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Carlson, R. and Granström, B. and Hunnicutt,
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B. BLISS COMMUNICATION WITH SPEECH OR TEXT OUTPUT *

Rolf Carlson, Björn Granström, and Sheri Hunnicutt

Abstract

A multi-language, portable text-to-speech system has been developed at the Royal Institute of Technology in Stockholm. The system contains a formant speech synthesizer on a signal processing chip, a powerful microcomputer and a variety of text input equipment. A special attachment is a 500-symbol Bliss Board. Swedish and English Bliss-to-speech programs transform a symbol string to the corresponding well-formed sentence. Bliss symbols and spelled text can be intermixed to produce either a spoken or written message.

A lexicon gives the pronunciation, part of speech and other grammatical features for each Bliss symbol on the Bliss Board. This information is used in a phrase structure grammar which can be modeled by a simple ATN to delimit noun, verb and prepositional phrases. Once the phrase structure is established, phrases are marked according to a transformational analysis. Referring to these phrase features, pronouns, nouns, verbs and (in Swedish) adjectives are given correct forms and pronunciations.

History and DevelopmentHistory

Bliss symbols were developed by the Austrian, Karl Blitz, in the 1940's (see Fig. II-B-1). He was deeply impressed by difficulties in communication among people who spoke different languages, or the same language with different intentions. While in China, Blitz -- now calling himself Charles Bliss -- was inspired by the Chinese ideographs to develop his own set of characters. He hoped they could be used as the basis of a system of world-wide commonality of expression and understanding. This system was set forth in his nearly 1,000-page work, Semantography(1).

*This paper will be presented at the 1982 IEEE-ICASSP, Paris, France.

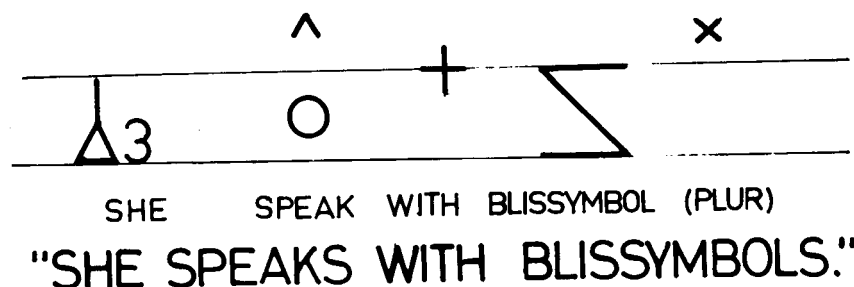


Fig. II-B-1 A simple Bliss symbol sentence

In 1971, a special education teacher at the Ontario Crippled Children's Centre found a description of Semantography, and obtained a copy for a symbol communication project which had been instituted for non-vocal pre-reading children (2). The project staff, with consultation from Charles Bliss, developed vocabularies and procedures for use of Bliss symbols (Blissymbols). An institute for the purpose of developing the Bliss system grew out of this work, being established in 1975. Located in Toronto, Ontario, Canada, it is called the Blissymbolics Communication Institute (3).

Blissymbolics was introduced in Sweden in 1976, and has gained acclamation from therapists and educators of the vocally handicapped. Programs for the use of Blissymbolics are administered by both the Swedish and Scandinavian Centers and promoted by a special Bliss Advisory Group for Sweden. Programs for the development and distribution of Bliss-related aids for the handicapped are the responsibility of the Swedish Institute for the Handicapped.

The "Talking Bliss Board"

The groups concerned with speech synthesis and vocal aids for the handicapped at the Royal Institute of Technology in Stockholm have, for some years, been interested in implementing a "talking Bliss system." This system was realized for Swedish in early 1981, and has since then been developed for English (4). Bliss users interact with a 500-symbol Bliss board which is a special attachment to a multi-language, portable text-to-speech system discussed in another paper in this issue (Fig. II-B-2). This system presently contains a formant speech synthesizer implemented on a programmed signal processing chip, a powerful microcomputer, and a variety of text input equipment. The Swedish and English

Bliss-to-speech and Bliss-to-text programs transform the symbol string indicated by the Bliss user to the corresponding well-formed sentence. The user may intermix Bliss symbols and spelled words to produce the spoken or written message.

Structure - Chart and Lexicon

Composition of the Bliss Board

The Bliss board contains approximately 500 squares, most of which are lexical items, arranged according to their part of speech. This arrangement corresponds to the standard Swedish Bliss chart. There are approximately 200 nouns, 80 verbs, 70 adjectives and adverbs, 50 function words, 30 commonly used referents of persons (e.g., "boy," "friend," "visitor"), and 10 common expressions (e.g., "hello," "yes").

