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Computer criticism*

1 Introduction

Computer applications for language and literature studies have generally fallen into two major groups: those concerned primarily with the production through textual manipulation of conventional aids for future research (dictionaries, concordances, etc.) and those in which the computer was used in the analysis of specific works of literature (thematic analyses, stylistic studies, etc.). The former group has, in general, been viewed as beneficial or, at least, inevitable; the products that have resulted have been familiar and their value apparent. The latter group of applications has presented certain problems. These studies have often been based on initial assumptions that are unfamiliar and developed through techniques that seem more mathematical than literary. (See Sedelow 1970, Widman 1971.) In such cases the critic has had to supply an intellectual context for his study, relating it to conventional critical approaches, or risk losing his reader. Preferable to statements of context on an ad hoc basis would be a general awareness, on the part of computer critic and general reader alike, of the assumptions and methods inherent in computer assisted studies of literature and the generic relation with major areas of conventional critical thought. Of greater consequence, however, would be the increased awareness of critics that this new critical methodology is available for use on a wide variety of problems. As late as 1973 Paul de Man wrote:

'It can legitimately be said . . . that, from a technical point of view, very little has happened in American criticism since the innovative work of New Criticism. There certainly have been numerous excellent books of criticism since, but in none of them have the techniques of description and interpretation evolved beyond the techniques of close reading established in the thirties and forties.' (De Man 1973: 27)

The computer, properly and sensitively applied, offers the literary critic a rich collection of new techniques; unfortunately, this new methodology has been overlooked, even by Structuralist critics such as de Man, largely because it has appeared in rather specialized journals not read by the profession at large, and not in the standard periodicals or full length works.

In the remarks that follow, I shall try to speak to these needs by considering three aspects of computer studies of literature. First, I shall look exactly at some of what one does in using the computer to study language. Then, I shall try to identify a mode of criticism that arises from using the computer, which I term 'Computer Criticism'. Finally, I shall try to show that this mode of criticism, which appears rather foreign at first glance, is closely related to the major critical developments of this century and, in many respects, is a next logical step.

Let me confess at the outset that I am uncomfortable with the term, Computer Criticism, for it suggests that, somehow, it is the computer that does the criticism. Nothing could be further from the truth. A more accurate term might be 'applied semiological analysis', but this appellation is probably worse. The role of the computer is to gather the information the critic asks for, to display or present the information, or to apply some analytic model to the information. As with any mode of criticism, assimilation and interpretation takes place in the mind of the critic. One might argue that the computer is simply amplifying the critic's powers of perception and recall in concert with conventional perspectives. This is true, and what I have termed Computer Criticism could be viewed as a lateral extension of Formalism, New Criticism, Structuralism, etc. On the other hand, it is well known that occasionally a tool will emerge that proves to be of such seminal importance that it radically alters human culture and human self-concepts. (This process has been amply popularized by Marshall McLuhan, Arthur C. Clarke, Stanley Kubrick, and others.) The creative, sensitive, and extended use of the computer in pursuit of a fuller understanding of literature can lead to an intellectual perspective that is consistent with the main stream of critical thought but, nevertheless, different enough to warrant independent identification. Computer Criticism is, thus, parallel to recent schools of criticism but it is also an emerging school in its own right.

In attempting to document the relations between conventional criticism and Computer Criticism I shall concentrate most heavily on the material that I assume is least familiar to the reader; however, as I develop the assumptions and implications of this mode of inquiry, I shall relate them to assumptions and implications inherent in other perspectives. Because most readers are familiar with conventional criticism and because of the availability of numerous excellent surveys for those who are not, a summary of recent critical developments is not necessary; however, since my thesis is based on my particular view of those developments, I wish to pause momentarily to state that perspective.

In my view, the mainstream of twentieth century criticism has moved steadily, inexorably, toward greater formality and toward the notion of a 'science' or 'sciences' of criticism (these assertions are probably two sides of the same coin). In this country, this movement begins, at least in earnest, with

the New Critics and their attempts to break criticism out of the philological mold, to remove the encumbrance of authorial intention (an epistemic impossibility), and to center the critical response on the language of the work itself. Similar intentions lie behind the earlier Russian Formalists. Concentrating more on linguistics, rather than on diction or rhetoric, they sought to distinguish the language of literature, viewed as coherent systems of linguistic traits, from other language/mental activities. They were most successful in their thematic studies (such as Propp) where their analyses really began after language per se was left behind and they were able to deal semiotically with the structure of symbols/categories derived from language. A necessary step toward formality is the awareness of the relativity of models or critical perspectives; this important step in the progression toward greater formality was provided by, among others, the Chicago Aristotelian critics. Stressing the necessity for critical pluralism, they liberated the work of literature from the critical statement just as the New Critics had liberated it from the author. More recently, formalism has moved one step further in the Structuralists' view of the literary work, itself, as a semiotic structure. The full implications of regarding the literary work as a sequence of signs, as a material object, that is 'waiting' to be characterized by external models or systems have yet to be realized. Inherent is the possibility for defining content by formal rules of association, contiguity, and syntax; inherent is the possibility of defining esthetic response by similar formal rules.

The potential of structuralist thought has not been realized, in my opinion, for two reasons. First, in spite of statements that structuralism is really only a method, it is not methodical enough; structuralists have never codified a set of methods or techniques that is adequate and general enough to accommodate close, sophisticated analyses of a variety of specific literary works. Second, and understandably because of their linear descent from de Saussure, their concept of structure has been overwhelmed by the notion of linguistic structure. There is no reason to believe, and in fact numerous reasons to believe otherwise, that segments larger than the sentence are structured in a form similar to the structures within a sentence. The next logical step in this progression toward greater formality would be a mode of criticism based on a coherent set of techniques that includes linguistic models but that goes beyond to include any concept of structure that is potentially useful for characterizing linear sequences of signs.

The progression toward the concept of a science of criticism is probably another manifestation of the movement toward greater formalism. The New Critics, while often using 'the scientist' as a whipping boy in their efforts to distinguish the rich, connotative language of poetry from merely descriptive language, nevertheless, endorse a mode of criticism that would be more precise, systematic, structural, i.e., 'scientific'. The Russian Formalists were more

direct: as William Harkins has observed, they quite consciously saw themselves as 'trying to create a literary science' (Harkins 1951: 184). While not calling criticism a 'science' per se, Northrop Frye has forcefully described the scientific aspects of contemporary inquiry:

It seems absurd to say there *may* be a scientific element in criticism when there are dozens of learned journals based on the assumption that there is, and hundreds of scholars engaged in a scientific procedure related to literary criticism. Evidence is examined scientifically, texts are edited scientifically. Prosody is scientific in structure; so is phonetics; so is philology. Either literary criticism is scientific, or all these highly trained and intelligent scholars are wasting their time on some pseudo-science like phrenology. (1957: 8)

Similarly, Robert Scholes has identified the 'scientific' aspect of criticism with the 'cumulative' aspect of scholarship (1974: 77), a practice prescribed by McKerrow in 1952 and now expected by virtually every serious journal. A final, and perhaps extreme, view of a science of criticism is that of Roland Barthes stated in 1967: 'Science versus literature'. Barthes not only identifies a scientific mode of criticism present in French Structuralist/Semiological Criticism, but asserts that the emerging field of semiology will constitute a 'meta-language' (by which he means a meta-science involving both perspective and method) that will eventually include and absorb the sciences proper.

This brief overview of the structuralist/formalist tradition and the related movement toward a science of criticism has omitted reference to social, psychological, and phenomenological criticisms. There have, of course, already been partial attempts to bring Marxist and Freudian criticism into the domain of structuralism. It is my personal belief that this trend is likely to increase and that social and psychological approaches will make substantial, permanent impact only to the extent that they can be incorporated into a formal consideration of the text itself. As for phenomenological approaches, I see them as the 'loyal opposition', the inevitable and opposite reaction to this very strong main current of thought.

In the remarks that follow, I shall try to infer through a consideration of specific analyses the intellectual perspective termed Computer Criticism and to link this perspective at key points with the formalist/structuralist tradition. For the reader unfamiliar with the computer, however, I shall look first at what is actually done in exposing a literary text to a computer before considering the more general implications of these applications.

2 Textual processing

In principle, a computer is a very simple machine. It is a symbol manipulator that can recognize 256 codes or characters.¹ These codes, which are thought

of as being ordered from zero to 255, can stand for numbers, letters of the alphabet, or practically anything that one wishes to associate with them. They may be considered separately, as is usually the case for language processing, but they can be considered in groups in order that numbers larger than 255 can be represented or texts with more than 256 characters (texts with a variety of fonts) can be represented. The second major point to remember is that computers operate sequentially: they can look at two characters, compare them to see if they are equal, see if one is higher or lower than the other in alphabetic sequence, or move them from one place to another. For numbers, the computer does the same things but it may also add them, subtract them, multiply them, divide them, etc. Using these basic operations one can describe procedures that can be applied to a text to do something useful and, eventually, to do something interesting.

Before such a procedure can be applied to a text, however, the text must be presented to the computer in a form that it can recognize; unfortunately this is normally not in the form of a physical book. Usually the text must be typed onto cards or, preferably, typed directly into the computer memory using a keyboard terminal. Both keypunches and keyboard terminals have a (virtually) standard typewriter keyboard; in fact, several popular terminals employ the IBM Selectric typewriter mechanism. When a key is struck on a keypunch, it prints the character on the top of the card but also punches a series of holes that the computer can interpret as one of its group of 256 characters. Similarly, the terminal types or displays the character but instead of punching holes it sends via a regular telephone line a Morse code-like representation of the character that is received and kept by the computer until it is told what to do.

Texts are normally typed virtually as they appear in the printed book: one textual line per card or one textual line per terminal line. To facilitate later processing or to represent characters in the text that do not appear on the keyboard, one may employ special typing conventions; for example, one may wish to mark italics by placing, say, a pound sign (£) immediately before or after the word to inform the computer that this word is of different font and to mark it accordingly. With most textual material and with many sets of conventions, the encoded text can be read both by the computer and by the human being without great difficulty.

