Abstract
The authors describe their research experiences and results in their study (analysis and synthesis) of the phonetic structure of Russian speech in recent years. Based on their findings, they developed a Russian language text-to-speech system called RUSSON. In their paper, of key importance are some key phonetic questions related to RUSSON: phonetic analyses of the sound structure, palatalization-suprasegmental structure, and realization of Russian speech using a twelve-channel oscillograph. The synthesized samples clearly suggested that lengthening always indicates stress, although in certain positions, the duration of the stressed vowel (particularly in two-syllable words) may be equal, or even less than that of unstressed vowels. The reason for this is that stress is tied to the word form and is present in actual use even if unrealized by phonetic means.

Introduction
Production of artificial speech does not amount to a special scientific achievement. Lately, attention is focused rather on the application of the synthetic speech and on automatic speech recognition. In Hungary, the first sound and speech synthesizer systems were developed in the late seventies, early eighties as a result of research conducted by the Department of Phonetics of the Linguistics Institute of the Hungarian Academy of Sciences. Their primary aim was to aid scientific study of the sound structure of speech. The present paper is an account of our research experiences and results accumulated in the past few years in the phonetic analysis and synthesis of Russian speech. Preliminary work and earlier results were reported in our book "A Conspectus of Russian Speech Sounds" published in 1981, as well as papers in the series "Hungarian Papers of Phonetics" No. 1-16. (1978-1983).

1. RUSSON as a phonetic research aid
RUSSON was meant as a computer model of Russian phonetic processes. It provides means to verify our analysis and to use the analysis-by-synthesis method. The synthesizer enables us to alter any of the individual acoustic features of speech at will, to extract and analyze its physical and phonetic elements, and to filter out those constituents and features which have no linguistic function; to establish the language specific rules of sound combinations and to study the combination and variability of elements, to analyze the structural relevance of sound elements and the sound structures made up of these.

2. Phonetic analyses of the sound structure of Russian
The Russian writing system is a syllabic system, with the sounds of Russian based on its phonetic structure. The Russian writing system is a syllabic system, with the sounds of Russian based on its phonetic structure. The sound structure of Russian speech is basically determined by two factors: its duration is determined by its stress, and its vowel substance by the palatal-pharyngeal articulation.

3. Intonational-structural prosodies
The text-to-speech system RUSSON uses the following matrix to produce the actual intonation form. If our intonation experiments so require, the values of the matrix can be adjusted.

Fig. 4. The main steps of the operation of the Russian text-to-speech system RUSSON

The program produces sentences of any content entered in correct Russian orthography in the following three main steps:
1. First, using a set of rules the program maps the letter sequence into a series of so-called microelements, which ultimately form the segmental basis of artificial speech.
2. Next, on the basis of the sentence final punctuation mark the suprasegmental content entered.
structure is generated and then integrated with the segmental structure.

The operation of the program is made more detailed steps is illustrated in the flowchart in Fig. 1.

The stock of microelements

The control program produces the given sentence with the help of a system of rules and the inventory of microelements. The system of rules is implemented in the flowchart and is described in the next section. The stock of microelements contains the speech sounds and the pauses. Each sound is built up of 4 microelements. The RUSKON program produces the sound structure out of a possible set of 37 consonants and 35 vowel phoneme realizations. The pauses between words and sentences are generated out of 5 microelements of different length. Thus, the inventory of microelements must contain 37 * 4 + 35 * 4 + 32 elements.

The letter-to-phone transformation

The Russian text may consist of 31 letters as well as a soft and a hard mark. Going through the setting of letters in the sentence the program selects out of the 31 consonants and 5 vowels those which correspond to the letters, simultaneously checking for any softening where required. At this stage the program also registers word stress as well as possible sentence stress by storing the ordinal number of the stressed vowel.

Selection of vowel phoneme realizations

The program segment designed to establish the correct vowel phoneme realizations takes as input data the word to be processed, and the vowel phonemes making up the word as yielded by the letter-to-phone transformation. They can be of the following five types: A, O, U, I, E. Taking these five vowels and their phonetic positions inside the given word the program selects one of the 35 possible vowel realizations.

Selection of the consonant phoneme realization

The consonant phoneme number yielded by the letter-to-phone transformation is identical to the phoneme realization number. However, in the course of later processing the sequence of consonants may undergo change as a result of the program segment which checks for voicing or palatalization.

Printing and dating

The program extracts the two-member sound clusters from the words of the sentence one by one. If the cluster is made up of two consonants, both members will be checked to see if either of them belong to exceptions. If the first member is listed as one undergoing no modification or the second member belongs to the set of consonants that do not change the preceding consonant, then the program passes on to the next cluster. When a modification is called for, it is carried out with the help of a table, word-final consonant-consonant clusters require special treatment. First, the word-final consonant is deprived (if necessary) and then the preceding consonant is processed.

Defining the transitions between vowel realizations

The vowel transitions are composed whenever a vowel occurs next to a consonant. In order to enhance acceptable reproduction the vowel realizations have to be adjusted to the actual phonetic environment. This adjustment affects the initial and the last microelement of the vowel realization. The modification concerns the adjustment of intensity (j) and the first two formants (F1, F2) in such a way that it would conform to the corresponding values of the preceding or following consonant.

Generation of the suprasegmental structure

The suprasegmental structure is generated when the segmental structure of the utterance has been defined. The construction of the suprasegmental structure is aided by the sentence stress typed in the text as well as by the sentence final punctuation mark. The temporal structure of the utterance is modified so that the duration of the vowel bearing sentence stress is doubled. The sentence final punctuation mark defines one of the eight possible intonation contours to be used. The RUSKON program recognizes the following sentence final punctuation marks: (Full stop), (colon), (comma), (semicolon), (exclamation mark), (question mark), (question mark) (exclamation mark), (double question mark).

Control of the speech synthesizer

The sequence of code thus generated is passed on to the speech synthesizer to control its operation when it is to sound to the text.