of their past whereas the second kind 'forget' that knowledge.⁵ Thus, a closed dynamic system of the Newtonian kind, operating according to known laws of motion, is amenable to its state being calculated for any point in the past or future, whereas for an open thermodynamic system moving entropically towards a dissolution of structure this will not be possible. The information that would permit us to reconstruct its initial conditions and the history of how those conditions had changed would not have been preserved.

A textual system has certain features characteristic of a closed system. An influential development in textual theory, which originated in nineteenth-century Germany and, in England, reached its apogee in 1927 with the publication of Greg's *The Calculus of Variants*, aimed at describing traditions as closed systems which preserved a memory both of their initial state (i.e. the exact wording of the archetype) and of their history since departing from that state (as presented in graphic form in the stemma). Neither memory would ever be perfect, but it was assumed that a good editor, by using Lachmannian methods of genealogical analysis, could recover most of the history, and that a knowledge of the history would yield knowledge of the initial state. An understanding of habits of scribes, supplemented by philological knowledge, would permit certain readings to be classified as prior to others or even as 'original' in the sense used by classicists, while analysis of the distribution of secondary or derived readings would permit a reconstruction of the family-tree of copyings, which then became a decision tree for the reconstruction of the archetype. In Greg's study the 'closed-system' model was taken to the extent of expressing the structure of traditions in the form of algebraical formulae. But these formulae did not describe actual traditions, being nothing more than algorithms for the generation of model traditions of a simple and uncomplicated kind. The 'black-box' approach outlined in Vinton Dearing's *Principles and Practice of Textual Analysis* represents the most single-minded development since that date of the closed-system principle.⁶

Genealogical reasoning of this kind is also used by linguists and folklorists to reconstruct ancestral forms of languages and folk-tales respectively and by biologists to model the putative common ancestors of diverse surviving species. In each case the logic of the process makes the demand that the history of the system, as well as being non-entropic and uninfluenced by external factors, should be free of loops, reversals, lateral information flows, redundancies, or any situations in which the same change-generating processes operate independently in discrete sub-systems. Its practical success will depend on how effectively corrections can be made for the fact that all of these things will invariably happen if the system is allowed to operate long enough. Using the terms just defined we can say that such methods are appropriate only for a system whose surviving states are predominantly from the divergent phase and would be useless for a system whose surviving states were all from the convergent phase.⁷

Other editors, however, have preferred to approach textual traditions as open systems. In the great Richard Bentley (1662-1742) we see a critic whose ability to analyse the succession of copying seems to have remained at kindergarten level, but who compensated for this by treating the texts he edited as open systems within the wider system of language.⁸ Bentley is credited with the statement that common sense and an understanding of context were of more use than a hundred manuscripts: in his view the critic should proceed by spotting unconvincing readings and emending them speculatively.⁹ Seen in this way the tradition had no memory either of its history or its initial state, but language — in the sense of the totality of surviving records of the tongue concerned — did, providing it could be correctly interrogated. Bentley's notorious edition of *Paradise Lost* shows the drawbacks of such an approach; but he was right to the extent that the act of copying is always open to the linguistic formations of the scribe and his culture. W.J. Cameron has summed up this perception in the statement 'all texts are in fact conflated texts — a conflation of the exemplar and a structure of linguistic expectations that is present in the mind of the scribe'.¹⁰ A similar statement of the open-system principle might well be extracted from Kane and Donaldson's critique of recensional editing in the introductions to their editions of the A and B texts of *Piers Plowman*, though I am inclined to think that their real ideal was one of treating the tradition as a closed system at the microscopic level rather than as an open system at the intermediate level.¹¹ In any case they were probably correct in their belief that the tradition they were concerned with was too profoundly entropic to be conducive to Lachmannian analysis.

In fairness to Greg, it should be pointed out that his allegiance to the closed-system ideal was qualified by an awareness of the limitations to genealogical reasoning posed by what is known as the ambiguity of three texts. Put in its simplest form, this states that, given variations in the form AB : AC : BC, it is impossible to tell by distributive reasoning alone whether they indicate a ternary junction or one of three possible successive binary junctions.¹² This ambiguity places a formal limit on the extent to which a tradition can be said to 'remember' its history, and in turn restricts the extent to which a knowledge of that history can be used to reconstruct the initial state of the tradition. Faced with this problem, editors employing the closed-system approach will often be forced to switch temporarily to an open system model, drawing on philological, codicological, historical and biographical evidence to resolve points of ambiguity in the stemma. This heuristic approach accepts that a textual tradition is really an open system, but one that, like the dissipative structures of thermodynamics, possesses certain powers of self-organisation. In our next section we will consider how these might operate.

