A COMPUTER-ASSISTED COURSE IN RUSSIAN
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A computer-assisted course in first-year college Russian, consisting of some 135 computer-assisted sessions, constituted a part of the offerings of the Slavic department at Stanford University for the first time in the academic year 1967-1968. The computer-assisted course was taken on a regular credit basis by Stanford students, and both the midterm and the final examinations for each of the three academic quarters were largely or, in the case of the spring final, totally identical with the examinations taken by students in Stanford's regular first-year Russian course.

The course was written and implemented on the DEC PDPI timesharing system at the Institute for Mathematical Studies in the Social Sciences (IMSSS) at Stanford University. Since computer-assisted courses of this type have not, to our knowledge, been available up to now, it may be well to say a few words about the exact nature of our undertaking.

Perhaps the most important feature of the course was that it relied solely on the computer to convey information to the student. No classroom instructors were used for the acquisition of reading, writing, or aural comprehension skills, although written homework and language-laboratory drills were corrected by a research associate and returned to the students. No classroom instruction was given in pronunciation; the students did, however, make short recordings of their own speech that were evaluated for them in private interviews with a native Russian. Even in this case, no new information was taught by the evaluator.

1. METHODS

1.1 The Students

The participants in the computer-assisted course were drawn from students who reported to the sectioning meeting for first-year Russian held on the first day of classes of the Stanford Fall Quarter in September 1967. The students were informed that a computer-assisted version of the course

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was available, and the first 30 students who signed up were admitted to the computer section. No selectional criteria were employed and no detailed information was gathered on the makeup of either the computer-assisted or the regular sections. However, it should be noted that over half of the students who eventually registered for the regular sections had expressed a desire to enroll in the computer-assisted section.

1.2 The Physical Framework

The computer-assisted sessions took place in a special classroom at IMSSS in Ventura Hall on the Stanford campus. During these sessions each student received coordinated audio and visual stimuli. The latter were provided by one of six Model-35 teletypes capable of printing both English and Russian texts, but having only a Russian keyboard. Audio stimuli came from a set of headphones connected to an Ampex tape player (one for each teletype) which, like the teletype, was controlled by the central processor. Thus, while the student could both listen to and read either Russian or English material, he could type only in Russian. Furthermore, only typed responses could be evaluated for accuracy by the computer. In the case of spoken responses, the student had to rely on a comparison of his own response with the correct answer given on the audio tape. (Students using the facilities of the Stanford Language Laboratory for dictation and comprehension drills did so in much the same manner as students from the regular language courses. A master tape was played at hourly intervals to which students listened with laboratory earphones.)

The only other item in the computer-assisted classroom that was regularly used by the students was a set of numbered slots—one for each student—from which the students obtained their summary sheets, both new and corrected homework assignments, and in which they deposited homework for correction.

While a proctor was regularly present during all sessions, his only function was to mount and rewind audio tapes and to report any technical difficulties to the computer staff.

1.3 The Underlying System

The material for the computer-assisted sessions was typed, corrected, and converted to machine run-code on one of the 12 Philco display consoles at IMSSS. The amount of typing to enter material was greatly reduced by the use of special input coding and a preprocessor program that used the coding to generate all the redundant portions of a given frame type. A complete listing of the most recent version of our input coding along with examples of raw and processed input, is given in Appendix A. A discussion of the program for the generation of machine-run code and for the control of the teletypes and tape players is given in Appendix B, which also contains a brief outline of the entire supporting system.
1.4 Classroom Scheduling

The day following the meeting in which the students were assigned to sections was devoted to arranging individual student schedules. Each student was scheduled for five computer-assisted sessions per week (i.e., one session per day, Monday through Friday). This schedule paralleled the class meetings of the regular sections. Students were urged to schedule all of their sessions for the same hour, but in a few cases were allowed to choose one hour for their Monday, Wednesday, Friday sessions and another for Tuesday and Thursday.

In the fall quarter, sessions were scheduled to begin 15 minutes after the hour from 1:15 PM through 5:15 PM. No students were scheduled between 6:15 PM and 7:15 PM, but students were regularly scheduled for 7:15 PM. In addition, students who had missed or failed a session were allowed to sign up for makeup sessions at 8:15 PM or on Saturday mornings. This schedule was also followed for the second term. In the third quarter, make-up sessions were scheduled for 12:15 PM, and the evening and Saturday sessions were dropped—a change made possible by a decrease in student enrollment to 24 (see Table 1).

<table>
<thead>
<tr>
<th>Table 1. Decrease in Student Enrollment</th>
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<tbody>
<tr>
<td>Computer-assisted section</td>
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<tr>
<td>Autumn Quarter</td>
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<td>Beginning = 30 students</td>
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<tr>
<td>End = 29 students</td>
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<tr>
<td>Winter Quarter</td>
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<tr>
<td>Beginning = 28 students</td>
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<td>(26 who had taken the first quarter plus 2 new students)</td>
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<td>End = 27 students</td>
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<td>Spring Quarter</td>
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<td>Beginning = 24 students</td>
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<tr>
<td>End = 24 students</td>
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<tr>
<td>(22 who had taken all 3 quarters of the academic year, plus 2 students who joined the class at the beginning of the second quarter)</td>
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</table>
Normally, only five students were regularly scheduled for a given hour on a given weekday. This allowed us to keep one instructional station as a backup station in case another station needed repairs or readjustments. However, nonscheduled students were allowed to use the sixth station for makeup sessions, if it was not needed by regularly scheduled students.

1.5 Student-Computer Interaction

Presentation of material. Throughout the course, the presentation of material to students remained essentially the same: English or Russian material was typed by the teletype or played by the tape player. However, the first lessons contained a much larger amount of English audio material than did the following ones. Eventually no English material was used on the tapes at all. In addition, as the students’ knowledge of Russian increased, standard instructions, as “listen,” “repeat,” and “type in Russian,” were given in Russian instead of English.

Response evaluation. During much of the first quarter, the computer-assisted sessions were simply linear programs through which each student proceeded in exactly the same manner. In these sessions, the only variables in the instructional sequence were the inclusion or omission of an error message when the computer encountered or failed to encounter a deviating response character.

By Lesson 27, routines were available that permitted the computer to omit a given block of material in a machine session if the student had handled satisfactorily a certain number of test items immediately preceding that block. Examples of such a remedial block and a preceding test item are given in Appendix A under codings such as \( bb \) and \( srm \). Branching of this kind was used throughout the course. The contents of the omittable blocks, however, changed greatly during the last weeks of the Fall Quarter. In Lesson 27 and the immediately following lessons, the block had often contained a short pattern drill on a given rule. It soon became clear that students derived little benefit from such drills, especially if the rule in question had been introduced some time before. Accordingly, during the last week of the quarter, and throughout the rest of the year, the contents of such blocks regularly consisted either of a supplementary explanation of a new rule or of an instruction to review a rule or rules presented during an earlier lesson. The results of the first-quarter final examination (presented in Table 3, below) indicate that this approach was highly effective.

By the second quarter, routines had been written to allow the automatic generation of a remedial block after each of a series of drill items covered by the same rule. This development, which greatly reduced the amount of input needed in such cases, resulted in a significant increase in the number of remedial blocks included in the machine sessions.

Restart points. During the first quarter, a student who, because of technical difficulties, failed to complete a computer-assisted session before
signing off had two alternatives: repeat the entire session or request the attendant to schedule him for the next session—a request granted only if the student had completed almost the entire session.

