



STANFORD RESEARCH INSTITUTE
Menlo Park, California 94025 · U.S.A.

File Copy

June 1973

AUTOMATED LANGUAGE PROCESSING

By

Donald E. Walker

Annual Review of Information Science and Technology,
Volume 8, Carlos A. Cuadra, editor (American Society
for Information Science, Washington, D.C., to be
published 1973).

Artificial Intelligence Center

Technical Note 77



INTRODUCTION

During the years 1971 and 1972, there has been a remarkable amount of activity and interest in automated language processing--so much so, that it is difficult to know precisely where to begin in order to convey the implications of this observation to the reader. The time has been one of substantive development, critical appraisal, and retrospective evaluation.

The major development area involves work on question-answering systems, now coming to be called "computer understanding." The change in terminology indicates an enrichment and elaboration of the components of such systems. However, the resulting complexity raises serious questions about the possibility of near term applicability. Both points will be considered further in the course of the review.

Major studies have been made of the relevance of a center or network for computer research on language (Sedelow & Sedelow, 268), of the feasibility of fully automatic high quality translation (Lehmann & Stachowitz, 158), and of the practicality of the understanding of continuous speech by computer (Newell et al., 199). Support for implementation of the study recommendations has been provided in the case of speech understanding, and it is reasonable to expect support for the other areas.

There also has been a considerable amount of reflection on recent developments in automated language processing; assessments of various facets of the field have appeared that make the work of a reviewer somewhat

easier. Two items in particular deserve mention at this point, the first because it provides a general framework for viewing automated language processing in the context of information science, the second because it reflects the collective thinking of many of the major research workers in the field of computational linguistics.

The book by Sparck Jones & Kay on Linguistics and Information Science (286) constitutes a basic reference work on the two disciplines identified in the title, particularly in relation to the use of computers for linguistic operations involving document analysis, description, and retrieval. The review of materials for their survey was completed early in 1971, so the amount of overlap between its coverage and that of the present review is minimal. However, science is a cumulative enterprise, and the richness and incisiveness of the analysis provided by Sparck Jones and Kay allows them to project into this period. Consequently, Linguistics and Information Science is strongly recommended for anyone interested in automated language processing, both now and for some years to come.

The second reference to be cited here is the report of a Conference on Research Trends in Computational Linguistics (Center for Applied Linguistics, 40), held in March of 1972. The report summarizes the results of workshop sessions on the range of topics that might be said to constitute the scientific basis for automated language processing. As a participant in the Conference, this reviewer shared in the deliberations, and the present review certainly has been affected in the process.

Perspectives on Automated Language Processing

It may seem strange to include in a review article a special section on other reviews and overviews of the field, but the wealth of such material for automated language processing certainly warrants it. Furthermore, the scope of some of the references is so broad that they do not fall naturally into specific topic areas. In any case, this treatment may allow an interested reader to explore the field in some breadth before plunging into the depths.

Linguistics and Information Science by Sparck Jones and Kay (286) is an appropriate place to start. The book begins with a review of information retrieval, emphasizing the role of computers in documentation. A brief overview of linguistics follows, intended primarily to orient the reader to the potential contributions of that field to information science. Returning to documentation, the authors examine carefully the role of language in information retrieval. They provide a thorough review of the relevant literature and should be commended for their treatment of work outside of the United States. Substantive chapters on syntax and on semantics cover linguistic theories, computational strategies, and applications to documentation. Fact retrieval and question-answering systems are treated in a separate chapter, because the authors believe that work on those topics is likely to provide the major source of new ideas for documentation. Sparck

Jones and Kay conclude that a lot more work needs to be done in linguistics, in information science, and particularly in attempts to relate the two fields in order to establish exactly what the most productive relation between the two fields can be.

The report of the Conference on Research Trends in Computational Linguistics (Center for Applied Linguistics, 40) contains summaries of sessions that were held on the following topics: (1) Computational Linguistics and Linguistics; (2) Integrated Computer Systems for Language; (3) Computer-Oriented Grammars and Parsing; (4) Machines and Speech; (5) Language Performance (Psycholinguistics and Dialectology); (6) Social Implications of Automatic Language Processing; and (7) Professional Ethics, Standards, and Education. Most of these summaries will be referred to again in the relevant sections below.

The proceedings of a symposium on natural language processing held at New York University (Rustin, 245) contains a collection of papers describing many of the current computer programs for analyzing the structure of natural language. The individual papers are discussed in the sections that follow.

Another good collection of papers, somewhat broader in scope than the foregoing, is contained in a book on Computer Models of Thought and Language edited by Colby & Schank (54). Relevant individual papers are considered below.

Volume 11 of Advance in Computers (Yovits, 322) contains three chapters surveying literature on automated language processing: one on mechanical

translation; two on speech recognition. They will be referred to again in the corresponding sections of this review.

Moyne (194) has prepared a survey of grammars and recognizers that stresses theoretical aspects of the structure both of natural languages (emphasizing transformational grammars) and of the artificial and formal languages of computers, mathematics, and automata theory. He includes a section on applications in information science.

Two other, briefer reviews deserve mention here because of their scope. Other, more focused reviews will be referenced where appropriate. Montgomery (191) uses the concept of a natural language information system to relate work by computational linguists and information scientists and as the basis for an integrated approach to automated language processing. Mey (181) in a similar fashion documents the convergence of computational linguistics and information science, projecting for the current decade that an emerging linguistic theory of performance will provide the basis for practical systems.

Progress toward effective automated language processing systems may well be enhanced by efforts directed toward bringing research workers together. Sally and Walter Sedelow (268) conducted a study for the National Science Foundation to determine the possibility and desirability of a national center or network for research on language. They view language broadly to include all kinds of symbol systems: natural, formal, and

graphic. Their report is in major part a summary of the reactions of the relevant research community, which were overwhelmingly positive. It also contains recommendations for a major planning effort directed toward the implementation of a network in conjunction with one or more centers, perhaps building on existing major research groups as nuclei. Appendices contain three reports covering "knowledge systemics," humanities applications, and art applications; five bibliographies on centers and networks (51 pages), cybernetics and systems (47 pages), measures of language (33 pages), computational linguistics and information retrieval (43 pages), and the sociology of language (61 pages); and a listing of "scholars and scientists consulted" that contains almost 300 names.

One last item worth special mention is a Bibliography of Mathematical and Computational Linguistics, being prepared in machine-readable form by Edmundson et al. (76) at the University of Maryland. As of March 1972, it contained 541 papers, articles, technical reports, and books; 18 journals in linguistics, mathematics, and computer science were systematically reviewed in the process. The compilation effort is expected to continue, with the deficiencies in coverage of literature outside the United States to be remedied in subsequent editions.

COMPUTATIONAL LINGUISTICS

There is considerable and proper confusion about the relative scope of the terms "automated language processing" and "computational linguistics." Neither term is used with precision, and the choice of one or the other is often a matter of the audience one is addressing rather than the content of the remarks. In this review, automated language processing is the more general term, encompassing all studies, theoretical or applied, of the use of computers or computational techniques in the processing of language, primarily natural language. Computational linguistics is considered to be a proper subset of automated language processing, distinctive in its relation to linguistics. However, since the majority of the studies reviewed in this chapter fall under this heading, it is clear that computational linguistics is the primary focus for work in the whole area.

A discussion by a group of computational linguists on the nature and status of their field revealed a remarkable variety of opinions, as summarized by Barnes (9). However, they conclude that computational linguistics is a genuine interdisciplinary field in its own right with a focus on "linguistic algorithms," their structure and application, and with close historical, conceptual, and practical ties to linguistics, although with a concern legitimately far broader than natural language. Considered in relation to automated language processing and information

science, linguistics is the primary reference point, although the perspective on computational linguistics presented by Hays (114) implicates psychology as well as formal and descriptive linguistics and computation. Chomsky's position that linguistics is a branch of cognitive psychology (Chomsky, 48-50) has not had much impact yet on computational linguistics, but as later sections will show, the potential is substantial.

Linguistics and Computational Linguistics

The interplay of computational linguistics and linguistics has been distinctive in a number of respects. Linguists for the most part have not accepted the computer or even computation as an essential methodological component of their field. Moreover, many linguists have denied not only the relevance of the results of computational linguistic research for linguistics, but, more importantly, the possible relevance of such results. It probably is accurate to state that computational linguistics has had little effect on linguistics, but some elaboration certainly is necessary to justify the assertion that there are likely to be significant effects in the future.

Computational techniques can be applied--and computers used--in fields where a sufficient amount of formalization and/or systematization of description has been achieved. In spite of the substantial accomplishments of linguistics, it has not provided a rigorous and coherent organization of theories or data involving language. Where sufficiently detailed specifications have been provided, computational linguists have embodied them in computational procedures. Thus, following Chomsky's early formulations in Syntactic Structures (Chomsky, 47) and in papers by him and his colleagues through the early 1960s, which did provide a (preliminary) formalization of linguistics, a number of computer-based models were developed (see previous Annual Review chapters for details). However, by the time they appeared,

the inadequacies of that early formulation of transformational grammar had become apparent, and there has been no attempt since that time to develop models that are as encompassing.

Of course, it is only within the last few years that the greater availability of computers and the increasingly sophisticated technology of interactive programming have provided any hope of allowing computational linguists who keep current with the rapid pace of developments in linguistics to feed back the results of their computational research to the linguist in time to be of use to him. Consequently, an accurate assessment of the potential value of computational linguistics in support of the linguist's research remains for the future. However, it is contingent on the willingness and the ability of the linguist to formulate problems in computationally relevant ways as well as on the proximity and responsiveness of the computational linguist.

Friedman's computer model of transformational grammar (95) provides the best example of work in computational linguistics intended to be of use to linguists. Based on the formulation presented in Aspects of the Theory of Syntax (Chomsky, 48), it provides a facility for developing and testing grammars or sets of grammatical rules consistent with the general framework. Recently, the system has been extended to handle phonological rules (Friedman & Morin, 97; Morin & Friedman, 193; Morin, 192), particularly those deriving from Chomsky & Halle's Sound Pattern of English

(51). Friedman's system, which now is running on a number of computer facilities in different parts of the world, (e.g., Batori, 12, 13; Rochon, 239), has been used not only to test rules for a variety of languages (see also Friedman, 94, for work following that listed in 95), but also for identifying theoretical inconsistencies and formal inadequacies in linguistics and for prompting alternative formulations (see Morin & Friedman, 193, for phonology, and O'Malley et al., 209, for syntax). Friedman (96) illustrates the use of the system for comparing mathematical and computational models of transformational grammar in order to identify the theoretical consequences of various kinds of restrictions as they relate to generative capacity and explanatory adequacy.

Until linguists begin writing substantial amounts of rules, there will not be much use made of systems like Friedman's for testing them. However, it is likely that the most significant effect on linguistics in the long term will result from modeling and system building by computational linguists where the goal is not support of linguists but, rather, that of question answering or computer understanding. The grounds for this assertion will become clearer below after an extended discussion of those topics.

The remarks in this section so far have been concerned primarily with the influence of computational linguistics on linguistics. The effects in the other direction have been more substantial and many of the current controversies in linguistics are mirrored in work in computational linguistics.

It is beyond the scope of this paper to provide a thorough coverage of contemporary linguistics. Relevant concerns will be discussed in subsequent sections on parsing and question-answering systems, on semantics, logic, and representation, and on psycholinguistics, sociolinguistics, and performance. As mentioned before, Sparck Jones and Kay (286) present a good perspective from the standpoint of information science. The last Annual Review chapter, also by Kay and Sparck Jones (136) contains a section on theoretical linguistics that is still relevant. The linguist's point of view can be gotten from A Survey of Linguistic Science, edited by Dingwall (69), and from the Twenty-Second Annual Georgetown Roundtable (O'Brien, 205), which contains a series of papers reflecting back on the 1960s and forward to the 1970s. Both books suggest a trend in linguistics toward a more comprehensive view of language that is likely to prove increasingly relevant for computational linguistics and to which work in computational linguistics should contribute.

Fillmore (83) provides a specification of requirements for a fully developed system of linguistic description that is equally relevant for computational linguistics:

The linguistic description of a language

- (1) must characterize, for each lexical item in the language
 - (a) the grammatical constructions in which it can occur,
 - (b) the grammatical processes to which it is subject in each relevant context,

- (c) the grammatical processes which its presence in a construction determines, and
 - (d) information about speech act conditions, conversation rules, and semantic interpretation which must be associated in an idiosyncratic way with the lexical item in question;
- (2) it must provide the apparatus which characterizes
- (a) the grammatical structures of sentences on the "deep" or abstract level, and
 - (b) the grammatical processes by which abstract linguistic structures are processed and become surface sentences;
- (3) it must contain a component for calculating the complete semantic and pragmatic description of a sentence given its grammatical structure and information associated with each lexical item;
- (4) it must be able to draw on a theory of illocutionary acts, in terms of which the calculations of (3) are empowered to provide a full account of the potential illocutionary force of each sentence;
- (5) it must be able to draw on a theory of discourse which relates the use of sentences in social and conversational situations; and
- (6) it must be able to draw on a theory of "natural logic" by means of which such judgments as the success of an argument or the appropriateness of elements in conversations can be deduced
- (83, pp. 93-94).

This passage has been quoted in full--and in spite of some unfamiliar terminology--because it provides a framework for the sections that follow. Systems for automated language processing are beginning to develop capabilities that will make it possible to analyze language in use (illocutionary acts in the context of conversational discourse).

Parsing and Question Answering

As noted in the Introduction, work on question-answering systems has provided the major developments in the area of automated language processing during the past two years. This section on "parsing and question answering" and the next on "semantics, logic, and representation" together review research on "computer understanding," although some (and potentially all) of the work covered under the heading "psycholinguistics, sociolinguistics, and performance" also is relevant. A subsequent section on "speech-understanding systems" considers related work that is distinctive not only because of the treatment of speech but also because the choice of problem domains for some of those efforts is likely to introduce a new significance to the phrase "conversational interaction with a computer." The trend is clearly toward including performance of a task as an integral part of the system. Thus, it is increasingly difficult to discuss parsing outside of the context of question answering, and question answering necessarily involves dealing with semantics, logic, and representation. Consequently, many of the papers considered in this section have addressed in at least a preliminary fashion the problems dealt with more intensively in the next section, although there these problems usually are approached outside the context of an integrated automated language processing system. It is fair to remark in advance that none of the problems can be considered solved, although many of the directions being explored are promising.

A remarkable number of the efforts included here are continuations of research begun some years ago and reported in previous Annual Review volumes and in other reviews of research on question answering (e.g., Simmons, 272). The changes made in the systems reflect increasing acceptance of the distinction between deep and surface structures of language, now almost uniformly accepted throughout linguistics. Syntactic and semantic features have been added, and Fillmore's work on case grammars (83, 84) has influenced the design of algorithms for syntactic analysis. Procedures for deduction and inference have become more sophisticated, and developments in computer science, especially artificial intelligence, have resulted in new programming techniques and new heuristics. The summaries from two of the sessions at the Conference on Research Trends in Computational Linguistics (Center for Applied Linguistics, 39) are particularly relevant for this section: Computer-Oriented Grammars and Parsing (Petrick, 227) and Integrated Computer Systems for Language (Simmons, 274).

Petrick (228) describes recent work at the IBM Watson Research Center on the development of a transformational analysis algorithm and computer implementation for a class of transformational grammars that does correspond to contemporary linguistic descriptive practice. Robinson (238) discusses the lexicon being used in the grammar, emphasizing its role as the last component of a generative grammar and the first component of the corresponding recognition grammar. Petrick and his colleagues are building

a question-answering system that will use his parser. Semantic interpretation for it makes use of a syntax-based translator (Petrick, 226). The system is programmed in LISP and runs on an IBM 360/67.

Another IBM system based directly on transformational grammar was reported by Loveman, Moyne, & Tobey (167). The system, called CUE, was intended to provide an English language interface between a user and an arbitrary computer system. Syntactic and semantic analysis modules could be customized for particular applications. A prototype version, Proto-RELADES, was developed to query a library catalog; it ran on an IBM 360/67 computer. It is not clear that this project is continuing; none of the authors is now at IBM.

Papers from the NYU Linguistic String Project present the latest work on the use of syntactic analysis, based on the linguistic theories of Zellig Harris, for processing the content of scientific texts. Sager (248, 249) and Grishman (109) describe the parser itself, which decomposes a sentence into strings. A set of restrictions or local transformations serves to convert those strings into the informational components of the sentence. The current implementation of their system is in FORTRAN on a CDC 6600. In two other papers, Sager (246, 247) shows for pharmacology how grammars for special technical sublanguages can be developed and how they can be used with the parser to analyze scientific texts. Salkoff (253) is using a similar string parser to analyze French scientific texts.

Woods (319) discusses transition network grammars and describes his transition network parser as a practical way of performing a transformational analysis of English in a computationally efficient manner. His parser is incorporated into "The Lunar Sciences Natural Language Information System" (Woods et al., 320) which is programmed in LISP and runs on one or more PDP-10s. This system, developed at Bolt Beranek & Newman, has been used by NASA lunar geologists to access, compare, and evaluate chemical analysis data on lunar rock and soil composition. The language processing and retrieval components are separate, communication between them being accomplished by file buffer transfers. Woods has done some experiments to determine the effectiveness of semantic screening during the parsing; results to date do not show any clear advantage, and the total time for processing is increased.

The MIND system, developed by Kay and his colleagues at the RAND Corporation (Kay, 135) contains a set of linguistic processors that can be used in different combinations for grammar testing, question answering, and language translation (Bisbey & Kay, 22). Presently available in PL/1 on an IBM 360/65 computer are morphological and syntactic analyzers, a semantic file processor, a transformational component, a morphological synthesizer, and a program for interactive disambiguation. The chart parser concept (Kay, 134; Kaplan, 130) has been extended, and information between programs passes through a single common data region called the

"chart," which is a machine representation of a directed graph, interpretable as a transition network. Graphic access to the MIND system is described in Bisbey (21).

Recently, Kaplan, now at Harvard, is generalizing the parser he and Kay had developed for the MIND system. The result is a General Syntactic Processor (GSP) (Kaplan, 133), an algorithm for mapping strings of trees into strings of trees that is controlled by grammars consisting of networks of sequences of primitive operations. Kaplan shows how GSP can simulate the operation of Kay's chart parser, Wood's augmented transition network parser, and procedures for transformational generation and grammar testing. GSP is implemented in PL/1 on an IBM 360/65 computer and in BBN-LISP on a PDP-10; a TX-2 version is being written in BCPL.

Work at the System Development Corporation on the CONVERSE natural language data management system (Kellogg, 138; Kellogg et al., 139) has continued. Versions of the system, which is programmed in LISP, have run successively on the Q-32 computer, on the IBM 360/67, and, currently, on the IBM 370/145. The most interesting recent developments have been modifications of the parser and augmentation of the capabilities for logical inference. Syntactic analysis using a modified case grammar is now accomplished by a combination of Kay's chart parser with network structure building similar to that done by Woods. A deductive grapher is being developed to operate on predicate calculus canonical forms produced by the

semantic translator (Travis et al., 296). CONVERSE has been tested with a number of experimental files: census data, computer programs, and information about the syntactic properties of English sentences. The latter file has been used in checkout and validation of the CONVERSE grammar.

