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Chaos in the Virtual Library; strange attractors in the design studio

John Wood,
Department of Design,
Goldsmiths University of London

We know...that if an element of chance enters a deterministic construction all is undone. This is why religions and philosophies everywhere have always driven chance back to the limits of the universe." Xenakis, Iannis, "Formalised Music, Indiana University Press, 1971.

ABSTRACT

Many designers feel uncomfortable with linear, explicit, scholarly modes of writing and this can be accounted for by an epistemological split between the university research tradition and the design studio tradition. The IDEAbase authoring system is designed to ameliorate in this historical division by promoting a hybrid design research culture. The system registers implicit knowledge unobtrusively, and generates a non-linear, hypertext representation that encourages collaborative design activities. Traditionalist, fundamentalist metaphors for reading and learning are inclined to emphasise linear, predictive elements, but these are increasingly challenged by a dramatic increase in 'market-led' public access communication and information systems. Unless fresh perspectives are found to inform the new patterns of study, problems of management may develop in the classroom. Chaos theories offer a helpful paradigm that allows us to explore psychoanalytical and other aspects of reading that may assist creative designers in the early stages of the design process.

Background

The IDEAbase^{1,2,3,4} research programme was initiated in 1990 to develop author-centred software aids for drafting, archiving, and publishing theoretical works within a University's Department of Design. Its principal aim is to enhance the culture of ideas and creative practices in this academic community. The IDEAbase authoring system enables authors to use their conventional drafting skills to generate original text. This is then converted into a powerful form of hypertext⁵ without requiring the author to make conscious 'links' between zones in the text. Several original IDEAbase "books" are being specially written for the system (Taylor, 1994)⁶, and these will be evaluated after being used by students on our forthcoming MA in Design Futures programme starting in October 1994.

IDEAbase uses SGML⁷ to comply with international exchange protocols. The current version was prototyped in Hypertalk, and incorporates a database (HyperHits) for automatic storage of hypertext features such as 'authors', 'headings', 'keywords', and 'implicate keywords'. All database and coding operations are invisible to users. On-screen text can be 'interrogated' (see figure 1) by selecting any visible word or phrase with a mouse-click. This creates a local 'pop-up' options box that offers different 'search and collate' strategies. There are no permanent hypertext 'links' between zones in the documents. Instead, non-linear reader-pathways are managed dynamically as the result of hidden keyword associations created by the author or authors. Associations between keywords and their subordinate keywords may be chosen either systematically or spontaneously without causing conflicts in functionality. This enables implicit knowledge to be embedded and traced within more orthodox structures of argumentation. By developing non-linear modes of representation, IDEAbase is intended to offer a better conceptual 'bridge' between the studio and the library.