The growth of traditions in history

We are now ready to consider the life cycle of a 'representative' tradition, insofar as the term can be allowed meaning. I am thinking here of an ancient or mediaeval text which was widely copied and which sustained interest long enough to become the subject of a modern critical edition. The novelty of my treatment will be to insist that the critical edition is itself part of the system — an ultimate expression of the convergent principle. Despite what he or she might believe, the editor does not stand outside the tradition, but simply marks a stage in its evolution.

Whether our concern is with the ancient world, the Middle Ages, or with any of the later survivals of scribal publication, it is likely that the earliest stage of transmission of an important new work would be by donation from the author to friends and patrons; that these copies would serve as exemplars for further 'social' copying; and that, at a fairly early stage, organized transcription would take place in commercial or ecclesiastical scriptoria. As copies were made from copies, as textual junctions arose, and as new subfamilies were created, the system would expand in a spatial sense, whether this is conceived in terms of geographical distribution or the radiation of the stemma.

Two processes would at once come into play. Under the first, which I will call the differentiating, alterations of the kinds already discussed would be made, most of which would pass into copies of the source-text in which they originated. By the second, which I call the reconstitutive, readings which puzzled a scribe to the extent of suggesting corruption would be altered to yield a more probable sense. In some cases reconstitutive change would result in a return to some prior reading, whether or not original; in others it would not, therefore giving rise to divergent not convergent motion.¹³ Except in unusual circumstances, differentiative change would always outweigh reconstitutive in the early phase of the growth of the tradition. We need to imagine this phase as marked by a rapid proliferation and a no less rapid geographical dispersal of copies. As long as the text of the work remained in reasonably good condition, there would be no particular reason to seek out other copies for comparison; moreover, even if such copies were available, there would be no obvious reason why their readings should be afforded a privileged status.

However, as copying progressed, texts would begin to be written whose corruptions were grossly evident, provoking heroic attempts at reconstitution which would only worsen the situation. Here we encounter a multiplier effect, which holds that the greater the difficulties posed by a variant version the more unstable it becomes. An important factor is that scribal attempts at repair are frequently made without a full understanding of the relationship of the reading to its wider context. The attention span of the scribe processing a text as a series of transient memorizations is short, often not extending from the beginning of a sentence to its conclusion. It is also progressive in the sense that change would often be made on the basis of what had been read so far and without knowledge

of what was to come. The search would be for a restricted not a global congruence, and its result a situation in which the work fragmented, under the influence of another kind of multiplier, to a pattern of local meaning within overall incoherence. The divergent phase of copying can therefore be seen as a process of continual mutation in which, as in autocatalytic chemical reactions, change has the effect of promoting further change.

A simple example of this process in action can be given from the manuscripts of Rochester's 'Upon Nothing'. The poem is written in a stanza of two pentameters followed by a hexameter. Scribes, misperceiving the hexameter as hypermetric, would regularly shorten it into a pentameter — particularly in the early stanzas of the poem. In the text in which the process has proceeded furthest, nine out of seventeen hexameters have been so reduced, further increasing the sense of the hexameter as anomalous, and it is likely that, if copying had proceeded indefinitely, a version would eventually have been produced in which no hexameters remained. In this case the instability was metrical rather than semantic, but the principle by which the local comes to lose its links with the larger entity is clearly illustrated.

The proliferation of variety in the tradition, even when that variety is not destructive of meaning, must eventually lead to a process by which, instead of merely trying to guess at solutions and thus creating even greater variety, scribes and readers begin to make systematic comparisons with other source texts. In the early stages such comparisons might well be memorial, since scribes would have internalized much of the wording of culturally important texts; but it would eventually become visible through the transcribing of variants from one text into the margins of another. At a more advanced stage these marginal records evolve into a commentary which attaches itself to the text. At a yet later period we may find scholars exchanging lists of the readings in which remote manuscripts vary from some standard text (by now probably a printed one), until eventually we encounter the global record of variation of the modern critical edition. This process might also mark a geographical implosion, as manuscripts were gathered together physically in Athens, Alexandria, Rome, Byzantium, Florence, Paris, London or San Marino to permit comparison. The present-day scholar's filing cabinet of microfilms represents a further stage of the same progression. In terms of our systemic model we have reached a point at which the elements of the system, having earlier lost contact, begin to communicate with each other, and the system increasingly acts as a unified entity rather than as a dispersed corpus of source texts. This is an incremental process: the critical edition with its historical record of variation represents a stage in which the lemma possesses an awareness of the microscopic state, at that point, of (ideally) all surviving records.