After the text has been encoded it must be 'read' by the computer. For cards, this is done by a card reader, a device that examines each column of each card, in order, to determine which of the 256 characters is represented. For texts typed directly into the computer through a terminal, this is done through a statement which is typed on the terminal but which the computer recognizes as a command rather than as more text. To read the text and to process it, the computer requires a detailed sequence of instructions or pro-

gram; this can be written by the analyst but there are an increasing number of such programs available. These may be stored in the computer's program library and simply called by the analyst when required.

As far as the computer is concerned, the text will appear as one long sequence of characters, starting with the first, continuing from card to card or line to line, to the last. It is usually preferable to segment the text into recognizable units: words, sentences, paragraphs, etc. Each segment, however, must be described to the computer in terms that it can 'understand'; for example, a word might be described to the computer as a sequence of non-blank characters bounded on the left and right by blanks. The situation can get a bit more complicated for abbreviations, words before commas, the last word in the sentence, etc.; but by careful planning and through a set of encoding conventions that anticipates such difficulties, the computer can be trained to recognize a word within the stream of characters. Similarly, it may be given a set of instructions or rules to recognize sentences, paragraphs, chapters, etc.

Once the appropriate unit is recognized, it may be moved out of the flow of characters and placed somewhere else where it is more accessible. For example, it may be placed in a list of words, one per line, where each word may be dealt with as a single item. After the entire text has been processed and all words extracted, one word in the list could be compared with the word below it in the list. If the lower word is higher in alphabetic sequence, the computer could then exchange the two words. Repeating this operation over and over, the computer could eventually arrange the entire list into descending alphabetic sequence. It would then be quite easy to derive a dictionary for the text being processed as well as the frequency of occurrence for each word.

If two texts were processed, one placed in one list and the other in a second list, the computer could be used to collate the two. That is, it could be instructed to compare the first word in each list. If they are identical, it would go to the next word in each list and repeat the process. If they are not identical it could then move down one list until the words match or if that doesn't work move down the second list. In some cases the comparison can be a bit tricky requiring a jump ahead and comparisons both backwards and forwards within both lists, but the computer is far more accurate than the human eye, particularly for texts representing different type settings.

If the computer is instructed to recognize not just words but also sentences, the words may be placed in one list and the entire sentence for each word placed in a second wider, but corresponding, list. When the list of words is rearranged alphabetically, the corresponding sentences may also be rearranged. In this manner the computer can be used to construct a concordance providing full sentence context. The entire concordance could be printed by the com-

puter, or it could be instructed to print a selected concordance for only a specific set of words supplied. It could even be instructed to print a concordance for only those sentences in which particular combinations of words appear.

In practice, these techniques are often expanded or modified for efficiency and to accommodate large texts. However, these brief examples will give the reader unfamiliar with computers a sense of how they operate and how they can be used to process a text. The 'products' that resulted were all familiar critical apparatus: a dictionary, a collated text, a concordance. In the remarks that follow, where I shall be dealing with computer materials that may be less familiar, I shall not burden the reader with discussion of *how* the particular aid was produced; I shall concentrate more on describing the product itself, the assumptions that have led to it, and its implications for literary research and critical perspective.

3.1 Computer criticism: Materialist view of a text

It is well known that the act of reading includes a number of assumptions and a number of mental actions that are normally unconscious. We can, but seldom do, distinguish between the concept of a character and its shape or form; we are even less likely to examine (consciously) the physical aspects of the character: the ink that is used to form it, the paper on which it is printed, etc. Instead, we normally deal with the character — or, more often, aggregates of characters — on the level of meaning. We see configurations of characters and we think word, phrase, or concept. The important point, however, is that if pushed not only can we distinguish between signifier and signified, we can move in the opposite direction and distinguish between physical medium and signifier.

These strata do not exist for the computer. Its total 'awareness' resides in its ability to distinguish among a small (256) set of states or sequential combinations of states. The only physical dimension of these states is the electrical impulses that constitute them. All other 'awareness' is relational: one state 'higher' or 'lower' than another (A higher than B in alphabetic sequence).

Because the computer is a sequential processor of symbols, there is a notion of linearity and segmentation inherent in its design. The concept of linearity is fundamental to the 'stream' of characters that it receives from outside — through the card reader or terminal. Any concept of segmentation based on the length of the card or the length of the terminal line is physical and, hence, lost when the text is considered in its encoded, symbolic form. The fundamental segment is, of course, the character. Since each character is represented by one of 256 states there is no variable spacing: all characters occupy equal space in the sequence and all are segmented from one another. Segmentation,

then, in the linguistic sense must be defined for the computer formally and functionally: the sequence of non-blank characters between blanks, or some equivalent definition. If these segments, words in this case, are moved to a list where each slot is of equal width, then this transformed version of the text becomes a text of equally spaced segments analogous to the character-level defined text. Thus, the items in the list, words, become the fundamental units or states and are usually dealt with by the computer as 'wholes'; and the text considered as a sequence of words emerges with the same material characteristics as the text viewed as a sequence of characters.

The notion of signified is, therefore, missing from the text considered as a sequence of words just as it is missing from the text considered as a sequence of characters. When the computer 'reads' a text, the three levels — the physical, the signifier, and the signified — collapse into the single stratum of the signifier: the sequence of characters or internal states of the computer. The process is necessarily and formally reductive but perhaps not as limiting as it may first appear. While the computer can deal only with *encoded* material, there is no reason that physical as well as semantic characteristics cannot be encoded into parallel symbol sequences. That is, characteristics such as physical segmentation (page, line, position within line), font, etc. can be encoded as separate sequences of symbols parallel to the actual textual characters. Similarly, semantic relations such as synonymity, oppositeness, etc., can be encoded in another symbol sequence (or if necessary, several such sequences), and the text 'viewed' by the computer as three or more parallel symbol sequences; unlike the human being, however, the computer cannot infer any relation or order among these separate sequences unless that relation is supplied, directly or indirectly, by the researcher. So considered, a text becomes for the computer a material, linear sequence or sequences of symbols (Fig. 1).

This stratified view of a text is dependent on the notion of category. At the physical level, the researcher might establish categories denoting italics, bold face, etc. and encode this information by appropriate symbols in a sequence parallel to the main stream of characters. One could consider the stream of characters that constitute the text a category system as well: that is, a set of 256 categories into which the characters of the physical text are mapped. Since this correspondence is usually straight-forward, one is seldom even conscious of the categorical aspect. Much more important is the concept of category at the level of the signified. Since the computer can deal only with formal relations among characters, words, or other segments, the researcher must provide all concepts of 'meaning'; this is usually done through a system or systems of categories.

Since the computer can produce a dictionary, we may assume that the researcher has at his disposal an alphabetized list of the words that occur in the text under consideration. One concept of category is equivalent to

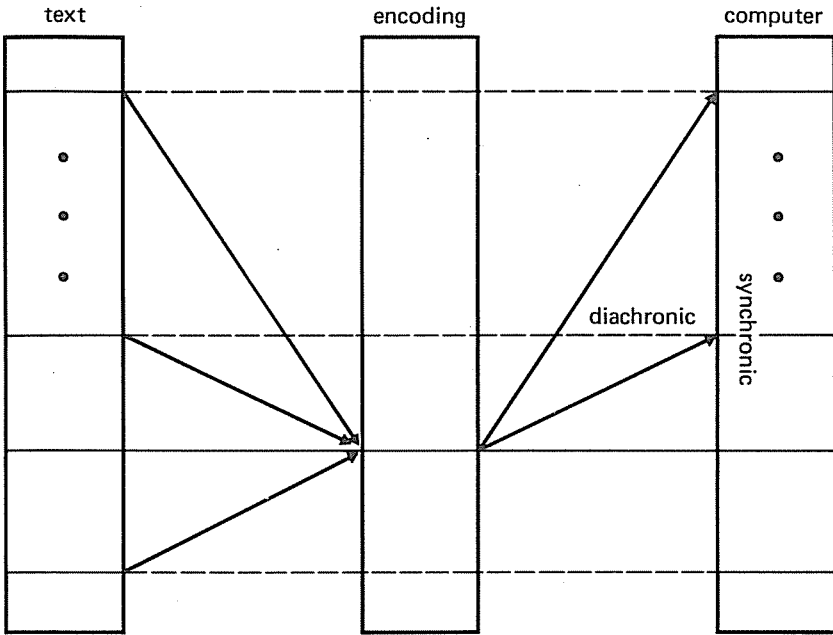


Figure 1. Computer 'view' of a text

dividing or partitioning the dictionary. That is, the researcher might read down the dictionary and divide the vocabulary into words that suggest sensory impressions (images) or words that carry content (as opposed to some list of functors), or any other grouping appropriate for the study. The computer, in its capacity as symbol manipulator, could then be instructed to consider only that category or collection of words and ignore the rest. Similarly, the researcher may wish to designate a number of categories, as appropriate for a thematic analysis, in which the vocabulary of the text is divided into a number of separate categories. For example, he may select for the theme, *fire*, the words *burn*, *burned*, *burning*, *fire*, *heat*, *hot*; and for *water*: *damp*, *water*, *watery*, *wet*, etc. It is this information, encoded as some set of symbols such that the appropriate symbol is associated with the corresponding word in the textual sequence, that would constitute one of the signified strata. A broader study might deal with all content words but ignore, in its semantic emphasis, syntactic variability indicated by suffix. An appropriate category system for such an analysis, instead of having twenty or thirty categories, could employ

several thousand with each category standing only for a single root-group (*hope, hoped, hoping*, etc.) and containing only a half-dozen or so members. From the standpoint of the computer, it makes no difference whether the vocabulary is divided into two categories, thirty categories, or several thousand, nor does the rationale behind the particular categorization scheme matter: all such relations can be handled analogously.