An operational prototype of the Rapidly Extensible Language (REL) system (Dostert & Thompson, 73, 74, 75; Dostert, 72) is now running on an IBM 370/135 in assembly language at the California Institute of Technology. The REL language processor can handle a variety of high-level languages, REL-English being one of the "base" languages (along with languages for music, algebra, and animated films); user-specific languages can be tailored to individual requirements. An earlier version of the system was used extensively by an anthropologist and by a "computer artist." The parser is a modified form of Kay's chart parser; syntactic features in a case grammar structure have been added to handle transformations. Because of the small computer now used, decisions involving data elements have had to be separated from the analysis of the structure of the input sentence. Furthermore, to handle large data bases, particular attention has been paid to optimizing access to large files in disk memory through paging algorithms. As a result of these facility constraints, REL separates syntactic analysis from the semantics of the data involved, an approach in marked contrast to that taken by Thompson in his work on DEACON at

General Electric TEMPO. He was one of the earliest and most ardent proponents of the desirability of conjoint processing of syntax and semantics.

At Stanford Research Institute, Coles (57, 58) has extended a system previously used for controlling robots and retrieving drug information to explore its relevance for retrieving information from a larger data base. The latest version, ENGLAW, also uses a syntax-directed interpreter to parse and translate sentences into a predicate calculus representation which is then processed in relation to an axiomatized data base by a resolution theorem prover. The new data base is derived from a text on physical laws and their effects, hence the name of the system. Because of his interest in man-machine communication and for possible applications of his system to computer-assisted instruction, Coles has done a great deal of work on simplifying the user interface. ENGLAW is programmed in BBN-LISP and runs on a PDP-10 computer.

Schank (259-261) is continuing his work on a conceptual parser, now running in MLISP on the PDP-10 computer at the Stanford University Artificial Intelligence Laboratory. He is establishing a conceptual base into which utterances are mapped during understanding. Syntax is used minimally to bracket a sentence into phrases and to identify verbs and objects. Then conceptual procedures are used to identify a meaning structure. Extensive studies in semantics have been carried out to provide a substantive theoretical base for the system (e.g., Schank et al., 263; Russell, 244).

Schank et al. (264) report on the system program structure: the analyzer, the memory, and a generator that makes use of Simmons' semantic networks (276; Simmons & Slocum, 278)--considered further below--to produce English output.

The systems described so far have been under development for several years. The following have appeared in the literature for the first time during the last two years (so far as it has been possible to determine), although work on them may have been underway for some time.

The most revolutionary of the newer systems is Winograd's program for understanding natural language (317, 318). Based on Halliday's systemic grammar (see Hudson, 123), Winograd interweaves syntactic and semantic processing in the analysis of conversational interactions with a simulated robot regarding the manipulation of blocks. Grammatical rules are programs, and knowledge about the problem domain is represented as procedures. The system runs on a PDP-10 computer in LISP and in Micro-Planner, a subset of Hewitt's PLANNER language (117) developed by Sussman & Winograd (293). Jeff Hill, at the Computer Corporation of America (62), has just completed a modification of Winograd's system for processing information retrieval requests from a file of weather data. He reports that relatively few changes in the linguistic components were required; the Micro-Planner code was replaced by a set of LISP functions specific to the new problem domain.

The Swedish Question Answering Project (SQAP) is developing a system for the Sweden Research Institute of National Defense in Stockholm that will incorporate Sandewall's predicate calculus formalizations of English (see the next section), although work also is being done on Esperanto and on a simplified Swedish. The program is intended to accept facts and answers questions about any subject matter; no particular data base is described, and test sentences are presented from a variety of sources. Palme (217-221) reports on the parser and the grammar for the system. The processing strategy involves a sequence of surface parsing, transformation, semantic network representation, a predicate calculus internal language, and a factual data base. The programs are written in PL360 and presumably run on an IBM 360 computer.

Heidorn (115), at the Naval Postgraduate School, has written a simulation programming system in which GPSS models for queuing problems can be constructed through natural language interactions. Lamb's stratification theory is used as the grammatical basis for translating text input into a multi-dimensional network and back out again. The system is programmed in FORTRAN and runs on an IBM 360/67.

Colmerauer, who developed the Q-system being used at Montreal for mechanical translation (Colmerauer et al., 60; see the section on MT below), is developing a new system for man-machine communication at the University of Aix-Marseille (Colmerauer et al., 61). He and his colleagues

have written a predicate calculus programming language which is being used to build a parser, a semantic translator, routines for conversion into predicate calculus formulas, and procedures for deduction. They will be processing statements and questions in French that can be axiomatized and from which inferences can be made accordingly. They are currently using an IBM 360/67 computer.

A number of other question-answering systems have appeared in the literature during 1971 and 1972. They are reviewed summarily here, primarily to illustrate that the technology is advanced sufficiently to allow putting together components in different application areas. Ramani (232) and Gelb (101) have developed natural language problem solving systems that handle physics and probability examples, respectively. McCalla & Sampson (173) have added a simple syntactic component to a Quillian-type semantic network memory. Biss et al. (23) use a higher order logical calculus to answer questions about 2000 sentences from the Illinois Drivers' Manual. Lingard & Wilczynski (163) have developed a syntax-directed approach for handling natural language relations that combines key words and frame matching with an attribute-value-list data type. Mishelevich (185) and Isner (126) have been processing medical data: Mishelevich analyzes noun phrases semantically; Isner uses a conceptually oriented parser to translate into a heuristic problem solving language. Badre (7) has used a transition network parser with a semantic network in the

development of a program that learns elementary arithmetic by processing sentences from a fourth-grade textbook. Although each of these systems has some unique feature or distinguishing characteristic, it is interesting to speculate what the effect would be if all of the resources expended on them had been concentrated instead on one of the better established systems. Too many research groups are trying to develop individual approaches, and the results are not that productive. The question remains: how to prompt innovation while conserving those scarce commodities: people, computer facilities, and money.

This section on parsing and question answering has been presented in catalog form both to illustrate the number and variety of systems under development and because their complexity does not allow any simple grouping. Nevertheless, it is possible and desirable to make some evaluative comments to provide a perspective for the reader.

First, it should be noted that none of the systems is being used on a production basis and that few have been exercised by other than the people who designed and implemented them. Wood's Lunar Sciences Natural Language Information System (Woods et al., 320), Kellogg's CONVERSE (138), and Thompson & Dostert's REL (Dostert, 72) are among the exceptions. In short, question answering still is an experimental area.

A variety of linguistic theories have been incorporated directly into the design of question-answering systems. The influence of Chomsky's

transformational generative grammar has been most pervasive, but also represented are Harris's string grammar, Halliday's systemic grammar, and Lamb's stratificational grammar. None of the implementations constitutes an adequate model of the corresponding theory, although Petrick (228) has been particularly concerned with trying to do that. Moreover, the similarities among the linguistic theories are becoming more impressive than their differences. In any case, a more critical requirement for research on question answering is an adequate description of the grammatical rules of English, no matter what "persuasion." Here, one of the main issues to be resolved is the way in which semantics and syntax are combined, a topic considered in more detail in the next section.

In conclusion, it may be worth remarking that three parsing systems have been particularly influential during the two years reviewed here and that they are likely to continue to be so. They are Wood's augmented transition network parser (319), Kay's chart parser (134, 135), and Winograd's program for natural language understanding (317, 318). Wood's and Kay's programs have been incorporated into a number of other systems, so their influence extends beyond their initial system implementations. Winograd's approach has prompted the most excitement for its novel treatment of semantics interacting with syntax in the determination of sentence structure. Future innovations are likely to be strongly influenced by Winograd's work.

Semantics, Logic, and Representation

The future of question-answering systems depends critically on the development of procedures for handling meaning. As will become evident from the number of papers referenced in this section, many attempts are being made to do just that. Raphael & Robinson (233) issued a bibliography on computer semantics, which they identify as an area at the boundaries of linguistics, psychology, and computer science. More than 200 references are classified topically with key references identified as entry points into the literature. Papers by Pacak & Pratt (215) and by Mishelevich (186) provide introductory surveys of semantic models that have been used in automated language processing. However, neither represents adequately the variety of disciplines that are contributing to a computational analysis of meaning. Several books of readings have appeared, bringing together older but still relevant papers from many areas; of particular interest are those by Steinberg & Jakobovits (287), Davidson & Harman (67), and Rosenberg & Travis (241).

As mentioned before, linguistics is becoming increasingly interested in and willing to take responsibility for semantics as a proper part of its scope. Three developments are singled out for major consideration here, although they are not that easy to separate within linguistics itself. The first development is in case grammar. Fillmore's work on a case base for

transformational grammar (83, 84) has already been mentioned as an influence on question-answering systems, and it is referred to again a number of times in this section. According to Fillmore, the propositional core of a sentence consists of a predicator (a verb, adjective, or noun acting as a logical predicate) to which other sentence elements (essentially logical arguments) bear specific kinds of case relations. Fillmore believes that the following cases may prove to be adequate: agent, experiencer, instrument, object, source, goal, place, and time. However this list is modified, he believes that the number is likely to remain small. Case grammar has had a significant influence on the form of the UCLA grammar (Stockwell et al., 288), the most comprehensive description of English from a transformational point of view. Also of interest is a collection of papers by Fillmore's students at Ohio State University (Fillmore, 86); it illustrates the case approach in a variety of linguistic constructions and in a number of different languages.

An approach quite similar to that of case grammar has been under development in the Soviet Union for substantially the same period of time and quite independently. Mel'čuk and his colleagues (Mel'čuk, 174-176; Mel'čuk & Žolkovskij, 177; Žolkovskij et al., 325; Kulagina et al., 149) are preparing a model of language as a logical device that converts any given meaning into all texts corresponding to it and deduces from any given text its meaning. Their lexical functions act as cases.

The second linguistic development likely to have an impact on the formalization of meaning is the work generated in the controversy between the interpretive and the generative semanticists. Both groups reject as too simplistic earlier views of transformational grammar in which syntactic deep structures were converted into syntactic surface structures by transformations that were essentially independent of the semantic rules involved in deriving meanings from those deep structures. The generativists want to introduce an abstract semantic deep structure. The interpretivists accept semantic interpretation of a syntactic base, but are willing to take into consideration surface structures and perhaps intermediate structures as well. Partee (222, 223) summarizes the two positions; relevant papers can be found in Fillmore & Langendoen (87), Davidson & Harman (67), and almost any linguistic journal (e.g., Language, Linguistic Inquiry, Foundations of Language, Journal of Linguistics) or the papers from any linguistics meeting (e.g., the Linguistic Society of America, the Chicago Linguistic Society). Resolution of this controversy--or more adequate formalization of either position--could have a significant effect on the design of question-answering systems.

The third development within linguistics is relatively recent. It involves an attempt to establish a logical base for language. The most extreme statement of the position has been made by Montague (187-189); he argues that it should be possible to provide one natural and mathematically

precise theory that will comprehend the syntax and semantics both of natural languages and of the artificial languages of logicians. Montague's position and other related views are discussed in a volume edited by Hintikka et al. (122). Rodman (240) presents a number of "Papers in Montague Grammar" written by linguists.

Keenan (137), who also is interested in deriving natural language sentences syntactically from their logical structures, discusses the inadequacies of the first-order predicate calculus for this purpose; he proposes an extended logic and shows how surface structures in natural language can be derived from it. Lakoff's linguistic analysis of "hedges" (151) builds directly on work by Zadeh (323, 324) on fuzzy sets. Bartsch & Venneman (11) argue that relative adjectives and comparison can be handled only by establishing semantic representations as logical forms that can be mapped directly from logical syntax onto models of states-of-affairs. As will be seen below, the positions presented in this paragraph have arisen quite independently in developments in computational linguistics not motivated by linguistics.

Three other linguistic approaches should be mentioned here because of their concern with relations between people's knowledge of the world and semantics as embedded in comprehensive theories of language. Chafe (41, 42) has continued his work on formalizing the semantic structure of English as described in his book, Meaning and the Structure of Language (40),

and is extending it to establish the semantic prerequisites to high-quality machine translation (43). Lamb (152) has changed the name of his theory from "stratificational" to "cognitive linguistics" in recognition of the necessity for including within it a conceptual system containing all of an individual's knowledge. Pike's recent work on a tagmemic theory of language (229) has been directed toward the development of mathematical models for linguistic situations. Also in the tagmemic tradition and of particular interest is the work of Grimes (106, 107) on discourse, again a problem just becoming appreciated in question-answering systems. Grimes & Cranmer (108) have prepared a 23 page bibliography on discourse and related topics.

Up to this point in this section, the discussion has been concerned with activities within linguistics that are particularly relevant for semantics, logic, and representation. The references that follow describe attempts to explore computational implementations of these and other approaches to the formalization of meaning.

As noted earlier, the work of Fillmore on case grammar has been particularly influential. CONVERSE and REL, described in the previous section, both make use of case structures. Celce-Murcia (38) has combined insights from Fillmore and Chafe with those of Gruber (111, 112) in her development of a recognition grammar for use in computer-aided instruction. She combines perceptual cues from surface structure with lexical information and underlying syntactic relations.

Simmons (273, 276), influenced both by Fillmore and Celce-Murcia, has embodied case structures in semantic networks. The networks are being used by him and his students in question-answering programs (Alexander, 4; Thompson, 294; Hendrix, 116; Slocum, 283) for computer-assisted instruction (Melton, 178), and for generating English discourse (Simmons & Slocum, 278). Baranofsky (8) describes the semantic structure for nouns used in his system. Simmons & Bruce (277) show similarities between semantic networks and predicate calculus representations and present an algorithm for conversion. Bruce (30) relates his more recent work to the beginnings of a logic for case structure systems. Also, in a more philosophical vein, Simmons (275) argues for a stepwise continuity of linguistic models from keyword scanner to deep structure analyzer, showing their respective relevance to simpler and to more complex models of the world.

Another approach to the development of semantic networks can be found in Kay's work on the MIND system (135), referenced earlier. An appropriate network data structure and procedures for managing semantic data in that system are described by Shapiro (269, 270) and Su (292). Su (291) also has begun a computational model of paragraph production.

Networks are being used in a question-answering system for analyzing Japanese being developed by Nagao (195; Nagao & Tsujii, 196) both in a conceptual hierarchy dictionary and to relate semantic representation of input sentences.

Semantic information networks also form an integral part of SCHOLAR, a system being developed both for question-answering and for mixed-initiative man-computer instructional dialogs (Carbonell, 32; Carbonell & Collins, 33). Collins et al. (59) describe the inference-making capabilities in the system.

Formalizations of natural language in the predicate calculus continue to be of interest quite independent of the recent involvement in logic by linguists mentioned earlier. Sandewall (256-258) has been one of the most enthusiastic advocates of the predicate calculus as a deep structure for question-answering systems (see the description of Palme's work in the preceding section). His latest version, PCF-2 (Sandewall, 258), is a logical calculus for re-expressing natural-language information. It will incorporate elements of psychology, linguistics, and computer science, as well as logic, in a "modus operandi" model of language; that is, a model that captures the processes whereby sentences are produced by a speaker and understood by a listener.

The predicate calculus--and its limitations for representing natural language discourse--are also discussed by Isard & Longuet-Higgins (125), by Biss et al. (24), and by Peterson (225). Paducheva (216) examines the problems of translation from logical languages to natural languages in relation to an information-logic language for elementary geometry. A set-theoretic approach to semantics is being examined by Smith & Suppes (285).

As Minker & Sable's survey of relational data systems (184) shows, almost every question-answering system capable of performing inference contains logical elements. Work specifically on relational data structures and their use in question answering is considered by Kuhns (146-148) and DiPaola (71) with particular reference to the RAND relational data file. Marill et al. (169) describe work in progress at Computer Corporation of America on relational structures, using a content-addressable n-tuple format as a mechanism for storing basically unstructured data.

Winograd's work (317, 318) was described in the previous section as the most revolutionary of the new approaches to question answering. Its significance for the present section lies in the way it incorporates semantics and a procedural representation of knowledge and uses heuristics in logical inference, thus avoiding the rigidity of resolution-type theorem provers. Formalizing real-world knowledge for comprehension is also addressed by Charniak (44, 45) and by Meyer (183) in their work on children's stories; by Becker (16-18) in his simulation of a robot finding its way through a city; by Norman (203) in his work on memory and question answering; and by Davies & Isard (68) and Longuet-Higgins (166) in several contexts.

A number of other efforts have arisen from the context of artificial intelligence. Lindsay (162) reports on the use of problem solving and learning heuristics in natural language parsing. Wilks (314-316) has

developed a template system that uses a set of semantic elements and formulas to determine the messages in phrases and that can handle paragraphs as well as sentences; he has applied this "preference semantics" approach to machine translation. A number of interesting papers have addressed the problems of time, tense, and causality: Findler & Chen (88), Walker (301), Bruce (30), and Kuhns (148). Klein et al. (145) describe a program for generating reports on the status and history of stochastically modifiable semantic models of arbitrary universes. Klein & Dennison (144) have added to AUTOLING, which is a general system for learning transformational grammars of natural and artificial languages, a subcomponent that learns morphological rules by eliciting responses from informants. A methodology for modeling and testing language contact phenomena is presented in Klein (143).

More generally, it is clear that much of the work in artificial intelligence is potentially relevant to computational linguistics and to systems for automated language processing. The interested reader is referred to the papers from the Second International Joint Conference on Artificial Intelligence (265), to the volumes of papers from the Edinburgh conferences, Machine Intelligence 6 (Meltzer & Michie, 179) and Machine Intelligence 7 (Meltzer & Michie, 180), to the Findler & Meltzer NATO Advanced Study Institute volume (89), and to the new journal Artificial Intelligence. Simon & Siklossy (279) have reprinted some

earlier papers on representation and meaning that are also worth considering in relation to more recent developments. Of general interest to computational linguists are the high level programming languages being developed for artificial intelligence research (Hewitt, 117; Rulifson, Derksen & Waldinger, 243).

Information systems and documentation have been the focus for a number of papers. Noel (201, 202) has made particularly interesting use of case structures in his work on semantic analysis of abstracts. His procedures for mechanized indexing also build on Sager's string analysis (discussed above), on Gardin's work (98; see also Bely et al., 19), and on much of contemporary linguistics. Montgomery (191) provides a framework within which the work of Noel, relational logics, net structures, and linguistic semantics are integrated. Lehmann & Stachowitz (160) describe their work on normalization of natural language for information retrieval and indicate their plans for a canonization component that will convert normal forms into the predicate calculus for inference.

Olney & Ramsey (207) describe the data sets they have obtained by processing the machine-readable transcripts of the Webster's Seventh New Collegiate Dictionary and its pocket abridgement. They indicate their plans to describe English affixes, to extract generic hierarchies among the word definitions, and to generate lists of sense-specific synonyms. Also discussed is the possibility of developing a lexicon tester (on the

model of a grammar tester) that would allow assessing the effects of systematically modifying the definition of a word.

A variety of papers consider semantic analysis for the development of more adequate dictionaries, thesauruses, and lexicons for information processing. Leslie (161) has specified requirements for a computerized lexicography. Nagao (195) is developing a conceptual hierarchy dictionary for a document retrieval system. Nakai (197) has analyzed semantic role indicators in the Japanese language in relation to a computerized thesaurus. Edmundson & Epstein (77) present a modified and extended version of an axiom system that constitutes a model of synonymy and antonymy and is intended to lead to the automated construction of dictionaries in computer-processable form. Pratt (230) and Pacak et al. (214) are continuing their work at the National Institutes of Health on morphosemantic analysis of medical English in relation to the development of both simplified and multi-language dictionaries and microglossaries for medicine.