This growing communication between the elements of the system is accompanied by a progressive modification of the newly-written source-texts towards an elimination of difference. In the great historical traditions of the ancient and mediaeval world this led to the evolution of what is called a 'vulgate'

text, whose stability was ensured by institutional supervision and a familiarity acquired during early education. While mutations would continue to occur during copying, these would generally be recognized as such and the familiar reading restored. For the same reason, unfamiliar readings found in surviving manuscripts from earlier stages of the tradition might well be assumed to be incorrect.¹⁴ Overall, the process of comparison would tend to favour the majority reading over the minority one and the plausible reading over any anomalous original one.¹⁴ This represents a return of the system from a condition of intolerable variety between source-records and of semantic incoherence within them to a condition of self-organizing equilibrium, though one that clearly manifests a number of entropic features. The new understanding of critical editorial method which accompanied the Renaissance brought about a realisation of the inadequacies of these vulgate texts. In two new processes of change, libraries were ransacked for ancient manuscripts preserving superseded states of texts, and a series of Bentley-like virtuosos in speculative emendation bombarded the scholarly world with imagined 'original' readings. However, relatively few of these speculations have passed into our modern scholarly editions: modern classical scholarship soon established its own vulgate texts, which, while probably closer to those of the earliest period of transmission, increasingly asserted their stability against Bentley's kind of ingenuity.

A point that should be made at this stage is that, although the supposed aim of the critical edition is to restore the readings of a lost original, there are limits to how far this can be achieved. Such an edition will probably identify and remove the grosser corruptions, and may make some intelligent guesses concerning original readings; but it will almost certainly fail to restore all those authorial readings which were genuinely idiosyncratic and anomalous. While editors recognize the importance of considering the '*difficilior lectio*', their reasoning is basically of a probabilistic kind. A 'vulgate' text, whether mediaeval or modern, is above all a text without anomalies. That the modern editor is sometimes able to restore lost original readings only reflects the greater amplitude of the philological information through which he or she can search for probabilities. Moreover, it must be stressed that such restorations must always remain hypothetical except in the very rare event of their being validated by a newly discovered source-text from close to the origin of the tradition. In one indicative case in the field of Renaissance musicology, an editor discovered that, through feeling obliged to observe an anachronistic notion of correctness, he had produced a much blander text than the composer.¹⁵ Our modern 'standard' texts reflect the pressure towards consensus applied by a particular interpretative community: if they introduce too many novelties they will not be recommended to students. The kind of discrimination germane to the reconstitutive enterprise is more helpfully expressed as one between institutionally acceptable and unacceptable readings than in the customary terminology of original and erroneous readings, which at best expresses an aspiration.

A second point to bear in mind is that the historical survival of source-texts was influenced by their position in the evolution of the system. The survival rate of very early texts was discriminated against by chronology and by the fact that they tended to cluster in imperial centres whose history has included intervals of violent destruction. Texts from the transitional or 'turbulent' phase would tend to be discarded as soon as more plausible 'vulgate' texts became available. It is these heavily conflated vulgate texts that form the largest part of any long-lived tradition.

Our model of the growth of the textual tradition may now be summarized once again in terms of two phases. The first is marked by a predominance of differentiative change and of divergent motion. Its distinctive characteristic is that the total number of variant readings available in the system is continually rising. In the latter stage, dominated by reconstitutive change and convergent motion, new readings will continue to be invented, but there will also be a strong tendency for certain classes of reading within the system to multiply at the expense of others. Those which will be lost are the anomalous and the apparently corrupt; those whose representation will increase are the familiar, the plausible, and those which seem to offer a meaningful alternative to corruption.¹⁶ (Here we must be aware that convergent motion is not to be interpreted as a backward tracing of old pathways.) As the activity of reconstitution expands its range from the particular reading to consider the place of that reading in the work as a whole (implying an editorial rather than a merely scribal kind of scrutiny), it will also tend to favour those variants which, rightly or wrongly, are felt to be most congruent with the whole. The overall movement during this phase is towards a state of equilibrium in which the text will rarely be altered by successive editors in more than a few readings, firstly because anomaly, the principal source of change, will by and large have been removed, and secondly because there is now a continuing high level of communication within the system. In the case of some long-lived texts, it is likely that this cycle may have been repeated several times. Successive conflatory vulgate texts of Homer were created in sixth-century-B.C. Athens, at the library of Alexandria, and during the Byzantine period, in each case to deal with an unacceptable level of variation.