This notion of category, dependent on the concept of a dictionary, alone, is not sufficient for many studies. For example, the configuration of characters, *rose*, may signify a flower, as appropriate for an imagery study; but it may also describe an action — *he rose from his chair*. Here context must be taken into consideration. Since the computer can produce a concordance, we may assume the researcher has at his disposal a concordance as well as a dictionary. Consequently, the concept of category can be refined to include linear, diachronic relations as well as dictionary-based, synchronic relations defined for every occurrence of a given configuration of characters. Since the computer, through its ability as symbol manipulator, can be instructed to regard a number of different words as equivalent, the category of linear configuration of words can be extended to include linear configurations of word categories: that is, instances involving a paradigm-like configuration where members of the paradigm may be any specific word within a category. One of the earlier content analysis programs, *The General Inquirer*, formally defined content as precisely this: the logical configuration of conceptual categories of words (see Stone 1966). In retrospect, we have seen that the text can be formally segmented in a step by step manner such that each higher segment is defined in terms of units at the next lower level, ranging from the character to the entire work considered as a whole and by extension to the corpus. For each level of segmentation, parallel strata of symbols representing both physical as well as conceptual aspects of the text may be established. These may refer directly back to the textual sequence, itself, and are hence parallel to one another, but they may also be established hierarchically by referring directly to some secondary stratum (category of categories, categories of syntactic forms, etc.). Concepts of form, structure, and meaning relate to patterns along, across, and among these various strata. Below I shall describe some of the formal models that are available for characterizing such relations, but first I shall pause to relate these basic concepts of textual materiality and interpretive categorical strata to similar concepts within several recent conventional critical perspectives.

3.2 Conventional criticism: Materialist view of a text

The concepts of the autonomy of art, the materiality of the text, and the primacy of category to define and characterize form are all central for Russian

Formalism as well as its second generation in Prague. As Victor Erlich has observed, the autonomy of art for the Formalists ranges 'from the autonomy of the individual poetic word *vis-à-vis* its object to the autonomy of the literary work of art with regard to reality' (1955: 177). At the level of word or figure, the observance of *ostranenie* or 'making strange' was an attempt to liberate the word from fixed connotations so that its full richness could be seen (Erlich 1955: see especially his discussion of Skaftymov in Chapter 10). At the other extreme, Skaftymov demonstrated that character in a narrative, the action in the plot, and, indeed, the philosophic dimensions of the fictive universe must be considered first as components organized within an autonomous esthetic structure before substantive extrapolation can be attempted (Erlich 1955: 176-177).

The concept of category, also, is both pervasive and varied in its manifestation. To reveal the universal narrative structure of a collection of fairy tales, Vladimir Propp (1968) reduced the texts of a collection of some 479 tales to sequences of basic actions or 'functions'. Since Propp's 'function' represents an action described in the narrative, it is analogous to the category of logical configurations of dictionary groupings discussed above; Propp's familiar symbolic representation of thematic structure could be viewed as a sequence of symbols parallel to the textual sequence, analogous to one of the semantic strata inherent in Computer Criticism (Propp 1968, especially Chapter 2). A. A. Reformatsky is one step closer to the 'bootstrap' hierarchical relations of Computer Criticism's category strata. He distinguishes among 'themes', 'the simplest static unit of plot construction', 'motif', a set (usually two) of themes joined by a verb, and 'plot theme', units composed of combinations of themes and motifs (1973: 88-89). Because Reformatsky is primarily interested in narrative sequence, he often collapses these logically distinct categorical strata into a single symbol sequence in order to represent narrative structure. More important, particularly in later structuralist thought, is the concept of metonymy. In distinguishing between figures of speech natural for poetry and those natural for prose, Roman Jakobson (1936) distinguishes between the relation of comparison inherent in metaphor and logically contiguous substitution inherent in metonymy. The latter, of course, when considered methodologically, is clearly an example of semantic category: the collection of textual items used individually to stand for the set.²

More familiar, but less directly related, is American New Criticism. The concept of a materialistic text is apparent in Ransom's ontological concern for the 'poem as object', a predominantly holistic perspective in which sound and meaning must be joined phenomenologically by the critic (Ransom 1940). Ransom's perspective is made much more concrete and applicable in Wellek and Warren's delineation of perceptual strata. They divide the text into: (1) the sound stratum; (2) the units of meaning; (3) stylistic devices such as image

and metaphor; (4) the fictive world of the poem; and (5) the metaphysical dimensions of that world (Wellek - Warren 1956: 157). While their delineation of strata has been useful for students of literature, their emphasis is historical and comparative rather than methodological. In fact, it is one of the great ironies that the New Critics, while never establishing a general methodology, produced an unusual amount of perceptive and helpful criticism through the extraordinary talents of its major practitioners. Perhaps the closest approximation to a New Critical methodology is Caroline Spurgeon's earlier categorization and tabulation of Shakespeare's images (1958), although her biographical extrapolations were, of course, contrary to New Critical principles.

More directly related to Computer Criticism's assumptions of a material text and the notion of categorical strata is French Structuralist Criticism, perhaps best summarized in Roland Barthes' 'The Structuralist activity' (1972). Most Structuralists claim at least all of the arts as their domains while their near kind, the Semiologists, claim all knowledge; consequently, when Barthes addresses first the ontological nature of the object of scrutiny and, next, its dissociation into parts from which collections (paradigms) are formed, he does so for areas other than literature:

The goal of all structuralist activity, whether reflexive or poetic, is to reconstruct an 'object' in such a way as to manifest thereby the rules of functioning (the 'functions') of this object. . . .

The structuralist activity involves two typical operations: dissection and articulation. To dissect the first object, the one which is given to the simulacrum-activity, is to find in it certain mobile fragments whose differential situation engenders a certain meaning; the fragment has no meaning in itself, but it is nonetheless such that the slightest variation wrought in its configuration produces a change in the whole; a *square* by Mondrian, a *series* of Pousseur, a *versicle* of Butor's *Mobile*, the 'mytheme' in Levi-Strauss, the phoneme in the work of the phonologist, the 'theme' in certain literary criticism -- all these units . . . have no significant existence except by their frontiers: those that separate them from other actual units of the discourse . . . and also which distinguish them from other virtual units, with which they form a certain class (which linguistics calls a *paradigm*); this notion of paradigm is essential, apparently, if we are to understand the structuralist vision: the paradigm is a group or reservoir -- as limited as possible -- of objects . . . ; what characterizes the paradigmatic object is that it is, vis-à-vis other objects of its class in a certain relation of affinity and dissimilarity. . . . The dissection operation thus produces an initial dispersed state of the simulacrum, but the units of the structure are not at all anarchic: before being distributed and fixed in the continuity of the composition, each one forms with its own virtual group or reservoir an intelligent organism, subject to a sovereign motor principle: that of the least difference. (Barthes 1972: 214, 216-217)

Illustrative of Barthes' view of the text as 'mobile fragments' and his insistence on the primacy of category (paradigm) for critical analysis is Tzvetan Todorov's *Grammaire du Decameron* in which he proposes a specific instance (Grammar of Narrative) of a universal grammar appropriate for all conceptualization.

Similar to Propp's study of Russian folk tales, Todorov's study is a highly abstract study of narrative sequence after it has been reduced to several strata of categories. He first distinguishes among textual segments: stories, sequence (a complete 'little tale'), propositions (basic narrative sentence), and parts of speech. He next reduces all actions to the verb categories and all attributes to the other categories. He then proposes a transformational grammar of narrative to accommodate the individual tales. Both the statement of principle as well as the illustrative example emphasize a critical perspective based on a segmented text of functional units that may be grouped in various ways in order to define relational patterns. Computer Criticism shares this perspective but, of course, is more inclusive; that is, it demands neither Barthes' concept of the smallest possible set or Todorov's specific categories. Even greater flexibility is present in its liberation from linguistic concepts of structure — virtually a universal assumption of French Structuralism.

The formalist group closest to Computer Criticism is the London School, centered around J.R. Firth but most thoroughly and articulately developed by M.A.K. Halliday. Earlier, we saw that the computer 'considers' a character as one of 256 distinguishable states ordered sequentially; analogously, it is convenient to consider a text as a sequence of equally spaced character patterns or words. Firth and Halliday use the concept of 'exponent' both to define the substantive within a categorical stratum and to connect the various strata. Halliday, who borrows the concept from Firth, states the relation as follows:

Exponence is the scale which relates the categories of the theory, which are categories of the highest degree of abstraction, to the data . . . Each category can be linked *directly* by exponence to the formal item. This has then to be related, in turn, to the substance . . . When grammar reaches the formal item, either it has said all there is formally to be said about it or it hands it over to lexis. (1961: 270-271)

'Lexis', for Halliday, is the 'set' of substantives that occupy the places in the sequence of categorical units within a stratum; at the lowest, or most delicate level, this consists of the orthographic or phonemic symbols. Larger units — words, phrases, syntactic patterns, etc. — are produced by formal patterns of textual co-occurrences, called 'collocations', which may be enumerated to form sets. There is, thus, a direct correspondence between the Firth/Halliday notion of 'sets' and the Computer Criticism concept of 'states' that constitute textual items; both share the view that subsequent categorical strata can be formed by formal delineation of patterns within a lower level; finally, both establish correspondences between strata, one by the concept of exponency, the other through the concept of location and direct co-occurrence. This and other similarities will be explored further in the discussion of the concept of structure below.

This brief, but I hope not too distorted, comparison illustrates the close compatibility between several recent structuralist schools and Computer Criticism. All contain the basic premise that the text exists as an object in its own right and all approach the text by establishing with varying degrees of formality strata through which the critic views the text. Computer Criticism differs in that it demands formal rules for establishing strata, it suggests a greater number of strata relating to a greater range of textual features, but most important, all such strata are arbitrary and can be established in response to a wide range of specific critical intents. By contrast, the conventional perspectives discussed assign strata a fixed definition (syntactic, thematic, etc.) with prescriptive structural frameworks. Conceptually, then, the specific aspects of textual materiality and interpretive categorical stratification of these examples can be viewed as special cases of the more general concepts found in Computer Criticism.