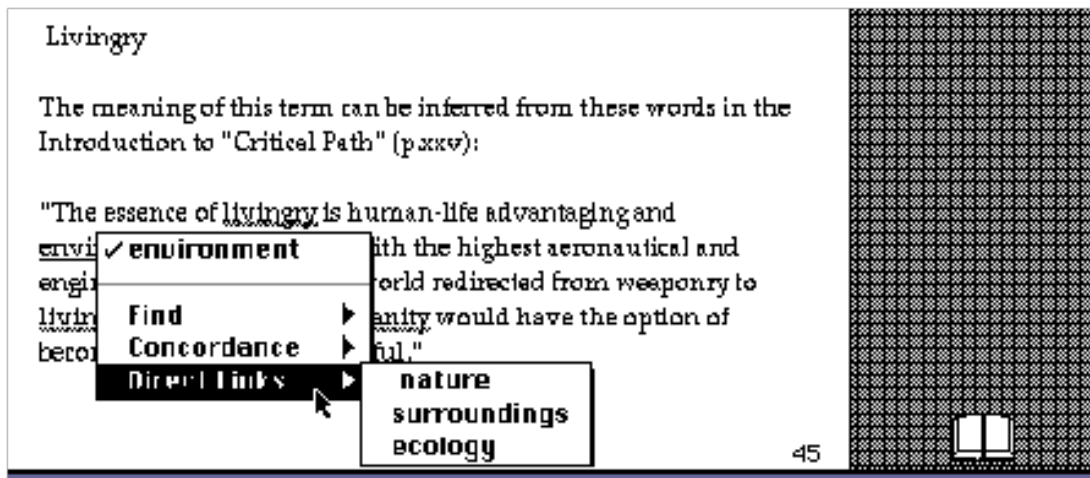


Fig. 1 Example screen-shot of the IDEAbase system in use by a reader

Modes of Information

It has been argued (e.g. Lansdown, 1994)⁸ that designers need relevant and well-structured information at an early stage in a given project to optimise its execution. This is uncontested, and some would argue (Wood, 1994)⁹ that the acquisition of text-based data and knowledge will be of increasing importance to the design profession, as there is a growing need for better environmental, ethical, and managerial standards. For designers this approach may be seen to complement long established scholarly methods as exemplified by the research tradition and the representational modes of the academic, paper-based book. However, Schon¹⁰ (1985) identifies important epistemological differences between practices that value tacit-knowledge (i.e. 'hands-on' studio practices such as design & technology, art, and craft), and theory-based disciplines that emphasise linear, sentential chains of argumentation and logical reasoning.

Clearly in the last decade, despite a greater tolerance to 'practice-based' modes of learning by our traditionally logocentric culture, the division between the two schools of thought remains. Efforts to bridge the gap are taking place at many levels (e.g. Frayling, 1994)¹¹ and pose many interesting questions at the philosophical, social, cultural, and professional levels. However there is little published evidence of new and workable hybrids of 'praxis' that could reconcile useful attributes of both traditions and, as a consequence, design students are increasingly encouraged to follow, simultaneously, the divergent methods of the two camps, i.e.

- Design – i.e. situated, non-linear modes of thinking that incorporate skills of judgement, supported by sketching, mapping, modelling, brainstorming and modes of implicit and tacit knowledge to develop design solutions.
- Scholarship – i.e. detached, linear, rigorous, focused, analytical, discursive modes of acquiring, applying, and book-knowledge

This problem is being addressed by many teachers, but often in uncharted and intuitive ways. Moreover we are all, to some extent, limited by the gaps between the languages of these separate worlds. For this reason much design theory has either confined itself to superficial critical commentary, or has emphasised the theoretical aspects of problem-solving, inductive, and organisational aspects of thinking.

Work on the IDEAbase system has focused on the abductive aspects of design thinking, as this provides an identifiably typical thinking process. This use of the notion of abduction is attributed to C.S. Peirce¹²: "A surprising fact, C, is observed. But if a proposition, A, were true, C would be a matter of course. Hence, there is a reason to suspect that A is true." It has been recognised (Wood & Taylor, 1994)¹³ that designers rely heavily on abductive modes of thinking because it helps them to seek answers to immediate problems that cannot be



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found within the problem space itself. In other words, they will probably have to look beyond the confines of the design problem itself to find a workable solution.

The abductive concept embodies and emphasises the creative, imaginative attributes of cognition in the reader, rather than encouraging an 'objective' reading of the text. Similarly, there are common variations of abductive thinking that are 'interpolative' in the sense that they aim to 'find' an imaginative compromise between several imperfect but useful propositions. Whereas the scholarly researcher sees the library as a primary source of relevant evidence, verification, clarification and confirmation (i.e. to narrow the scope of available propositions), the design practitioner may often be seeking more ambiguous, dissonant, exotic (often seemingly non-relevant) sources that can inspire her within the current context of the design problem itself (i.e. to provoke a number of 'divergent' propositions for abductive purposes).

Problems for designers in the Library

For all the above reasons it often seems unrealistic to predict which information domain will be relevant in clarifying particular problems or in reaching fresh solutions, and it has even been shown^{14, 15} that in the early phases of a creative design process, it may actually be unhelpful to forecast the sequence of decisions about solutions. In this sense there may be no general correspondence between a given studio problem and a seemingly relevant tract of text from scholarly sources. As Plato once commented, books are like the painted figures that "seem to be alive, but do not answer a word to the questions they are asked."