Beginning in the second quarter, restart points were inserted in the session text, so that the student could skip material he had already completed and could start the session close to the point he had reached on the preceding day.

1.6 Supplementary Activities

In addition to the computer-assisted sessions, the students in the computer-assisted group regularly carried on a number of additional activities designed to reinforce the material taught in the classroom. These included:

1. preparation of written homework assignments (primarily the translation of English sentences into Russian, occasionally the completion of missing endings in a Russian text).

2. work with additional audio tapes in the Stanford Language Laboratory (students listened to and repeated sentences, took Russian dictation, and wrote answers to spoken Russian questions about a paragraph read on the immediately preceding portion of the tape).

No new vocabulary or grammar was included in either the homework or the laboratory tapes. All material written by the students was placed in the numbered slots described earlier, collected by a research associate, corrected, and returned to the students.

Two or three times per quarter each student was required to record on tape a short Russian passage containing only material already taught during machine sessions. Immediately after the recording was made, it was evaluated for the student by a native Russian with a background in the teaching of the language. Students were informed of any pronunciation defects and advised how to correct them.

Since the computer-assisted sessions included a coverage of the pronunciation features regularly taught in first-year Russian, no new material on pronunciation was taught to the students during the evaluation of their recording. Rather, their attention was drawn to any points that had already been covered, but which they had failed to master.

Students who wished to discuss their work had access to staff members at IMSBS and in the Slavic department. However, such contacts, which were relatively rare, were always initiated by the student and had nothing to do with the curriculum.

1.7 Supplementary Material

The following supplementary materials were written and distributed to the students:
1. A programmed introduction to Russian handwriting, coordinated with the first seven computer-assisted sessions.

2. A set of summary sheets for individual machine sessions. These sheets included both the grammar and the vocabulary presented in the session. They were generated originally for all sessions except review sessions from Session 39 on. The sheets for Sessions 1 through 38 were in the revised course.

3. Six preexamination summaries containing the vocabulary and rules covered up to the midterm or final examination for each of the three quarters. These summaries covered not only material presented during the current quarter but also material taught in the preceding quarter or quarters.

4. Homework assignments coordinated with individual machine sessions. Such assignments were available regularly for all sessions, except a few review sessions beginning with Session 8. (The handwriting introduction contained written homework for the first seven sessions.)

5. Response sheets for language-laboratory drills. These were sheets of paper containing the name of the drill and space for the responses.

The materials that were not distributed to students included:

1. Forty audio tapes used for language-laboratory drills.
2. Six videotapes prepared under Professor Suppes' direction.

1.8 The Daily Summary

The data on student performance were made available in the form of a daily summary of student progress. It contained the following information for each student: the student's name and number, the number of the session taken on the day in question (if no session was taken, this was also indicated), the percentage of correct responses, the running time in minutes, and the next session scheduled for the student. Examples of daily summaries are found in Appendix C.

The summaries were used in a number of ways. First, the classroom proctor used the summaries to ascertain which audio tape or tapes would be needed during the coming day's instruction. (As the examples in Appendix C show, not all students took the same lesson the same day.) Second, the sheets also indicated which students, because of illness or other difficulties, fell more than two or three sessions behind the official schedule. Such students were contacted and arrangements were made for the necessary number of makeup sessions.

Third, the summaries were used to evaluate the effectiveness of a given session and, consequently, of new techniques that played a major role in that session. Thus, if a relatively large number of students took more than 50 minutes to finish a particular session, it was clear that the session contained material either too difficult or too voluminous to be handled within the allotted time. This knowledge was useful not only in the revision of the session itself, but also in predicting the average run time necessary for
subsequent sessions of similar type and magnitude. Such sessions could then be modified to require a more suitable average run time.

The same considerations applied to the percentage of correct responses. Whenever a relatively large number of students had relatively low scores (the minimal score required before the student was allowed to proceed to the next session was 70% correct), it was apparent that the session was too difficult for the students to handle successfully. If, as was sometimes the case, the session was distinguished by the extensive use of a technique not previously employed or not previously used to any significant degree, it was tentatively assumed that the difficulty was attributable to that factor. This hypothesis was tested in one or two following sessions in which the technique in question played as essential a role as in the session where the low scores first appeared. If the scores in those sessions showed similar distributional characteristics, the use of the technique in question was eliminated or reduced in future sessions and in the revision of the session already written. Otherwise, it was assumed that this technique was not in itself unsatisfactory, and the session that did show a large number of low scores was reexamined in the hope of isolating other factors to which the students' difficulties could be attributed.

In order to achieve a reasonably satisfactory basis for a comparative evaluation of the performances of the computer-assisted and the regular sections, the grammar and vocabulary presented to the former group were chosen in such a manner as to provide as large an overlap as possible with the material taught to the latter. The text used by the regular sections was the Introductory Russian Grammar by Galina Stilman and William E. Harkins. All the grammar material was taught, but, since the instructors of the regular sections felt that the vocabulary in the text was far too extensive for a first-year course, they compiled a list of those vocabulary items from the book which they felt should be mastered by their own students. The students of the regular sections were informed that only words included in this list need be memorized, and it was this list, and not the total Stilman-Harkins vocabulary, which was used to determine the items included in the computer-assisted course.

While the vocabulary overlap was not complete, both the project staff and the instructors of the regular sections felt that a single examination for both groups was justified, because the items learned by both groups constituted a large portion, 85 to 90%, of the total number of words for which the students were held responsible.

The overlap in grammatical material was even greater. Both groups covered all the inflectional material regularly taught during the first year. The sole inflectional category included in Stilman-Harkins, but not taught to the computer-assisted group, was the present passive participle, a category represented in their material only by two vocabulary items -ljubimyj- and -tak nazyvaemyj-. On the other hand, two topics—the second genitive
and the second locative—were included in the computer-assisted sessions, although they were mentioned only in footnotes in Stilman-Harkins.

The material covered in any of the six half-terms of the computer-assisted course was sequenced according to the principal investigator's conception of the most satisfactory programmed presentation. The textbook served only as a general guide in compiling the total list of topics to be included in each half term. In addition, where this was considered conducive to a more satisfactory overall program, some material was introduced earlier in the computer-assisted course than in the regular sections, while other material was presented much later.

It is clear from the above that the material covered by the computer-assisted and the regular sections was not entirely identical. As a result, the findings discussed in section 2.1 must be viewed with considerable reservations. Nevertheless, it is true that the examinations given to both groups of students were felt to be a reasonably fair test of their achievements not only by the project staff, but also by the instructors of the regular sections, and that until further research is possible, our findings, though they leave much to be desired, represent the only comparative evidence of this type in existence.

2. FINDINGS AND ANALYSIS

2.1 Comparative Results of the Examinations

All midterm and final examinations conformed to the standard requirements of Stanford University for courses meeting five hours a week. These were that the midterm examination be one academic hour (i.e., 50 minutes) in length and the final examination be two full hours (i.e., 120 minutes), that the examination not be identical to previous examinations in the same course, and that the students not see the examination in advance.

Because of unavoidable differences in the sequencing of vocabulary and grammatical material, the examinations for the first two quarters and the Spring midterm were divided into a "common portion," given to both groups.