4.1 Computer criticism: Concepts of structure

A functional concept of form or structure emerges from the functional notions of sequence and category. Inherent in the sequence of signifiers is a concept of form based on contiguity or transition: one item is followed by another item, followed by another item, etc. Between the level of signifier and all other levels there exists an inherent, diachronic relation; symbols occur in the same slot in the text as the signifier whether that signifier is a textual segment or a segment within some higher categorical stratum. All other concepts of form are relations that work in a state of tension with these fundamental relations: that is, structures that associate in some meaningful way items that are not adjacent or parallel.

The domain or textual segment for which structural relations are sought is most important. If the segment is the sentence, then structure becomes essentially linguistic (for example, syntax is a system that associates in a meaningful way sometimes noncontiguous words on the basis of grammatical categories). If the segment is the paragraph, the concept of structure would be that of discourse analysis. For an entire text, a description of the structure and its rules and dynamics could be seen as interpretive criticism; for the canon of the author, the endeavor can be seen to resemble Frye's concept of contextual criticism.

By viewing the text as a functional, materialist sequence of symbols, the critic is free to employ linguistic models where they are appropriate but he is also entitled to employ any model that fits this view of a text and which is potentially useful. I shall try to locate some of the domains in which descriptive models may function and some of the specific, non-linguistic models that

can be employed. To give this discussion an illustrative content, I shall discuss these models as they could be used for a thematic analysis, where theme means a collection or metonymic category of words that suggest the same basic concept (such as the collection of words related to *fire* and *water* mentioned above).³ Other definitions of 'theme' as well as other critical foci can, of course, be accommodated under the general notion of category.

The concept of category 'exists' conceptually on the level of the signified regardless of whether it is encoded as a sequence of symbols parallel to the textual sequence of signifiers or represented in some other way.⁴ Mere designation of the theme or category, as was seen in Spurgeon's study of Shakespeare, draws the critic's attention to the functional equivalence of the words or units of the category. It also suggests the further possibility of describing the form or 'behavior' of the theme over the entire text. That is, we may count the number of times the category appears and by comparing this value with similar totals for other thematic groups gain some partial insight into its relative prevalence and, perhaps, importance. If the text is segmented on the physical level into units of equal length (say, 500 words) and subtotals for each such unit computed, the resulting values may be used to produce a distribution of the theme over the text (see Figure 2: a distribution of the theme, *fire*, for Joyce's *A portrait of the artist as a young man*). In such a drawing we may not only confirm critical impressions of thematic density, we may see exactly the proportional concentration in one section of the text compared with another.

While a distribution of a theme can be regarded as a structural description of that theme, Computer Criticism can go one step further and employ models that characterize that distribution. That is, the critic may not only display the actual distribution, but uncover the underlying form or dynamics of that distribution and compare it with similar analyzed distributions. By regarding the diachronic sequence of words as analogous to the unitary progression of time, the critic may employ a variety of analytic models, known collectively as Time Series Analysis, to characterize the distribution. One such model is Fourier Analysis.

To apply Fourier Analysis to the distribution of a category or theme, the critic must view the distribution as analogous to a wave over time, such as a graph of a sound wave over some period of time. If the sound wave has definite maximum and minimum frequencies, as would a sound wave carried over a telephone, it is a remarkable mathematical fact that no matter how irregular the wave appears, it can be reproduced by combining a definite number of flowing, perfectly regular (sine and cosine) waves of different frequencies and amplitudes/heights. By picking only the highest, most important waves, adding them together, and ignoring the rest, one can produce a 'smoothed' transformation of the original distribution in which the form and

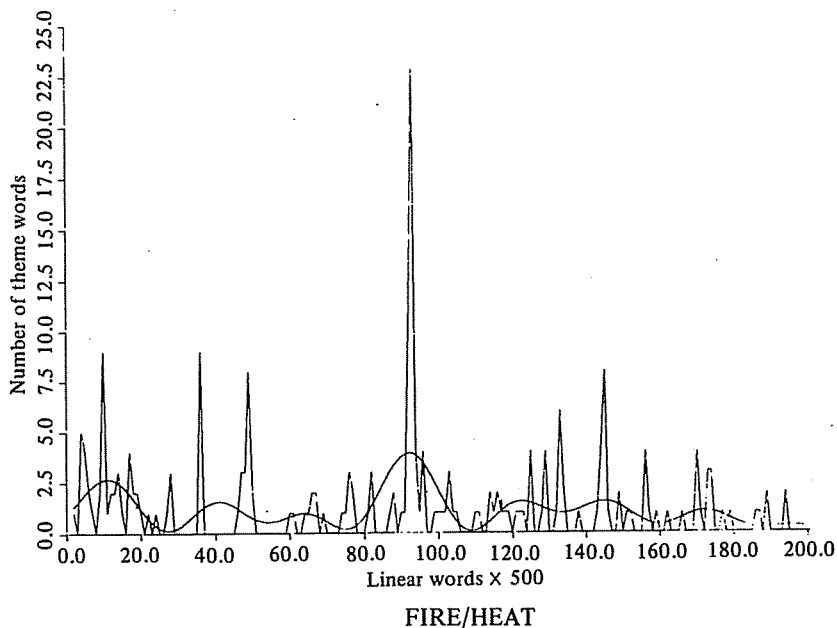


Figure 2. Distribution of *fire*

major dynamics of the theme are readily apparent. Further, a distribution of the amplitudes (actually, a function of the amplitudes) of the smooth waves can be regarded as a formal description of the complexity of the theme; a thematic distribution with only eight important terms or rhythms might be considered less 'complex' than a distribution with sixteen. Thus, the critic may use the computer to draw attention to the variety of words connoting a theme, to compute its frequency of occurrence, to display its form or behavior over an entire text, and to characterize that form. The techniques described could also be employed to consider a variety of themes and the resulting materials used for comparative purposes. Other techniques more directly suited for considering thematic comparisons and interactions, however, will be discussed below.

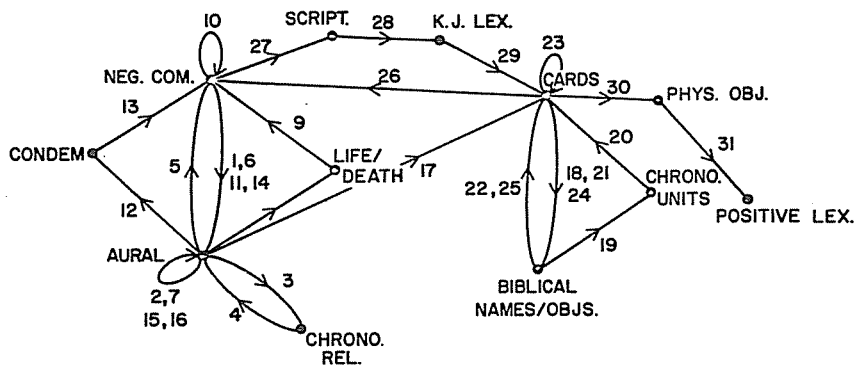
The concept of distribution is a diachronic concept of structure that parallels the three levels — physical segmentation, sequence of signifiers, sequential categories of significant — described earlier; a different concept of form or structure is the collection of synchronic relations among a number of such distributions and, further, changes in the pattern of such interrelations over the text. Synchronic patterns of interrelation are, essentially, patterns of co-occurrence. For example, in Joyce's *Portrait*, a great deal is revealed about Stephen by the combination of themes and images that flow through his

mind. In Chapter 1, he seldom recalls the pleasant and secure hearth fire of home without recalling the dreadful fall into the cold waters of the ditch; other combinations abound. While techniques for determining synchronic patterns of interrelations will reveal thematic groups that tend to cluster, of even greater interest are techniques for revealing the progression of such interactions through the text. Returning to *Portrait*, the strong interaction between fire and water imagery disappears and is replaced by other strong associations. In fact, the entire development of Stephen's personality can be traced by first establishing the dominant patterns of association or co-occurrence for a section of text and then observing the shifts that take place at epiphanal moments.

A number of models are available for determining such patterns of co-occurrence: one I have found particularly useful is factor analysis or, more specifically, Principal Component Analysis. To use it, in the context cited above, the critic would determine a section of text — possibly the entire text — in which he feels that thematic interaction is relatively consistent. By next dividing that portion of the text into small, uniform physical units (perhaps 100 words) and by computing distributions on the basis of those units for all themes or categories to be considered, he may use factor analysis to determine specific clusters or groups of themes that consistently occur close to one another. With this information he may return to his concordance or to the text to explore the specific thematic significance suggested by these patterns of inter-relation.

To trace the developing network of associations among themes, I shall describe two approaches. The first, employing a device known as the state diagram, is rather simple to apply; the second, known by the acronym, CGAMS, at present requires rather specialized computing equipment but is more powerful. State diagrams are widely used in Automata Theory to designate the particular configurations or states of a theoretical computing machine, the history of the 'machine,' or the permissible transitions from state to state. This is done by representing the states as a set of points and the transitions by lines or arrows between the points. The technique can be used to reveal the developing structure or network of thematic associations by representing each theme by a point and indicating the associative relations between themes as lines joining the appropriate points/themes. More specifically, one could have the computer mark each theme or, perhaps, cluster of a theme (a cluster could be a section of text in which, say, three words in the same theme occur within 100 words of one another).