It is more difficult to provide evaluative comments on the activities in the general area of semantics, logic, and representation than it was on work in parsing and question answering. Case structures, networks, and logical analysis will continue to be explored as frameworks for housing semantic mechanisms that can be incorporated into systems. However, it is doubtful that any of the versions currently proposed will prove wholly adequate. The key problem is the representation of knowledge. Modeling

specific task domains seems likely to provide the most valuable guidelines
for addressing that problem.

Psycholinguistics, Sociolinguistics, and Performance

The work reported so far on computational linguistics has been concerned with establishing procedures for processing natural language that deal in some sense with "the ideal case." Little attention has been given as yet to variability in the use of language that can be attributed to differences among individuals and differences in situations--in short, the psychology and sociology of automated language processing. Consequently, this section will be both brief and cursory. It is included primarily as a challenge to future work, and it contains for the most part general and representative references to literature that has not concerned itself at all with computation.

Linguists have always had to be respectful of variability among their informants. However, they have not tried to incorporate such data into formal models of language recently because of their concern with representing universals in grammar--what is true for all speakers of a language. This approach is most clearly identified with Chomsky and his preoccupation with competence to the exclusion of performance: "Linguistic theory is concerned primarily with an ideal speaker-listener, in a completely homogeneous speech-community, who knows its language perfectly and is unaffected by such grammatically irrelevant conditions as memory limitations, distractions, shifts of attention and interest, and errors (random or characteristic) in applying his knowledge of the language in actual performance"

(48, p. 3). For Chomsky, competence is "the speaker-hearer's knowledge of his language" and performance is "the actual use of language in concrete situations" (48, p. 4).

Focus on the "ideal speaker-listener" probably has been beneficial for computational linguistics. The programs for syntactic and semantic analysis developed so far have been as successful as they are at least in part because they have avoided the complications involved in capturing variability. But at some point question-answering systems will no longer be exclusively research vehicles, and they will have to accommodate differences in users and in situations. As an extreme position, Mey (182) and Wilks (313), in spite of other disagreements, share the view that performance should be the major (if not the only) concern of computational linguistics (and perhaps of linguistics as well). Regardless of the merits of their arguments, the conceptualization of competence and performance must be reworked.

Some new developments in linguistics are extremely relevant here. They are epitomized in The First Annual Colloquium on New Ways of Analyzing Variation in English, held at Georgetown University 26-28 October 1972, and in the papers on Sociolinguistics: Current Trends and Prospects presented at the Twenty-Third Georgetown Round Table (Shuy, 271). Although the work discussed at those meetings is most closely identified with sociolinguistics, the implications for linguistics itself are particularly

well stated in Labov's paper on Methodology (150). He stresses the critical importance of studying casual speech within the speech community, noting that there is inherent variability that must be incorporated into linguistics as variable constraints on grammatical rules. Fillmore (85) also argues for the position that linguistics is responsible for how, for what purposes, and in what settings people use language. This point of view certainly is reflected in the new trends in question-answering systems mentioned earlier.

An overview of what some computational linguists think about language performance is provided by Carroll (35). Most of the material they find relevant comes from psychology. And, indeed, psycholinguistics is a major research area as evidenced by the 209 items contained in the review by Fillenbaum (82) and by the surveys of Gough (104) on experimental psycholinguistics and Slobin (282) on developmental psycholinguistics. Particularly relevant for showing the effects of linguistic theory on psychological research is the book on Psychology and Generative Grammar by Fodor et al. (91). Dingwall (70) sets out a program for what he calls "psychological linguistics," the purpose of which is to explore the psychological reality of linguistics. Chomsky's view (48-50) of linguistics as a branch of cognitive psychology has already been mentioned.

One of the ways in which psychological studies will influence computational linguistics is in the simulation of cognitive and linguistic

processes. The book, Computer Models of Thought and Language, edited by Colby & Schank (54), contains a number of examples. Particularly relevant is the work on belief systems by Abelson (1) and by Colby (53). Colby and his colleagues have developed models for paranoia (Colby et al., 55, 56) and procedures for machine-mediated interviewing (Hilf, 118; Hilf et al., 119). The work of Waterman & Newell (309, 310) is also relevant here; they are attempting to automate protocol analysis so that they can infer from a subject's behavior in solving a problem what his changing knowledge states have been. Their work is based on the theory of problem solving developed by Newell & Simon (200).

Only one example was uncovered in which computational linguistics might make a direct contribution to psychological research. Kaplan (131, 132) shows how the augmented transition network parser can be interpreted as a psychological model of sentence comprehension. He acknowledges that much more work needs to be done to sustain this interpretation.

Speech Understanding

A speech-understanding system is a computer understanding system that accepts continuous speech as input. As such it involves research of the kind described in the previous three sections with some substantial additions. However, it is clear that the problem is not solved just by the addition of an acoustic analysis component to an existing question-answering system. The term "speech understanding" was introduced into the literature in the final report of a study group (Newell et al., 199) supported by the Advanced Research Projects Agency (ARPA). As a result of the recommendations in this report, a major program of research has been funded to develop a prototype system. The report contains a detailed analysis of the problems involved, together with the specification of a set of objectives, and consideration of alternative ways to meet them. The system should "accept continuous speech from many cooperative speakers of the general American dialect, in a quiet room over a good quality microphone, allowing slight tuning of the system per speaker, but requiring only natural adaptation by the user, permitting a slightly selected vocabulary of 1,000 words, with a highly artificial syntax and a [manageable] task, with a simple psychological model of the user, providing graceful interaction, tolerating less than 10% semantic error, in a few times real time, and be demonstrable in 1976 with a moderate chance of success." (199, p. 2) Reports on preliminary, more limited systems being developed as

part of the ARPA program will be described below. First some general background information is necessary.

Research on speech recognition has been conducted for over twenty years, and a number of modest systems capable of handling isolated words from a small vocabulary actually have been commercially available. This work has depended almost exclusively on acoustic analysis, either building up the word from phonetic elements or using a pattern-matching strategy. It has been realized for many years that higher-order linguistic constraints would be necessary, but until recently it has not been clear how to incorporate them. The results of work in question answering have provided the primary source of inspiration. Actually, it is appropriate to credit developments in artificial intelligence more generally for a new orientation to the problem. The goal of speech recognition had been to provide an orthographic transcription of the words or utterances being analyzed, and phonetic typewriters and systems for automatic dictation had been envisioned as the practical products. In contrast, the goal of speech understanding is to perform some task using speech, and the system can respond appropriately without necessarily recognizing every word that has been spoken. As a result, the definition of the task and the specification of the problem domain have become major sources of information for the analysis. The first speech-understanding system in this perspective was the Vicens-Reddy system (Vicens, 300; Reddy, 234) which processes continuous

speech, although in a highly constrained language, using the results of the analysis to direct a computer-controlled arm in picking up blocks.

The ARPA study report (Newell et al., 199) provides an excellent introduction to the concept of speech understanding. In addition, a number of other reviews of the literature have been prepared. Lea (153) presents a thorough coverage of most of the relevant literature in linguistics. Hill (120, 121) surveyed the whole area of man-machine interaction using speech; the later paper includes an appendix containing performance figures for speech recognition systems. Otten (212) and Broad (28) both present perspectives on the acoustic and phonetic problems involved in approaches to recognition (as opposed to understanding). The classic introduction to the engineering aspects of acoustics and speech, now in its second edition, is Flanagan's book, Speech Analysis, Synthesis and Perception (90). From the standpoint of computational linguistics, Cooper (65) considers both speech understanding and speech production. His treatment of speech production is in the context of reading machines for the blind, but it is relevant for the more general problem of producing natural-sounding language from a computer. The 1972 Conference on Speech Communication and Processing (Air Force Cambridge Research Laboratories, 2) contains a large number of papers that, together, represent the current state of the art in these areas, primarily from an engineering perspective.

The ARPA program on speech understanding is not far enough along to allow an evaluation of its progress toward a prototype system satisfying all the specified objectives. Reddy et al. (236, 237) describe the current Carnegie-Mellon University system which uses chess as its task domain (see also Erman et al., 81); a collection of working papers from their group has been issued (Reddy et al., 235). Walker (304, 305) reports on the structure of the Stanford Research Institute approach which is distinctive in the way syntax and semantics are used to predict words and thus minimize acoustic processing. SRI began working with an adaptation of Winograd's programs for language understanding (Winograd, 317, 318), using his world of block manipulation described earlier; more recently the work there has been directed toward assembling or repairing objects like pumps and faucets. Paxton & Robinson (224) are designing a new parsing procedure at SRI to provide more flexible ways of accommodating syntactic, semantic, pragmatic, and prosodic (intonation, stress, pause, juncture) information in the course of the analysis. Barnett (10) presents the work of the System Development Corporation on a vocal data management system which is driven by syntax and semantics; initial work involves a formatted query language, but they hope to link their work with Kellogg's CONVERSE system (Kellogg, 138; Kellogg et al., 139). Wood's augmented transition network parser (Woods, 319) and lunar sciences natural language information system (Woods et al., 320) are being used in

the speech understanding system at Bolt Beranek and Newman. The BBN system is being developed following an "incremental simulation" approach in which people are used initially to simulate components with the procedures they use being successively automated (Woods & Makhoul, 321). The strategies for recognition of spoken sentences from visual examination of speech spectrograms developed by Klatt & Stevens (141, 142) forms the basis for their extract module. Forgie (92, 93) describes the Lincoln Laboratory work which has concentrated on acoustic analysis and on the development of a large speech data base for use by the various ARPA contractors; accessing that data base will be their task domain. A new approach to formant analysis called linear predictive coding is being used extensively in the ARPA program. Essentially a replacement for Fourier Analysis, it was developed by Atal & Hanauer (6) and Markel (170) (see also Makhoul & Wolf, 168). Related work is being done on prosodics at UNIVAC by Medress, Lea, and their colleagues (Lea, 153, 154; Lea et al., 155, 156) and at the University of Michigan by O'Malley and his colleagues (O'Malley & Herman, 208). The Speech Communications Research Laboratory in Santa Barbara, California, is concerned primarily with acoustic-phonetic and phonological rules and the transcription and linguistic analysis of speech samples. The ARPA program is expected to make extensive use of the ARPA Network (see Crocker et al., 66, and companion papers at the 1972 Spring Joint Computer Conference for information about and other references to the ARPA Network).

No attempt has been made in this section to review all work related to speech understanding; in particular, the current activities in speech recognition have not been covered nor has relevant work in linguistics or acoustics. The reviews cited earlier provide an entry to that literature for the interested reader. It is appropriate, however, to recognize the fact that relevant research is being done in Japan and the Soviet Union; again only an entry point to their literature will be given. Professor Sakai's laboratory at Kyoto University (see Sakai & Nagao, 250) is working on speech analysis, synthesis, and recognition (Sakai & Ohtani, 251); a thesis by Ohtani (206) describes their work in some detail; it also references other Japanese research in this area. A thorough review of the recent Soviet literature has been compiled by Tsemel' (298); an English translation is available. Although most of their current work does involve statistical and pattern matching strategies, they are beginning to develop systems for speech understanding.

Mathematical Models

The development of a mathematical model had a profound effect on early formulations in transformational grammar (Chomsky, 47). Since that time, work on mathematical models, although clearly relevant, has had less practical consequences for linguistics and for computational linguistics. Three introductory textbooks have appeared: Brainerd's Introduction to the Mathematics of Language Study (26), Gross' Mathematical Models in Linguistics (110), and Wall's Introduction to Mathematical Linguistics (307). Wall (306) has written a more succinct summary of current questions being raised about the generative capacity of transformational grammars and about their explanatory adequacy. Joshi (127) has prepared a brief survey of mathematical results in the general area of transformational grammars, primarily concerned with mappings of trees onto trees.

Of somewhat more direct computational linguistic interest are Moyne's review of grammars and recognizers for formal and natural languages (194) and Petrick's paper (226) on syntax-based translators for symbolic and algebraic manipulation. Friedman (96) has actually provided computer implementations of proofs of theorems involving several mathematical models of transformational grammar in order to provide a basis for comparing the models.

Much more work has been done in this area, but coverage is clearly beyond the scope of this review.

TEXT PROCESSING

It will be clear from the contents of this section and the remaining ones in the review that the boundaries between computational linguistics and the rest of automated language processing are not clear and distinct. Actually, it is reasonable both to predict and to argue for an increasing comprehensiveness in the models of language underlying computational linguistics. As a result, all manipulation of language data in the information sciences could reflect the resulting increase in sophistication--within limits and if needed for the purpose. A similar point is made in Martins' tutorial paper on dimensions of text processing (172). Having identified two such dimensions--scope and depth of structure, he organizes the variety of systems accordingly. Scope involves the relative magnitude of the problem domain in which a system can be of effective use. Depth of structure refers to the complexity of analysis. Text-editing systems like Engelbart's (see below) are high in scope, low in depth of structure. Winograd's system is low in scope, high in depth of structure. Deploying the current state of the art against a graph with these two points at the upper left and lower right hand corners, respectively, Martins finds that the rest of them fall in the region to the left of a hyperbolic curve (toward the corner of no scope, no depth of structure). Thus there is a tradeoff between the two dimensions so that the curve itself contains

systems of comparable power or sophistication. Martins would like to break through this "barrier" and develop systems high in both scope and depth of structure, but this possibility remains to be seen.

Augmentation Systems

Engelbart (79, 80) and his colleagues have extended the facilities of the Augmentation Research Center so that the functions of a "knowledge workshop" not only are available to the individual research worker, but can be shared effectively by local and network linked communities. Collaborative dialog is supported by facilities for document development, production, and control, and for storing as "research intelligence" externally generated documents, commentary and related information items. In a more philosophical vein, Engelbart considers the extension of these types of computer support and communication in relation to the emergence of more highly developed institutional forms for intellectual support.

AUTONOTE, which began as a simple system for personal information storage and retrieval, has developed toward a more general means for facilitating personal information processing (Linn & Reitman, 165). Of particular interest are the features described in more detail in Linn (164); they include a heuristic-based parser for establishing syntactic dependencies in topic descriptions, a network structure for organizing topics, improved retrieval mechanisms, and various kinds of topic network processing techniques. These additions are intended to add to the descriptive powers available to the user and to the ease and efficiency of communication with AUTONOTE.

SHOEBOX, another system for personal text file creation and manipulation, has been revised and extended by Bayard et al. (15). Although less sophisticated than the two preceding systems, it is better adapted to handling more traditional bibliographic materials for search and retrieval.

The further development of personal and intellectually supportive information systems is likely to heighten the awareness of our lack of understanding of the significance of differences among users in a system. Work on the "user interface in interactive systems" is beginning to receive serious attention (see Walker, 302; Bennett, 20; Martin, 171). Of particular interest in the present context are Treu's establishment of a facility within which these differences can be studied (297) and Carlisle's work on the effects of differences in human information processing styles and levels of system-task complexity on the process and performance of man-computer interaction (34).

A survey of on-line text editing by Van Dam & Rice (299) provides a good overview of some available systems. Hansen (113) discusses the general principles involved in designing an interactive system in relation to the development of a text editor. Elliott et al. (78) describe an extended editing system in which all the versions of a manuscript can be preserved and called out as required.

Document Analysis

A number of systems for analyzing the structure and content of documents are being developed. Only a few items will be included here, and these considered briefly; Batten's chapter on Document Description and Representation (14) in this Annual Review examines this area in more detail. Sedelow (266, 267) has summarized the work on her automated language analysis project. Of particular interest are the extensions of the VIA (Verbally Indexed Associations) programs for computer-based recognition of semantically-related words in any written or transcribed document or text. Roget's International Thesaurus is now available for use with the system. Other systems for concordance generation and statistical manipulation of language data have been reported by Borden & Watts (25), Smith (284), and Ross & Rasche (242). Hunter (124) presents a data representation code for use in text-processing systems, and Brown (29) and Joyce (129) describe programming languages for use in text manipulation. None of these systems presents major innovations; for the most part they provide similar capabilities on different computer facilities. Computer and the Humanities (63, 64) is continuing its listings of verbal materials in machine-readable form. The new American Heritage Word Frequency Book (Carroll et al., 36) is likely to be extremely valuable for statistical research. It contains 86,741 different word types based on over 5 million word tokens.

There has been a substantial literature resulting from applications of techniques for document analysis to the humanities, as evidenced in the chapter by Raben & Widmann (231) in Volume 7 of the Annual Review. No attempt is made to update that review here. Two surveys by Widmann, one on computers and literary scholarship (311) and one on recent scholarship in literary and linguistic studies (312), contain extensive bibliographies. Of interest, too, is Oomen's paper (211) on new models and methods in text analysis in which she discusses the complementarity of grammatical and textual analyses. Stone (289) describes an application of content analysis to the development of social indicators. Carroll et al. (37) present a new statistical technique for content analysis that identifies noun phrases.

Document Retrieval

Work on document retrieval was reviewed in Volume 7 of the Annual Review (Brandhorst & Eckert, 27), so only those references will be mentioned here that involve natural language processing as a primary concern. Of general interest, of course, is the collection of experiments with the SMART retrieval system, recently compiled by Salton (255); a number of the experiments deal with language elements specifically. The book was reviewed extensively by Brandhorst & Eckert. Nugent (204) describes a plan for establishing a full-text data base for the U.S. Patent Office, and Glantz (103) reports on the design of an on-line query language for its search. Choueka et al. (52) report on a project for full text retrieval of Hebrew legal documents.

The general question of natural language as a query language was discussed again. Giuliano (102) defends such a use, while Montgomery (190) points out the problems resulting from the complexity of form-meaning relations in language. Otten & Pacak (213) provide an interesting perspective on the variety of intermediate languages for automatic language processing between natural language and machine language.

Dictionaries and Lexicons

The current status of work on the Chinese Dialect Dictionary being computerized at the University of California, Berkeley, is presented by Streeter (290). Grimes (105) describes a computerized data base capable of storing comparative word lists in all the world's languages; the system is now in operation at the University of Oklahoma. Two papers present techniques for use in handling dictionary data. Onderisin (210) has developed a new dictionary arrangement technique that speeds up dictionary lookup. Smith provides a facility for interactive lexicon updating. Also of interest is a procedure for automatically constructing word discriminator lists for use in the SMART system (Salton, 254); it provides an automatic way for constructing a term dictionary.

Automatic and Machine-Aided Translation of Language

There is a certain arbitrariness in grouping work on mechanical translation with text processing rather than computational linguistics. Certainly the results of the Feasibility Study on Fully Automatic High Quality Translation conducted by Lehmann & Stachowitz (158) at the University of Texas testify to the importance of computational linguistic techniques for successful attainment of that goal. Moreover, many, if not all, of the works cited here do make use of such techniques. Nevertheless, those techniques are the less successful parts of existing translation systems, and to the extent that one is concerned with practical throughput, the text processing components are more effective. In any case, all of the developments in research on computational linguistics can be expected to have consequences for automating translation.

The Texas Feasibility Study involved 20 consultants who were brought together for a number of conferences or met individually with the principal investigators. Papers presented and discussed covered individual assessments of machine translation, linguistic and computational linguistic support, philosophical considerations, and computer hardware and software. Many of these documents are included as an appendix to the report. Lehmann & Stachowitz conclude from the study that linguistic analysis constitutes the major problem area for the future, that more restricted grammatical models may be desirable, that discourse analysis is critical as is more

effective semantics, and that a more careful evaluation of the ways in which translation are actually used will provide perspective on what the phrase "high quality" really means. The authors recommend support for research on machine translation, on linguistics--descriptive, theoretical, comparative, on stylistics, and on clarification of the knowledge base required for translation. These conclusions and recommendations are consistent with the perspective on question-answering, semantics, and related areas provided in previous sections of this review. It is likely to be the case that machine translation will be successful to the degree that "understanding systems" come to understand. It is puzzling that the term "computational linguistics" does not appear in either the conclusions or the recommendations of the Texas study.