Perhaps significantly, the linear format of the Book has dominated Western philosophical thoughts for several millennia, perhaps even contributing to inflexible modes of thought that still overburden our democratic systems. The anthropologist Jack Goody notes that writing "tends to arrange terms in (linear) rows and (hierarchical) columns in such a way that each item is allocated a single position where it stands in a definite, permanent, and unambiguous relationship to the others"¹⁶. Poster comment that writing promotes forms of spoken grammar such as lists, formulas and recipes, and that these forms are rare, and less conducive to reason, freedom, and equality than speech.

Chaos and The Book

Arguably, the overemphasis on linearity is sometimes perpetuated within education, where the word "curriculum" refers to the idea of a repetitious journey around a race track. This metaphor also sustains the stereotypical establishment's view of reading as a well-planned journey along a monosemic text path. Educational fundamentalism of this complexion clashes with liberal notions of creative discovery and individualism, and is therefore under increasing threat from more recent theories that focus upon the reader's imagination rather than the intentions of the author. (Sperber & Wilson, 1986)¹⁷; (Freund, 1987)¹⁸

Whereas conventional library classification systems have always tended to differentiate sharply between disciplines, the likely rapid growths of 'Virtual Libraries'¹⁹ are likely to promote more anarchistic reading habits. Many libraries have yet to catch up with computer technologies of the last twenty years, but the more subtle phases of this revolution will soon be surpassed by some unmistakably new paradigms of knowledge access that will challenge conventional scholarly methods.

In 1945, Vanevar Bush²⁰ called for the development of a new type of "mechanised private file and library". He envisaged a mechanical device with which users could make their own associative leaps; creating mnemonic codes and 'connecting' data items together into information 'trails'. This led to the arrival of 'hypertext'. Now well established as a set of software tools for text handling and reader-guidance, hypertext is known for its 'non-linearity'. This chiefly derives from the fact that the user is encouraged to discover individual 'reader pathways', and is therefore likely to experience a more chaotic sequence of ideas than those organised in conventional linear text.



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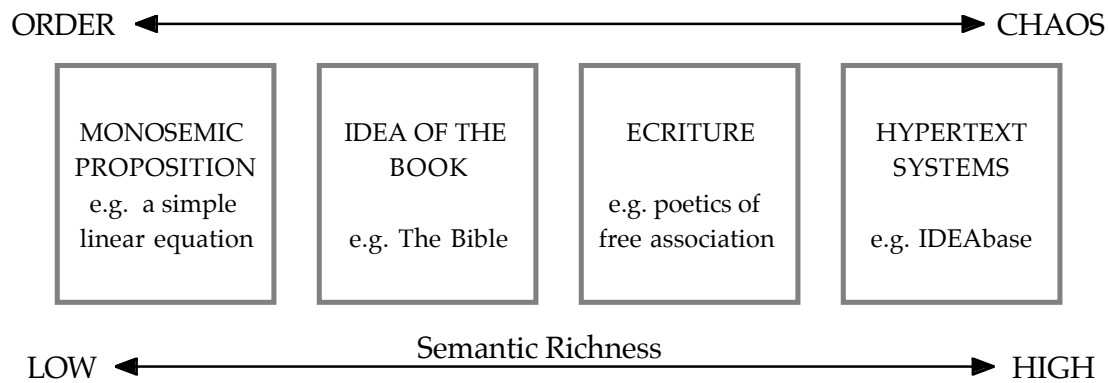


Fig. 2 Order and chaos in different reading genres

Some research²¹ has already suggested that hypertext is less effective in information retrieval than paper-based documents. However, as we have shown, the imperatives of the design studio can differ significantly from those of a conventional classroom and it is doubtful whether readership by 'action-oriented' artists and designers are comparable to the readership of more 'theory-oriented' scholars. Moreover, it is important to recognise in hypertext, a twentieth century Western iconoclasm that has sought to dissolve all boundaries and to unpick the institutional stitching and binding of the Book, both in a literal, and anagogic sense. Ted Nelson (1980) said: "In an important sense there are no subjects at all; there is only knowledge, since the cross-connections among the myriad topics of this world simply cannot be divided up neatly". Although this kind of evangelism poses exciting challenges for teachers and administrators, it could also require new educational guidelines if the technologies of the library were to make curricula significantly more diffused and indeterminate. It has been argued that information is doubling every twenty months²², and that by the turn of the century this will happen every seventy days.