The progression from theme to theme or from cluster to cluster can be traced by drawing and numbering the lines from appropriate point to appropriate point. Close thematic interaction will be revealed in points close to one another in the diagram and by those having a number of lines joining them. An example of a thematic network of this sort is shown in figures 3 and 4,



DOC I

Figure 3. Thematic structure of DOC I

representing two versions of the same basic text, in this case, a folk sermon.⁵ While the diagram itself represents a synchronic structure for the entire text, the diachronic progression from theme to theme can be traced: locate START; find the path marked 1, move to the next point or theme; find the path marked 2; move to the next theme; etc. Used singly, diagrams of individual texts reveal the specific thematic structure of that text; diagrams for several texts can be used in combination for comparative purposes to approach questions such as thematic complexity and the relation of thematic structure to other aspects of the work.⁶

When the critic wishes to explore the dynamics of thematic interaction over a long text, the computational system, CGAMS, may be more appropriate (Smith 1974). CGAMS, while most useful for deriving a macroscopic representation of thematic relations, may also be used for close inspection of specific thematic relations within a small textual segment. The system produces a pictorial representation of the relations between a selected set of themes on a T.V.-like screen (see figure 5). The basic picture resembles an aerial view of a mountain range in which there is a peak for each theme. The height of a peak represents the relative prevalence of that theme for the section of text under consideration. The horizontal distance between peaks represents the proportional diachronic distances in the text between those two themes relative to similar distances for all other theme pairs. The slope of the facet between two themes/peaks indicates whether the two themes tend to be a stable distance from one another (for example, nearly always ten or twelve words apart) resulting in a sharp, abrupt facet, or whether the distances vary considerably (sometimes two or three words apart; sometimes twenty or thirty words apart) resulting in a sloping facet. The perspective on the 'mountain

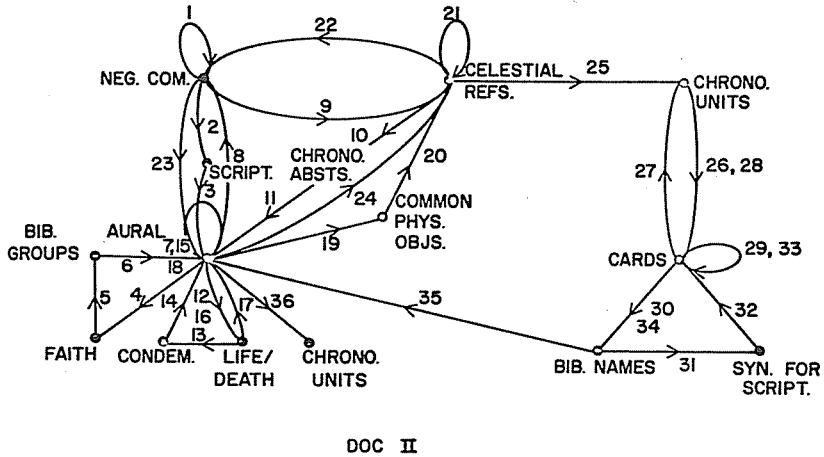


Figure 4. Thematic structure of DOC II

range' may be changed by turning dials so that the critic can zoom up and look down on it from above, move down and look at it from ground level, or assume any other position he wishes. By producing an entire picture for, say, the first 1000 words of the text, another, cumulative, picture for the first 2000 words, another for the first 3000, etc. through the entire text one can note in the progression of pictures the way in which themes grow and shift in relation to one another over the diachronic course of the work.

The basic view of the peaks resembles a fishnet laid over mounds of sand; to gain a closer, more detailed perspective of the exact pattern of thematic interaction for a section of text, the researcher may remove the 'fishnet' and examine the specific information on which the picture is based. Thus, CGAMS can portray the structural dynamics for selected themes from a micro-perspective as well as a macro-perspective.

An example of a CGAMS application may be helpful. I have argued elsewhere (Smith 1972) that in Joyce's *Portrait* the personality of Stephen remains constant between moments of epiphany (the pandybat episode, the encounter with the prostitute, the confession, the encounter on the beach, etc.). At these moments of epiphany, however, what exactly changes is the pattern of associations among images manifest in changes in the pattern of proximity of images in the text. CGAMS is helpful for tracing the nature of those shifts for major thematic groups of images; figure 4, as noted, is a representation of some half dozen thematic groups for the first chapter. The careful reader will, of course, notice certain shifts in proximity and association, but CGAMS marks the exact place where shifts occur, reveals the precise nature of the shift relative to other thematic relations, indicates the relative

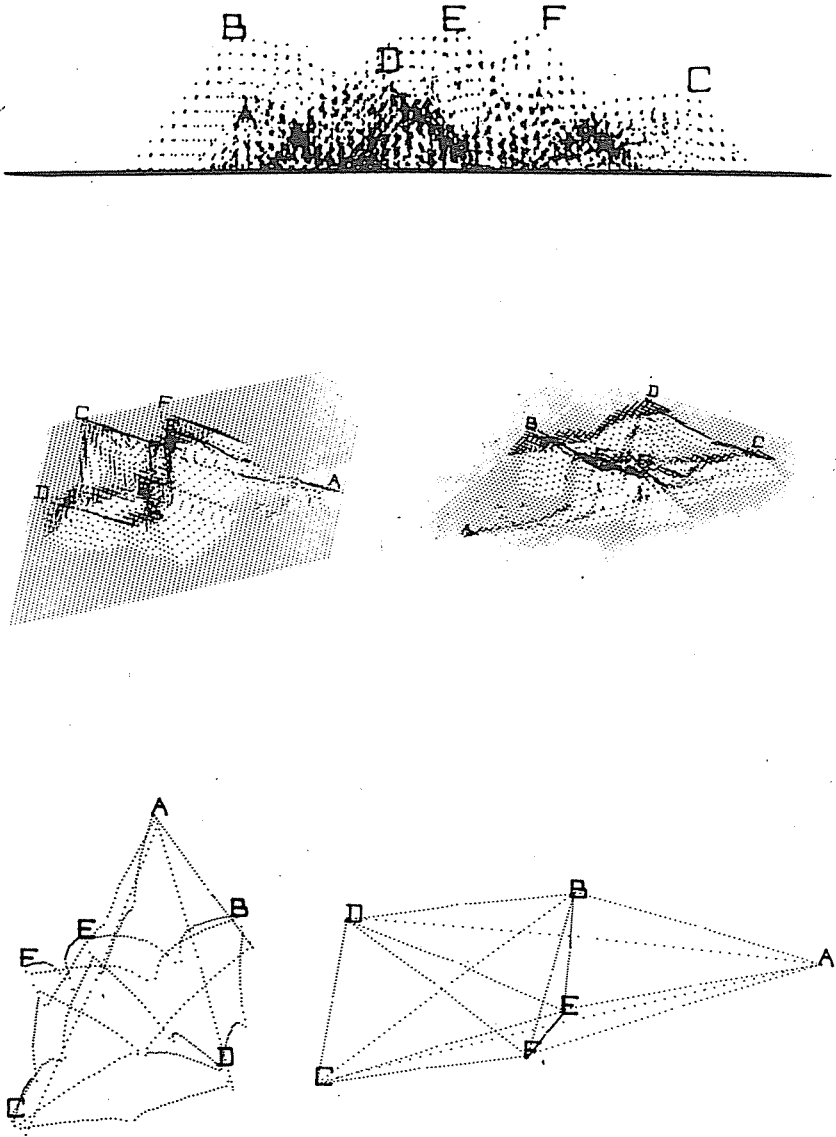


Figure 5. CGAMS images, from varying perspectives

importance of the shift, but most importantly, produces an actual visual representation that can be used for demonstration or for comparison with similar representations of thematic activity in other textual sections.

Diachronic distributions, Fourier Analysis, Principal Component Analysis, state diagrams, and CGAMS are a few of the models that may be used to explore thematic structure and relations. All, except the state diagram, were models appropriate for examining an entire text, such as a novel. There are numerous other concepts of structure useful for such textual segments; similarly, there are other models appropriate for other segments: the word, the sentence, the paragraph, etc. This brief selection of examples, hopefully, will give the reader a glimpse of the range of potential critical approaches that can be derived from the materialistic view of a text and the other assumptions and implications discussed above.

4.2 Conventional criticism: Concepts of structure

Most of the formalist schools of criticism discussed above have also used a stratified view of the text as the basis of their concept of form or structure. Summarizing the theoretical assumptions of the Russian Formalist, Tzvetan Todorov observes (1973: 11): 'The concept of form produces and is then fused with the concept of function. Analysis of form . . . leads to the identification of its function, i.e., the relation between its various components. Its components . . . are connected by algebraic signs of co-relation and integration . . . : horizontal relations of distribution and vertical relations of integration.' The concept of vertical strata is most strongly associated with Shklovsky's metaphor of 'staircase' construction. Without explicitly identifying the nature of individual stratificational levels, Shklovsky asserts that a considerable part of the esthetic effect of a literary work is produced by the artful juxtaposition of episodes and other narrative features in varying contexts. Erlich comments on Shklovsky's concept of staircase structure (1955: 212): 'The principle of juxtaposition, Shklovsky asserted, is especially pertinent to the short story, the most 'artful' fictional genre. In short stories and novelettes the esthetic effect rests more often than not upon deliberate exploitation of various types of contrasts and incongruity. These range from a 'realization' of a pun in terms of narrative structure through a motif of misunderstanding to that of a collision between two codes of morals.' While Shklovsky's staircase structure necessarily embodies a horizontal narrative medium, it emphasizes the effect of modulated vertical tensions and attractions among the various denotative and connotative strata parallel to the text.

An *Opojaz* structural notion emphasizing the horizontal dimension of a text was that of retardation. Closely related to the factors producing staircase

structure, retardation is the effect of delay in the narrative of episodic development relative to time or what might be expected if one simply stated the sequence of narrative events without digression, supplementation, or embellishment. By noting the relation between suspense and retardation, the Formalists suggest the possibility of developing a formal explanation of esthetic response or behavior; unfortunately, they did not pursue this lead to its logical conclusion.

Integration of vertical and horizontal concepts of structure was also foreseen by the Russian Formalists, but the development of specific methods or models for achieving this was, again, only partially realized. As already noted, A.A. Reformatzky established several distinct strata of categories, denoting theme, motif, etc., parallel to the textual sequence. Propp went one step further by formulating comparable symbol sequences for a number of narratives and then deducing the inclusive underlying structure shared by all such sequences under omission or simple transformation. The concept of structure in both, however, is the unidimensional projection of strata into a single sequence of symbols. Pattern or form must be inferred through observation of repeated sequences of symbols or symbol groups.