Another group of symbols has a syntactic function. A user may indicate a verb in past, present or future tense, an adjective, or a noun. "Plural" may also be indicated. The designations "adjective" and "noun" are used only for spelled words; the other categories can be used to mark both Bliss symbols and spelled words.

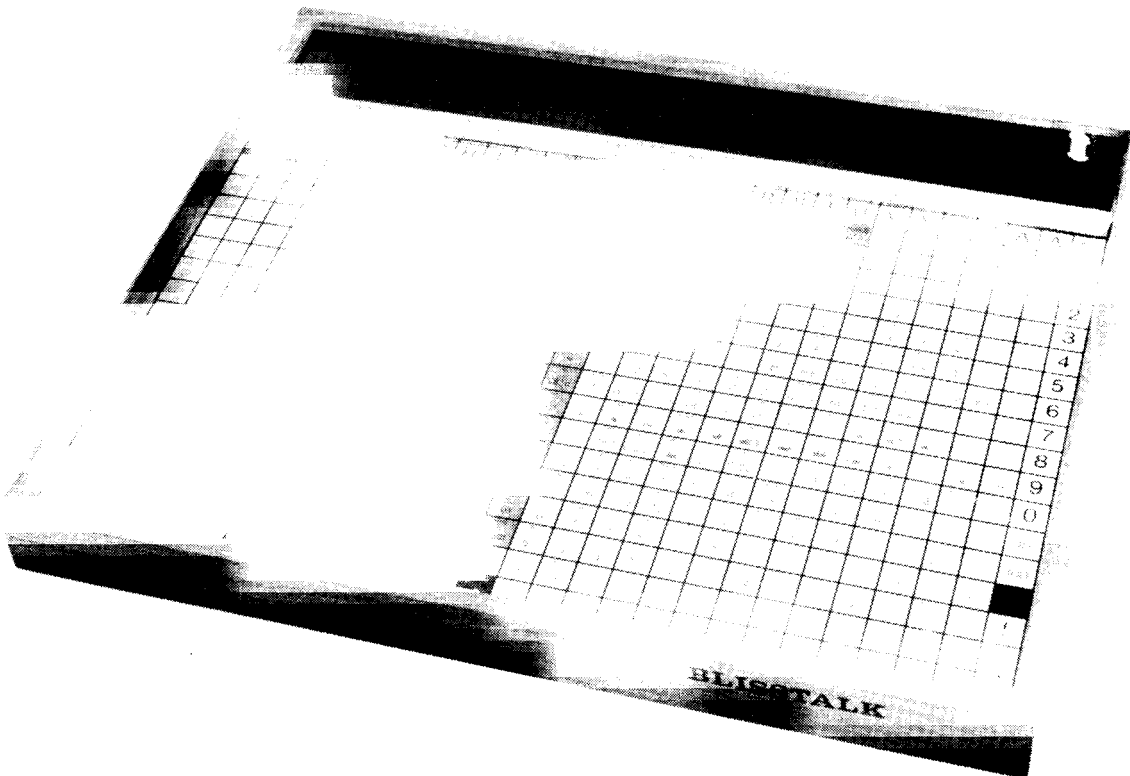


Fig. II-B-2 The "talking Bliss board"

Other special symbols are meant to aid in the formation of concepts other than those on the board. These are "combination," "the opposite of," "the same as," "similar to," "sounds like," "part of," and "goes with" (used for possessive). With the exception of the possessive marker which becomes a feature of the preceding noun or pronoun, they are simply spoken or printed at the point of insertion.

Another group of previously unassigned squares is being used to implement special functions to accompany speech synthesis. These functions allow users to delete their last choice, to choose a second meaning (some squares have more than one label, e.g., all/whole, string/thread), and to repeat, save and retrieve sentences they create.

Letters, numbers and punctuation marks are also present. When these symbols are used, the system automatically accesses the lexicon, the number rules and the text-to-phonetic rules of the text-to-speech system, thus allowing the synthesis of any word (or number) not appearing as a Bliss symbol (see Fig. II-B-3). This facility permits a user to have speech output from the synthesis system in the same manner as if a terminal were used to input text.