Initial and final states

While the evolution of the system, then, is usually one towards an equilibrium in which change is experienced as fluctuation rather than mutation, the initial state of the tradition in the authorial text or an archetype descended from it is invariably unstable. While it is possible to imagine a text whose contents were so lucid and predictable that any departures in copying could be restored, such a text would by definition fail to give rise to a textual tradition. In fact most of the works which have given rise to large traditions have not only been complex and difficult but also the focus of intense interpretative debate. This implies a

discontinuity between the text of the work as the outcome, say, of a 'literary' system and as the point of origin for a textual system. What is stable in the one (as the result of a highly-skilled 'aesthetic' perception of the interrelationship of elements) becomes unstable in the other (as puzzling to scribes whose attention to the work as such is non-aesthetic and discontinuous).

My purpose here is simply to indicate that much of this change is of a determined nature, both at the level of the scribe's involuntary reflexes and at the less predictable level of culturally induced change. The example of the hexameters from 'Upon Nothing' characterises a situation in which, if copying proceeds long enough, certain kinds of change will inevitably occur, not only once but independently in different parts of the tradition. (With this comes the related principle stated by Greg as 'the easier it is to explain how an error arose, the less valid the assumption that it only arose once':¹⁷ many of the problems encountered by the *Piers Plowman* editors seem to derive from this cause.) However, the text of 'Upon Nothing' could also be called upon for examples of kinds of verbal reading which are, in effect, changes waiting to happen through philological, palaeographical or cultural necessity.¹⁸ Just as certainly, some of these changes will in due course revert to their original state, acting as loops or switches in the system. (Thus, in English texts of this period singular and plural forms of nouns and third-person verbs interchange regularly through flourishes being mistaken for final '-s' and final '-s' for flourishes.) While changes of a less predictable kind will also be found, and may occur at any stage of copying, the real grotesqueries which amaze editors tend to be the cumulative result of a sequence of operations which may individually have been of a predictable, determined nature.

The final state, however, is by definition one of equilibrium in which the possibilities of change inherent in the initial state have to a large extent been exhausted. I have already suggested that, in this movement from a complex, anomalous, unstable structure to a state of equilibrium, the textual tradition shows features which greatly resemble those of biological and non-equilibrium thermodynamic systems. Before concluding I would like to look more closely at these resemblances.

Thermodynamic and biological models

The application of thermodynamic models to biosocial systems has quite a long history apart from the work of Prigogine and Stengers.¹⁹ The principle governing the evolution of thermodynamic systems is entropy, which the second law tells us always increases. However, while this is true of entropy as a cosmic principle, the existence of literary texts as much as that of the universe as we know it requires the recognition of local anti-entropic movement. In connection with textual traditions we can speak of a cybernetic entropy, by which the information represented by the original state (which, as we have seen, is the product of another order of organisation, the literary system) is progressively

converted into noise; however, at the microscopic level, at least, this is resisted by the formation of new semantic units which present a plausible kind of local sense, but in doing so degrade the semantic relations of the work as a whole. If copying was to continue indefinitely without lateral communication of readings within the system, we would theoretically be left with texts which lacked all coherence as wholes but contained many islands of lucidity. This is something different from the randomly distributed conversion of information into noise that occurs, say, when a text is read-in by a not very efficient scanner — and much more interesting. It brings with it the realisation that in the study of textual systemics very bad texts are much more important than very good ones.

In describing the transition from laminar flow to turbulence, Prigogine and Stengers propose that, while at the macroscopic level there is no appearance of order, at the microscopic (which in this case is the molecular level) a variety of structures exist, one of which will eventually give rise to fluctuations which overcome the whole system and lead to a new equilibrium. This is also the point at which their version of the ‘butterfly effect’ of Chaos theory comes into play. As points of bifurcation arise within the non-equilibrium system, it becomes increasingly sensitive to its environment and can make ‘decisions’ which are of a stochastic, unpredictable character. Transformations of an analogous kind certainly occur in the history of some textual traditions; but what is more common is for the *approach* of turbulence, as signalled by semantic decay and a socially unacceptable level of disagreement between available texts, to promote the activity of comparison, giving rise first to widespread conflation and then the emergence of a stable vulgate text.