The Russian Formalists' concept of structure was extended by the Prague Structuralists in two important respects. With their emphasis on esthetic theory and esthetic response, they made important contributions toward establishing normative patterns; second, they were able to define more clearly the functional strata operating in a literary work and to demonstrate the value of this perspective by actually tracing structural patterns within and across the various strata.

The relation between normative expectation and variation is most thoroughly developed by Jan Mukařovský in considering the relation between standard language and poetic language.

The function of poetic language consists in the maximum of foregrounding of the utterance. Foregrounding is the opposite of automatization. . . . The standard language in its purest form, as the language of science . . . , avoids foregrounding. . . . In poetic language foregrounding achieves maximum intensity to the extent of pushing communication into the background as the objective of expression and of being used for its own sake; it is not used in the service of communication but in order to place in the foreground the act of expression, the act of speech itself. (1964: 19)

Mukařovský goes on to suggest that since non-normative language can only be perceived against a background of standard language, the esthetic effect of poetic language is determined in large part by patterns of transition between the two:

Foregrounding arises from the fact that a given component in some way . . . deviates

from correct usage. . . . The simultaneous foregrounding of all components is therefore unthinkable. (1964: 65)

Having observed that the transition from esthetically indifferent speech to esthetically colored speech can occur quite rapidly, often in the same sentence, Mukařovský concludes that the structure of such transitions and juxtapositions constitutes the esthetic structure of the work:

The work of poetry forms a complex, yet unified, esthetic structure into which enters as constituents all of its components, foregrounding or not, as well as their interrelationships. . . . The predominancy of the esthetic function in poetic language, by contrast with communication speech, thus consists in the esthetic relevance of the utterance as a whole. (1964: 65)

To become a practical method of analysis, this view must be supported by a description of normative language. A functional model for normative stylistic traits has recently been described by Lubomir Doležel, a member of the Prague School now at the University of Toronto. Doležel proposes that the investigator begin with a large collection of statistical measures for a text. Among these, he can determine empirically those that represent objective factors of language in general and, hence, remain constant throughout all texts (distributions of graphemes and phonemes), those that vary widely in all texts and, thus, represent subjective factors (distributions of specific content words), and, finally, those that range within certain limits over a number of texts and, hence, represent context sensitive or 'subjective-objective' characteristics (sentence and word length distributions). Under this taxonomy, Doležel proposes that we may determine empirically not only normative values for a variety of statistical measures but an adequate set of distinctive features for characterizing a spectrum of styles over a variety of authors and subjects. While Doležel does not specifically say so, it is clear that the computer affords the only practical way to apply his model to a text of any substantial length. To the best of my knowledge, this had not been attempted.

The second major contribution by the Prague Structuralists in the continuing development of a stratified concept of structure is contained in the rather recent and controversial paper by Jakobson and Levi-Strauss. While numerous structuralists, we have seen, have indicated the possibility of analyzing literary works formally in terms of complex relations within and among a number of linguistic strata, Jakobson and Levi-Strauss (1973) have demonstrated the validity of this view by exhaustively examining a sonnet by Baudelaire. Beginning with the rhyme scheme, they go on to factor out the phonic, syntactic, and semantic levels, and the patterns and relation within each. However, it is in the complex relations across these strata that the poem presents the most difficulty; all are drawn into a coherent organization within the in-

interpretive domain as they contribute to a highly generalized theme of dialectic tension and resolution.

The notion of structure most prevalent in American New Criticism is that of organic unity, relating part to whole, defined primarily in terms of metrical relations and image patterns. Caroline Spurgeon's classification and cataloging of Shakespeare's imagery has already been mentioned; the concept of structure, however, contained in that work is that of category and frequency. By classifying images and then counting the members of the various classes present in each play, she draws our attention to the tone-setting, often substantive, backdrop of verbal figures. Questions concerning combinations and patterns among categories, not her concern, were raised by later New Critics, such as Cleanth Brooks. In his discussion of imagery in *Macbeth*, he concentrates on two predominant patterns: images of clothes and concealment and images denoting babes. He goes beyond Spurgeon's method, however, by showing that it is the interaction of these two groups that underscores and comments upon the major action and theme of the play. Macbeth's ill fitting garments, like adult clothes on a child, make him ridiculous in his present circumstances; the naked babe, paradoxically, suggests the strength of historical continuity that eventually crushes Macbeth's vain hopes. While it is the interweaving of these two image groups that results in the complex, multi-faceted semantic structure that attracts the critics' attention, the concept of structure involved is still that of 'organic form' suggested by combination and juxtaposition.

In theory, however, the New Critics do move a bit closer to a formal definition of structure. Wellek and Warren, describing the levels of existence of a text, present an interpretive stratification somewhat similar to that described above. They note some eight interpretive dimensions (1956: 157): (1) the sound stratum, euphony, rhythm, and meter; (2) the units of meaning which determine linguistic and stylistic structure; (3) image and metaphor; (4) mythic level of poetic symbols; (5) the fictive world; (6) the system of genres inherent in literature; (7) the evaluative domain; and (8) the historical context of the work. Within each stratum, they discuss the historical background of critical concern and often suggest approaches that could lead to methodological formality. For example, in discussing the level of euphony, rhythm, and meter, they note Tomashevsky's statistical methods as well as other acoustic approaches; in their discussion of stylistics they, similarly, note the possibility of a stylistics based on normative values and a set of distinctive features; but in their attempt to be suggestive rather than critically dogmatic, they stop short of advocating any specific methodology beyond recognition of these factored strata. Structure remains a metaphoric concept suggested by 'orchestration' or 'organic form'.

Within French Structuralist criticism there has been extremely wide vari-

ability concerning the concept of structure. For Barthes, structure means primarily patterns of recurrence and association:

Once the units are posited, structural man must discover in them or establish for them certain rules of association. . . . What we discover in every work of structural enterprise is the submission to regular constraints whose formalism . . . is much less important than their stability; for what is happening . . . is a kind of battle against chance; this is why the constraint of recurrence of the units has an almost demiurgic value: it is the regular return of the unit and of the association of units that the work appears constructed . . . Form, it has been said, is what keeps the contiguity of units from appearing as a pure effect of chance. (1972: 217)

The best known application of Barthes' concept of structure is his study, *S/Z*. Barthes divides a short story by Balzac, entitled *Sarrisine*, into some 561 textual segments or 'lexies' each of which represents Barthes' judgment of the smallest portion of the narrative that carries 'meaning'. He then factors this 'meaning' into five vertical planes or 'codes' parallel to the horizontal sequence of lexies. Each code represents a fundamental relation between the narrator, the subject matter of the text, and reality. The first code identified is the code of action, including all physical gestures, movements, etc. Above that is the hermeneutic code or code of questions, motives, and puzzles. Next is the cultural code which includes the common information of the culture as well as its stock expressions and clichés. The fourth code is the connotative structure established within the context of the work, while the last code, the symbolic, is the interpretive dimension in which the major theme of the work is cast. Barthes' method of application for this unusual stratified structural model is to work his way through the story, lexis by lexis, commenting on the portion of his experience as a highly informed reader drawn into focus by the various codes. The result is a brilliant but highly idiosyncratic reading. Associations and patterns of repetition are observed and discussed but are limited to the patterns Barthes happens to notice through his polarized critical apparatus. There is no attempt at formality or reproducibility.

Todorov's analysis of structure in the *Decameron* (1969) includes a concept of structure that is essentially that of the transformation: individual tales are shown to be derivable from a general, paradigmatic form. Todorov demonstrates that all tales can be derived from a small number of paradigms through a set of basic transformations. Thus, there exists a narrative generative grammar analogous to, say, a Chomskyan-style generative grammar for some set of sentences. If we regard the specific paradigm as one of a set of specifiable paradigms then the occurrence of that particular narrative structure within the textual sequence of all tales could be noted as a category item in a stratum parallel to the textual sequence; thus, this concept of structure could be represented within the Computer Criticism model outlined above and analyzed

accordingly. While Todorov does extrapolate on the mental factors involved in composing large tale sequences, he does not attempt any systematic analysis of his paradigm sequences or their macroscopic structure.

More recently, Paul de Man has suggested the possibility of a different concept of structure, similar to the lattice model behind the state diagram and CGAMS approaches discussed above. After noting the scarcity of new techniques for literary study ('There certainly have been numerous excellent books of criticism since, but in none of these have the techniques of description and interpretation evolved beyond the technique of close reading established in the thirties and forties.' 1973: 27) he considers a passage from Proust from a rhetorical perspective. Concentrating on metonymic patterns of association as opposed to the more conventional assertions carried by metaphor, de Man foresees the possibility of a truly comprehensive structural methodology:

The further text of Proust's novel . . . responds perfectly to an extended application of this de-constructive pattern: not only can similar gestures be repeated throughout the novel, at all the crucial articulations or all passages where large aesthetic and metaphysical claims are being made . . . , but a vast thematic and semiotic network is revealed that structures the entire narrative and that remained invisible to a reader caught in naive metaphorical mystification. The whole of literature would respond in similar fashion, although the techniques and the patterns would have to vary considerably, of course, from author to author. (1973: 32)

Such networks of associations have been partially realized though considerations of selected passages in the work of Genette (particularly in *Figures III*), Greimas, and other semiological critics; however, it is likely to remain impractical to explore the associative patterns of full length works, as suggested by Barthes, without the aid of a computer.