The text of the common portion of the first two final examinations and the complete text of the Spring final are given in Appendix D. While no claim is made that the common portion of the examinations constituted a completely objective criterion for the evaluation of the relative achievements of the computer-assisted and regular sections, efforts were made to prevent an overly great bias in favor of either group. Thus, during the first two quarters, the project staff prepared the common portion of one midterm and one final examination, while the instructors of the regular courses prepared the common portion of the other final and midterm. In each case, the group which prepared the material submitted it for modification.
to the other group before the final copy was typed. In the third quarter, each group contributed approximately 50% of the material on both the midterm and the final examinations.

The Autumn Quarter. Approximately 66% of both the midterm and the final examinations for the Autumn Quarter were identical, both for the computer-assisted and for the regular Russian 1 sections. Table 2 shows the results for the midterm; Table 3 for the final. As is clear from Table 2, the midterm performance of the computer-assisted group was in no way superior to that of the regular students. The computer-assisted group, however, greatly excelled the regular group on the final. Thus, the average number of errors for the regular group was three times greater than that for the computer-assisted group. Fourteen out of 28 students in the regular group made more errors than did the poorest student in the computer-assisted group. Of 13 students who made fewer than 10 errors, 12 were in the computer-assisted group, while of 23 students making fewer than 20 errors, 19 were in the computer-assisted group.

The Winter Quarter. Approximately 66% of both the midterm and the final examinations for the Winter Quarter were identical, both for the computer-assisted and for the regular Russian 1 sections. Table 4 shows the results for the midterm; Table 5 shows those for the final.

While the performance of the computer-assisted group continued to be superior to that of the regular group, the most striking difference was in the number of students who completed the second quarter. Although only 26 of the original 30 computer-assisted students remained, (see Table 1), a much larger portion of students remained in the computer-assisted group than in the regular group. Since students who fail to complete at least one year of college Russian know too little to use the language effectively, it would appear that computer-assisted instruction would avoid much of the wasted time and effort which mark present-day university language courses.

The Spring Quarter. Approximately 80% of the midterm examination was identical for both the computer-assisted and the regular groups. The final examination was completely identical for both groups. Table 6 shows the results for the midterm; Table 7 shows the results for the final examination.

While the computer-assisted group did only slightly better on the midterm (see sec. 2.1), their performance on the final which covered the entire year's material was significantly superior to that of the regular students.

The results for this final examination are particularly interesting in that they include performance data for the sole student who abandoned the computer-assisted course for the regular section. At the end of the second quarter, this student expressed dissatisfaction with the computer-assisted course and obtained the permission of an instructor in one of the regular
Table 2
Results of First-year Russian Fall Quarter Midterm Examination
(Common Portion)

<table>
<thead>
<tr>
<th>Number of errors</th>
<th>Computer-assisted section</th>
<th>Regular section</th>
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Total number of students 29 30  
Total number of errors 429 442
### Table 3
Results of First-year Russian Fall Quarter Final Examination
(Common Portion)

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Total number of students: 29 (Computer-assisted section), 28 (Regular section)
Total number of errors: 457.5 (Computer-assisted section), 1,372 (Regular section)
Total possible errors per student: 350 (Computer-assisted section), 350 (Regular section)
Table 4
Results of First-year Russian Winter Quarter Midterm Examination (Common Portion)

<table>
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<tr>
<th>Number of errors</th>
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<th>Computer-assisted section (New)</th>
<th>Computer-assisted section (Total)</th>
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Total number of errors 316 2 335.5 190
Average number of errors 12.1 9.75 12 12.7
Table 5
Results of First-year Russian Winter Quarter Final Examination
(Common Portion)

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Average number of errors 21.06 30.5 21.8 25.8
TABLE 6
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(Common Portion)

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<td>43.5</td>
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</table>

Total number of students | 22 | 2 | 24 | 16
Total number of errors | 336 | 25.5 | 361.5 | 260.5
Average number of errors | 15.27 | 12.73 | 15.1 | 16.3
### Table 7
Results of First-year Russian Spring Quarter Final Examination
(Common Portion)

<table>
<thead>
<tr>
<th>Number of errors</th>
<th>Computer-assisted section (Old)</th>
<th>Computer-assisted section (New)</th>
<th>Computer-assisted section (Total)</th>
<th>Regular section (Old)</th>
<th>Regular section (New)</th>
<th>Regular section (Total)</th>
<th>Transfer</th>
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</tbody>
</table>

| Total number of students | 22 | 2 | 24 | 13 | 3 | 15 | 1 |
sections to transfer to that group. As seen in the results of the spring final examination, the student was unable to perform successfully in a regular classroom setting.

The significance of his failure is unclear. On the one hand it might be seen as an indication that computer-assisted instruction, repugnant as it was to the student, was a major factor in his success in dealing with the work of the first two quarters. On the other hand, it might be viewed as a sign that the students in the regular sections developed a set of learning techniques for dealing with the materials of their course which the computer-assisted students did not acquire. Since either of these possibilities would, if correct, be of great significance in the evaluation of the effectiveness of computer-assisted instruction, one may hope that the future research will focus on questions of this type.

As is shown by columns 2 and 4 of Table 7, the two students who joined the computer-assisted course at the beginning of the Winter Quarter were counterbalanced by three students who joined the regular sections at the beginning of the third quarter (for their history, see Table 1). It follows that of the 30 students who began the computer-assisted course, 22 or 73.5% successfully completed the entire three quarters of the course. Of the 38 students who entered the regular sections, only 12, or less than 31.5%, completed three quarters. Even if the eight students who left the regular course before the end of the first quarter are disregarded, thus obtaining an initial enrollment of 30 for both groups, only 40% of the regular group completed the course.

The consistently superior performance of the computer-assisted group is even more impressive in light of these statistics. A large number of the students who left the regular course did so because they were unable to perform satisfactorily. Since, as Table 1 shows, 7 of the 8 students who
left the computer-assisted course did so for other reasons, it is not improbable that the 12 students who completed three quarters on a regular basis represented a much more gifted group than the group of 22 who completed three quarters of computer-assisted work. The failure of this small, select group of "survivors' to surpass the larger computer-assisted group, which had not been subjected to any significant "weeding-out" process based on the quality of past performance, was particularly encouraging.

Midterm examination results versus final examination results. It is particularly interesting to compare the results of the midterm examinations with those of the finals in each of the three quarters. The average number of errors was practically identical for both groups on the midterm examinations. On each of the three finals, however, the computer-assisted group did significantly better than the regular group.

We feel that these facts are not the result of mere chance, but represent a striking illustration of one of the basic advantages of computer-assisted instruction as compared with regular classroom instruction—the fact that the former constitutes a much more efficient apparatus for the review of a large amount of previously learned material than does the latter. Thus, while the 50-minute midterm examinations centered primarily around vocabulary and grammar material introduced in the immediately preceding month or five weeks, the final examination included not only the material covered throughout the entire quarter, but also, in the case of the Winter and Spring terms, a great deal of material introduced earlier. In the classroom, it is extremely difficult, if not impossible, to ascertain in detail which of a large number of words or rules has been forgotten by which student or students. A computer-assisted review of the same body of vocabulary and grammar provides each individual student with detailed indications as to exactly which items he has forgotten and needs to review. If he follows these indications conscientiously, and if the time gap between the review and the examination is not too large, his chances of success are extremely good.