What we are seeing here, in another analogy used by Prigogine and Stengers, is the elements of the system entering into communication with each other so as to permit the system as a whole to behave in a self-organizing way prior to returning to equilibrium. This development, while usually leading to the removal of many inferior readings, remains entropic in that it tends to reduce the system’s memory of its history: a heavily conflated text is one that has forgotten the pathways through which it received its readings, and when, as in certain ancient traditions, all surviving source texts are in this state, there is no possibility of applying genealogical reasoning.²⁰ Such a realisation is normally a mortifying one for editors, but it is only what we would expect as students of textual systemics, a subject to which the hopes, fears and frustrations of the editorial project are of no significance, except insofar as that they are themselves manifestations of the evolution of the system.

The limitations of the thermodynamic analogy are that, firstly, there is no clear counterpart in textual systems to the principle of conservation of energy, and, secondly, that earlier states are not necessarily superseded by later ones but will often persist as active influences on the growth of the system. For this reason it will be helpful at this point to consider analogies with another model — that of a biological system in evolution.

In this case we reject any privileged status for the initial state of the system except as a producer of variation. We have already seen that much of this variation will be of a determined kind, though the time at which possibilities of variation will become realized is unpredictable. This can be given greater precision through the idea of adaptation to an environment. While determined change — especially the kind that produces reversals and then re-reversals of the same two readings — will continue indefinitely, a text that has accommodated itself, in the terms proposed by Cameron, to the linguistic and cultural expectations of scribes belonging to a specific culture is likely to remain stable as long as that culture and its language remain unchanged (which, when the language is a dead one, may be for a very long time).

The analogy here would be with the way in which a living species copes with a catastrophic change in the nature of its environment. We must presume that mutations have been regularly appearing on a chance basis within the species but that the maladaptive ones have not survived. We will also assume that the species is a populous one evenly distributed over the environment, with the result that there is frequent communication of genetic information throughout the population. Under the altered conditions there will be an overall increase in variation as some of what were formerly maladaptive changes cease to be so and perhaps become advantageous. We might also expect a drop in overall population and a dispersal of the species into isolated colonies in which the breakdown of communication and an increased vulnerability to predators would enhance the production of genetic variation. At certain points in this process, favourable variations would establish themselves which in the course of time would disseminate themselves through a rebuilt population. The model is very close to what we have observed in the history of textual systems, with the exception that the text being transmitted is not a verbal but a genetic one, encoded as DNA, and that the notion of a 'well-adapted' literary text could only be derived tautologically from an ability to resist further change. We might note that genetic systems are partially able to 'remember' their history in the sense that selective breeding can be used to reactivate ancestral states. Given these similarities, I would be surprised if the biological model did not have at least as much to tell us as the thermodynamic model about the behaviour of textual traditions.

Conclusion

The point I would most like to stress is that the modern editor is both a product and a part of the system, and that her or his particular kind of interest in the text — which is one of trying to help it 'remember' its initial state — should not be allowed to distort our wider perception of the nature and role of textual systemics. The source-texts which are likely to be of greatest interest to such a study are exactly those which most baffle and irritate editors. Indeed, the more completely we are able to free ourselves from the editorial perspective, the more

we are likely to observe and understand about traditions as producers and suppressors of variation. And yet, insofar as textual systemics creates the possibility of applying the statistical procedures that have proved so valuable in understanding physical and biological as well as economic and sociological systems, it is possible that a rejection of the editorial perspective could be rewarded in the long term by the discovery of new editorial tools, especially for dealing with texts from the convergent phases of the tradition.