Josselson (128) concludes from his thorough survey of "automatic translation of languages since 1960" that further research and development should be supported. It is justified, even if fully automatic high quality translation could not be realized, by the practical value of machine-aided and intermediate level results and by the contribution to our understanding of language. He recommends that studies should concentrate on small subfields of science, building microgrammars and microglossaries; that guides should be created for reading computer output, thus limiting the need for post-editing; and, especially, that a more appropriate division of labor between man and machine should be established, with human resolution of subtle

contextual ambiguities. Garvin (99), looking forward to the 1970s and still highly optimistic, reviews what he considers to be the major controversial issues in machine translation. In contrast to the findings of the Texas Feasibility Study, he argues that inadequacies in linguistic theory are not a problem; rather, research should be influenced by weak models that will not prejudge the direction of research. He discusses operational problems having to do with linguistics, system design, and the "bread-and-butter problems" of speed/accuracy tradeoffs, input preparation, and staffing. A collection of Garvin's papers (100) has just been published.

Reports on a number of machine translation systems have been issued. Toma et al. (295) describe recent efforts toward optimization of the SYSTRAN system for translation of Russian to English. Aldridge (3) is modifying SYSTRAN for translating French to English. The English-to-French translation effort at the University of Montreal now uses Colmerauer's Q-system formalism (Colmerauer et al., 60). Wilks' system (315) also translates English to French, but uses a template system for processing phrase by phrase and then establishing semantic connectivities through paragraph analysis. Lehmann & Stachowitz (159) are continuing their work on German-to-English translation and report progress in theoretical and descriptive linguistics, lexicography, and system design. Research directed toward a prototype system for Chinese-English translation is documented by

Wang et al. (308); apart from expanding the dictionary, the main tasks have been extending the grammar and improving programming routines. A system for translating from Japanese into English was reported by Sakai et al. (252); current work on syntax and semantics of Japanese and English (Sakai & Nagao, 250) can be expected to result in augmentation of that system. Bisbey & Kay (22) describe the use of the MIND system for "human-aided translation" from English to Korean or Spanish; a monolingual consultant, rather than a bilingual editor, is used to resolve ambiguities in the translation process. Chauché et al. (46) report on a new parsing system being developed at Grenoble for use in automatic translation; it uses a finite-state model similar to that of Kay's MIND system and Colmerauer's Q-system.

Evaluating translation efforts continues to be a problem. Sinaiko and his colleagues have developed readability tests and conducted a number of studies (Sinaiko & Klare, 280, 281; Klare et al., 140), concluding that human translation is consistently better than computer-produced translation, even when the latter is edited. Leavitt et al. (157) describe a study of the SYSTRAN effort being conducted to evaluate both translation quality and the process of producing translations; no substantive results are available yet, and it is not clear that an adequate methodology for evaluation has yet been developed.

The last item in this section does not involve machine translation directly, but it may be expected to at some point in the future. In the meantime it is relevant to documentalists for identifying the language a particular text is written in. Nakamura (198) has developed a procedure for identifying languages on the basis of small samples of text. It is based on a statistical treatment of language elements and has been applied to 25 languages from a variety of language families with reasonable good success.

CONCLUSIONS

The conclusions can be brief because they have been anticipated in the introduction and reinforced throughout this review. Kay and Sparck Jones (136) ended their Annual Review chapter on automated language processing with some uncertainty about the future of computational linguistics. On the basis both of quality and quantity, the literature in the current chapter testifies to the viability of the field, regardless of whether it can yet be considered an academic discipline. Many threads are being spun; whether they can be woven together to form effective systems remains to be seen. However, it was reasonable for the Conference on Research Trends in Computational Linguistics to include a session on the social implications of automatic language processing (Walker, 303), in which serious attention was paid to the possible consequences, both positive and negative, of the products of research in this area.

It seems appropriate to conclude, on the basis of the evidence presented, that effective systems for automated language processing can be developed and that they will have significant consequences for the information sciences. The systems will be much more complex than most people had anticipated, and probably narrower in the task or problem domains in which they can be applied. Possibly more important, though, than the resulting technology will be the models of language and people and situations that will have been produced in the process.

REFERENCES

1. ABELSON, ROBERT P. "THE STRUCTURE OF BELIEF SYSTEMS." IN: COLBY AND SCHANK, 1973.
2. AIR FORCE CAMBRIDGE RESEARCH LABORATORIES, 1972 CONFERENCE ON SPEECH COMMUNICATION AND PROCESSING, NEWTON, MASSACHUSETTS, APRIL 24-26, 1972, AIR FORCE CAMBRIDGE RESEARCH LABORATORIES, BEDFORD, MASSACHUSETTS, 22 FEBRUARY 1972, 457 PP. (AFCRL-72-0120, SPECIAL REPORTS NO. 131)
3. ALDRIDGE, LEE F. FRENCH-ENGLISH MACHINE TRANSLATION--GENERAL PRELIMINARIES AND LEXICAL ROUTINE DEVELOPMENT, WRIGHT-PATTERSON AIR FORCE BASE, OHIO. SCHOOL OF ENGINEERING, AIR FORCE INSTITUTE OF TECHNOLOGY, DECEMBER 1971, 129 PP. (REPORT NO. GE/EE/72-1)
4. ALEXANDER, BILL. A QUESTIONING-ANSWERING PROGRAM FOR SIMPLE KERNEL SENTENCES (QUE2). DEPARTMENT OF COMPUTER SCIENCES, UNIVERSITY OF TEXAS, AUSTIN, TEXAS, MARCH 1971, 30 PP. (TECHNICAL REPORT NO. NL-5)
5. ASSOCIATION FOR COMPUTING MACHINERY. SYMPOSIUM ON INFORMATION STORAGE AND RETRIEVAL, COLLEGE PARK, MARYLAND, 1-2 APRIL 1971. PROCEEDINGS, EDITED BY JACK MINKER AND SAMUEL ROSENFELD. UNIVERSITY OF MARYLAND, CONFERENCE AND INSTITUTE DIVISION, COLLEGE PARK, MARYLAND, 1971, 285 PP.
6. ATAL, B. S.; HANAUER, SUZANNE L. "SPEECH ANALYSIS AND SYNTHESIS BY LINEAR PREDICTION OF THE SPEECH WAVE." JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA, 50:2:2 (AUGUST 1971) 637-655.
7. BADRE, NAGIB A. COMPUTER LEARNING FROM ENGLISH TEXT, ELECTRONICS RESEARCH LABORATORY, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA, DECEMBER 1972, 196 PP. (MEMORANDUM NO. ERL-M372)
8. BARANOFSKY, SHARON. "A SEMANTIC STRUCTURE FOR NOUNS," PRESENTED AT THE ASSOCIATION FOR COMPUTATIONAL LINGUISTICS, CHAPEL HILL, NORTH CAROLINA, 26-27 JULY 1972.
9. BARNES, ROBERT F., JR. "COMPUTATIONAL LINGUISTICS AND LINGUISTICS," IN: CENTER FOR APPLIED LINGUISTICS, 1972, 1-6.
10. BARNETT, JEFFREY. "A VOCAL DATA MANAGEMENT SYSTEM," IN: AIR FORCE CAMBRIDGE RESEARCH LABORATORIES, 1972, 340-343.
11. BARTSCH, RENATE; VENNEMANN, THEO. "RELATIVE ADJECTIVES AND COMPARISON." IN: EXPLORATIONS IN SYNTACTIC THEORY, EDITED BY GEORGE BEDELL. UCLA PAPERS IN SYNTAX, NO. 2. UNIVERSITY OF CALIFORNIA AT LOS ANGELES, LOS ANGELES, CALIFORNIA, JULY 1972, 107-197.
12. BATORI, ISTVAN. "GENERATIVE GRAMMATIK UND MASCHINELLE SPRACHANALYSE." IBM NACHRICHTEN, 208 (OKTOBER 1971) 890-896.
13. BATORI, ISTVAN. "TRANSFORMATIONELLE SPRACHANALYSE." LINGUISTISCHE BERICHTEN, 17 (1972) 31-46.
14. BATTEN, WILLIAM E. "DOCUMENT DESCRIPTION AND REPRESENTATION," IN: ANNUAL REVIEW OF INFORMATION SCIENCE AND TECHNOLOGY, VOLUME 8, EDITED BY CARLOS A. CUADRA. AMERICAN SOCIETY FOR INFORMATION SCIENCE, WASHINGTON, D.C., 1973.

15. BAYARD, HENRY; GLANTZ, RICHARD; GROSS, LOUIS. SHOEBOX USER'S MANUAL. MITRE CORPORATION, BEDFORD, MASSACHUSETTS, JUNE 1973, 177 PP.
16. BECKER, JOSEPH D. "ROBOT" COMPUTER PROBLEM SOLVING SYSTEM. QUARTERLY PROGRESS REPORT NO. 1. BOLT BERANEK & NEWMAN, INC., CAMBRIDGE, MASSACHUSETTS, 15 DECEMBER 1971, 17 PP.
17. BECKER, JOSEPH D. "ROBOT" COMPUTER PROBLEM SOLVING SYSTEM. QUARTERLY PROGRESS REPORT NO. 2. BOLT BERANEK & NEWMAN, CAMBRIDGE, MASSACHUSETTS, 15 MARCH 1972, 25 PP.
18. BECKER, JOSEPH D. "A MODEL FOR THE ENCODING OF EXPONENTIAL INFORMATION." IN: COLBY & SCHANK, 1973.
19. BELY, N.; BORILLO, A.; SIOT-DECAUVILLE, N.; VIRBEL, J. PROCEURES D'ANALYSE SEMANTIQUE APPLIQUES A LA DOCUMENTATION SCIENTIFIQUE, GAUTHIER-VILLARS, PARIS, 1970.
20. BENNETT, JOHN L. "THE USER INTERFACE IN INTERACTIVE SYSTEMS." IN: ANNUAL REVIEW OF INFORMATION SCIENCE AND TECHNOLOGY, VOLUME 7. EDITED BY CARLOS A. CUADRA. AMERICAN SOCIETY FOR INFORMATION SCIENCE, WASHINGTON, D.C., 1972, 159-196.
21. BISBEY, RICHARD L. A TREE GRAPHER FOR THE LINGUIST. RAND CORPORATION, SANTA MONICA, CALIFORNIA, 1971, 20 PP.
22. BISBEY, RICHARD L; KAY, MARTIN. THE MIND TRANSLATION SYSTEM: A STUDY IN MAN-MACHINE COLLABORATION, THE RAND CORPORATION, SANTA MONICA, CALIFORNIA, MARCH 1972, 28 PP. (REPORT P-4786)
23. BISS, K.O.; CHIEN, R.T.; STAHL, F.A. "R2--A NATURAL LANGUAGE QUESTION-ANSWERING SYSTEM." AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES, SPRING JOINT COMPUTER CONFERENCE, ATLANTIC CITY, NEW JERSEY, 1971. PROCEEDINGS, VOLUME 38. AFIPS PRESS, MONTVALE, NEW JERSEY, 1971, 303-308.
24. BISS, K. O.; CHIEN, R. T.; STAHL, F. A. "A DATA STRUCTURE FOR COGNITIVE INFORMATION RETRIEVAL." INTERNATIONAL JOURNAL OF COMPUTER AND INFORMATION SCIENCES 1:1. 1972, 17-27.
25. BORDEN, GEORGE A.; WATTS, JAMES J. "A COMPUTERIZED LANGUAGE ANALYSIS SYSTEM." COMPUTERS AND THE HUMANITIES, 5:3, JANUARY 1971, 129-141.
26. BRAINERD, BARRON. INTRODUCTION TO THE MATHEMATICS OF LANGUAGE STUDY. AMERICAN ELSEVIER, NEW YORK, 1971, 313 PP.
27. BRANDHORST, WESLEY T.; ECKERT, PHILIP F. "DOCUMENT RETRIEVAL AND DISSEMINATION SYSTEMS." IN: ANNUAL REVIEW OF INFORMATION SCIENCE AND TECHNOLOGY, EDITED BY CARLOS A. CUADRA. VOLUME 7. AMERICAN SOCIETY FOR INFORMATION SCIENCE, WASHINGTON, D.C., 1972, 379-437.
28. BROAD, DAVID J. "BASIC DIRECTIONS IN AUTOMATIC SPEECH RECOGNITION." INTERNATIONAL JOURNAL OF MAN-MACHINE STUDIES, 4 (1972) 105-118.
29. BROWN, P. J. "SCAN: A SIMPLE CONVERSATIONAL PROGRAMMING LANGUAGE FOR TEXT ANALYSIS." COMPUTERS AND THE HUMANITIES, 6:4 (1972) 223-227.

30. BRUCE, BERTRAM. "A MODEL FOR TEMPORAL REFERENCES AND ITS APPLICATION IN A QUESTION ANSWERING PROGRAM," ARTIFICIAL INTELLIGENCE, 3 (1972) 1-25.
31. BRUCE, BERTRAM. CASE STRUCTURE SYSTEMS. DEPARTMENT OF COMPUTER SCIENCE, RUTGERS UNIVERSITY, NEW BRUNSWICK, NEW JERSEY, 10 JANUARY 1973, 21 PP.
32. CARBONELL, JAIME R. "ARTIFICIAL INTELLIGENCE AND LARGE INTERACTIVE MAN COMPUTER SYSTEMS." IN: ANNUAL SYMPOSIUM IEEE SYSTEMS, MAN AND CYBERNETICS GROUP, PROCEEDINGS, 1971, 167-173.
33. CARBONELL, JAIME R.; COLLINS, ALLAN M. NATURAL SEMANTICS IN ARTIFICIAL INTELLIGENCE. BOLT BERANEK AND NEWMAN, INC. CAMBRIDGE, MASSACHUSETTS, FEBRUARY 1973, 25 PP.
34. CARLISLE, JAMES. THESIS PROPOSAL. YALE UNIVERSITY, NEW HAVEN, CONNECTICUT, SEPTEMBER 28, 1972.
35. CARROLL, JOHN B. "LANGUAGE PERFORMANCE (PSYCHOLINGUISTICS AND DIALECTOLOGY)." IN: CENTER FOR APPLIED LINGUISTICS, 1972, 67-78.
36. CARROLL, JOHN B.; DAVIES, PETER; RICHMAN, BARRY. THE AMERICAN HERITAGE WORD FREQUENCY BOOK. HOUGHTON MIFFLIN, AMERICAN HERITAGE PUBLISHING COMPANY, BOSTON, NEW YORK, 1971, 856 PP.
37. CARROLL, JOHN M.; FRASER, WILLIAM; GILL, GREGORY. "AUTOMATIC CONTENT ANALYSIS IN AN ON-LINE ENVIRONMENT," INFORMATION PROCESSING LETTERS 1 (1972) 134-140.
38. CELCE-MURCIA, MARIANNE. PARADIGMS FOR SENTENCE RECOGNITION. SYSTEM DEVELOPMENT CORPORATION, SANTA MONICA, CALIFORNIA, 1972, 46 PP. (AFHRL-TR-30)
39. CENTER FOR APPLIED LINGUISTICS. RESEARCH TRENDS IN COMPUTATIONAL LINGUISTICS. REPORT OF A CONFERENCE, WASHINGTON, D.C., MARCH 14-16, 1972, CENTER FOR APPLIED LINGUISTICS, ARLINGTON, VIRGINIA, 1972, 91 PP.
40. CHAFE, WALLACE L. MEANING AND THE STRUCTURE OF LANGUAGE. THE UNIVERSITY OF CHICAGO PRESS, CHICAGO, 1970, 360 PP.
41. CHAFE, WALLACE L. "DIRECTIONALITY AND PARAPHRASE." LANGUAGE, 47:1 (MARCH 1971) 1-26.
42. CHAFE, WALLACE L. "LINGUISTICS AND HUMAN KNOWLEDGE." IN: O'BRIEN, 1971, 57-69.
43. CHAFE, WALLACE L. CONTRASTIVE SEMANTICS PROJECT. FIRST TECHNICAL REPORT. DEPARTMENT OF LINGUISTICS, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA, OCTOBER 1972, 37 PP.
44. CHARNIAK, EUGENE. TOWARD A MODEL OF CHILDREN'S STORY COMPREHENSION. ARTIFICIAL INTELLIGENCE LABORATORY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS, 02139, DECEMBER 1972, 302 PP. (AI TR-266)
45. CHARNIAK, EUGENE. "CONTEXT AND THE REFERENCE PROBLEM." IN: RUSTIN, 1973, 311-329.
46. CHAUCHE, J.; GUILLAUME, P.; QUEZEL-AMBRUNAZ, M. LE SYSTEME A.T.E.F. (ANALYSE DE TEXTES EN ETATS FINIS). GROUP D'ETUDES POUR LA TRADUCTION AUTOMATIQUE, OCTOBER 1972, 85 PP. (G-2600-A)

47. CHOMSKY, NOAM. SYNTACTIC STRUCTURES. MOUTON & CO., THE HAGUE THE NETHERLANDS, 1957. 118 PP.
48. CHOMSKY, NOAM. ASPECTS OF THE THEORY OF SYNTAX. MIT PRESS, CAMBRIDGE, MASSACHUSETTS, 1965, 251 PP.
49. CHOMSKY, NOAM. CARTESIAN LINGUISTICS. HARPER & ROW, NEW YORK, 1966, 119 PP.
50. CHOMSKY, NOAM. LANGUAGE AND MIND. HARCOURT, BRACE & WORLD, NEW YORK, 1968, 88 PP.
51. CHOMSKY, NOAM; HALLE, MORRIS. THE SOUND PATTERN OF ENGLISH. HARPER & ROW, NEW YORK, EVANSTON, AND LONDON, 1968, 470 PP.
52. CHOUKEA, Y.; COHEN, M.; DUECK, J.; FRAENKEL, A. S.; SLAE, M. "FULL TEXT DOCUMENT RETRIEVAL: HEBREW LEGAL TEXTS." IN: ASSOCIATION FOR COMPUTING MACHINERY, 1971, 61-79.
53. COLBY, KENNETH M. "SIMULATIONS OF BELIEF SYSTEMS." IN: COLBY AND SCHANK, 1973.
54. COLBY, KENNETH M.; SCHANK, ROGER. EDS. COMPUTER MODELS OF THOUGHT AND LANGUAGE. FREEMAN & COMPANY, SAN FRANCISCO, CALIFORNIA, 1973.
55. COLBY, KENNETH MARK; HILF, FRANKLIN DENNIS; WEBER, SYLVIA; KRAEMER, HELENA C. "TURING-LIKE INDISTINGUISHABILITY TESTS FOR THE VALIDATION OF A COMPUTER SIMULATION OF PARANOID PROCESSES." ARTIFICIAL INTELLIGENCE 3 (1972) 199-221.
56. COLBY, KENNETH MARK; WEBER, SYLVIA; HILF, FRANKLIN DENNIS. "ARTIFICIAL PARANOIA." ARTIFICIAL INTELLIGENCE 2 (1971) 1-25.
57. COLES, L. STEPHEN. "THE APPLICATIONS OF THEOREM PROVING TO INFORMATION RETRIEVAL." 5TH HAWAIIAN INTERNATIONAL CONFERENCE ON SYSTEMS SCIENCES. PROCEEDINGS, HONOLULU, HAWAII, 1972, 410-412.
58. COLES, L. STEPHEN. TECHNIQUES FOR INFORMATION RETRIEVAL USING AN INFERENTIAL QUESTION-ANSWERING SYSTEM WITH NATURAL-LANGUAGE INPUT. ARTIFICIAL INTELLIGENCE CENTER, STANFORD RESEARCH INSTITUTE, MENLO PARK, CALIFORNIA, NOVEMBER 1972, 187 PP. (TECHNICAL NOTE 74).
59. COLLINS, ALLAN M.; CARBONELL, JAIME R.; WARNOCK, ELEANOR H. "SEMANTIC INFERENTIAL PROCESSING BY COMPUTER." INTERNATIONAL CONGRESS OF CYBERNETICS AND SYSTEMS, PROCEEDINGS, OXFORD, ENGLAND, AUGUST 1972.
60. COLMERAUER, ALAIN; DANSEREAU, JULES; HARRIS, BRIAN; KITTREDGE, RICHARD; VAN CANEGHEM, MICHEL. AN ENGLISH-FRENCH MT PROTOTYPE. PRESENTED AT THE INTERNATIONAL MEETING ON COMPUTATIONAL LINGUISTICS, DEBRECEN, HUNGARY, 4-7 SEPTEMBER 1971.
61. COLMERAUER, ALAIN; KANOU, HENRI; PASERO, ROBERT; ROUSSEL, PHIL. UN SYSTEME DE COMMUNICATION HOMME-MACHINE EN FRANCAIS. GROUPE DE RECHERCHE EN INTELLIGENCE ARTIFICIELLE, UNIVERSITE D'AIX-MARSEILLE, OCTOBER 1972, 85 PP.
62. COMPUTER CORPORATION OF AMERICA. DEMONSTRATION OF DATACOMPUTER WITH NATURAL-LANGUAGE FRONT-END. COMPUTER CORPORATION OF AMERICA, CAMBRIDGE, MASSACHUSETTS (1972), 1 P.