In the world of education, this mind-numbing plethora of potentially available information is managed by a hierarchy of power that delegates and interprets information in a chain of authority extending from the Minister of Education down to the individual child in the classroom. However, in this context, the recent public interest in interactive networks and personal information systems poses a considerable threat to the orderly (i.e. controlled) management of knowledge in the classroom. Browsing (or 'surfing') the data highways and byways is still affordably cheap and provides, for some, an attractive option to the pulp fetishism of the library.

The term 'browsing' was first used in 1890 about an article by Hosmer in the American 'Library Journal Index'. It still carries overtones of aimlessness and, by implication, anti-professionalism. Some academics stress that "browsing is not deliberate reading in search of information known to be vital to current work", and has been described as "an untidy operation" (Apted, 1972)²³. Others have warned against browsing for graduate work, suggesting that the volume of unpublished material in any field is so great that "browsing is well-nigh impossible and usually unproductive" (Orne, 1972)²⁴.

These objections to using the human faculties of search and recognition may have to be reconsidered in the light of new technologies of text retrieval and organisation. Current developments (e.g. 'gophers' and 'intelligent agents') facilitate automatic searches that are more obedient, exhaustive, reliable, and focused than their human counterpart, yet are so far (Wood, 1994)²⁵ detached from the tacitly located needs of their users.

Outside the positivistic tradition of scholarship, however, designers seem to have no hesitation in using browsing as a stimulus to imaginative speculation. In fact, browsing can be a useful metaphor to describe the



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way in which experience is accessed and restructured, by designers.

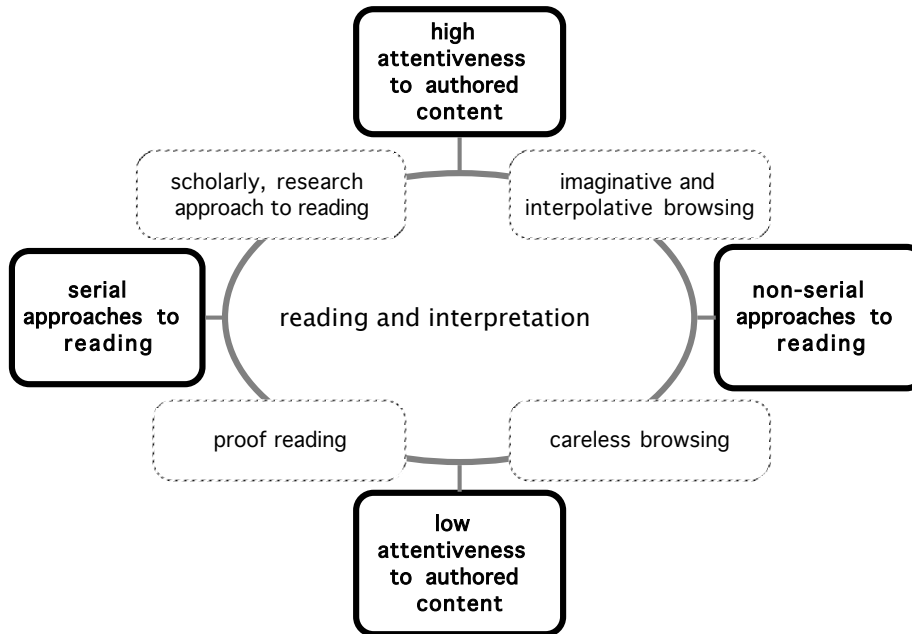


Fig. 3 Modes of reading (less chaotic on left-hand side)

"The reason I find it difficult is that I don't think kind of logically; it's sort of like a whirlpool of thoughts and I guess I can't really express it in a sort of sequential way.." (Respondent in IDEAbase research survey, 1994)

"Often if I have a project I'll go around the library for inspiration, not even for research." (Respondent in IDEAbase research survey, 1994)



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A paradigm of creative thinking

Chaos Theory²⁶ is a fascinating paradigm for this less predictable era as it offers a helpful conceptual framework for identifying properties in large complex systems that are causal yet unperiodic. In Chaos Theory, a conventional way to represent a dynamic system is to plot its state at each instant as a single point. At the following instant the system will have altered slightly and the point will therefore occupy a new position. In the case of a perfectly periodic system the point would, in time, return to its original position and the resulting (closed) loop would become retraced endlessly. However, models of systems in chaos will inevitably entail orbital graphs with phase changes in their repetitious activity cycles.