Modes of Operation

The message can be pronounced (or printed) word by word or as a full sentence. For spelled words, each letter can be pronounced. In the normal operating mode, each word (or letter) is pronounced as shown above the symbol when that symbol is chosen. When the user terminates the sentence with a punctuation mark, the complete grammatically well-formed sentence is spoken. If the deletion square is chosen, the last entry is deleted, and the string of words up to that point is pronounced to aid the user in making the correction. A sentence or other completed expression may be repeated, and may also be temporarily stored and quickly retrieved.

It is possible to reprogram the board so that any square corresponding to a lexical entry can be placed in any space reserved for lexical entries. One may also designate either 4 or 16 squares to have the same value so that larger (and fewer) symbols may be used for beginners. This design feature allows a great deal of flexibility in specifying the format of the board. Communication between the Bliss board and other parts of the text-to-speech system is accomplished via the new BLISCII codes. It will therefore be possible to connect to any type of input or output device utilizing this code.

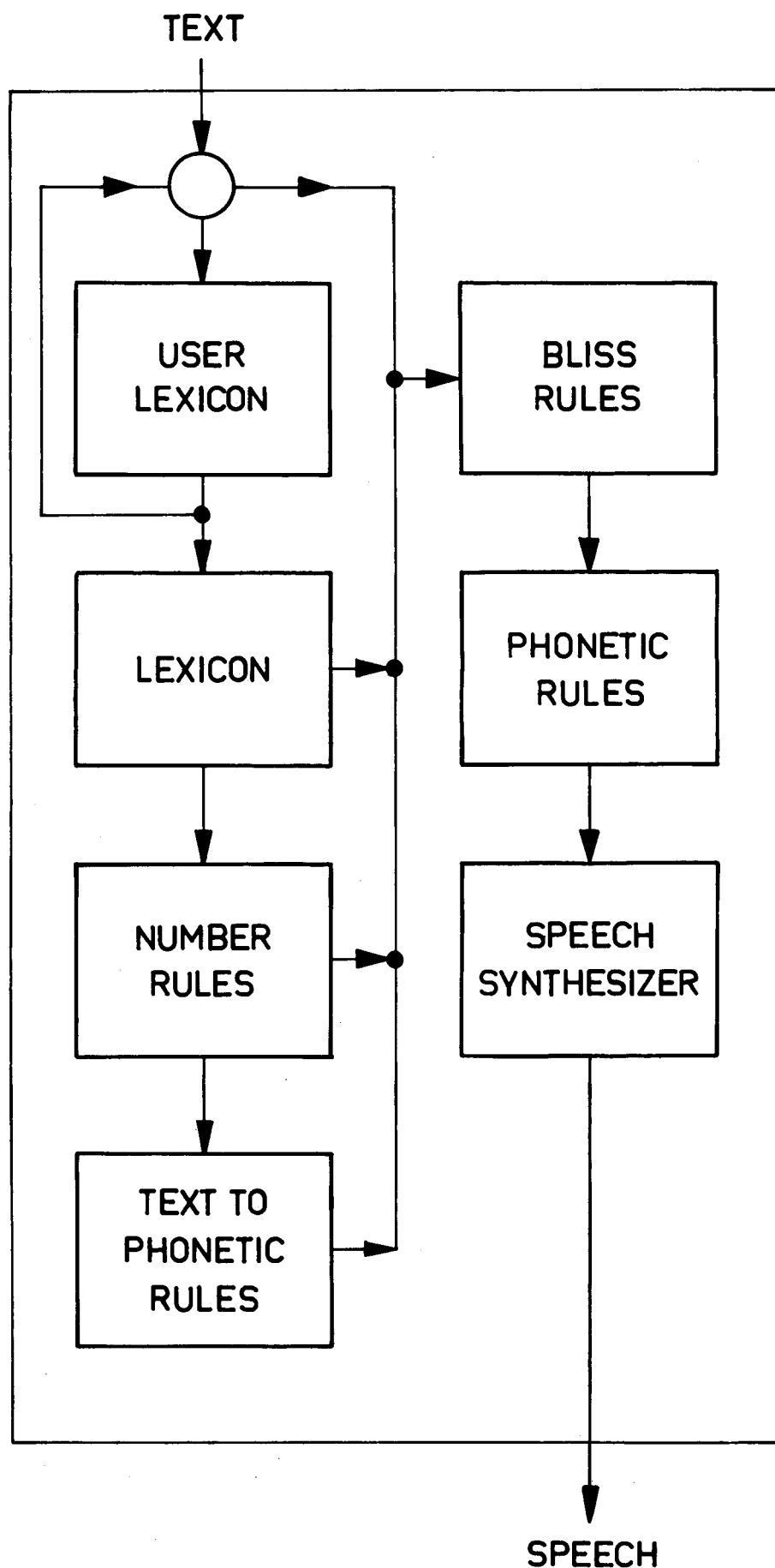


Fig. II-B-3 The complete text-to-speech system with Bliss rules

The Lexicon

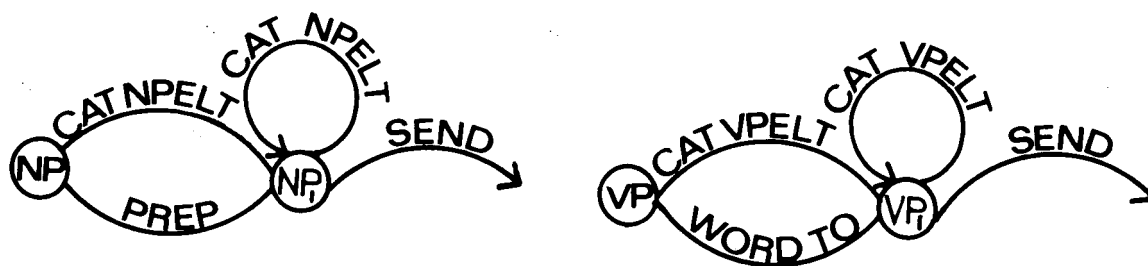
Each symbol on the Bliss Board which represents a lexical item corresponds to an entry in a lexicon. This entry gives the pronunciation for the item, its part of speech, and features such as inflection category. These features, as well as features introduced on the board (e.g., "plural," "past tense," "possessive"), and those provided as default values are incorporated as features of the part of speech. This information is then available to the parsing algorithm.

Operation - the Grammar

The Phrase Structure Grammar

The algorithm for producing a well-formed sentence proceeds by first introducing phrase markers. Noun phrases and verb phrases are initially delimited by recognition of which words can or must not appear in them. Noun phrases can then be further divided by recognition of ordering conventions within them into double objects or into subject-object pairs in a question or in an adverb-initial sentence in Swedish. Verb phrases are split before a marked infinitive (one introduced by "to" in English, by "att" in Swedish). A prepositional phrase is considered to be a special case of a noun phrase.

This grammar can be modeled by a very simple ATN (augmented transition network) phrase structure grammar such as the one in Fig. II-B-4.