63. COMPUTERS AND THE HUMANITIES. "VERBAL MATERIALS IN MACHINE-READABLE FORM." 5:3 (JANUARY 1971) 170-173.
64. COMPUTERS AND THE HUMANITIES. "VERBAL MATERIALS IN MACHINE-READABLE FORM." 6:3 (JANUARY 1972) 166-175.
65. COOPER, FRANKLIN S. "MACHINES AND SPEECH." IN: CENTER FOR APPLIED LINGUISTICS, 1972, 38-66.
66. CROCKER, STEPHEN D.; HEAFNER, JOHN F.; METCALFE, ROBERT M.; POSTEL, JONATHAN B. "FUNCTION-ORIENTED PROTOCOLS FOR THE ARPA COMPUTER NETWORK." AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES, SPRING JOINT COMPUTER CONFERENCE. ATLANTIC CITY, NEW JERSEY. PROCEEDINGS, VOLUME 40, AFIPS PRESS, MONTVALE, NEW JERSEY (1972) 271-279.
67. DAVIDSON, DONALD; HARMAN, GILBERT, EDS. SEMANTICS OF NATURAL LANGUAGE, REIDEL PUBLISHING COMPANY, DORDRECHT, HOLLAND, 1972, 769 PP.
68. DAVIES, D. JULIAN M.; ISARD, STEPHEN D. "UTTERANCES AS PROGRAMS," IN: MELTZER AND MICHIE, 1972, 325-339
69. DINGWALL, WILLIAM ORR, ED. A SURVEY OF LINGUISTIC SCIENCE. LINGUISTICS PROGRAM, UNIVERSITY OF MARYLAND, COLLEGE PARK, MARYLAND, 1971, 810 PP.
70. DINGWALL, WILLIAM ORR. "LINGUISTICS AS PSYCHOLOGY: A DEFINITION AND SOME INITIAL TASKS." IN: DINGWALL, 1971, 758-802.
71. DIPAOLO, ROBERT A. "THE RELATIONAL DATA FILE AND THE DECISION PROBLEM FOR CLASSES OF PROPER FORMULAS." IN: ASSOCIATION FOR COMPUTING MACHINERY, 1971, 95-104.
72. DOSTERT, BOZENA HENISZ. REL--AN INFORMATION SYSTEM FOR A DYNAMIC ENVIRONMENT. CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIFORNIA, DECEMBER 1971, 50 PP. (REL REPORT NO. 3).
73. DOSTERT, BOZENA HENISZ; THOMPSON, FREDERICK B. "SYNTACTIC ANALYSIS IN REL ENGLISH." SMIL8. STATISTICAL METHODS IN LINGUISTICS, 8 (1972) 5-38.
74. DOSTERT, BOZENA HENISZ; THOMPSON, FREDERICK B. THE SYNTAX OF REL ENGLISH. CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIFORNIA, SEPTEMBER, 1971, 128 PP. (REL REPORT NO. 1).
75. DOSTERT, BOZENA, HENISZ; THOMPSON, FREDERICK B. "HOW FEATURES RESOLVE SYNTACTIC AMBIGUITY." IN: ASSOCIATION FOR COMPUTING MACHINERY, 1971, 19-32.
76. EDMUNDSON, HAROLD P.; CROOK, D.; TUNG, I. BIBLIOGRAPHY OF MATHEMATICAL AND COMPUTATIONAL LINGUISTICS. UNIVERSITY OF MARYLAND, COMPUTER SCIENCE CENTER, COLLEGE PARK, MARYLAND, MARCH 1972, 39 PP. (TECHNICAL REPORT TR-189)
77. EDMUNDSON, HAROLD P.; EPSTEIN, MARTIN N. RESEARCH ON SYNONYMY AND ANTONYMY: A MODEL AND ITS REPRESENTATION. COMPUTER SCIENCE CENTER, UNIVERSITY OF MARYLAND, COLLEGE PARK, MARYLAND, MARCH 1972, 18 PP. (TECHNICAL REPORT TR-285)
78. ELLIOTT, WILLIAM D.; POTAS, WARREN A.; VAN DAM, ANDRIES. "COMPUTER ASSISTED TRACING OF TEXT EVOLUTION." AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES. FALL JOINT COMPUTER CONFERENCE, LAS VEGAS, NEVADA, 1971. CONFERENCE PROCEEDINGS, VOLUME 39. AFIPS PRESS, MONTVALE, NEW JERSEY, 1971, 533-540.

79. ENGELBART, DOUGLAS C. EXPERIMENTAL DEVELOPMENT OF A SMALL COMPUTER-AUGMENTED INFORMATION SYSTEM. ANNUAL REPORT, STANFORD RESEARCH INSTITUTE, MENLO PARK, CALIFORNIA, 1972, 20 PP. (SRI-ARC 10045)
80. ENGELBART, DOUGLAS C. COORDINATED INFORMATION SERVICES FOR A DISCIPLINE- OR MISSION-ORIENTED COMMUNITY. PAPER PRESENTED AT THE SECOND ANNUAL COMPUTER COMMUNICATIONS CONFERENCE, SAN JOSE, CALIFORNIA, 24 JANUARY 1973, 11 PP.
81. ERMAN, LEE D.; FENNEL, RICK D.; LESSER, VICTOR R.; REDDY, D. RAJ. SYSTEM ORGANIZATIONS FOR SPEECH UNDERSTANDING. COMPUTER SCIENCE DEPARTMENT, CARNEGIE-MELLON UNIVERSITY, PITTSBURGH, PENNSYLVANIA, FEBRUARY 1973, 13 PP.
82. FILLENBAUM, SAMUEL. "PSYCHOLINGUISTICS." ANNUAL REVIEW OF PSYCHOLOGY, 1971, 22, 251-308.
83. FILLMORE, CHARLES J. "ON A FULLY DEVELOPED SYSTEM OF LINGUISTIC DESCRIPTION." IN: LEHMANN AND STACHOWITZ, 1971, 77-94.
84. FILLMORE, CHARLES J. "SOME PROBLEMS FOR CASE GRAMMAR." IN: O'BRIEN, 1971, 35-56.
85. FILLMORE, CHARLES J. "A GRAMMARIAN LOOKS TO SOCIOLINGUISTICS." IN: SHUY, 1972, 273-287.
86. FILLMORE, CHARLES J. ED. WORKING PAPERS IN LINGUISTICS NO. 10. DEPARTMENT OF LINGUISTICS, THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO, AUGUST 1971, 265 PP.
87. FILLMORE, CHARLES J; LANGENDOEN, D. TERENCE, EDS. STUDIES IN LINGUISTIC SEMANTICS. HOLT, RINEHART AND WINSTON, NEW YORK, 1971, 296 PP.
88. FINDLER, NICHOLAS V.; CHEN, DAVID. "ON THE PROBLEMS OF TIME, RETRIEVAL OF TEMPORAL RELATIONS, CAUSALITY, AND CO-EXISTENCE." IN: SECOND INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE 1971. PROCEEDINGS. 531-545.
89. FINDLER, NICHOLAS; MELTZER, BERNARD. EDS. ARTIFICIAL INTELLIGENCE AND HEURISTIC PROGRAMMING. EDINBURGH UNIVERSITY PRESS, EDINBURGH, SCOTLAND, 1971, 327 PP.
90. FLANAGAN, JAMES L. SPEECH ANALYSIS, SYNTHESIS AND PERCEPTION. SPRINGER-VERLAG, NEW YORK, HEIDELBERG, BERLIN, 1972, 444 PP.
91. FODOR, JERRY; GARRETT, MERRILL; BEVER, THOMAS. PSYCHOLOGY AND GENERATIVE GRAMMAR. MCGRAW-HILL, NEW YORK, 1972.
92. FORGIE, JAMES W. SPEECH, SEMI-ANNUAL TECHNICAL SUMMARY. LINCOLN LABORATORY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LEXINGTON, MASSACHUSETTS, 31 MAY 1972, 15 PP. (ESD-TR-72-165)
93. FORGIE, JAMES W. SPEECH, SEMI-ANNUAL TECHNICAL SUMMARY, LINCOLN LABORATORY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, LEXINGTON, MASSACHUSETTS, 30 NOVEMBER 1972, 17 PP. (ESD-TR-72-263)
94. FRIEDMAN, JOYCE. "COMPUTATIONAL LINGUISTICS." IN: DINGWALL, 1971, 718-753.
95. FRIEDMAN, JOYCE. A COMPUTER MODEL OF TRANSFORMATIONAL GRAMMAR. AMERICAN ELSEVIER PUBLISHING COMPANY, INC., NEW YORK, 1971, 166 PP.

96. FRIEDMAN, JOYCE, "MATHEMATICAL AND COMPUTATIONAL MODELS OF TRANSFORMATIONAL GRAMMAR," IN: MELTZER & MICHIE, 1972, 293-306.
97. FRIEDMAN, JOYCE; MORIN, YVES CH. PHONOLOGICAL GRAMMAR TESTER DESCRIPTION, NATURAL LANGUAGE STUDIES NO. 9 THE UNIVERSITY OF MICHIGAN, PHONETICS LABORATORY, ANN ARBOR, MICHIGAN, SEPTEMBER 1971, 152 PP.
98. GARDIN, J. C. "SEMANTIC ANALYSIS PROCEDURES IN THE SCIENCE OF MAN," SOCIAL SCIENCE INFORMATION, VIII:1, 1969.
99. GARVIN, PAUL L. MACHINE TRANSLATION IN THE SEVENTIES: A SURVEY OF THE FUNDAMENTAL ISSUES IN MACHINE TRANSLATION RESEARCH AND PRACTICE. PRESENTED AT THE INTERNATIONAL MEETING ON COMPUTATIONAL LINGUISTICS, DEBRECEN, HUNGARY, 4-7 SEPTEMBER 1971.
100. GARVIN, PAUL L. ON MACHINE TRANSLATION. MOUTON AND COMPANY, THE HAGUE, THE NETHERLANDS, 1972.
101. GELB, JACK P. "EXPERIMENTS WITH A NATURAL LANGUAGE PROBLEM-SOLVING SYSTEM." IN: SECOND INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE. PROCEEDINGS. 1971, 455-462.
102. GIULIANO, VINCENT E. "IN DEFENSE OF NATURAL LANGUAGE." ASSOCIATION FOR COMPUTING MACHINERY, ANNUAL CONFERENCE, BOSTON, MASSACHUSETTS, AUGUST 14-16, 1972, ACM, NEW YORK, 1972, 1074.
103. GLANTZ, RICHARD S. DESIGN OF AN ON-LINE QUERY LANGUAGE FOR FULL TEXT PATENT SEARCH. THE MITRE CORPORATION, BEDFORD, MASSACHUSETTS, 28 SEPTEMBER 1972, 73 PP. (M72-97)
104. GOUGH, PHILIP B. "EXPERIMENTAL PSYCHOLINGUISTICS." IN: DINGWALL, 1971, 252-292.
105. GRIMES, JOSEPH E. THE COMPARATIVE WORD LIST DATA BASE MANUAL OF PROCEDURES. INFORMATION SCIENCE SERIES, MONOGRAPH NUMBER VII, UNIVERSITY OF OKLAHOMA, NORMAN, OKLAHOMA, 1972, 153 PP.
106. GRIMES, JOSEPH E. "OUTLINES AND OVERLAYS." LANGUAGE, 48:3 (SEPTEMBER 1972) 513-524.
107. GRIMES, JOSEPH E. THE THREAD OF DISCOURSE, TECHNICAL REPORT NO. 1. DEPARTMENT OF MODERN LANGUAGES AND LINGUISTICS, CORNELL UNIVERSITY, ITHACA, NEW YORK, 1972, 374 PP.
108. GRIMES, JOSEPH E.; CRANMER, DAVID J. BIBLIOGRAPHY ON DISCOURSE AND RELATED TOPICS. CORNELL UNIVERSITY, ITHACA, NEW YORK, SPRING 1972, 23 PP.
109. GRISHMAN, RALPH. "IMPLEMENTATION OF THE STRING PARSER OF ENGLISH." IN: RUSTIN, 1973, 89-109.
110. GROSS, MAURICE. MATHEMATICAL MODELS IN LINGUISTICS. PRENTICE-HALL, ENGLEWOOD CLIFFS, NEW JERSEY, 1972, 159 PP.
111. GRUBER, JEFFREY. FUNCTIONS OF THE LEXICON IN FORMAL DESCRIPTIVE GRAMMARS. SYSTEM DEVELOPMENT CORPORATION, SANTA MONICA, CALIFORNIA, DECEMBER 1967, 172 PP. (TM-3770)
112. GRUBER, JEFFREY. STUDIES IN LEXICAL RELATIONS. MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS, SEPTEMBER 1965. (THESIS)

113. HANSEN, WILFRED J. USER ENGINEERING PRINCIPLES FOR INTERACTIVE SYSTEMS. AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES, FALL JOINT COMPUTER CONFERENCE, LAS VEGAS, NEVADA, 1971. CONFERENCE PROCEEDINGS, VOLUME 39. AFIPS PRESS, MONTVALE, NEW JERSEY, 1971, 523-532.
114. HAYS, DAVID, G. "THE FIELD AND SCOPE OF COMPUTATIONAL LINGUISTICS." THE FINITE STRING, 9:9-10 (NOVEMBER-DECEMBER 1972) 1-6.
115. HEIDORN, GEORGE E. NATURAL LANGUAGE INPUTS TO A SIMULATION PROGRAMMING SYSTEM. NAVAL POSTGRADUATE SCHOOL, MONTEREY, CALIFORNIA, OCTOBER 1972, 366 PP. (NPS-55HD72101A)
116. HENDRIX, G. G., QUESTION-ANSWERING VIA CANONICAL VERBS AND SEMANTIC MODELS: A MODEL OF TEXTUAL MEANING, DEPARTMENT OF COMPUTER SCIENCE, UNIVERSITY OF TEXAS, AUSTIN, TEXAS, JANUARY 1973, 23 PP. (TECHNICAL REPORT NL 12)
117. HEWITT, CARL. DESCRIPTION AND THEORETICAL ANALYSIS (USING SCHEMATA) OF PLANNER: A LANGUAGE FOR PROVING THEOREMS AND MANIPULATING MODELS IN A ROBOT. ARTIFICIAL INTELLIGENCE LABORATORY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS, APRIL 1972, 408 PP. (AI TR-258)
118. HILF, FRANKLIN DENNIS. "PARTIALLY AUTOMATED PSYCHIATRIC INTERVIEWING--A RESEARCH TOOL." JOURNAL OF NERVOUS AND MENTAL DISEASE, 155:6 (1972) 410-418.
119. HILF, FRANKLIN DENNIS; COLBY, KENNETH MARK; SMITH, DAVID CANFIELD; WITTNER, WILLIAM K. "MACHINE-MEDIATED INTERVIEWING." JOURNAL OF NERVOUS AND MENTAL DISEASE, 152 (1971) 278-288.
120. HILL, DAVID R. "MAN-MACHINE INTERACTION USING SPEECH." IN: YOVITS, 1971, 165-230.
121. HILL, DAVID R. "AN ABBREVIATED GUIDE TO PLANNING FOR SPEECH INTERACTION WITH MACHINES: THE STATE OF THE ART." INTERNATIONAL JOURNAL OF MAN-MACHINE STUDIES, 4:4 (OCTOBER 1972) 383-410.
122. HINTIKKA, JAAKO; MORAVCSIK, JULIUS; SUPPES, PATRICK, EDS. APPROACHES TO NATURAL LANGUAGE. REIDEL PUBLISHING COMPANY, DORDRECHT, THE NETHERLANDS, 1972.
123. HUDSON, R. A. ENGLISH COMPLEX SENTENCES. NORTH-HOLLAND PUBLISHING COMPANY, AMSTERDAM, THE NETHERLANDS, 1971, 387 PP.
124. HUNTER, LAWRENCE W. "A DATA REPRESENTATION CODE FOR TEXT PROCESSING SYSTEMS." INTERNATIONAL JOURNAL OF COMPUTER AND INFORMATION SCIENCES, 1:1 (1972) 29-42.
125. ISARD, STEPHEN; LONGUET-HIGGINS, H. CHRISTOPHER. "QUESTION-ANSWERING IN ENGLISH." IN: MELTZER AND MICHIE, 1971, 243-254.
126. ISNER, DALE W. "AN INFERENTIAL PROCESSOR FOR INTERACTING WITH BIOMEDICAL DATA USING RESTRICTED NATURAL LANGUAGE." AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES, SPRING JOINT COMPUTER CONFERENCE, ATLANTIC CITY, NEW JERSEY, 1972. PROCEEDINGS, VOLUME 40. AFIPS PRESS, MONTVALE, NEW JERSEY, 1972, 1107-1124.
127. JOSHI, ARAVIND K. "A BRIEF SURVEY OF SOME MATHEMATICAL RESULTS RELEVANT TO NATURAL LANGUAGE PROCESSING." IN: RUSTIN, 1973, 1-24.