Conventionally, this phase model may be exemplified by an unobstructed, frictionless pendulum in which one variable on the graph represents its position and the other, its time. However, Aristotle's and Galileo's long accepted observations of freely swinging pendulums - i.e. that they will tend to find a periodic and repetitive orbit after being disturbed - are now seen to represent unjustified assumptions. Instead, it has been shown (Gleick, 1987) that the tiny irregularities in even the most carefully constructed pendulum system will tend to become amplified into non-linear characteristics of behaviour. Many of these arguments emphasise the importance of small initial effects in a large system. A cardinal tenet of chaos theory reminds us that not only is it *practically* impossible to set a pendulum in a perfectly repeatable trajectory path, but it is also *theoretically* impossible as well. A useful idea in Chaos Theory is the 'strange attractor'²⁷, where any element in the system may tend to entice it into a new orbit.

The Psychoanalysis of Browsing

This new paradigm of physics may serve as a useful metaphor for the curriculum in the age of chaos. A proof-reader (see figure 3) is trained to follow a strict linear path through the text, attracted only by deviant spellings and typographic details. Where linear text mode provides explicit hierarchies of (author-led) meaning (e.g. main title, heading, followed by sub-heading, etc.) we might regard the main title as a 'fixed point' attractor with a reasonably linear correspondence to the frequency with which the proof reader notices it. By contrast, a casual reader who is browsing may well follow a far less predictable text path. Ruelle²⁸ has remarked that 'strange attractors' are psychoanalytically "suggestive", and we may assume that practically any textual unit or attribute can become an attractor if it is currently provocative to the reader's unconscious search agenda.

There is therefore an important distinction to be made between the examples of the proof reader and the browser, cited above. As Freud said: "It is obvious that in cases of losing, the object is already provided; in cases of finding, it first has to be looked for." This is like the conundrum²⁹ in which the act of recognition sometimes appears to precede or to accompany cognition. It is also pertinent to the 'information object', or the 'hunch' in creative research. A book shop executive recently said that "If you buy a book, you will not have read it before". In such cases the act of 'noticing' is a crucial cognitive skill, yet it is likely that such mechanisms are inaccessible to scrutiny as they are chaotic³⁰ and therefore are resistant to empirical observation.

"If once you are given a brief there tends to be keywords that will trigger off things, you'll think about things that you have seen, that relate to that word, and then you start to draw on those." (Respondent in IDEAbase research survey, 1994)



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Chaos from order

This tendency for linear text to precipitate divergent properties is not new. It has been argued (Knoespel, 1991)³¹ that even the most monosemic, stable arguments in mediaeval biblical texts were challenged by familiar (but abductive) examples offered as explanatory metaphors. This points to the presence of chaos near to the centre of the most linear propositions. Knoespel suggests that the 'exemplum' provided the Middle Ages with the means to examine daily life and therefore can be seen as a counter force to the bible. "The 'example' is an advantageous figure with which to consider reading because it not only disrupts our viewpoint by making us refigure the fable but also offers a potential frame for ordering our re-assimilation of the story."

This tendency to disorder may also be precipitated by other techniques available to writers and readers, such as the iteration of a non-linear function. The results are not always unwelcome, and may be seen as a familiar tool in certain creative projects. "In deconstruction, as in the science of chaos, iteration and recursion are seen as ways to destabilize systems and make them yield unexpected conclusions."³²

Order within chaos

There is evidence, beyond the scope of this paper, that give clues to how we may begin to understand complex chaotic systems (including patterns of readership). Feigenbaum showed that systems go from ordered to chaotic states following a characteristic pattern of period doubling, and it has been argued that when a system has fixed point symmetries a small change can permeate everywhere (bullwhip) in a coordinated manner. Much more work needs to be done, here, but it is tempting to extrapolate these vague rules onto situations where a library user is reading, abductively, many books at the same time and suddenly discovers unexpected correspondences across unrelated domains of knowledge. Likewise, it may be necessary to invent novel terms for

.when water is flowing smoothly it is because molecules adjacent to bank follow same shape path as those further out. When minor perturbations occur they rearrange the influential adjacencies of contact so that further perturbations accrue. "Theorists have difficulties with these problems because they involve very many coupled degrees of freedom. It takes many variables to characterise a turbulent flow or the state of a fluid near the critical point."³³ His solution was to look for symmetries between different scales; i.e. recursive symmetries. he modeled them using renormalisation groups.