2.2 The Division of Labor Between Computer-assisted Sessions and Supplementary Activities.

During the Fall Quarter, as a result of the information provided by the daily summaries discussed in section 1.8, the scores of the midterm and final examinations, and feedback from student comments, a number of hypotheses concerning the most efficient utilization of computer-assisted instruction in the teaching of foreign languages gradually evolved. These hypotheses, which were to some extent confirmed by the success of instruction during the Winter and Spring quarters, attempted to define the optimal division of labor between computer-assisted and non-computer-assisted activities under the conditions governing work on the 1967–1968 course. While a
more sophisticated set of instructional devices (display consoles, light pens, etc.) might result in a different approach, the principles outlined below would be applicable to any computer-assisted language course employing the devices discussed in section 1.3 above.

Division of labor between the computer and the language laboratory. As the course progressed, it became apparent that certain activities which in the first lessons had been included in the computer-assisted sessions would be more effectively handled if relegated primarily to the language laboratory. This was particularly true of dictated sentences and responses to questions about material presented orally. These items proved much harder to type than to write down. Since all material to be checked by the computer had to be typed, the second half of the first quarter saw a gradual reduction in the length and number of such items in the computer-assisted lessons. However, other audio-lingual activities such as reading sentences after the speaker, responding to questions about typed material, or simply saying Russian sentences and then checking them against the tape were retained as part of the computer-assisted lessons. As things stand now, the student acquires the correct pronunciation of vocabulary items and a basic acquaintance with spoken Russian in his computer-assisted sessions. He extends this knowledge and undergoes extensive testing on his ability to comprehend spoken Russian in the language laboratory. His pronunciation is tested by the evaluation tapes described earlier.

Division of labor between the computer and written homework. It became clear during the first few weeks of the course that the computer was much more effective in handling smaller, more closely knit constructions than in dealing with long sentences or paragraphs. It was, therefore, decided to use the computer-assisted sessions primarily for the introduction and drilling of "building blocks" (i.e., sentence constituents) and to leave extensive work with long Russian sentences to the homework assignments. The results of the final examinations seemed to bear out the validity of the assumption underlying this approach (i.e., that a student who has mastered the production of sentence constituents thoroughly will have little difficulty in producing sentences composed of those constituents). While complete sentences are, of course, included in the computer-assisted sessions, they are generally given only after the student has performed intensive drill work on any new sentence components they may involve. Even under these conditions, sentences to be typed during the computer-assisted sessions were generally short and centered around one or two key constructions which were among the topics of the given lesson.

On the other hand, the number of sentences included in the written homework was significantly increased and special efforts were made to make sure that these sentences called for constructions covered not only by current lessons, but also by previous work. As things stand now, the com-
puter's job is primarily teaching vocabulary items and grammatical constructions. The integration of new vocabulary items and grammatical patterns into previously assimilated material is accomplished more effectively by written homework.

**Division of labor between the computer and lesson summaries.** Perhaps the most striking change which took place during the course of the first quarter's work was the role played by summaries for outside study. During the first 27 lessons, no outside summaries were given, and students wishing to review material had to do so on the basis of the printout of their computer-assisted sessions. It soon became apparent that such an approach tended to decrease the effectiveness of the computer-assisted course, since the student had to create his own material for outside study. Between the first of December and the final examination for the Autumn Quarter, lesson summaries were provided for each new lesson, and a final summary was provided covering the material of the entire quarter. Furthermore, during the final week's review, instead of providing the students with the correct answers to the review problems they missed, the computer simply told them to review a given rule or rules. The results of the Autumn final examination indicated that this approach was highly successful, and it was continued throughout the year.

Thus, the computer's role in reviewing material is that of a tutor who assesses a student's performance and, when necessary, directs him to the proper portion of his summary sheets. At following sessions the student is again tested on any items missed and informed whether more study is needed.

**3. CONCLUSIONS**

**3.1 Goals Achieved and Suggestions for Further Research**

The main objective in developing and implementing a computer-assisted course in first-year college Russian was to ascertain the extent to which such a course provided a desirable alternative to regular classroom instruction. The findings discussed in section 2.1 indicate that, at least insofar as the translation of English sentences into Russian is concerned, computer-assisted instruction is probably more effective than a regular classroom-taught course. Although it would be desirable to investigate this question on a wider scale than was possible in the present case, there is every reason to believe that the introduction of computer-assisted instruction in elementary language courses in which the acquisition of writing plays an important role would greatly improve the effectiveness of those courses.

The set of principles discussed in section 2.2 constitutes a first step in the direction of a general theory concerning the optimal utilization of
computer-assisted sessions in second-language learning. The development of the “building-blocks” concept as the fundamental notion underlying the division of labor between such machine sessions and supplementary, non-computer-assisted activities has, we feel, provided other scholars concerned with the creation of computer-assisted language courses with a fruitful way of approaching this problem. While this area too needs further investigation, there is every reason to anticipate that the general strategy evolved during the work on this project will prove a successful one.

3.2 Disposal of Course Materials and Detailed Data

The printout of the full text of the computer-assisted sessions (10 volumes including more than 300 pages each), the handwriting booklet, the homework assignments and study sheets, the pre-examination summaries, the printout of the reduced data described in section 1.8 (some 350 pages), and a complete set of all audio and video tapes made in connection with this project are on file at the Institute for Mathematical Studies in the Social Sciences, where they will be made available to scholars interested in a firsthand acquaintance with these materials.

APPENDIX A

THE CODING OF INPUT FOR COMPUTER-BASED SESSIONS

Lessons are coded in a shorthand coding hereafter referred to as “input code.” This is the basic format used to specify lessons. A standard transliteration will be employed.

Russian preprocessor I (RP-I) is used to convert this text to a format that can be listed with the Russian lister on teletypes with Russian characters. These listings are used as a script for recording the audio.

Russian preprocessor II (RP-II) converts this “listable code” into “run-time code” for the main program.