128. JOSSELSO, HARRY H. "AUTOMATIC TRANSLATION OF LANGUAGES SINCE 1960: A LINGUIST'S VIEW," IN: YOVITS, 1971, 1-58.
129. JOYCE, JAMES. "EXTENSIONS TO PL/1 FOR NATURAL-LANGUAGE PROCESSING," COMPUTERS AND THE HUMANITIES, 6:5 (MAY 1972) 271-275
130. KAPLAN, RONALD M. THE MIND-SYSTEM: A GRAMMAR-RULE LANGUAGE. THE RAND CORPORATION, SANTA MONICA, CALIFORNIA, 1970,, 73 PP. (RM-6265/1-PR)
131. KAPLAN, RONALD M. "AUGMENTED TRANSITION NETWORKS AS PSYCHOLOGICAL MODELS OF SENTENCE COMPREHENSION," IN: SECOND INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE, 1971, 429-443.
132. KAPLAN, RONALD M. "AUGMENTED TRANSITION NETWORKS AS PSYCHOLOGICAL MODELS OF SENTENCE COMPREHENSION," ARTIFICIAL INTELLIGENCE, 3 (1972) 77-100.
133. KAPLAN, RONALD M. "A GENERAL SYNTACTIC PROCESSOR," IN: RUSTIN, 1973, 193-241.
134. KAY, MARTIN. EXPERIMENTS WITH A POWERFUL PARSER, THE RAND CORPORATION, SANTA MONICA, CALIFORNIA, 1967, 28 PP. (RM-5452-PR)
135. KAY, MARTIN. "THE MIND SYSTEM," IN: RUSTIN, 1973, 155-187.
136. KAY, MARTIN; SPARCK JONES, KAREN. "AUTDMATED LANGUAGE PROCESSING," IN: ANNUAL REVIEW OF INFORMATION SCIENCE AND TECHNOLOGY, VOLUME 6, EDITED BY CARLOS A. CUADRA, ENCYCLOPEDIA BRITANNICA, CHICAGO; 1971, 141-166.
137. KEENAN, EDWARD L. "ON SEMANTICALLY BASED GRAMMAR." LINGUISTIC INQUIRY, III:4 (FALL 1972) 413-461.
138. KELLOGG, CHARLES. QUESTION ANSWERING IN THE CONVERSE SYSTEM. SYSTEM DEVELOPMENT CORPORATION, SANTA MONICA, CALIFORNIA, 17 OCTOBER 1972, 33 PP. (TECH MEMO 5015).
139. KELLOGG, CHARLES; BURGER, JOHN; DILLER, TIMOTHY; FOGT, KENNETH. "THE CONVERSE NATURAL LANGUAGE DATA MANAGEMENT SYSTEM: CURRENT STATUS AND PLANS," IN: ASSOCIATION FOR COMPUTING MACHINERY, 1971, 33-46.
140. KLARE, GEORGE R.; SINAIKO, H. WALLACE; STOLUROW, LAWRENCE M. THE CLOZE PROCEDURE: A CONVENIENT READABILITY TEST FOR TRAINING MATERIALS AND TRANSLATIONS, INSTITUTE FOR DEFENSE ANALYSES, ARLINGTON, VIRGINIA, JANUARY 1971, 53 PP. (PAPER P-660)
141. KLATT, DENNIS H.; STEVENS, KENNETH N. STRATEGIES FOR RECOGNITION OF SPOKEN SENTENCES FROM VISUAL EXAMINATION OF SPECTROGRAMS. BOLT BERANEK AND NEWMAN, INC., CAMBRIDGE, MASSACHUSETTS JUNE 1971, 31 PP. (BBN REPORT NO, 2154)
142. KLATT, DENNIS H.; STEVENS, KENNETH N. SENTENCE RECOGNITION FROM VISUAL EXAMINATION OF SPECTROGRAMS AND MACHINE-AIDED LEXICAL SEARCHING. IN: AIR FORCE CAMBRIDGE RESEARCH LABORATORIES, 1972, 315-318.
143. KLEIN, SHELDON. COMPUTER SIMULATION OF LANGUAGE CONTACT MODELS, COMPUTER SCIENCE DEPARTMENT, UNIVERSITY OF WISCONSIN, MADISON, WISCONSIN, OCTOBER 1972, 28 PP. (TECHNICAL REPORT NO, 163)
144. KLEIN, SHELDON; DENNISON, TERRY A. AN INTERACTIVE PROGRAM FOR LEARNING THE MORPHOLOGY OF NATURAL LANGUAGES, PRESENTED AT THE INTERNATIONAL MEETING ON COMPUTATIONAL LINGUISTICS, DEBRECEN, HUNGARY, 4-7 SEPTEMBER 1971.

145. KLEIN, SHELDON; OAKLEY, JOHN D.; SUURBALLE, DAVID J.; ZEISEMER, ROBERT A. "A PROGRAM FOR GENERATING REPORTS ON THE STATUS AND HISTORY OF STOCHASTICALLY MODIFIABLE SEMANTIC MODELS OF ARBITRARY UNIVERSES." SMILB, STATISTICAL METHODS IN LINGUISTICS, 8 (1972) 64-93.
146. KUHNS, J. L. "LOGICAL ASPECTS OF QUESTION-ANSWERING BY COMPUTER." IN: SOFTWARE ENGINEERING, VOLUME 2, EDITED BY JULIUS T. TOU, ACADEMIC PRESS, NEW YORK, 1971, 89-104.
147. KUHNS, J. L. "QUANTIFICATION IN QUERY SYSTEMS." IN: ASSOCIATION FOR COMPUTING MACHINERY, 1971, 81-93.
148. KUHNS, J. L. "SAPIENS - A TECHNIQUE FOR THE ANALYSIS OF TENSE AND TIME IN RELATIONAL DATA SYSTEMS." IN: PROCEEDINGS OF THE SIXTH ANNUAL PRINCETON CONFERENCE ON INFORMATION SCIENCES AND SYSTEMS, PRINCETON UNIVERSITY, MARCH 23-24, 1972, 93-97.
149. KULAGINA, O. S.; MELCUK, I. A.; & ERASTOV, K. O. ONE POSSIBLE SYSTEM OF MACHINE TRANSLATION, (IN RUSSIAN) PRELIMINARY PUBLICATIONS, PROBLEM GROUP ON EXPERIMENTAL & APPLIED LINGUISTICS, RUSSIAN LANGUAGE INSTITUTE OF THE SOVIET ACADEMY OF SCIENCES, 1971, 72 PP. (ISSUE NO. 21)
150. LABOV, WILLIAM, "METHODOLOGY." IN: DINGWALL, 1971, 412-491.
151. LAKOFF, GEORGE, "HEDGES: A STUDY IN MEANING CRITERIA AND THE LOGIC OF FUZZY CONCEPTS." IN: STUDIES IN GENERATIVE SEMANTICS II, LINGUISTICS DEPARTMENT, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN, JUNE 1972.
152. LAMB, SIDNEY M. "THE CROOKED PATH OF PROGRESS IN COGNITIVE LINGUISTICS." IN: O'BRIEN, 1971, 99-123.
153. LEA, WAYNE A. "COMPUTER RECOGNITION OF SPEECH." IN: CURRENT TRENDS IN LINGUISTICS, VOLUME 12, EDITED BY THOMAS A. SEBEOK, MOUTON & CO., THE HAGUE, THE NETHERLANDS, 1972, 1561-1620.
154. LEA, WAYNE A. "AN APPROACH TO SYNTACTIC RECOGNITION WITHOUT PHONEMICS." IEEE TRANSACTIONS ON AUDIO AND ELECTRO-ACOUSTICS (IN PRESS)
155. LEA, WAYNE A.; MEDRESS, MARK F.; SKINNER, TOBY E. PROSODIC AIDS TO SPEECH RECOGNITION. UNIVAC, DEFENSE SYSTEMS DIVISION, ST. PAUL, MINNESOTA, OCTOBER 1972, 68 PP. (REPORT NO. PX 7940)
156. LEA, WAYNE A.; MEDRESS, MARK F.; SKINNER, TOBY E. USE OF SYNTACTIC SEGMENTATION AND STRESSED SYLLABLE LOCATION IN PHONEMIC RECOGNITION. PRESENTED AT THE 84TH MEETING OF THE ACOUSTICAL SOCIETY OF AMERICA, MIAMI, FLORIDA, NOVEMBER 1972.
157. LEAVITT, ALVAN W.; GATES, JESSE L.; SHANNON, SUSAN C. MACHINE TRANSLATION QUALITY AND PRODUCTION PROCESS EVALUATION FINAL TECHNICAL REPORT. SYNECTICS CORPORATION, ALLISON PARK, PENNSYLVANIA, OCTOBER 1971, 161 PP. (REPORT NO. 132-C-1 RADC-TR-206)
158. LEHMANN, WINFRED P.; STACHOWITZ, ROLF A. FEASIBILITY STUDY ON FULLY AUTOMATIC HIGH QUALITY TRANSLATION. FINAL TECHNICAL REPORT, VOLUME I, II. UNIVERSITY OF TEXAS, AUSTIN, TEXAS, DECEMBER 1971, 576 PP. (RADC-TR-71-295)

159. LEHMANN, WINFRED P.; STACHOWITZ, ROLF A. DEVELOPMENT OF GERMAN-ENGLISH MACHINE TRANSLATION SYSTEM. LINGUISTICS RESEARCH CENTER, UNIVERSITY OF TEXAS, AUSTIN, TEXAS, MARCH, 1972, 50 P. (REPORT NO RADC-TR-72-47)
160. LEHMANN, WINFRED P.; STACHOWITZ, ROLF A. NORMALIZATION OF NATURAL LANGUAGE FOR INFORMATION RETRIEVAL. FINAL TECHNICAL REPORT. LINGUISTICS RESEARCH CENTER, UNIVERSITY OF TEXAS, AUSTIN, TEXAS, 1972, 178 PP.
161. LESLIE, ADRIAN ROY. QUEST FOR A COMPUTERIZED SEMANTICS. DEPARTMENT OF LINGUISTICS, UNIVERSITY OF VICTORIA, BRITISH COLUMBIA, CANADA, APRIL 1973, 155 PP. (THESIS)
162. LINDSAY, ROBERT K. "JIGSAW HEURISTICS AND A LANGUAGE LEARNING MODEL." IN: FINDLER AND MELTZER, 1971, 173-189.
163. LINGARD, ROBERT W.; WILCZYNSKI, DAVID. "A SYNTAX DIRECTED APPROACH FOR HANDLING NATURAL LANGUAGE RELATIONS." ASSOCIATION FOR COMPUTING MACHINERY, ANNUAL CONFERENCE, BOSTON, MASS., AUGUST 14-16, 1972. PROCEEDINGS. ASSOCIATION FOR COMPUTING MACHINERY, NEW YORK, 1972, 118-128.
164. LINN, WILLIAM ERWIN, JR. MAN-MACHINE REFERENTIAL COMMUNICATION IN A PERSONAL INFORMATION RETRIEVAL SYSTEM. MENTAL HEALTH RESEARCH INSTITUTE, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN, JULY 1972, 183 PP. (MHRI COMMUNICATION NO. 295 & IP-19)
165. LINN, WILLIAM E., JR.; REITMAN, WALTER. "REFERENTIAL COMMUNICATION IN AUTONOTE, A PERSONAL INFORMATION RETRIEVAL SYSTEM." ASSOCIATION FOR COMPUTING MACHINERY ANNUAL CONFERENCE, CHICAGO, ILLINOIS, AUGUST 3-5, 1971. PROCEEDINGS. ASSOCIATION FOR COMPUTING MACHINERY, NEW YORK, 1971, 67-81.
166. LONGUET-HIGGINS, H. CHRISTOPHER. THE ALGORITHMIC DESCRIPTION OF NATURAL LANGUAGE. THEORETICAL PSYCHOLOGY UNIT, SCHOOL OF ARTIFICIAL INTELLIGENCE, UNIVERSITY OF EDINBURGH, EDINBURGH, SCOTLAND, 1972, 32 PP.
167. LOVEMAN, DAVID B.; MOYNE, JOHN A.; TOBEY, ROBERT G. "CUE: A PREPROCESSOR SYSTEM FOR RESTRICTED, NATURAL ENGLISH." IN: ASSOCIATION FOR COMPUTING MACHINERY, 1971, 47-59.
168. MAKHOUL, JOHN I.; WOLF, JARED J. LINEAR PREDICTION AND THE SPECTRAL ANALYSIS OF SPEECH. BOLT BERANEK AND NEWMAN, INC., CAMBRIDGE, MASSACHUSETTS, 31 AUGUST 1972, 237 PP. (BBN REPORT NO. 2304)
169. MARILL, THOMAS; SEIFERAS, JOEL I.; SHIPMAN, DAVID W.; STERN, DALE H.; TURNER, ELIZABETH N. RELATIONAL STRUCTURES APPLICATIONS RESEARCH. FINAL REPORT. COMPUTER CORPORATION OF AMERICA, CAMBRIDGE, MASSACHUSETTS, 1971, 116 PP.
170. MARKEL, JOHN D. FORMANT TRAJECTORY ESTIMATION FROM A LINEAR LEAST-SQUARES INVERSE FILTER FORMULATION. SCRL MONOGRAPH NO. 7, SPEECH COMMUNICATIONS RESEARCH LABORATORY, SANTA BARBARA, CALIFORNIA, OCTOBER 1971, 180 PP.
171. MARTIN, THOMAS. THE USER INTERFACE IN INTERACTIVE SYSTEMS. IN: ANNUAL REVIEW OF INFORMATION SCIENCE AND TECHNOLOGY, VOLUME 8. EDITED BY CARLOS A. CUADRA. AMERICAN SOCIETY FOR INFORMATION SCIENCE, WASHINGTON, D.C., 1973.

172. MARTINS, GARY R. "DIMENSIONS OF TEXT PROCESSING." AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES, FALL JOINT COMPUTER CONFERENCE, ANAHEIM, CALIFORNIA, DECEMBER 5-7 1972, PROCEEDINGS, VOLUME 41. AFIPS PRESS, MONTVALE, NEW JERSEY, 1972, 801-810.
173. MCCALLA, GORDON I.; SAMPSON, JEFFREY R. "MUSE: A MODEL TO UNDERSTAND SIMPLE ENGLISH." COMMUNICATIONS OF THE ACM, 15:1 (JANUARY 1972) 29-40.
174. MEL'CUK, I.A. "TOWARDS A FUNCTIONING MODEL OF LANGUAGE," IN: PROGRESS IN LINGUISTICS, EDITED BY MANFRED BIERWISCH AND KARL ERICH HEIDOLPH. MOUTON, THE HAGUE, THE NETHERLANDS, 1970, 198-207.
175. MEL'CUK, I. A. 16 DICTIONARY ENTRIES OF AN EXPLANATORY SCHEME DICTIONARY OF THE RUSSIAN LANGUAGE, (IN RUSSIAN) PRELIMINARY PUBLICATIONS, PROBLEM GROUP ON EXPERIMENTAL & APPLIED LINGUISTICS, RUSSIAN LANGUAGE INSTITUTE OF THE SOVIET ACADEMY OF SCIENCES, 1971, 48 PP.
176. MEL'CUK, I. A. I. LEVEL OF REPRESENTATION OF EXPRESSIONS IN THE GENERAL STRUCTURE OF THE MODEL "MEANING-TEXT," II. WORD PATTERN AND CONVERSION. (IN RUSSIAN). PRELIMINARY PUBLICATIONS, PROBLEM GROUP ON EXPERIMENTAL & APPLIED LINGUISTICS, RUSSIAN LANGUAGE INSTITUTE OF THE ACADEMY OF SCIENCES, 1972, 45 PP. (ISSUE NO. 30)
177. MEL'CUK, I. A.; ZOLKOVSKIJ, A. K. "TOWARDS A FUNCTIONING 'MEANING-TEXT' MODEL OF LANGUAGE." LINGUISTICS, 57 (MAY 1970) 10-47.
178. MELTON, T. R. IT1: AN INTERPRETIVE TUTOR, DEPARTMENT OF COMPUTER SCIENCES, UNIVERSITY OF TEXAS, AUSTIN, TEXAS, MAY 1971, 55 PP. (TECHNICAL REPORT NO. NL-4)
179. MELTZER, BERNARD; MICHIE, DONALD. EDS. MACHINE INTELLIGENCE 6. AMERICAN ELSEVIER PUBLISHING COMPANY, INC., NEW YORK, 1971, 525 PP.
180. MELTZER, BERNARD; MICHIE, DONALD; EDS. MACHINE INTELLIGENCE 7. UNIVERSITY PRESS, EDINBURGH, SCOTLAND, 1972, 485 PP.
181. MEY, JACOB. "COMPUTATIONAL LINGUISTICS IN THE SEVENTIES." LINGUISTICS, AN INTERNATIONAL REVIEW. 74 (OCTOBER 1971) 36-61.
182. MEY, JACOB L. "COMPUTATIONAL LINGUISTICS AND THE STUDY OF LINGUISTIC PERFORMANCE." COMPUTERS AND THE HUMANITIES, 6:3 (JANUARY 1972) 131-136.
183. MEYER, GARRY S. INFANTS IN CHILDRENS STORIES - TOWARD A MODEL OF NATURAL LANGUAGE COMPREHENSION. ARTIFICIAL INTELLIGENCE LABORATORY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS, AUGUST 1972, 72 PP. (ARTIFICIAL INTELLIGENCE TECHNICAL MEMO NO. 2 - A.I. MEMO NO. 265)
184. MINKER, JACK; SABLE, JEROME D. RELATIONAL DATA SYSTEM STUDY. FINAL REPORT. AUERBACH CORPORATION, PHILADELPHIA, PENNSYLVANIA, SEPTEMBER 1970, 247 PP. (RADC-TR-70-180)
185. MISHELEVICH, DAVID J. "MEANINGEX--A COMPUTER-BASED SEMANTIC PARSE APPROACH TO THE ANALYSIS OF MEANING." AMERICAN FEDERATION OF INFORMATION PROCESING SOCIETIES, SPRING JOINT COMPUTER CONFERENCE, LAS VEGAS, NEVADA, 1971. PROCEEDINGS. VOLUME 39. AFIPS PRESS, MONTVALE, NEW JERSEY, 1971, 271-280.