The formalist school whose concept of structure most closely resembles the stratified concept implicit in Computer Criticism is that associated with Firth. However, the comparison is closest not in the relation between the term, structure, as I have used it in this essay, and the term, structure, as it is formally used by Firth and Halliday; rather, the comparison must be drawn between what I have called structure and the concept of the total language construct or model found in the London School. As mentioned above, Firth begins with a material text: either a sequence of characters or a sequence of sounds. He then suggests a succession of levels, each abstract but each growing out of a materialist consideration of the symbol sequence comprising a lower level, that culminates in a 'context of situation'. Inherent in the levels of this outer domain is the possibility of a behaviorialist theory of language which Firth anticipates in one of his final essays in his appeal for the aid of psychology and psychiatry in linguistic description (1968: 209). Because of his untimely death, Firth was unable to flesh out the model that he had sketched;

much of this job, fortunately, has been done by M.A.K. Halliday, particularly in the area of language study generally associated with syntax. Halliday's published elaborations have dealt primarily with levels ranging from text to sentence structure. 'Structure', as formally defined by Halliday is an 'arrangement of elements ordered in "places"'. Thus, structure is a 'horizontal' concept that describes patterns parallel to the textual sequence. Description of that horizontal order, which I have shown to be of primary concern for Computer Criticism, is not addressed by Halliday. Specific form is left as paradigm or, perhaps, at the syntactic level, as the business for generative-transformationalists or some other linguistic group to define or at the connotative level, as the business of the stylist to define collocations through statistical analyses. Relations that exist across levels are referred to as exponency, the relation between a category designator and the lower level numbers that constitute that category; however, since the relation is not formally one-to-one between levels, this view is slightly different from the basic concept of parallel associativity inherent within Computer Criticism.

In a more recent paper (1971), Halliday has shown the strength of this stratified view of language as a tool for literary and stylistic analysis. He begins with several samples of text distributed over William Golding's *The inheritors*. He then defines a level of syntactic patterns. Through frequency counts he establishes what are really syntactic collocations and is able to show that these patterns inform/constitute the growing conceptual awareness of the central character. The implication that this theme of growing mental complexity is, itself, an outer sequential level of the novel that could potentially be formally linked through exponency down through a dozen or so intermediate levels to the material text is an exciting, perhaps frightening, possibility. Halliday does not take this last step, probably because of the impracticality of formally doing so through conventional methods; however, because the relation between the Firth/Halliday construct is so closely related to the concept of structure inherent in Computer Criticism, there is the distinct possibility of actually achieving this final interpretive synthesis.

In retrospect, we can see that virtually every major formalist school of criticism in this century has included some notion of hierarchically organized structure along the textual continuum. This concept has ranged in concrete realization from the American New Critic's metaphoric notion of organic unity of connotative structure to the highly formal stratificational model developed by Firth and Halliday. Within this entire spectrum, however, interpretation usually follows immediately upon realization of factored horizontal and vertical dimensions. Computer Criticism differs from all of these in that it interjects an intermediate step between stratified structure and meaning. Once the text is encoded and the parallel systems of strata established, Computer Criticism, because of its methodological emphasis, attempts to define and demon-

strate patterns along, across, and among strata. That is, it attempts to display patterns of recurrence through distributions, Fourier analysis, concordance listings, etc.; it locates patterns of interaction across strata through correlation, factor analysis, and other multivariate procedures; finally, it locates patterns of interaction among various strata through lattices revealed in state diagrams, multidimensional scaling, and CGAMS. It is the collection of operatively defined patterns based on a number of structural models that furnish the matter for conceptual analysis and interpretation. The distinction between conventional structural methodology and Computer Criticism is the distinction between Paul de Man's intuitive realization that an entire novel is structured by a 'vast thematic and semiotic network' and an interpretation that begins with a concrete, visual representation of the network for that text.

5 Computer criticism: Temporal and behavioral extensions

The concepts and methods described above were based on a static, fixed text encoded as a sequence of signifiers. This sequence, we saw, could be accompanied by a similar sequence of symbols representing physical characteristics and, perhaps, one or more sequences representing categories or relations on the level of the signified. For some critical investigations a consideration of performance is necessary or desirable; that is, one may wish to consider a text embedded in a temporal domain (the time of the reading experience, or for a play, the time of the performance) as well as a behavioral domain (the phenomenological response of the reader, to the extent that it can be characterized, or, for a play, the characteristics of performance and the response of the audience). As with all other phases of Computer Criticism, these data must be encoded as sequences of symbols and submitted to the computer as strata parallel to the sequences of signifiers and the other sequential levels. Similarly, the validity of the final analysis will be dependent upon the accuracy and sensitivity of the information initially encoded.

To establish the temporal domain, the critic must be able to measure the passage of time with relation to the basic textual sequence. This can most readily be done if he has an audio or video/audio recording of the performance (since the phenomenological experience of reading implies a specific, temporal experience and since that experience can be characterized only through observable reaction (by the reader, by an observer, or by some form of instrumentation); I shall consider it a 'performance' as well as the more conventional notion of dramatic presentation or situation). Using a stop watch or some similar measuring device, the critic may determine the interval of time between segments appropriate for his study. On the basis of this information the segments (words, sentences, lines, or whatever is appropriate) can be distributed

along a uniform time sequence; or, conversely, time (measured in seconds) can be distributed along the uniform textual sequence (words or other segments).

To characterize performance or response to performance is a more delicate matter. Some will object that this implies 'quantification' of complex, esthetic phenomena. There is, however, a subtle but important distinction between categorizing and quantifying. Often we can accurately and without distortion distinguish among, say, the responses of an audience to a play: the audience laughs; the audience 'roars' with laughter; the audience gasps; the audience sits passively. To observe these categories of behavior, established through the experience and critical perspective of the researcher, is different from 'measuring' response, implying some numerical continuum of audience behavior. This distinction holds also when categories are ordered hierarchically but no attempt is made to establish significance to the interval between the hierarchically arranged items.

The behavioral factors observed — the recorded responses of the reader, the collective responses of an audience, or the facial gestures of an actor — will likely vary for each individual study. An example may illustrate the processes of establishing a set of categories and characterizing the form or pattern in the ensuing symbol sequences. Bruce Rosenberg, Robert Brubaker and I analyzed four fundamentalist sermons to demonstrate the formulaic structure of that highly stylized folk genre. In addition to revealing characteristics of the sermons, themselves, we hoped to develop descriptive techniques that could be applied to more sophisticated literary genres. One may reasonably focus an analysis of the sermons on at least three different levels: the entire sermon, thematic segments of twenty to seventy-five lines, and the individual line. Our study included all three levels; for the purpose of illustration, however, I shall discuss here only the dynamics involving the entire sermon.

When one considers the text and accompanying tape recordings of an entire sermon, several factors of the performance and the audience response are readily apparent. The characteristic pattern of interaction between preacher and congregation is statement followed by response: the preacher preaches a line, pauses, and the audience interjects 'Amen', 'Yes, Jesus', or some similar phrase. The interval of time in the cycle of stimulus and response ranges from twenty-three seconds to one second; further, one can observe that there is a general pattern in the changes of this duration: the preacher generally starts slowly, speeds up, and then slows down again at the end. Other apparent factors are the range of responses of the audience and the qualitative shifts in the preacher's tone of voice. The audience demonstrates three distinguishable responses: they may simply speak their responses; they may chant them; and they may chant continuously, overlapping with the preacher's statement. The preacher, in turn, may begin with a conversational tone of voice; he may 'preach' with a clear, orational tone; he may chant parts of lines or, sometimes,

entire lines; and, at times, his delivery is paced by very sharp, audible gasps for breath that function almost as a drum beat in their rhythmic regularity. Thus, the time interval between stimulus and response, the five categories of audience response, and the three categories of orational style could be viewed as correlated strata of symbol sequences parallel to the textual sequences. Doubtless, analysts with other intentions could note different categories; however, within the purview of our particular critical intentions these were the factors we hoped would be most productive. Space does not permit a full discussion of our methods and results (see Smith — Rosenberg 1971); however, among the most interesting was the clear indication that all other factors were secondary to the fundamental importance of the rhythmic pattern of stimulus and response. It really didn't matter what the preacher said (so long as his content did not intrude by getting too 'complicated'): the success or failure of his sermon was determined by his ability to establish within very narrow tolerances a particular pattern of rhythmic variation in the cycle of stimulus and response. All other factors correlated and were dependent upon this pattern.

While the reader may not share our enthusiasm for homiletics, there are several implications that may be useful for literary studies. First, we were able to develop techniques for describing subtle structural differences in actual performances. The patterns that were developed represent ontological structures within a materialistic view of a text that may relate to more subtle, complex patterns of esthetic response that are fundamental — perhaps archetypal. The relation between these ontological structures and the substance of the text is analogous to the relation between form and subject in representational visual art. The range of observable factors within literary performances is as diverse as the range of critical intentions. Hopefully, the example cited will illustrate how categories of performance and response can be established and applied. Once this is done and the results encoded, this information can function as strata analogous to the three fundamental strata discussed at length above; the same basic concepts of inherent sequential and parallel form hold. Implied, then, is the possibility of a science of esthetics that links the text with fully cultivated esthetic responses through a continuous series of inter-related structures. A comprehensive critical method must be able to define and characterize relations along and across these strata and a comprehensive critical analysis must interpret them and place them in context.

6 Computer criticism: Interpretation of form

Emphasis in the discussion of models of form was primarily empirical: models that can describe a particular structural characteristic. Used in this manner,

they can help the critic develop through close textual scrutiny patterns that, in turn, lead to larger patterns of patterns, etc. The approach is essentially ground-up or, in this case, text up. This empirical aspect of the analysis should be matched with an equal analytic or deductive phase that begins with a theoretical generalization and 'builds down' to meet the empirical. Stated more bluntly, it is the critic, not the computer, who provides the intellectual context of the study, interprets the information produced by the computer, and forms the critical insight. The computer, while it may influence the perspective as other major tools have done in the past, supplements rather than replaces the process of conventional scholarly inquiry.