Examples of raw and processed input follow.

```
INPUT

INPUT  OP4;

REM BB  DAME(A)+ RULE XX+ KNI(A)+

OUTPUT

TRY 1
GAA 1
TE COMPLETE.
LR KNI(A)
LR DAME(A)
RET 2

---------------------

INPUT  REMEDIAL BB  USED AS A TEST

REM BB  DAME(A)+
```

```
OUTPUT

TRY 1
GAA 1
TE COMPLETE.
TST 1
LR KN10(A)
BLX *
RET 1
TE REVIEW RULE XX
FIN *
IST 1
LR DAM(A)
BLX *
RET 1
TE REVIEW RULE XX
FIN *
RET 2
_____________________
BE SAMAS-BB- EXCEPT COMPLETE OMITTED, TAKES -REM-

INPUT <DOES NOT TAKE -REM-
D B RAT+ <ONLY ONE ITEM ALLOWED
 BROTHER <PLUS MEANS OPTIONAL ENG. TRANSLATION

OUTPUT

TRY 1
GAA 1
TE READ ALOUD
RET 1
TR B RAT
RET 1 <OMITTED IF ENG. TRANS. DOES NOT FOLLOWED
TE BROTHER <OPTIONAL
RET 2
_____________________
DM <SAME AS -D- EXCEPT USES DIFFERENT INSTRUCTIONS
TE READ AFTER ME

INPUT <DOES NOT TAKE -REM-
DM ON <SAME INPUT PATTERN AS -D-
HE

OUTPUT

TRY 1
GAA 1
TR PROHITAJTE FRAZU ZA MNIO.
RET 1
TR ON
AR ON
WAT 20 <PROGRAM CALCULATES WAIT TIME
RET 1
TE HE <OPTIONAL AS IN -D-
RET 2
_____________________
DMR <SAME AS -DM- EXCEPT USES DIFFERENT INSTRUCTIONS
TR HITAJTE ZA MNIO.

INPUT
EG B RAT+ <ONLY ONE ITEM ALLOWED-NEEDS PLUS
BROTHER <TRANS. ALWAYS FOLLOWS

OUTPUT

AR B RAT/ MEANS BROTHER
RET 1
TR B RAT /BROTHER
RET 2
_____________________
INPUT OP-CODES (CONT.)

INPUT <DOES NOT TAKE -REM- YET
FD PIS;M(O)+ <STEM(ENDING) -- NEEDS PLUS
     NO+ <3 CHAR. CODE FOR TABLE -- NEEDS PLUS
     PS, IS, GE, AS, <1-10 TWO CHAR. SYMBOLS
     <ALWAYS FOLLOWED BY A COMMA

OUTPUT
TRY 1
GAA 1
IE COMPLETE THE FOLLOWING FORMS OR PIS; MG
LE P.S. PIS; M(E)
LE I.S. PIS; M(K)
LE G.S. PIS; M(A)
LE A.S. PIS; M(O)
RET 2

----------------------------------
INPUT TAKES -REM-, ANY NO. OF ITEMS, IF -SR- IS LONGER THAN
ONE LINE ANSWER MUST BE ON LAST LINE OF -SR-
F
ITA ULIC(A) OHEN; OR +S; MA>,
> NE UME(=) HITAT; PO-RUS(KI).

OUTPUT
TRY 1
GAA 1
IE FILL IY.
SR ITA ULIC(A) OHEN; OR +S; MA>,
SR > NE UME(=) HITAT; PO-RUS(KI).
RET 2

----------------------------------
INPUT DOES NOT TAKE -REM- SERIES, ANY NO. OF ITEMS
FEA
VY BYLI VHERA NA LEXCII;?
U ITIX) MOLOD(YX) L-DEJ MNOGO KNI(G).

OUTPUT
TRY 1
GAA 1
AE LISTEN TO WHAT I SAY THEN FILL IN THE BLANKS.
AFR
VY BYLI VHERA NA LEXCII?
SR BYLY WHERA NA LEXCII;?
AFR
U ITIX) MOLOD(YX) L-DEJ MNOGO KNI(G).
SR U ITIX) MOLOD(YX) L-DEJ MNOGO KNI(G).
RET 2

----------------------------------
INPUT NO -REM-, ONE ITEM ONLY
L DAMA

OUTPUT
TE LISTEN,
RET 1
TR DAMA
AR DAMA ...
DAMA
RET 2

----------------------------------
INPUT
LCE (DA'(M) A+
     LADY

OUTPUT
TRY 1
GAA 2
FUNCTION     

INSTRUCTIONS      

LISTEN.    
AR  DA' MA  
DA' MA  
LISTEN AGAIN, THEN COMPLETE THE WORD.    
AR  DA' MA  
DA' MA  
TST  1  
SR  (DA'MA)  
BLX  1  
RET  1  
TE  COPY THE NEW WORD WITHOUT THE STRESS.    
LR  (DAMA)  
FIN  1  
TR  DA'MA/MEANS -LADY-  
RET  2  
-----------------------------------------------

INPUT      
LGE  DA'MA+  
     LADY  
OUTPUT      
TRY  1  
GAA  1  
TE  LISTEN CAREFULLY.    
AR  DA' MA  
DA' MA  
TE  LISTEN AGAIN AND THEN TYPE THE NEW WORD.    
AR  DA' MA  
DA' MA  
TST  1  
MLR  (DAMA)  
BLX  1  
RET  1  
TE  NOTE THAT DA'MA CONTAINS NO NEW SOUNDS OR LETTERS.  
COPY IT.    
MLR  (DAMA)  
FIN  1  
TR  DA'MA MEANS -LADY-  
RET  2  
-----------------------------------------------

INPUT NO -REM-, ONE ITEM ONLY      
O  MAL'HIK  
OUTPUT      
TE  OBSERVE  
RET  1  
TR  MAL'HIK  
RET  2  
-----------------------------------------------

INPUT NO -REM-, ONE ITEM ONLY      
R  KARTINA  
OUTPUT      
TE  REPEAT.  
RET  1  
TR  KARTINA  
AR  KARTINA...  
KARIINA...  
RET  
-----------------------------------------------

RMS  SAME AS -DMS- EXCEPT RUSSIAN INSTRUCTIONS  
TR  POTVORITE FREU ZA MNOJ.  

INPUT DOES NOT TAKE -REM-, ANY NO. OF ITEMS
S
HE IS SICK.
ON BOLLEN.

TE
SAY -- HE IS SICK.

WAT
30
AR
ON BOLLEN.
RET 2

SRR
SAME AS -S- EXCEPT RUSSIAN INSTRUCTIONS
TR
SKAQITE PO-RUSKII-- WHERE IS BORIS?

INPUT DOES NOT TAKE -REM-, ANY NO. OF ITEMS
SA
GDE VY BYLI VHERA?
NA LEXCII?
A GDE BYL VAV MUQ?
NA SOBRANI?

TE
SAY THE ANSWER.
RET 1
TR
GDE VY BYLI VHERA?
AR
NA LEXCII
RET 1
TR
A GDE BYL VAV MUQ?
AR
NA SOBRANI?
RET 2

INPUT DOES NOT TAKE -REM-, ANY NO. OF ITEMS
SA
VY ID-TE NA KONCERT?
DA,+
A BORIS ID-?
RET.

TE
SAY A ONE WORD ANSWER.
RET 1
TR
VY ID-TE NA KONCERT?
AR
DA,.
RET 1
TR
A BORIS ID-?
AR
RET.
RET 2

INPUT DOES NOT TAKE -REM-, ANY NO. OF ITEMS
SOP
UMNYJ+
GLUPYJ+
KRASIVIJ+
NEKRASIVIJ+
BOL;WOJ+
MALENKIJ
TE
SAY THE WORD WITH THE OPPOSITE MEANING.
RET 1
TR
UMNYJ
AR
GLUPYJ
RET 1
TR
KRASIVIJ
AR
NEKRASIVIJ
RET 1
TR
BOL;WOJ
AR
MALENKIJ
RET 2

INPUT
SRM
SPECIAL REMEDIAL ROUTINES
VARIED INPUT
<NOTE THAT -IS, ARE, THE, A, AN- ARE AUTOMATICALLY
Если открытое входное сообщение удаляется из хранимого входного сообщения и, следовательно, не учитывается при кодировании предложение.

"MOMMA IS AT HOME," ➔ "AT-" считается как слово 2;
"MAMA DAMA" ➔ "AND STORED WITH WORD 3 AS ONE UNIT"

WE WRITE,+
"MY P1 (WEM, SAT; WUT)"
2VAIPVPI!

"IVAN IS READING,) AN INTERESTING BOOK TO BORIS.+
IVAN HITA (TI, TI, TI) INTERESHEM(U, YU) KNIGU(A)
BORIS(U, U)+ ➔ "NOTE ZERO CODING FOR 2ND ENDING"
2VAIPVPI, 3A PAAAS, 4NAS NAA, 5NDS NED"

HE IS LYING, IE) DOWN.+
ON LET (IT, AT; AT)"
2VAIPVPI]

INPUT DOES NOT TAKE "REM-", ONLY ONE SENTENCE ALLOWED
NOT TO EXCEED 9 RUSSIAN WORDS

SRM
"MOMMA IS A LADY,"+
"MAMA DAMA"

OUTPUT
TRI
1
GAA
2
TST
1
TE
"TYPE IN RUSSIAN,
"MOMMA IS A LADY."
NLR
(MAMA) (DAMA)
BLX
1
TRY
1
GAA
1
RET
1
TST
1
LE
"THE BASIC FORM OF "MOMMA" IS [(MAMA)
BLX
1
RET
1
TE
"REVIEW THIS WORD IN YOUR VOCABULARY."
FIN
1
BLX
2
TST
1
LE
"THE BASIC FORM OF "LADY" IS [(DAMA)
BLX
1
RET
1
TE
"REVIEW THIS WORD IN YOUR VOCABULARY."
FIN
1
BLX
2
RET
1
TRY
2
GAA
1
TE
"TRY THE SENTENCE AGAIN."
NLR
(MAMA DAMA)
FIN
1
RET
2

INPUT TAKES "REM-", ANY NO. OF ITEMS
I
"WHERE ARE YOU FLYING?"
KUDA VY LETIE?

TRY
2
GAA
1
TE
"TYPE IN RUSSIAN."
RET
1
TE
"WHERE ARE YOU FLYING?"
VAN CAMPEN

NLR (KUDA VY LETITE?)
RET 2
---------------------
TAR SAME AS -T- EXCEPT RUSSIAN INSTRUCTIONS