Melbourne

NOTES

1. Originally given as a paper to the Monash University Centre for Bibliographical and Textual Studies seminar, 'Housman, Textual Editing and "The Desire of Knowledge"', 3 October 1992.
2. Other levels exist: a work may be found incomplete in some sources, or a short work may occur as part of a linked group, florilegium or anthology, which possesses its own transmissional identity; but I omit these for the sake of simplicity.
3. We do this by using the groupings to construct narratives describing the movement of variants from source to source; but it is purely a matter of chance whether in any given case the evidence is complete or reliable enough to permit this. More broadly, it is possible to conceptualize a textual tradition (1) synchronically as an algorithm describing the system as a whole; (2) diachronically as a series of intertwining narratives in historical time; and (3) diachronically as a succession of 'slice' synchronicities, each describing the readings of all source-texts that actually existed at that precise time. Under #2 the individual narratives might behave recursively, since earlier states often remain active within the system as sources of readings.
4. The mechanisms of these changes are described in J. Stoll, 'Zur Psychologie der Schreibfehler', *Fortschritte der Psychologie* 2(1913), 1-133, and Eugène Vinaver, 'Principles of Textual Emendation', in *Studies in French Language and Mediaeval Literature presented to Professor Mildred K. Pope* (Manchester, 1939), pp.351-69 (repr. in *Medieval Manuscripts and Textual Criticism*, ed. Christopher Kleinhenz (Chapel Hill, 1976), pp.139-66).
5. *Order out of Chaos: Man's new Dialogue with Nature* (London, 1984), pp.60-62, 121. My interest is not in the scientific validity of the models and interpretations proposed but their suggestiveness with regard to the behaviour of textual traditions.
6. (Los Angeles, 1974).
7. It is this problem, naturally, which most concerns contemporary textual scholarship. There is a survey of possible approaches in Michael Weitzman's outstanding article, 'The Analysis of Open Traditions', *SB* 38(1985), 82-120. The wider epistemological problem is illustrated by the recent questioning of the 'African Eve' hypothesis of early hominid evolution.
8. Bentley's method is discussed in R. Gordon Moyles, 'Iconoclast and Catalyst: Richard Bentley as Editor of *Paradise Lost*', in *Editing Poetry from Spenser to Dryden*, ed. A. H. de Quehen (New York, 1981), pp.77-98.
9. 'Nobis et ratio et res ipsa centum codicibus potiores sunt'. I am unable to give the original source for this by now proverbial phrase; but it is certainly a correct description of Bentley's practice.
10. *Poems on Affairs of State: Augustan Satirical Verse, 1660-1714. Volume 5: 1688-1697*, ed. William J. Cameron (New Haven, 1971), p.529.
11. *Piers Plowman: the A Version. Will's Visions of Piers Plowman and Do-well* (London, 1960; rev. repr. 1988) and *Piers Plowman: the B Version. Will's Visions of Piers Plowman, Do-well, Do-better and Do-best* (London, 1975; rev. repr., 1988).

12. Further discussed with diagrams in my *Scribal Publication in Seventeenth-century England* (Oxford, 1993), pp.338-40.
13. For simplicity, I have chosen to present reconstitutive change as defined by intention not effect, though in practice its workings might easily be unconscious. Convergence can also take place through texts accepting some reading which was not that of a previous state (e.g. when some new reading 'invades' the rest of the system — an example would be when the name of a new ruler has to be incorporated into some legal text). Differentiative change, which is more likely than not to be involuntary, produces convergent motion when the change is of the determined type likely to be repeated independently within a tradition if copying continues long enough.
14. A vulgate *Hamlet*, if there had ever been one, might have read 'sea of bubbles' rather than 'sea of troubles': only a very astute scribe would be tempted to alter 'bubbles' back to 'troubles', while others, confronted with a choice, might well have felt that 'bubbles' was the more natural reading — the sea being so full of them.
15. See H. Colin Slim's engaging article, 'A Royal Treasure at Sutton Coldfield', *Early Music* 6(1978), 57-74. Slim's *A Gift of Madrigals and Motets* (Chicago, 1972) was an edition of a manuscript collection of four- and five-part madrigals lacking the altus partbook, whose line had to be reconstructed by the editor. Comparing his reconstruction with the rediscovered partbook, Slim noted differences arising from his 'seeking to avoid harmonic asperities' and 'from being too timid in introducing suspensions' (p.65). He had also carefully observed the rule, which the composer was prepared to break, forbidding parallel fifths and octaves.
16. Cameron, discussing scribal change, notes: 'idiomatic phrases may be substituted for witty distortions of the language, metrically smooth wording may be substituted for satiric roughnesses, scribal preferences for certain prepositions or connective words may be substituted for the author's preferences' (p.529). On the whole such anomaly-reducing changes will be preserved by all but the most imaginative compilers of later recensions.
17. Sir Walter Greg, *The Calculus of Variants* (Oxford, 1927), p.20n.
18. For a variant-by-variant analysis of the poem from this point of view see my *The Text of Rochester's 'Upon Nothing'*, Monash University Centre for Bibliographical and Textual Studies, Occasional Papers 1 (Clayton, Victoria, 1985).
19. Joseph H. Vogel, 'Uninvited Guests: the Thermodynamic Approach to Resource Allocation', *Prometheus* 9(1991), 332-45, reviews some of this material.
20. Many fruitful suggestions about the systemics of such traditions many be extracted from Weitzman's article cited in n.7.

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