Hypertext is well known for its non-linear characteristics, however, a more orderly vision of its potential derives from its usefulness in group work. Barrett (1989)³⁴ describes hypertext as "an a-cyclic, asynchronous sharing of language around central topics of concern". Hypertext methods show particular promise for collaborative work at the early stages of the design process because it can adapt to unforeseen associations between individuals and topics. In this sense, IDEAbase is able to facilitate a consensus more immediately than would be possible using paper documents. "each link in a complex is important as the first one as it could become the magnet for a series of other objects....without hierarchical organisation all attributes are functionally equal and the complex merges with the objects that compose it....an advanced object emerges "only when the abstracted traits are synthesised anew and the resulting abstract synthesis becomes the main instrument of thought"³⁵.

"It works its way through like a modelling process, you can go forward or go back, until everything slots in." (Respondent in IDEAbase research survey, 1994)

"The reason I find it difficult is that I don't think kind of logically; it's sort of like a whirlpool of thoughts and I guess I can't really express it in a sort of sequential way.." (Respondent in IDEAbase research survey, 1994)

John Wood - EMAIL maxripple@gmail.com

FOOTNOTES



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¹The first four letters of "IDEAbase" are an acronym for the 'Interactive Database of Enabling Arguments'

²Wood, J., "The IDEAbase Project at Goldsmiths' College: Browsing for One's Own Ideas", in Autumn Collection, Kings College Computing Centre Publication, p. 3, 1990

³Wood, J., "A Hypertext Environment for Researchers in Art & Design", Conference Paper, 'Hypermedia in Vaasa', Finland, 1993 May

⁴Wood, J. & Clarke, J., "A Convivial Authoring Environment for Researchers in Art & Design", Conference Paper, Prolog in Education Group '93, Heriot Watt University, Edinburgh, 1993 July

⁵A term coined by Ted Nelson to describe (and to inspire the development of) computer systems which enable multi-dimensional document structuring which can be designed, maintained, and accessed by 'authors' and their 'active readers'.

⁶Taylor, P., "The Fuller Network", a non-linear introduction to the ideas and theories of Richard Buckminster Fuller. (IDEAbase document; Goldsmiths' University of London, 1994.)

⁷'Standard Generalised Markup Language'; An ISO-approved format for document description, and pre-cursor of HTML. All the codes in SGML documents are generic and reside in ASCII, and therefore provide an openly accessible way of bridging and transcending proprietary systems such as software products and networking protocols.

⁸Lansdown, J., "Visualising Design Ideas", in "Interacting with Virtual Environments", ed. MacDonald, L., and Vince, J., John Wiley & Sons Ltd, 1994, p. 64

⁹Wood, J., "Tacit Knowledge and the Research Tradition", in forthcoming first issue of "Co-Design" journal, October 1994.

¹⁰Schon, D., "The Design Studio", RIBA Publications Ltd., London, 1985

¹¹Chairman's remarks given at the "Design/Research" conference, Royal College of Art, 20 May 1994, London.