Tests on NP1: (SEND) if last element was a
NOUN or NON-POSSESSIVE PERSONAL PRONOUN

Fig. II-B-4 An ATN model of the phrase structure grammar

The grammar does not currently allow for a string of nouns in a single noun phrase, e.g., "hobby floor lamp." This is not a limitation for Swedish, where such terms are realized as compounds, and where a double object may be two consecutive nouns devoid of determiners. For English, however, such noun strings are currently separated into multiple phrases with the resultant change in prosodics. Experience may show that such noun-string noun phrases should be provided for. If so, the first test will be removed, and "look-ahead" for determiners and adjectives will be necessary (but not sufficient) to signal the construction of a new noun phrase node.

The grammar's success in delimiting phrases is a direct consequence of the fact that lexical part of speech is, for the most part, predetermined by the Blissymbol input. Ambiguity results only if a Bliss user attempts to use a symbol in a function other than that determined by its place on the board. It would be possible to allow a user to change the part of speech of a word to one of those specifiable. This facility would be easy to specify in English noun-verb conversion since both the singular form of a noun and the infinitive form of a corresponding verb may be the same (e.g., simple roots such as "walk" and "sleep"). Many Swedish nouns on the Bliss board could be converted to verbs by the addition of a final "a" (e.g., "fisk(a)," "rygg(a)," "form(a)"). It should be noted, however, that only regular forms of tenses, number, etc. would result. In any case, the result of any such conversion would be unambiguous, and could not complicate the grammar.

A comma is considered to introduce a new clause (there is no provision for lists as yet). A few words, such as "the relativizer" (realized as "that" in English and as "som" in Swedish) carry a comma preceding them in the Lexicon.

Phrase level analysis

Once the phrase structure is established, phrases are marked according to a transformational analysis. The introduction of a clause with a question mark, a question word (e.g., "who," "where") or a verb phrase causes the noun phrase following a modal auxiliary to be marked as -OBJECT. Otherwise, it is marked +OBJECT if there is a subject noun phrase present. For Swedish, noun phrases containing a possessive element are marked in order that the correct forms of adjectives and the head noun are realized. Reflexivization of a noun phrase (a pronoun) is implemented with the aid of a "self" square.