The 'build down' aspect must begin with a strong initial hypothesis or question. This critical assertion, in all probability, will be derived in the same way that any other assertion is derived: through reading, consideration of hunches, and logical argument. At this stage there is likely to be no formal mention of the computer; if it is present at all, it is in the form of a shadowy recollection of a method and a device for applying that method that may be useful for problems similar to that under consideration. In its initial formulation the problem should be cast in a familiar context, using conventional terminology and critical perspective. Similarly, the study must justify itself within conventional critical values; it must be worth doing in its own right and not simply something that is done because the computer can do it.

Once the hypothesis has been formulated in this manner, the critic may then consider whether or not the computer can be employed. To use the computer, he must be able to translate the hypothesis from substantive terms (as described above) to operative or functional terms. As with any translation process, there is great opportunity for distortion and error. The critic must be extremely judicious to insure that the operative definition of the hypothesis closely fits the substantive definition.

There is no set way in which this translation can always be made; however, an approach that may be useful for a number of studies is for the critic to simply probe his own critical assertions and assumptions, repeatedly asking himself, 'What, exactly, do I mean by _____?' For example, take the rather obvious assertion that the first chapter of Joyce's *Portrait* is structured by the tension between the themes of *fire* and *water*. To demonstrate this with the aid of the computer will involve several translation steps. The critic might engage himself in the following imaginary dialogue.

1. Q. What, exactly, do you mean by the themes, *fire* and *water*?
- A. Well, by 'theme', I mean a group of words or phrases, mostly images, that denote or suggest a basic concept or experience. Obviously, the theme of *fire* will be those words or phrases that

- suggest *fire* or *heat* and the theme *water* will be those words or phrases that suggest *water*, *wetness*, and, in this context, *coldness*.
2. Q. Fine, but what words or phrases suggest *fire* or *water*? To the computer, they all look alike.
 - A. I mean specific words like *burn*, *burned*, *burning*, *fire*, *hearth*, *heat*, etc. For *water*, I mean *cold*, *ditch*, *spit*, *water*, *watery*, etc.
 3. Q. Now that you have translated the term, 'theme', from a substantive term (a group of words or phrases that suggest the same basic concept or experience) to a functional term (a list of specific words or collocations of words) recognizable by the computer, can you take the next step and clarify what you mean by the relation 'tension', when you say that *fire* and *water* are in a state of tension?
 - A. *Fire* is usually related or associated in Stephen's mind with thoughts of home or other pleasant memories; conversely, *water* is associated with his terrible fall into the ditch. While these two themes carry dialectically opposite connotations, he seldom recalls one without his mind jumping to the other. It is this constant, ironic juxtaposition or association between basically opposite themes that constitutes tension.
 4. Q. Fine, but what do you mean by the statement that the chapter is 'structured' by this relation of tension between the themes of *fire* and *water*?
 - A. That's a little harder, because to say that the chapter is structured by this relation means several things. It means that this dialectic juxtaposition occurs frequently; it occurs at fairly regular intervals; and it is 'fundamental' in some respect to other thematic relations. That is, it occurs in a variety of thematic contexts; and other major themes, while relating to this pair, do not occur with the same regularity or with the same diversity of context.
 - Q. Let's take them one at a time. How can you show that these two themes occur close to one another frequently?
 - A. I could divide the text into, say, 100 word intervals, have the computer tally up all of the *fire* words for each such interval, and then have it draw a picture or graph of this distribution over the chapter. By comparing this with a similar distribution of *water* words I can tell both the prevalence and the consistency of association of these two themes.
 - Q. Fine, you killed two birds with one program, but how are you going to show that this relation is more 'fundamental' than other thematic relations?

- A. First, I'll have to define all of the themes that I feel are 'major', just as I did in step 2; but then I'll have to show that these are less 'prevalent' and less 'perverse' than *fire* and *water* and that they are oriented in some way to the *fire/water* dialectic. If I graph all of these themes, I can compare their distributions with those of *fire* and *water* for 'pervasiveness'. If this relation turns out to be true, then I can look at the section of text where these other themes seem to be important and see if they are in some way related to *fire* and *water*.
5. Q. How are you going to get the computer to tell you how these themes are related to *fire* and *water*?
- A. I can't, but the computer can tell me where to look. Thus, it points me in the right places and it can tell me whether I have looked at all the places.

The establishment of themes is, of course, one example of the more general notion of categorization discussed above. The examination of juxtaposition of opposite themes is an example of synchronic relation across strata; the test for pervasiveness, similarly, is an example of diachronic structure along the axis of the text. To actually use the computer for a full and critically interesting analysis, the critic would obviously have to extend the sequence of steps outlined above as well as expand each of the individual stages.

Having translated the substantive hypothesis into functional terms and having used the computer to gather and display information and to explore various structural relations, it is then incumbent upon the critic to assimilate this information, to place it in context, and to synthesize his 'interpretation'. Obviously, the computer can only augment, not replace, his critical judgment. The final results of the inquiry should be expressed, once again, in the vernacular of the Profession. To do this, the critic must translate in reverse the relations, patterns, and structure he has discovered on the functional level back into meaningful critical assertions. Once again, the computer should recede into the background leaving behind the unencumbered thesis, but a thesis that rests firmly on a body of specifiable assumptions and demonstrable textual relations. It is this joining of the deductive, critical response of the researcher with the empirical methodology of the computer that makes it possible to envision a science of literary criticism that is powerful but not reductive, sensitive but not simplistic.

Notes

- * This article originally appeared in *Style* 12.4: 326-356.
1. I shall discuss the computer and its functions for language analysis within the context of large IBM machines. These remarks can be interpolated for other computers.
 2. These concepts are discussed by Erlich (1955: 177-178, 200).
 3. For a more thorough discussion of models useful for illustrating and characterizing thematic structures see Smith 1975.
 4. For a more flexible and practical method of representing categories for actual Computer Criticism, see Schwupp and Smith 1964.
 5. For a detailed description of this study see Rosenberg and Smith forthcoming.
 6. For a full discussion of a formal notion of thematic complexity appropriate for thematic structure similar to that represented by state diagrams, see Smith 1975.

References

- Barthes, Roland
- 1967 "Science versus literature", *Times Literary Supplement* (September 1967) [Reprinted in *Structuralism: A reader*, edited by Michael Lane (London, 1970), 410-417.]
- 1972 "The Structuralist activity", *Critical essays* edited by Richard Howard (Evanston: Northwestern U.P.).
- Erlich, Victor
- 1955 *Russian Formalism: History - doctrine* (= *Slavistic Printings and Reprintings* 4) (The Hague: Mouton).
- Firth, J.R.
- 1968 "The treatment of language in general linguistics", in *Selected papers by J.R. Firth 1952-1959*, edited by F.R. Palmer (London: Longman).
- Frye, Northrop
- 1957 *The anatomy of criticism* (Princeton).
- Halliday, M.A.K.
- 1961 "Categories of the theory of grammar", *Word* 17: 241-292.
- 1971 "Linguistic function and literary style", *Literary style: A symposium*, edited by Seymour Chatman (London), 330-368.
- Harkins, William E.
- 1951 "Slavic Formalist theories in literary scholarship", *Word* 7.2: 177-185.
- Jakobson, Roman
- 1936 "Randbemerkungen zur Prosa des Dichters Pasternak", *Slavische Rundschau* 7: 357-374.
- Jakobson, Roman and Levi-Strauss, Claude
- 1973 "Charles Baudelaire's 'Les Chats'", *Issues in contemporary literary criticism*, edited by Gregory T. Polletta (Boston), 372-389.
- de Man, Paul
- 1973 "Semiology and rhetoric", *Diacritics* 3.2.
- Mukařovsky, Jan
- 1964 "Standard language and poetic language", in *A Prague School reader in linguistics*, edited by Josef Vachek.

- Propp, V.
1968 *Morphology of the folktale* (2nd edition) (Austin: Texas U.P.).
- Ransom, John Crowe
1940 "Wanted: An ontological critic", *The New Criticism* (Norfolk: New Directions), 297-301.
- Reformatsky, A.A.
1973 "An essay on the analysis of the composition of the Novella", translated by Christine Scholl, in *Russian Formalism*, edited by Stephen Bann and John E. Boulton (New York: Barnes & Noble).
- Rosenberg, Bruce A. and Smith, John B.
forthcoming "Thematic structure in four Fundamentalist sermons", to appear in *Journal of Western Folklore*.
- Scholes, Robert
1974 *Structuralism in literature* (New Haven).
- Schwupp, Paul W. and Smith, John B.
1964 "Random accessible text system for associative text analysis", *Siglash Newsletter* (December 1964), 8-11.
- Sedelow, Sally Yeates
1970 "The computer in the humanities and fine arts", *Computing Surveys* 2.2: 89-110.
- Smith, John B.
1972 "Image and imagery in Joyce's *Portrait*", in *Directions in literary criticism*, edited by Stanley Weintraub and Philip Young (University Park, Pa.), 220-227.
1974 "Computer generated analogues of mental structure from language data", *Proceedings of IFIP '74* (The Hague: Mouton).
1975 "Thematic structure and complexity", *Style* 9.1: 32-54.
- Smith, John B. and Rosenberg, Bruce A.
1971 "Rhythms in speech: Formulaic structure in four Fundamentalist sermons", *Computer Studies in the Humanities and Verbal Behavior* 4.3-4: 166-173.
- Spurgeon, Caroline F.E.
1958 *Shakespeare's imagery* (Boston: Beacon).
- Stone, Philip J.
1966 *The General Inquirer: A computer approach to content analysis* (Cambridge).
- Todorov, Tzvetan
1969 *Grammaire du Decameron* (The Hague).
1973 "Some approaches to Russian Formalism", translated by Bruce Merry, in *Russian Formalism*, edited by Stephen Bann and John E. Boulton (New York: Barnes & Noble).
- Welck, Rene and Warren, Austin
1956 *Theory of literature* (New York: Harcourt, Brace & World).
- Widmann, R.L.
1971 "Computers and literary scholarship", *Computers and the Humanities* 6.1: 3-14.