¹²Peirce, C. S., "Collected Papers of Charles Peirce", (ed. by C. Hartshorne & P. Weiss), Cambridge Massachusetts: Harvard University Press, (p. 374)

¹³Wood, J., and Taylor, P., "Mapping the Mapper", Electronic Journal of Virtual Culture, ed. Donald Day, Syracuse University, New York, May 1994

¹⁴Lawson, B., and Roberts, S.; Modes and Features: the Organisation of data in CAD supporting the early phases of design. - Design Studies Vol. 12 No. 2, p.p. 102 - 108

¹⁵Brown, J.S. "Notes Concerning Desired Functionality, Issues and Philosophy for an Authoring Land" Xerox PARC CIS Working Paper 1982

¹⁶quoted in Poster, M., "The Mode of Information", Polity Press, 1990; p. 84

¹⁷Sperber, D., & Wilson, D., "Relevance; Communication and Cognition", Basil Blackwell, 1986

¹⁸Freund, F., "The Return of the Reader", Methuen, 1987

¹⁹Networkable databases that represent information in multi-dimensional forms - c.f. conference proceedings of the "Electronic Library and Visual Information Research", De Montfort University, Milton Keynes, 3-5 May, 1994

²⁰"As We May Think" by Vannevar Bush 1945

²¹McKnight, C., Dillon, A., and Richardson, J., "A Comparison of Linear and Hypertext Formats in Information Retrieval", Hypertext II, Conference Proceedings, University of York, June 1989

²²Davidson, C., "What Your Database Hides Away"; New Scientist, 9th January 1993

²³Apted, S., M., "General Purposive Browsing" in "Library Association Record", 1971, 73(12)

²⁴Orne, J., "The Place of the Library in the Evolution of Graduate Work", in Hyman, R. J., "Access to Library Collections: an Enquiry into the Validity of Direct Shelf Approach with special reference to Browsing", Metucher: Scarecrow, 1972

²⁵Wood, J., "Tacit Knowledge and the Research Tradition", in forthcoming first issue of "Co-Design" journal, October 1994.

²⁶In terms of clarifying "Chaos Theory" as a topic, two separate and distinct categories of approach have been identified (Hayles 1991). This observation is itself likely to be controversial as the field is new and changing, but is partly based on the fact that the two groups do not appear to recognise each other within their published research findings. Broadly speaking, the first category seeks to define and to record deterministic yet unpredictable aspects of non-linear phenomena in a variety of ways that have been referred to collectively as "Chaos Theory". The main players here are Mitchell Feigenbaum ("Universal Behaviour"); Benoit Mandelbrot ("Fractal geometry"); Robert Shaw ("Strange Attractors", and "Fawcets"); and Kenneth Wilson ("Renormalisation"). The second group appears to be more interested in the implications of these phenomena, and how they may inform other concerns. In this group we find Arthur Winfree ("When Time Breaks Down"); Ilya Prigogine and Nicolis, G. ("Self-Organisation"); Ilya Prigogine and Isabelle Stengers ("Order Out of Chaos"); and René Thom ("Structural Stability").

²⁷A name invented by Ruelle and Takens in "On The Nature of Turbulence" (1971) . Hayles has said that an "attractor is any point of a system's cycle that seems to attract the system to it." N. Katherine Hayles, "Chaos and Order", University of Chicago Press, Chicago and London, 1991. p.8

²⁸One of the creators of the term "strange attractor". (c.f. Gleick, J., "Chaos, Making a New Science", Heinemann, 1988, London, p. 133)

²⁹Borges, J.,L, "Avatars of the Tortoise" pp. 114 in "Other Inquisitions", University of Texas Press, 1964, p. 117



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³⁰For an interesting theory of the chaotic principles inherent in neural activity during sensory arousal, c.f. Freeman, W. J., "The Physiology of Perception", Scientific American, Feb. 1991, pp. 34 to 41.

³¹c.f. Salvatore Battaglia, quoted by Knoespel, M., "Instability and Narrative Order", in N. Katherine Hayles, "Chaos and Order", University of Chicago Press, Chicago and London, 1991, p.110

³²N. Katherine Hayles, "Chaos and Order", University of Chicago Press, Chicago and London, 1991., p.11

³³Wilson, Kenneth G., "The Renormalisation Group and Critical Phenomena" Reviews of Modern Physics, 1983: 55:583-600, p.583

³⁴Barrett, E., "The Society of Text", MIT Press, Cambridge, Mass., 1989, p. xiii

³⁵Vygotsky, L. S., Thought and Language. Ed. and translated by Hanfman, E., & Vakar, G., Cambridge, Mass.: MIT Press, 1962. Edward Barrat's intro. to The Society of text, ed. Barrett, Edward. p.xvii)