TR PENATAJTE PO-RUSSKI!
---------------------
TAR SAME AS -T- EXCEPT INSTRUCTIONS OMITTED
---------------------
INPUT TAKES -REM-, ANY NO. OF ITEMS.
ISR SHE IS HOME.
ONDA DOMA

TRY 2
GAA 1
TR NAPEHATAJTE FRAZU PO-RUSSKI./
TE SHE IS HOME.
NLR (ONDA DOMA)
RET 2
---------------------
INPUT IGI MOMMA+
MAMA+
YES+
DA

OUTPUT
TRY 1
GAA 1
TE TYPE IN RUSSIAN
TST 1
TE MOMMA
NLR (MAMA)
BLK 
RET 1
TE COMPLETE THE WORD FOR MOMMA
SR (M) M(A)A
SR M(A)A
TE NOW TYPE THE WHOLE WORD.
NLR (MAMA)
FIN 
TE TYPE IN RUSSIAN
TST 1
TE YES
NLR (DA)
BLK 
RET 1
TE COMPLETE THE WORD FOR YES
SR (D) A
TE NOW TYPE THE WHOLE WORD.
NLR (DA)
FIN 
---------------------
INPUT TAKES -REM-, ANY NUMBER OF ITEMS

THW OK NO+
WINDOW+
DVER+
DOOR+
SAMOL-T+
AIRPLANE

TRY 2
GAA 1
TE TYPE
AFR OK NO
OK NO
LR (OK NO)
RET 1
TE  WINDOW
AFR  DVER;
LR  (DVER;)
RET 1
TE  DOOR
AFR  SAMOL-
LR  (SAMOL-)
RET 1
TE  AIRPLANE
RET 2
-------------------
TRR  SAME AS "THW" EXCEPT RUSSIAN INSTRUCTIONS
TR  PEHATAJE!
-------------------
INPUT DOES NOT TAKE "REM", ONLY ONE ITEM ALLOWED
THS  MD> BABUWKA UEXALA+  
     MY GRANDMOTHER LEFT.  <ENG. TRANSLATION OPTIONAL
TRY  2
GAA  1
TE  TYPE
AR  MD> BABUWKA UEXALA.  
     MD> BABUWKA UEXALA.
LR  (MD> BABUWKA UEXALA.)
RET 1
TE  MY GRANDMOTHER LEFT.
RET 2
-------------------
TRR  SAME AS "THS" EXCEPT RUSSIAN INSTRUCTIONS
TR  PEHATAJE!
-------------------
INPUT DOES NOT TAKE "REM", ANY NO. OF ITEMS ALLOWED
TOP  MAL;HIK+
     DEVOKA+
     XOROWJ+
     FLOXOJ
TRY  2
GAA  1
TE  TYPE THE WORD WORD WITH THE OPPOSITE MEANING.
RET 1
TR  MAL;HIK
MLR  (DEVOKA)
RET 1
TR  XOROWJ
MLR  (FLOXOJ)
RET 2
-------------------
INPUT DOES NOT TAKE "REM", ANY NO. OF ITEMS ALLOWED
TIT  GDE VY GIW-TE?+  
     V MOSK VE+  
     KUDA VY LETITE ZAVTRA?+  
     V LENINGRAD.
TRY  2
GAA  1
TE  TYPE THE ANSWER.
AR  GDE VY GIW-TE?  
     GDE VY GIW-TE?
LR  (V MOSK VE)  
     KUDA VY LETITE ZAVTRA?  
     KUDA VY LETITE ZAVTRA?
LR  (V LENINGRAD.)
RET 2
-------------------
TIR SAME AS -TTR- EXCEPT RUSSIAN INSTRUCTIONS
TR OTVENAJTE NA TELIPOINTER

INPUT DOES NOT TAKE -REM-, ANY NO. OF ITEMS

TIR SAME AS -TTR- EXCEPT RUSSIAN INSTRUCTIONS
TR OTVENAJTE ODNIM SLOVOM.

T2W KUDA MAWA EDET?+ V WKOLO.+ OMA EDET AVTOBUSOM?+ NET, PEOKOM.

TRY 2
GAA 1
TE TYPE ONE WORD ANSWERS.
AR KUDA MAWA EDET?
MR (V WKOLO.)
AR OMA EDET AVTOBUSOM?
MR (NET, PEOKOM.)
RET 2

T2R SAME AS -T2W- EXCEPT RUSSIAN INSTRUCTIONS
TR OTVENAJTE DVUMA SLOVAMI.

INPUT DOES NOT TAKE -REM-, ANY NO. OF ITEMS

T3W KOZDA PRILETIT SAMOL-T+ V DVA HASA.+ A KOZDA ULETIT?+ V POLOVIN P+TOGO.

TRY 2
GAA 1
TE TYPE THREE WORD ANSWERS.
AR KOZDA PRILETIT SAMOL-T?
MR (V DVA HASA.)
AR A KOZDA ULETIT?
MR (V POLOVIN P+TOGO.)
RET 2

T3R SAME AS -T3W- EXCEPT RUSSIAN INSTRUCTIONS
TR OTVENAJTE TREC SLOVAMI.

INPUT DOES NOT TAKE -REM-, ANY NO. OF ITEMS

T4W GDE KAT>T+
OMA Pował K BORISU,+ OMA SKORD P+ID=T+
V P+T; S POLOVINJ.
TRY
2
GAA
1
TE
TYPE FOUR WORD ANSWERS.
AR
ODA KAT+7
RET
2
LR
(ODA POWLA K BORISU,)
AR
ODA SKORO PRID+I?
LR
(V P+I; E POLOVINOJ,)

---------------

TAR
SAME AS -T4W- EXCEPT USES RUSSIAN INSTRUCTIONS
TR
OTVEMAJTE NETYRI;> SLOVAMI.
---------------

INPUT DOES NOT TAKE -REM-, ANY NUMBER OF ITEMS
---------------

TSW
BORIS UMNYJ+?
DA, ON OHEM; UMNYJ MAL;HIX,+ 
KTO EGO L<BIT+?
EGO VSE DETI OHEM; L<@+T.

TRY
2
GAA
1
TE
TYPE FIVE WORD ANSWERS.
AR
BORIS UMNYJ?
BORIS UMNYJ?
LR
(ODA, ON OHEM; UMNYJ MAL;HIX.)
AR
KTO EGO L<BIT?
KTO EGO L<BIT?
LR
(EGO VSE DETI OHEM; L<@+T.)

---------------

RET
2

---------------

TSR
SAME AS -T5W- EXCEPT USES RUSSIAN INSTRUCTIONS
---------------

INPUT ALLOWS ANY NO. OF ITEMS, TEST BLOCKS ALWAYS INCLUDED
WITHOUT USE OF -REM-
---------------

TSK
RULE G.G,W+ <PARENTHESES NOT ALLOWED IN THIS LINE
DOM() GEK,(A)+
STOL(),G,(A)+
STUDENT(),G,(A)

TRY
1
GAA
1
TE
COMPLETE.
TST
1
LR
DOM/GEN.,DOM(A)
BLK
:
RET
1
TE
REVIEW RULE G.G,W
FIN
:
TST
1
LR
STOL,G,STOL(A)
BLK
:
RET
1
TE
REVIEW RULE G.G,W
FIN
:
TST
:
LR
STUDENT,G,STUDENT(A)
BLK
:
RET
1
TE
REVIEW RULE G.G,W
FIN
:
RET
2

---------------

TKE
SAME AS -TSK- EXCEPT INSTRUCTION -COMPLETE- IS OMITTED
---------------
INPUT TAKES ANY NO. OF ITEMS, TEST BLOCKS ALWAYS INCLUDED
WITHOUT USE OF -REM-

TB0 THE RULE,+ <PARENTHESES NOT ALLOWED IN THIS LINE,
   D.M.(A), G.S.(Y)+
   D.S.(E)+
   D.S.(U)
TRY 1
GAA 1
TE COMPLETE,
TST 1
LR DAMA/ G.S.(DAM(Y)
BLK .
RET 1
TE REVIEW THE RULE.
FIN :
TST 1
LE D.S.(DAM(E)
BLK .
RET 1
TE REVIEW THE RULE.
FIN :
TST 1
LE D.S.(DAM(U)
BLK .
RET 1
TE REVIEW THE RULE.
FIN :
RET 2

THE SAME AS -TB0- EXCEPT INSTRUCTION -COMPLETE- IS OMITTED

INPUT DOES NOT TAKE -REM-, ANY NO. OF ITEMS

VOC
   BROTHER+
   BRAT+
   SISTER+
   SESTRA

TRY 1
GAA 1
TE WE WILL NOW HAVE A VOCABULARY REVIEW.
RET 1
TE BROTHER
NLR (BRAT)
RET 1
TE SISTER
NLR (SESTRA)
RET 2

W
   THE GEN. PL.+ GLUP(A) (XY) DA(MA)(Y)+
   (IT(I)(IX) KRASIVY(E)(X) DET(I)(E))

WAIT 30
TRY 1
GAA 1
TE TYPE THE GEN. PL.
AFR GLUP+ DAMA
GLUP+ DAMA
LR (GLUPX DAM)
AFR ITI KRASIVYE DEII
ITI KRASIVYE DEII
LR (ITIX KRASIVYX DEII)
RET 2

WR SAME AS -W- EXCEPT USES RUSSIAN INSTRUCTIONS
WR FORM ANODESIVEWOOD NISLA+
   DAMA(A)(Y) +
   MOLOD(A)(YE) BAB(A)(Y)
INPUT DOES NOT TAKE -REM-, ANY NO. OF ITEMS

WW THE SINGULAR:+
   SAMOL+(TY)(I)+
   NEPRI+TRE(YE)(A)+ DEVONK(I)(A)

TRY 1
GAA 1
TE TYPE THE SINGULAR.

RET 1
TR SAMOL+Y
NLR (SAMOL-T)
RET 1
TR NEPRI+TRE DEVONKI
NLR (NEPRI-TMA> DEVONKA)
RET 2

INPUT DOES NOT TAKE -REM-, ANY NO. OF ITEMS

WWR FORMU MOGESTVENNOGO HISLA+
   ULICE(A)(AM)+
   WIROK(OU)(IN) DOROGE(I)(AM)

TRY 1
GAA 1
TR NAPEHATAJTE FORMU MOGESTVENNOGO HISLA
RET 1
TR ULICE
LR (ULIC AM)
RET 1
TR WIROKUJ DOROGE
LR (WIROK IN DOROGAM)
RET 2

INPUT DOES NOT TAKE -REM-, ANY NO. OF ITEMS

Y THE PLURAL:+
   MAMA(AY) (Y)+
   DAMA(AY) (Y)

TRY 1
GAA 1
TE SAY THE PLURAL.

RET 1
TR DAMA
WAT 10
AP DAMY
RET 1
TR MAMA
WAT 10
AP DAMY
RET 2

YW SAME AS Y EXCEPT USES RUSSIAN INSTRUCTIONS
IN SKAQITE...
APPENDIX B

BORIS

1. General Description of the Basic Operating Russian Instructional System (BORIS)