186. MISHELEVICH, DAVID J. "COMPUTER-BASED SEMANTIC ANALYZERS." INTERNATIONAL JOURNAL OF COMPUTER AND INFORMATION SCIENCES, 1:3 (1972) 267-286.
187. MONTAGUE, RICHARD. "ENGLISH AS A FORMAL LANGUAGE." IN: LINGUAGGI NELLA SOCIETA E NELLA TECNICA, EDITED BY BRUNO VISENTINI ET AL. EDIGIONI DI COMUNITA, MILAN, ITALY, 1970, 189-223.
188. MONTAGUE, RICHARD. "UNIVERSAL GRAMMAR." THEORIA, 36:3 (1970) 373-398.
189. MONTAGUE, RICHARD. "THE PROPER TREATMENT OF QUANTIFICATION IN ORDINARY ENGLISH." IN: HINTIKKA, MORAVCSIK, & SUPPES, 1972.
190. MONTGOMERY, CHRISTINE A. "IS NATURAL LANGUAGE AN UNNATURAL QUERY LANGUAGE?" ASSOCIATION FOR COMPUTING MACHINERY. ANNUAL CONFERENCE, BOSTON, MASSACHUSETTS, AUGUST 14-16, 1972. ASSOCIATION FOR COMPUTING MACHINERY, NEW YORK, 1972, 1075-1078.
191. MONTGOMERY, CHRISTINE A. "LINGUISTICS AND INFORMATION SCIENCE." JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE 23:3 (MAY-JUNE 1972) 195-219.
192. MORIN, YVES CH. COMPUTER EXPERIMENTS IN GENERATIVE PHONOLOGY LOW-LEVEL FRENCH PHONOLOGY. NATURAL LANGUAGE STUDIES NO. 11. THE UNIVERSITY OF MICHIGAN, PHONETICS LABORATORY, ANN ARBOR, MICHIGAN, SEPTEMBER 1971, 206 PP.
193. MORIN, YVES CH.; FRIEDMAN, JOYCE. PHONOLOGICAL GRAMMAR TESTER UNDERLYING THEORY. NATURAL LANGUAGE STUDIES NO. 10. THE UNIVERSITY OF MICHIGAN, PHONETICS LABORATORY, ANN ARBOR, MICHIGAN, SEPTEMBER 1971, 100 PP.
194. MOYNE, JOHN A. "SOME GRAMMARS AND RECOGNIZERS FOR FORMAL AND NATURAL LANGUAGES." IN: ADVANCES IN INFORMATION SYSTEM SCIENCE, VOLUME 5. EDITED BY JULIUS T. TOU, PLENUM PRESS, NEW YORK, 1972.
195. NAGAO, MAKOTO. THESAURUS AND LANGUAGE PROCESSING. U.S.-JAPAN SEMINAR ON COMPILATION AND DEVELOPMENT OF THESAURUS, HONOLULU, HAWAII, JANUARY 1973.
196. NAGAO, MAKOTO; TSUJII, JUN-ICHI. DEDUCTIVE QUESTION ANSWERING SYSTEM BY NATURAL LANGUAGE. KYOTO UNIVERSITY, DEPARTMENT OF ELECTRICAL ENGINEERING, KYOTO, JAPAN, 1973, 24 PP.
197. NAKAI, HIROSHI. THESAURUS AND COMPUTATIONAL LINGUISTICS: SYNTACTIC STRUCTURE MODEL OF JAPANESE AND PROBLEMS ON SEMANTIC INFORMATION. RESOURCES DIVISION, THE JAPAN INFORMATION CENTER OF SCIENCE AND TECHNOLOGY, TOKYO, JAPAN, 1972, 13 PP.
198. NAKAMURA, YUKIO. IDENTIFICATION OF LANGUAGES WITH SHORT SAMPLE TEXTS, A LINGUOMETRIC STUDY. LIBRARY AND INFORMATION SCIENCE, NO. 9 (1971), 459-481.
199. NEWELL, ALLEN; BARNETT, JEFFREY; FORGIE, JAMES W.; GREEN, CORDELL; KLATT, DENNIS; LICKLIDER, J.C.R.; MUNSON, JOHN; REDDY, D. RAJ; WOODS, WILLIAM A. SPEECH UNDERSTANDING SYSTEMS. NORTH-HOLLAND PUBLISHING COMPANY, AMSTERDAM, THE NETHERLANDS, 1973, 137 PP.
200. NEWELL, ALLEN; SIMON, HERBERT A. HUMAN PROBLEM SOLVING. PRENTICE-HALL, ENGLEWOOD CLIFFS, NEW JERSEY, 1972, 920 PP.

201. NOEL, JACQUES. "LINGUISTICS AND MECHANIZED INDEXING OF LEGAL TEXTS." REVUE, 3 (1971) 219-233.
202. NOEL, JACQUES. A SEMANTIC ANALYSIS OF ABSTRACTS--AROUND AN EXPERIMENT IN MECHANIZED INDEXING. UNIVERSITE DE LIEGE, LIEGE, BELGIUM, 1972, 553 PP. (PH.D. THESIS)
203. NORMAN, DONALD A. MEMORY, KNOWLEDGE, AND THE ANSWERING OF QUESTIONS. CENTER FOR HUMAN INFORMATION PROCESSING, UNIVERSITY OF CALIFORNIA AT SAN DIEGO, LA JOLLA, CALIFORNIA, MAY 1972, 41 PP. (CHIP 25).
204. NUGENT, WILLIAM R. "THE U.S. PATENT OFFICE DATA BASE: A FULL TEXT COMMUNICATIONS FORMAT FOR COMPUTER-AIDED CLASSIFICATION, RETRIEVAL, AND EXAMINATION OF PATENTS." AMERICAN SOCIETY FOR INFORMATION SCIENCE, ANNUAL MEETING, DENVER, COLORADO, NOVEMBER 7-11, 1971. PROCEEDINGS, VOLUME 8. AMERICAN SOCIETY FOR INFORMATION SCIENCE, WASHINGTON, D. C., 1971, 179-184.
205. O'BRIEN, RICHARD J, ED. LINGUISTICS: DEVELOPMENTS OF THE SIXTIES--VIEWPOINTS FOR THE SEVENTIES, 22ND ANNUAL GEORGETOWN ROUND TABLE. MONOGRAPH SERIES ON LANGUAGES AND LINGUISTICS, NO. 24. GEORGETOWN UNIVERSITY PRESS, WASHINGTON, D.C., 1971, 316 PP.
206. OHTANI, KENJI. SPEECH SYNTHESIS AND RECOGNITION BY COMPUTER. DEPARTMENT OF INFORMATION SCIENCE, KYOTO UNIVERSITY, KYOTO, JAPAN, JULY 1972, 127 PP. (PH.D. THESIS)
207. OLNEY, JOHN; RAMSEY, DONALD. "FROM MACHINE-READABLE DICTIONARIES TO A LEXICON TESTER: PROGRESS, PLANS, AND AN OFFER." COMPUTER STUDIES IN THE HUMANITIES AND VERBAL BEHAVIOR, III:4 (NOVEMBER 1972) 213-220.
208. O'MALLEY, MICHAEL H.; HERMAN, STEVE J. THE ACOUSTIC FEATURES OF PROSOOIES: SURVEY AND BIBLIOGRAPHY. UNIVERSITY OF MICHIGAN PHONETICS LABORATORY, MAY 31, 1972, 8 PP.
209. O'MALLEY, MICHAEL; SHANK, ROLLAN; SMITH, DALE. WHAT DOES A MORPHEME SPITTER SPIT: A COMPUTATIONAL STUDY. NATURAL LANGUAGE STUDIES NO. 6. THE UNIVERSITY OF MICHIGAN, PHONETICS LABORATORY, ANN ARBOR, MICHIGAN, JULY 1971, 85 PP.
210. ONDERISIN, ELAINE M. "THE LEAST COMMON BIGRAM: A DICTIONARY ARRANGEMENT TECHNIQUE FOR COMPUTERIZED NATURAL-LANGUAGE TEXT SEARCHING." ASSOCIATION FOR COMPUTING MACHINERY. ANNUAL CONFERENCE, CHICAGO, ILLINOIS, AUGUST 3-5, 1971. PROCEEDINGS. ASSOCIATION FOR COMPUTING MACHINERY, NEW YORK, 1971, 82-96.
211. OOMEN, URSULA. "NEW MODELS AND METHODS IN TEXT ANALYSIS." IN: O'BRIEN, 1971, 211-222.
212. OTTEN, KLAUS. "APPROACHES TO THE MACHINE RECOGNITION OF CONVERSATIONAL SPEECH." IN: YOVITS, 1971, 127-163.
213. OTTEN, MICHAEL; PACAK, MILOS G. "INTERMEDIATE LANGUAGES FOR AUTOMATIC LANGUAGE PROCESSING." IN: SOFTWARE ENGINEERING, VOLUME 2, EDITED BY JULIUS T. TOU. ACADEMIC PRESS, NEW YORK, 1971, 105-118.

214. PACAK, MILOS; COUSINEAU, L.; WHITE, W. THE SEGMENTATION APPROACH TO DICTIONARY CONSTRUCTION. PRESENTED AT THE 8TH ANNUAL MEETING OF CANADIAN ASSOCIATION OF PATHOLOGISTS, SHERBROOKE, QUEBEC, CANADA, JUNE 1972.
215. PACAK, MILOS; PRATT, ARNOLD W. "THE FUNCTION OF SEMANTICS IN AUTOMATED LANGUAGE PROCESSING," IN: ASSOCIATION FOR COMPUTING MACHINERY, 1971, 5-18.
216. PADUCHEVA, YE, V. PROBLEMS IN SEMANTIC COMPARISON OF NATURAL AND MATHEMATICAL LOGIC LANGUAGES. JOINT PUBLICATIONS RESEARCH SERVICE, ARLINGTON, VIRGINIA, 15 MARCH 1971, 27 PP. (JPRS 52621)
217. PALME, JACOB. "MAKING COMPUTERS UNDERSTAND NATURAL LANGUAGE," IN: FINDLER AND MELTZER, 1971, 199-144.
218. PALME, JACOB. A NATURAL LANGUAGE PARSING PROGRAM FOR QUESTION ANSWERING. RESEARCH INSTITUTE OF NATIONAL DEFENSE, OPERATIONS RESEARCH CENTER, STOCKHOLM, SWEDEN, FEBRUARY 1971, 54 PP. (FOA P RAPPORT C 8268-11(64))
219. PALME, JACOB. INTERNAL STRUCTURE OF THE SQAP NATURAL LANGUAGE PARSER. RESEARCH INSTITUTE OF NATIONAL DEFENSE, OPERATIONS RESEARCH CENTER, STOCKHOLM, SWEDEN, APRIL 1971, 83 PP. (FOA P RAPPORT C 8286-11(64))
220. PALME, JACOB. FROM PARSING TREE TO PREDICATE CALCULUS - A PRELIMINARY SURVEY. RESEARCH INSTITUTE OF SWEDISH NATIONAL DEFENSE, OPERATIONS RESEARCH CENTER, STOCKHOLM, SWEDEN, FEBRUARY 1972, 98 PP. (FOA P RAPPORT C 8313-M3(E5))
221. PALME, JACOB. SYNTAX AND DICTIONARY FOR A COMPUTER ENGLISH. RESEARCH INSTITUTE OF NATIONAL DEFENSE, OPERATIONS RESEARCH CENTER, STOCKHOLM, SWEDEN, JULY 1972, 66 PP. (FOA P RAPPORT C 8312-M3(E5))
222. PARTEE, BARBARA HALL. "LINGUISTIC METATHEORY," IN: DINGWALL, 1971, 650-679.
223. PARTEE, BARBARA HALL. "ON THE REQUIREMENT THAT TRANSFORMATIONS PRESERVE MEANING." IN: FILLMORE & LANGENDOEN, 1971, 1-21.
224. PAXTON, WILLIAM H.; ROBINSON, ANN E. A PARSER FOR A SPEECH UNDERSTANDING SYSTEM. STANFORD RESEARCH INSTITUTE, MENLO PARK, CALIFORNIA, 1973, 25 PP.
225. PETERSON, PHILIP L. PREDICATE MODIFIERS - A REVIEW OF THE LOGICAL PROBLEM WITH MORALS FOR AND FROM GRAMMAR. PRESENTED AT LINGUISTIC SOCIETY OF AMERICA 1972 SUMMER MEETING, UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL, NORTH CAROLINA, JULY 29, 1972.
226. PETRICK, STANLEY R. "ON THE USE OF SYNTAX-BASED TRANSLATORS FOR SYMBOLIC AND ALGEBRAIC MANIPULATION," IN: SECOND SYMPOSIUM ON SYMBOLIC AND ALGEBRAIC MANIPULATION. MARCH 23-25, 1971, LOS ANGELES, CALIFORNIA. PROCEEDINGS EDITED BY STANLEY R. PETRICK, ASSOCIATION FOR COMPUTING MACHINERY, NEW YORK, NEW YORK, 1971, 224-237.
227. PETRICK, STANLEY R. "COMPUTER-ORIENTED GRAMMARS AND PARSING." IN: CENTER FOR APPLIED LINGUISTICS, 1972, 22-37.
228. PETRICK, STANLEY R. "TRANSFORMATIONAL ANALYSIS." IN: RUSTIN, 1973, 27-41.

229. PIKE, KENNETH L. "CRUCIAL QUESTIONS IN THE DEVELOPMENT OF TAGMEMICS--THE SIXTIES AND SEVENTIES." IN: O'BRIEN, 1971, 79-98.
230. PRATT, ARNOLD W. AUTOMATIC PROCESSING OF PATHOLOGY DATA. PRESENTED AT CONFERENCE OF INSTITUT DE RECHERCHE D'INFORMATIQUE ET D'AUTOMATIQUE (IRIA) MARCH 1-5, 1971, ST. LARY, FRANCE.
231. RABEN, JOSEPH; WIDMANN, R. L. "INFORMATION SYSTEMS APPLICATIONS IN THE HUMANITIES." IN: ANNUAL REVIEW OF INFORMATION SCIENCE AND TECHNOLOGY, VOLUME 7, EDITED BY CARLOS A. CUADRA, AMERICAN SOCIETY FOR INFORMATION SCIENCES, WASHINGTON, D.C., 1972, 439-469.
232. RAMANI, S. "A LANGUAGE BASED PROBLEM SOLVER." IN: SECOND INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE. PROCEEDINGS, 1971, 463-473.
233. RAPHAEL, BERTRAM; ROBINSON, ANN E. BIBLIOGRAPHY ON COMPUTER SEMANTICS. SIGART NEWSLETTER, NUMBER 37, (DECEMBER 1972) 30-52. (TECHNICAL NOTE 72, ARTIFICIAL INTELLIGENCE CENTER, STANFORD RESEARCH INSTITUTE, MENLO PARK, CALIFORNIA, OCTOBER 1972).
234. REDDY, D. RAJ. "COMPUTER RECOGNITION OF CONNECTED SPEECH." JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA, 42, (1967) 329-347.
235. REDDY, D. RAJ; ERMAN, LEE; NEELY, RICHARD. ET AL. WORKING PAPERS IN SPEECH RECOGNITION, I. COMPUTER SCIENCE DEPARTMENT CARNEGIE-MELLON UNIVERSITY, PITTSBURGH, PENNSYLVANIA APRIL 21, 1972, 79 PP.
236. REDDY, D. RAJ; ERMAN, LEE D.; NEELY, RICHARD B. A MODEL AND A SYSTEM FOR MACHINE RECOGNITION OF SPEECH. IEEE TRANSACTIONS ON AUDIO AND ELECTROACOUSTICS (IN PRESS)
237. REDDY, D. RAJ; ERMAN, LEE D.; FENNELL, RICK D.; NEELY, RICHARD. THE HEARSAY SPEECH UNDERSTANDING SYSTEM. COMPUTER SCIENCE DEPARTMENT, CARNEGIE-MELLON UNIVERSITY, PITTSBURGH, PENNSYLVANIA, FEBRUARY 1973, 10 PP.
238. ROBINSON, JANE J. "AN INVERSE TRANSFORMATIONAL LEXICON." IN: RUSTIN, 1973, 43-60.
239. ROCHON, JEAN-FRANCOIS. SYSTEME DE SYNTHESE TRANSFORMATIONNELLE. GROUPE DE RECHERCHE EN LINGUISTIQUE FORMELLE, UNIVERSITE DE MONTREAL, MONTREAL, QUEBEC, CANADA, 1971, 117 PP. (PUBLICATION INTERNE NO. 1)
240. RODMAN, ROBERT. ED. PAPERS IN MONTAGUE GRAMMAR. OCCASIONAL PAPERS IN LINGUISTICS, NO. 2. UNIVERSITY OF CALIFORNIA AT LOS ANGELES, LOS ANGELES, CALIFORNIA, SEPTEMBER 1972, 149 PP.
241. ROSENBERG, JAY F.; TRAVIS, CHARLES. EDS. READINGS IN THE PHILOSOPHY OF LANGUAGE. PRENTICE-HALL, ENGLEWOOD CLIFFS, N.J., 1971, 645 PP.
242. ROSS, DONALD, JR.; RASCHE, ROBERT H. "EYEBALL: A COMPUTER PROGRAM FOR DESCRIPTION OF STYLE." COMPUTERS AND THE HUMANITIES, 6:4 (1972) 213-221.

243. RULIFSON, JOHNS F.; DERKSEN, JAN A.; WALDINGER, RICHARD J.
QA4: A PROCEDURAL CALCULUS FOR INTUITIVE REASONING.
ARTIFICIAL INTELLIGENCE CENTER, STANFORD RESEARCH
INSTITUTE, MENLO PARK, CALIFORNIA, NOVEMBER 1972,
363 PP. (TECHNICAL NOTE 73)
244. RUSSELL, SYLVIA WEBER. SEMANTIC CATEGORIES OF NOMINALS FOR
CONCEPTUAL DEPENDENCY ANALYSIS OF NATURAL LANGUAGE. STANFORD
ARTIFICIAL INTELLIGENCE PROJECT, STANFORD UNIVERSITY,
STANFORD, CALIFORNIA, JULY 1972, 64 PP. (MEMO AIM-172)
245. RUSTIN, RANDALL, ED. NATURAL LANGUAGE PROCESSING. COURANT
COMPUTER SCIENCE SYMPOSIUM 8: DECEMBER 20-21, 1971.
ALGORITHMICS PRESS, INC., NEW YORK, 1973, 350 PP.
246. SAGER, NAOMI. "THE SUBLANGUAGE METHOD IN STRING GRAMMARS."
IN: STUDIES IN LANGUAGE AND LINGUISTICS (1970-71), EDITED
BY RALPH W. EWTON, JR., AND JACOB ORNSTEIN, TEXAS WESTERN
PRESS, EL PASO, TEXAS, 1972.
247. SAGER, NAOMI. "SYNTACTIC FORMATTING OF SCIENCE INFORMATION."
AMERICAN FEDERATION OF INFORMATION SOCIETIES, FALL JOINT
COMPUTER CONFERENCE, ANAHEIM, CALIFORNIA, DECEMBER 5-7, 1972.
VOLUME 42. AFIPS PRESS, MONTVALE, NEW JERSEY,
1972, 791-800.
248. SAGER, NAOMI. "THE STRING PARSER FOR SCIENTIFIC LITERATURE."
IN: RUSTIN, 1973, 61-87.
249. SAGER, NAOMI. "A TWO-STAGE BNF SPECIFICATION OF NATURAL
LANGUAGE." INFORMATION SCIENCES (IN PRESS)
250. SAKAI, TOSHIYUKI; NAGAO, MAKOTO. RESEARCHES ON INFORMATION
PROCESSING. KYOTO UNIVERSITY, KYOTO, JAPAN, SEPTEMBER
1972, 24 PP.
251. SAKAI, TOSHIYUKI; OHTANI, KENJI. SPEECH ANALYSIS-SYNTHESIS AND
RECOGNITION SYSTEM. STUDIA PHONOLOGICA, VI (1972) 70-80.
252. SAKAI, TOSHIYUKI; SUGITA, SHIGEHARU; WATANABE, AKIMASA.
"MECHANICAL TRANSLATION FROM JAPANESE TO ENGLISH."
INFORMATION PROCESSING IN JAPAN, 10 (1970) 32-39.
253. SALKOFF, MORRIS. UNE GRAMMAIRE EN CHAINE DU FRANCAIS.
DUNOD, PARIS, 1973.
254. SALTON, GERARD. "A NEW COMPARISON BETWEEN CONVENTIONAL INDEXING
(MEDLARS) AND AUTOMATIC TEXT PROCESSING (SMART)."
JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE
23:2 (MARCH-APRIL 1972) 75-84.
255. SALTON, GERARD, ED. THE SMART RETRIEVAL SYSTEM--EXPERIMENTS
IN AUTOMATIC DOCUMENT PROCESSING. PRENTICE-HALL,
ENGLEWOOD CLIFFS, NEW JERSEY, 1971, 556 PP.
256. SANDEWALL, ERIK. "FORMAL METHODS IN THE DESIGN OF QUESTION-
ANSWERING SYSTEMS." ARTIFICIAL INTELLIGENCE.
2 (1971) 129-145.
257. SANDEWALL, ERIK. "REPRESENTING NATURAL LANGUAGE INFORMATION
IN PREDICATE CALCULUS." IN: MELTZER AND MICHIE, 1971, 255-277.
258. SANDEWALL, ERIK. PCF-2, A FIRST-ORDER CALCULUS FOR EXPRESSING
CONCEPTUAL INFORMATION. COMPUTER SCIENCES DEPARTMENT,
UPPSALA UNIVERSITY, UPPSALA, SWEDEN, FEBRUARY 1972, 143 PP.