The imperative status of a verb phrase is cued by its clause-initial position and the appearance of an exclamation mark at the end of the sentence. A verb phrase is considered to have passive status if it is also marked "past" and includes the verb "be," followed, but not necessarily immediately, by another verb. In English, if the verb is preceded by "be" and is not marked "past," present progressive status of the verb phrase is inferred. Also in English, the proper form (person, number, tense) of "do" is inserted in questions not beginning with a verbal element. Verb phrases including modal auxiliaries are also marked.

Indication of the negative mark presently results in the introduction of a single word ("not" in English; "inte" in Swedish). There are plans for its further development in English, however, where such diverse forms as "doesn't" and "won't" are rather common in spoken language.

Referring to these marks, or features of phrases, correct forms are chosen for words within them. A pronoun may be in subject, object or possessive form, and may be reflexive as well. Nouns may be singular or plural, and in Swedish may be real (non-neuter) or neuter, and definite or indefinite. A noun may also be possessive. Adjectives in Swedish

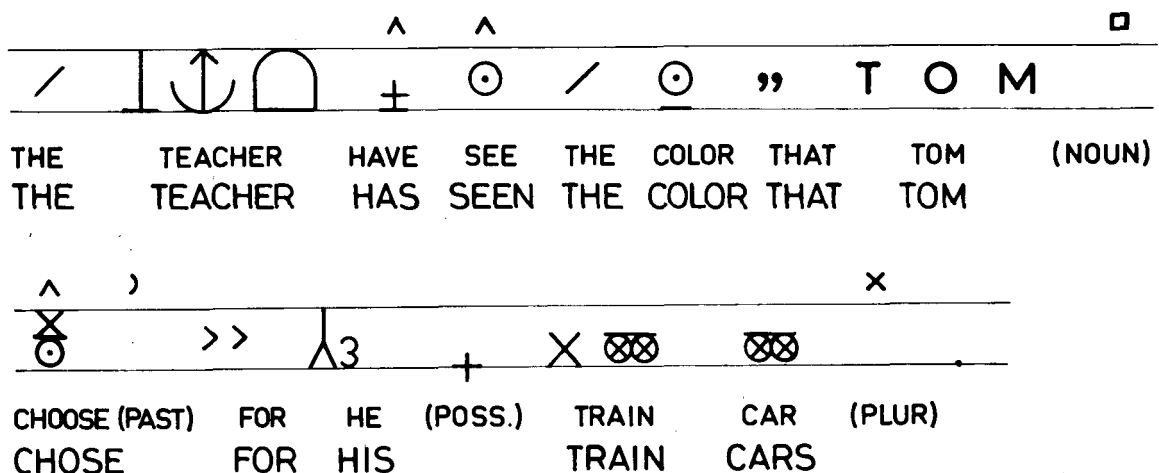


Fig. II-B-5 An example of Bliss to speech. (Special symbols for the auxiliary verb HAVE may, in the future, replace this non-standard usage of the non-auxiliary.)

must also be marked for number, gender and definiteness. A verb may appear as an infinitive, in the present, simple past or future tense, or in an imperfect or perfect past construction. English also allows for present progressive and for different forms of the present depending upon the subject (which sometimes follows the verb). The correct pronunciation is specified for each of these forms according to inflection category. Irregular nouns, verbs, and adjectives, and all pronouns are entered in the lexicon in all their forms. Rules governing irregular forms choose the correct form from these multiple entries.

Final Remarks

System Use and Further Research

The current Bliss board allows a user to compose many well-formed sentences with flexibility of expression. (See the example in Fig. II-B-5.) With the addition of some new grammatical forms and a few new sentence types, it can be expected that the needs of rather sophisticated users will be met. It will be quite interesting to study how a grammar in this framework can be extended and to determine, with a criterion of simplicity of expression, which constructions can be provided for.

It is possible, however, that with experience through actual usage (by young vocally handicapped children, for example), that another type of research will be indicated. The demand may be for simpler and more restricted grammars rather than for more complex and flexible ones. A child's grammar changes continuously as it develops, and, for some years, is not a proper subset of adult grammar. To what extent can we model this development? Will a child prefer to have the Bliss board speak for him as the adults around him speak? Since he can understand their speech, this represents his speech competence. Or will he only be comfortable using the grammar of a vocal peer, or perhaps a somewhat younger vocal child? What about the actual voice -- before good quality synthetic children's voices become available, perhaps an adult voice with a child's grammar would be unacceptable. There are many questions that must be answered in order to serve the Bliss-using community well, and work toward this end will involve research in a variety of fields.

Acknowledgments

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