BORIS is a computer-assisted instructional system which runs on the Zeus time-sharing system on a PDP-1 computer at the Institute for Mathematical Studies in the Social Sciences at Stanford University.

2. The Background System

Zeus is the name of the IMSSS time-sharing system. It operates on a Digital Equipment Corporation PDP-1. Associated with the main processor are an IBM 1301 disk unit, 12 Philco READ units with keyboard and display scope, and several Model-33 and Model-35 teletypewriters. The system includes as standard user programs a text-editor by which text-files may be generated onto the disk from the keyboard and a lister program by which hard copies of text files may be printed on a teletype.

BORIS runs as a user program under this time-sharing system and itself time-shares the students as individual micro-users under the run-time program. Figure 1 shows various programs and disk-files used in the BORIS system with their interconnections.

3. Input Preparation

The text of each day’s lesson goes through four files and three preprocessors before it is available to the run-time program. Briefly, the procedure is as follows:
1. Using the text-editor, a manuscript is entered into the computer. This text-file (INPUT) consists of highly coded material using a set of predefined op-codes and combinations of English and Russian (transliterated) text. (For examples of the input coding, see Appendix A.)

2. The INPUT is processed by Processor-I, which acts generally as a macro-expander, to produce a second text-file (SCRIPT). The SCRIPT, like the INPUT, consists of op-codes and text. The codes, however, have been reduced to a limited set of basic operations and the text now mirrors both the actual text which will be presented to the student on the teletype and those answers which will be expected of him. The audio portion of the SCRIPT is then listed on a teletype to prepare an audio script used for preparing the audio portion of the lesson.

3. The SCRIPT is processed by Processor-II to produce the run-code used by the run-time program. This code is generated onto a scratch (temporary) file while, at the same time, the SCRIPT is checked for format correctness.

4. If the SCRIPT contains no errors, the run-code is transferred from the scratch file onto a permanent run-code file by Processor III.

Copies of the INPUT, the SCRIPT, and the RUN-CODE for each lesson are read onto DEC micro-tapes for back-up purposes and the process of preparing input can be initiated at any desired point in the above chain by starting with the appropriate text.

4. Audio Preparation

Using the listed audio script prepared from the SCRIPT, a master tape of the audio portion of the lesson is recorded on channel-A of a two-track tape. This is done off-line. The master tape is mounted on one of the Ampex units with record facilities and the tape is "beeped," using a program which, under the intervention of an operator listening to a playback of channel-A and following the marked script, records a beep (four teletype characters) directly onto channel-B at the appropriate places on the tape. The first three characters of a beep are simply a sequential count and the last character is a special stop code which, as will be explained, signals the end of a message. Each discrete message of the audio portion of the lesson is thus marked with a beep. Once the master tape has been beeped, several copies of the tape are made to be used on the audio equipment at each student station.

During the course of the lesson, messages are played sequentially as they appear on the tape and are not repeated.

5. Control of the Audio

The audio units are controlled through the teletypes. Each teletype has associated with it one audio station. Five special teletype characters are used to control the audio (i.e., characters sent to the teletype act as control functions for the audio units). The five characters are:

- play — turn on the recorder for playback;
- silent — cause the message to not be heard over the earphones;
- stop — stop the recorder;
- fast forward — advance the tape quickly;
- rewind — fast reverse, rewind the tape.

Zeus the time-sharing system has been programmed so that the stop code may be automatically duplexed; when recognized as an input character, it will generate a
Figure 1. BORIS files and programs.
like output character. This feature allows the tape to be stopped as soon as the stop
code recorded with each beep is recognized by Zeus and frees the run-time user
program from the responsibility of sending a signal to stop the tape.

6. The Text

The text for the Russian is a combination of English and Russian. To indicate
Russian text, a transliteration of the Cyrillic alphabet is used as shown in Figure 2.
To simplify the material, a one-to-one character transliteration is used, employing
the 26 letters of the Latin alphabet and 7 additional non-alphabetic characters
(<>; ; ] =). These are all lower-case characters on the Philco keyboard and are
included in the standard set of teletype characters, thus allowing accurate listings
of the text-files.

\begin{verbatim}
RUSSIAN CHARACTERS AND TRANSLITERATION
A B C D E F G A E E X Z И Й
A B V G D E Ф Q Z И Й
К Л М Н О П Р С Т У Ь
K L M N P R S T U F
X Ç Ч Ш Ы Ь Ъ Ь Ь Ь Ь Ь Ь
X C M W = : Y ; J < >

ENGLISH CHARACTERS
ABCDEFGHIJKLMNOPQRSTUVWXYZ

NUMERALS
0 1 2 3 4 5 6 7 8 9

OTHER CHARACTERS
' , ? - !

Figure 2. Transliteration of the Cyrillic alphabet.
\end{verbatim}

To indicate whether a character in the text represents a Latin or a Cyrillic letter,
two additional characters, / and \ are used. A special version of the standard lister
program available under Zeus is used that prints both of the above characters as
space, but recognizes / as a signal to switch from Cyrillic (Russian) to Latin (English)
and \ as a signal to switch from Latin to Cyrillic. Thus, a line of text might read