259. SCHANK, ROGER C. "FINDING THE CONCEPTUAL CONTENT AND INTENTION IN AN UTTERANCE IN NATURAL LANGUAGE CONVERSATION." IN: SECOND INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE 1971, 444-454.
260. SCHANK, ROGER. "CONCEPTUAL DEPENDENCY: A THEORY OF NATURAL LANGUAGE UNDERSTANDING." COGNITIVE PSYCHOLOGY, 3:4 (1972) 552-631.
261. SCHANK, ROGER. "THE CONCEPTUAL ANALYSIS OF NATURAL LANGUAGE." IN: RUSTIN, 1973, 291-309.
262. SCHANK, ROGER C. "IDENTIFICATION OF CONCEPTUALIZATIONS UNDERLYING NATURAL LANGUAGE." IN: COLBY AND SCHANK, 1973.
263. SCHANK, ROGER C.; GOLDMAN, NEIL; RIEGER, CHARLES J.; RIESBECK, CHRISTOPHER K. PRIMITIVE CONCEPTS UNDERLYING VERBS OF THOUGHT. STANFORD ARTIFICIAL INTELLIGENCE PROJECT, STANFORD UNIVERSITY, STANFORD, CALIFORNIA, FEBRUARY 1972, 98 PP. (MEMO AIM-162)
264. SCHANK, ROGER; GOLOMAN, NEIL; REGER, CHUCK; RIESBECK, CHRIS. MARGIE: MEMORY, ANALYSIS, RESPONSE GENERATION, AND INFERENCE ON ENGLISH. COMPUTER SCIENCE DEPARTMENT, STANFORD UNIVERSITY, STANFORD, CALIFORNIA, FEBRUARY 1973, 26 PP.
265. SECOND INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE. ADVANCE PAPERS OF THE CONFERENCE, 1-3 SEPTEMBER 1971. THE BRITISH COMPUTER SOCIETY, LONDON, ENGLAND 1971, 658 PP.
266. SEDELOW, SALLY YEATES. AUTOMATED ANALYSIS OF LANGUAGE STYLE AND STRUCTURE IN TECHNICAL AND OTHER DOCUMENTS. DEPARTMENT OF COMPUTER SCIENCE OF LINGUISTICS, UNIVERSITY OF KANSAS, LAWRENCE, KANSAS, SEPTEMBER 1971, 124 PP. (TECHNICAL REPORT NO. 1)
267. SEDELOW, SALLY YEATES. AUTOMATED LANGUAGE ANALYSIS. UNIVERSITY OF KANSAS, LAWRENCE, KANSAS, 1972, 275 PP.
268. SEDELOW, SALLY YEATES; SEDELOW, WALTER A., JR. LANGUAGE RESEARCH AND THE COMPUTER. THE UNIVERSITY OF KANSAS, LAWRENCE, KANSAS, 1972, 480 PP.
269. SHAPIRO, STUART C. "A NEW STRUCTURE FOR SEMANTIC INFORMATION STORAGE, DEDUPLICATION AND RETRIEVAL." IN: SECOND INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE, 1971, 512-523.
270. SHAPIRO, STUART CHARLES. THE MIND SYSTEM: A DATA STRUCTURE FOR SEMANTIC INFORMATION PROCESSING. RAND CORPORATION, SANTA MONICA, CALIFORNIA, AUGUST 1971, 162 PP. (R-837-PR)
271. SHUY, ROGER, ED. SOCIOLINGUISTICS: CURRENT TRENDS AND PROSPECTS. 23RD ANNUAL GEORGE TOWN ROUND TABLE, MONOGRAPH SERIES ON LANGUAGES AND LINGUISTICS, NO. 25. GEORGETOWN UNIVERSITY PRESS, WASHINGTON, D.C., 1972, 351 PP.
272. SIMMONS, ROBERT F. "NATURAL LANGUAGE QUESTION-ANSWERING SYSTEMS: 1969." COMMUNICATIONS OF THE ACM. 13:1 (JANUARY 1970) 15-30.
273. SIMMONS, ROBERT F. "NATURAL LANGUAGE FOR INSTRUCTIONAL COMMUNICATION." IN: FINDLER AND MELTZER, 1971, 191-198.
274. SIMMONS, ROBERT F. "INTEGRATED COMPUTER SYSTEMS FOR LANGUAGE." IN: CENTER FOR APPLIED LINGUISTICS, 1972, 7-21.
275. SIMMONS, ROBERT F. MAPPING ENGLISH STRINGS INTO MEANINGS. DEPARTMENT OF COMPUTER SCIENCES, UNIVERSITY OF TEXAS, AUSTIN, TEXAS, JANUARY 1973, 21 PP. (TECHNICAL REPORT NL 10)

276. SIMMONS, ROBERT F. "SEMANTIC NETWORKS: THEIR COMPUTATION AND USE FOR UNDERSTANDING ENGLISH SENTENCES," IN: COLBY AND SCHANK, 1973.
277. SIMMONS, ROBERT F.; BRUCE, BERTRAM C, "SOME RELATIONS BETWEEN PREDICATE CALCULUS AND SEMANTIC NET REPRESENTATIONS OF DISCOURSE," IN: SECOND INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE, 1971, 524-530.
278. SIMMONS, ROBERT F.; SLOCUM, JONATHAN "GENERATING ENGLISH DISCOURSE FROM SEMANTIC NETWORKS," COMMUNICATIONS OF THE ASSOCIATION FOR COMPUTING MACHINERY, 15:10, (OCTOBER 1972) 891-905.
279. SIMON, HERBERT A.; SIKLOSSY, LAURENT, EDS, REPRESENTATION AND MEANING: EXPERIMENTS WITH INFORMATION PROCESSING SYSTEMS. PRENTICE-HALL, INC., ENGLEWOOD CLIFFS, NEW JERSEY, 1972, 430 PP.
280. SINAIKO, H. WALLACE; KLARE, GEORGE R, FURTHER EXPERIMENTS IN LANGUAGE TRANSLATION: READABILITY OF COMPUTER TRANSLATIONS. INSTITUTE FOR DEFENSE ANALYSES, ARLINGTON, VIRGINIA, AUGUST 1971, 109 PP, (PAPER P-761)
281. SINAIKO, H. WALLACE; KLARE, GEORGE R, FURTHER EXPERIMENTS IN LANGUAGE TRANSLATION: A SECOND EVALUATION OF THE READABILITY OF COMPUTER TRANSLATIONS. INSTITUTE FOR DEFENSE ANALYSES, ARLINGTON, VIRGINIA, DECEMBER 1971, 52 PP, (PAPER P-805)
282. SLOBIN, DAN I. "DEVELOPMENTAL PSYCHOLINGUISTICS," IN: DINGWALL, 1971, 298-400.
283. SLOCUM, JONATHAN, QUESTION ANSWERING VIA CANONICAL VERB AND SEMANTIC MODELS: GENERATING ENGLISH FROM THE MODEL. DEPARTMENT OF COMPUTER SCIENCE, THE UNIVERSITY OF TEXAS, AUSTIN, TEXAS, JANUARY 1973, 18 PP, (TECHNICAL REPORT NL 13)
284. SMITH, RAOUL N. "INTERACTIVE LEXICON UPDATING," COMPUTERS AND THE HUMANITIES, 6:3 (JANUARY 1972) 137-145.
285. SMITH, ROBERT; SUPPES, PATRICK. ON THE SEMANTIC THEORY OF COMPUTER DIALOGUES. INSTITUTE FOR MATHEMATICAL STUDIES IN THE SOCIAL SCIENCES, STANFORD UNIVERSITY, STANFORD CALIFORNIA, 1973, 22 PP.
286. SPARCK JONES, KAREN; KAY, MARTIN. LINGUISTICS AND INFORMATION SCIENCE, ACADEMIC PRESS, NEW YORK, 1973.
287. STEINBERG, DANNY; JAKOBOVITS, LEON. EDS. SEMANTICS, AN INTERDISCIPLINARY READER IN PHILOSOPHY, LINGUISTICS, AND PSYCHOLOGY, CAMBRIDGE UNIVERSITY PRESS, CAMBRIDGE, 1971, 603 PP.
288. STOCKWELL, ROBERT; SCHACHTER, PAUL; PARTEE, BARBARA. THE MAJOR SYNTACTIC STRUCTURES OF ENGLISH, HOLT, RINEHART, & WINSTON, NEW YORK 1973, 847 PP.
289. STONE, PHILIP J. "SOCIAL INDICATORS BASED ON COMMUNICATION CONTENT," AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES. FALL JOINT COMPUTER CONFERENCE, ANAHEIM, CALIFORNIA, 1972. CONFERENCE PROCEEDINGS, VOLUME 41. AFIPS PRESS, MONTVALE, NEW JERSEY, 1972, 811-817.

290. STREETER, MARY L. "DOC, 1971: A CHINESE DIALECT DICTIONARY ON COMPUTER," COMPUTERS AND THE HUMANITIES, 6:5 (MAY 1972) 259-270.
291. SU, STANLEY Y. W. A COMPUTATIONAL MODEL OF PARAGRAPH PRODUCTION. CENTER FOR INFORMATICS RESEARCH, UNIVERSITY OF FLORIDA, GAINESVILLE, FLORIDA, NOVEMBER, 1971, 37 PP. (TECHNICAL REPORT NO. 71-102)
292. SU, STANLEY Y. W. "MANAGING SEMANTIC DATA IN AN ASSOCIATIVE NET." IN: ASSOCIATION FOR COMPUTING MACHINERY, 1971, 105-116.
293. SUSSMAN, GERALD JAY; WINOGRAD, TERRY. MICRO-PLANNER REFERENCE MANUAL. PROJECT MAC, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS 02138, JULY 1970, 20 PP. (ARTIFICIAL INTELLIGENCE MEMO NO. 203)
294. THOMPSON, CRAIG W., QUESTION ANSWERING VIA CANONICAL VERBS AND SEMANTIC MODELS: PARSING TO CANONICAL VERB FORMS. DEPARTMENT OF COMPUTER SCIENCE, THE UNIVERSITY OF TEXAS, AUSTIN, TEXAS, JANUARY 1973, 15 PP. (TECHNICAL REPORT NL 11)
295. TOMA, PETER P.; KOZLIK, LUDEK A.; PERWIN, DONALD G. OPTIMIZATION OF SYSTRAN SYSTEM. FINAL TECHNICAL REPORT, LATSEC, INC., LA JOLLA, CALIFORNIA, APRIL 1972, 193 PP.
296. TRAVIS, LARRY; KELLOGG, CHARLES; KLAHR, PHILIP, INFERENTIAL QUESTION-ANSWERING: EXTENDING CONVERSE. SYSTEM DEVELOPMENT CORPORATION, SANTA MONICA, CALIFORNIA JANUARY 1973, 74 PP. (SP-3679)
297. TREU, SIEGFRIED. A COMPUTER TERMINAL NETWORK FOR TRANSPARENT STIMULATION OF THE USER OF AN ON-LINE RETRIEVAL SYSTEM. NATIONAL BUREAU OF STANDARDS, WASHINGTON, D.C., JULY 1972, 39 PP. (NBS TECHNICAL NOTE 732)
298. TSEMEL', G. I. RECOGNITION OF SPOKEN SIGNALS. TRANSLATION OF OPOZNAVANIYE RECHEVYKH SIGNALOV. SCIENCE PUBLISHING HOUSE, MOSCOW, U.S.S.R., 1971. JOINT PUBLICATION RESEARCH SERVICE, ARLINGTON, VIRGINIA, 28 JUNE 1972, 147 PP. (JPRS 56370)
299. VAN DAM, ANDRIES; RICE, DAVID E. "ON-LINE TEXT EDITING: A SURVEY," COMPUTING SURVEYS, 3:3 (SEPTEMBER 1971) 93-114.
300. VICENS, PIERRE. ASPECTS OF SPEECH RECOGNITION BY COMPUTER. COMPUTER SCIENCE DEPARTMENT, STANFORD UNIVERSITY, STANFORD, CALIFORNIA, 1969, 210 PP. (A.I. MEMO NO. 85)
301. WALKER, ADRIAN. AN APPROACH TO ENGLISH-LANGUAGE INPUT FOR THE TIME SYSTEM OF FINDLER AND CHEN. DEPARTMENT OF COMPUTER SCIENCE, STATE UNIVERSITY OF NEW YORK AT BUFFALO, BUFFALO, NEW YORK, 1973, 21 PP.
302. WALKER, DONALD E. ED. INTERACTIVE BIBLIOGRAPHIC SEARCH: THE USER/COMPUTER INTERFACE. AFIPS PRESS, MONTVALE, NEW JERSEY, 1971, 375 PP.
303. WALKER, DONALD E. "SOCIAL IMPLICATIONS OF AUTOMATIC LANGUAGE PROCESSING." IN: CENTER FOR APPLIED LINGUISTICS, 1972, 79-86.
304. WALKER, DONALD E. SPEECH UNDERSTANDING RESEARCH, ANNUAL TECHNICAL REPORT, PROJECT 1526. STANFORD RESEARCH INSTITUTE, MENLO PARK, CALIFORNIA, FEBRUARY 1973, 59 PP.

305. WALKER, DONALD E. SPEECH UNDERSTANDING THROUGH SYNTACTIC AND SEMANTIC ANALYSIS. STANFORD RESEARCH INSTITUTE, MENLO PARK, CALIFORNIA, FEBRUARY 1973, 25 PP.
306. WALL, ROBERT E. "MATHEMATICAL LINGUISTICS," IN: DINGWALL, 1971, 682-712.
307. WALL, ROBERT E. INTRODUCTION TO MATHEMATICAL LINGUISTICS. PRENTICE-HALL, ENGLEWOOD CLIFFS, NEW JERSEY, 1972, 337 PP.
308. WANG, WILLIAM S-Y.; T'SOU, BENJAMIN K.; CHEN, STEPHEN W.; ET AL. RESEARCH IN CHINESE-ENGLISH MACHINE TRANSLATION. UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA, NOVEMBER 1971, 245 PP. (REPORT NO, RADG-TR-71-211)
309. WATERMAN, DONALD A.; NEWELL, ALLEN "PROTOCOL ANALYSIS AS A TASK FOR ARTIFICIAL INTELLIGENCE." ARTIFICIAL INTELLIGENCE, 2 (1971) 285-318.
310. WATERMAN, DONALD A.; NEWELL, ALLEN. PRELIMINARY RESULTS WITH A SYSTEM FOR AUTOMATIC PROTOCOL ANALYSIS, DEPARTMENTS OF PSYCHOLOGY AND COMPUTER SCIENCE, CARNEGIE-MELLON UNIVERSITY, PITTSBURGH, PENNSYLVANIA, MAY 1972, 181 PP. (CIP WORKING PAPER #211)
311. WIDMANN, R. L. "COMPUTERS AND LITERARY SCHOLARSHIP." COMPUTERS AND THE HUMANITIES, 6:1 (SEPTEMBER 1971) 3-14.
312. WIDMANN, R. L. "RECENT SCHOLARSHIP IN LITERARY AND LINGUISTIC STUDIES." COMPUTERS AND THE HUMANITIES, 7:1 (SEPTEMBER 1972) 3-27.
313. WILKS, YORICK. ONE SMALL HEAD--SOME REMARKS ON THE USE OF 'MODEL' IN LINGUISTICS. COMPUTER SCIENCE DEPARTMENT, STANFORD UNIVERSITY, STANFORD, CALIFORNIA, DECEMBER, 1971, 15 PP. (ARTIFICIAL INTELLIGENCE MEMO AIM-157)
314. WILKS, YORICK. GRAMMAR, MEANING, AND THE MACHINE ANALYSIS OF LANGUAGE. ROUTLEDGE AND KEGAN PAUL, LONDON, 1972, 208 PP.
315. WILKS, YORICK. "THE STANFORD MACHINE TRANSLATION PROJECT." IN: RUSTIN, 1973, 243-290.
316. WILKS, YORICK. UNDERSTANDING WITHOUT PROOFS, ARTIFICIAL INTELLIGENCE PROJECT, STANFORD UNIVERSITY, STANFORD, CALIFORNIA, 1973, 29 PP.
317. WINOGRAD, TERRY. PROCEDURES AS A REPRESENTATION FOR DATA IN A COMPUTER PROGRAM FOR UNDERSTANDING NATURAL LANGUAGE, PROJECT MAC, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS, JANUARY 1971, 462 PP. (MAC TR-84)
318. WINOGRAD, TERRY. UNDERSTANDING NATURAL LANGUAGE, ACADEMIC PRESS, NEW YORK, NEW YORK, 1972, 200 PP. ALSO, COGNITIVE PSYCHOLOGY 3:1 (JANUARY 1972), 1-191.
319. WOODS WILLIAM A. "AN EXPERIMENTAL PARSING SYSTEM FOR TRANSITION NETWORK GRAMMARS," IN: RUSTIN, 1973, 111-154.
320. WOODS, WILLIAM A.; KAPLAN, RONALD M.; NASH-WEBBER, BONNIE. THE LUNAR SCIENCES NATURAL LANGUAGE INFORMATION SYSTEM. FINAL REPORT. BOLT BERANEK AND NEWMAN, INC., CAMBRIDGE, MASSACHUSETTS, 15 JUNE, 1972, 387 PP. (BBN REPORT NO. 2378),
321. WOODS, WILLIAM A.; MAKHOUL, JOHN. MECHANICAL INFERENCE PROBLEMS IN CONTINUOUS SPEECH UNDERSTANDING, BOLT BERANEK AND NEWMAN, CAMBRIDGE, MASSACHUSETTS, FEBRUARY 1973, 37 PP.

322. YOVITS, MARSHALL C. ED. ADVANCES IN COMPUTERS, VOLUME 11. ACADEMIC PRESS, NEW YORK - LONDON, 1971, 409 PP.
323. ZADEH, LOTFI. FUZZY LANGUAGES AND THEIR RELATION TO HUMAN INTELLIGENCE. ELECTRONIC RESEARCH LABORATORY, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA, 1971. (MEMORANDUM ERL-M302)
324. ZADEH, LOTFI. "QUANTITATIVE FUZZY SEMANTICS." INFORMATION SCIENCES, 3 (1971) 159-176.
325. ZOLKOVSKIJ, A. K.; ME'LCUK, I. A.; & SALYAPINA. EXPERIMENTAL FRAGMENT: ENGLISH-RUSSIAN EXPLANATORY SCHEME DICTIONARY IN THE PROCESS OF TRANSLATION. (IN RUSSIAN) PRELIMINARY PUBLICATIONS, PROBLEM GROUP ON EXPERIMENTAL & APPLIED LINGUISTICS, RUSSIAN LANGUAGE INSTITUTE OF THE SOVIET ACADEMY OF SCIENCES, 1971, 37 PP.

END