\[-kniga/-means -book-, but\[-knigi/-means -books-.

These methods are also used by Processor-II when generating run-code from the
SCRIPT text-file.
7. Input
The original input into the computer is in the form of a highly coded manuscript. (See Appendix A.)
The INPUT is listed with the standard system lister program to obtain hard copy for proofreading and reflects exactly what is contained on the text-file.

8. Script
The script consists of the following set of 33 basic op-codes:

- **audio**
  - AE audio English
    - The text following, which begins in English, is to be recorded on the audio tape, and a signal to play an audio message is to be generated at this point.
  - AR audio Russian
  - AFE audio future English
    - Same as AE, but the signal to play the tape is delayed until the teletype has positioned itself awaiting the student's response.
  - AFR audio future Russian

- **teletype output**
  - TE type English
    - The following text, which begins in English, is to be typed on the teletype.
  - TR type Russian
  - RET returns
    - The number following this op-code specifies the number of line-feeds desired for spacing and grouping of material on the teletype at run-time.

- **teletype input**
  - 123 This actually represents 16 separate op-codes. The text following the op-code contains one or more sets of parentheses. The material outside the parentheses will be typed by the computer, that inside the parentheses is the required answer, e.g.,
    - book is [(kniga)
      - fill in—(on duma(l), ona duma(la).
  - 1 is either null or N. If null, two line-feeds will be generated in the run-code preceding the text in order to space it on the paper; if N, these line-feeds will be suppressed.
  - 2 is one of "S, Q, C, L." These represent the four basic ways in which a response may be elicited from the student. S (simple) means that the line will be typed with an underscore to position the response and the teletype will then return and position itself at the underscores, awaiting the student response. This is used for responses to fill in blanks. Q (quick) means that the teletype will type up to the desired response and wait for the student to supply the answer. Then it will continue the line to the next response desired. This is used for responses to complete word endings. Both S- and Q-type answers require the student to start over and type the entire desired response when given additional opportunities after an error. C (character) and L (linear) are equivalent
to S and Q, but signal the run-time program to supply those initial characters of the answer which are correctly typed in. Thus a student, rather than having to start over later, merely needs to try again at the point at which the error occurred.

3 is either E or R and merely indicates whether the text begins in English or in Russian.

timing and repetition control

WAT wait n
N specifies a length of time for the program to wait while the student repeats an audio message or says a sentence in Russian.

RST restart
This marks a restart point to which the lesson will return should system failure cause a student’s lesson to terminate abruptly prior to completion.

TRY set try to n
Set a parameter, originally 3, which tells how many times a student must repeat subsequent responses before the program gives up and proceeds to the following lesson material.

GAA give answer after n
Set a parameter, originally 2, which tells how many times subsequent answers must be typed incorrectly before the program will give the answer.

TIM set time to n
Set a parameter, originally 10 seconds, which tells how long to wait on subsequent answers before declaring “time is up.”

program flow

BEG begin
Marks the beginning of a lesson.

END end
Marks the end of a lesson.

TST test
Marks the beginning of a test section.

BLK remedial block
Marks the termination of the preceding test and the start of material which will be ignored if the student responded correctly to the material in that test.

FIN end of remedial block.

9. Run Code
The run code, unlike INPUT and SCRIPT, is not a text-file, although it consists of a combination of op-codes and text. In the run-code, there are now only 20 basic operations and the text material is stored two teletype characters per 18-bit machine word. The basic operations at run-time are:

full response

audio Signal to play an audio message

first-time audio Like audio, but since it has been generated by AFE or AFR, it occurs in the middle of the text and must be ignored if the student repeats a response attempt.
type  Type some text to the student.

problem statement  Type some text to the student, but note position in case problem must be repeated.

new problem  Increment problem counter.

full response  The following text is to be compared with the characters typed in by the student above the underscores. The comparison is performed character by character as the response is typed. This operation corresponds to S (simple) type response specification, and the student is required to repeat the full response should he make an error.

correctable full response  Corresponds to Q (quick) response specification. As the answer is not limited by the space indicated with the underscores, the student is allowed to type extra characters which indicate that previous characters were in error and are to be ignored. Thus, the student is allowed to correct mistakes before his response is evaluated. Naturally, for such answers, the student is required to type a special character to indicate that he is satisfied with what he has typed and is, therefore, finished with his response. Again, he is required to retype the entire answer should his first try be incorrect.

character response  Corresponds to C (character) response specification. If he makes a mistake when filling in underscores, the program will supply any initial characters which were typed correctly.

correctable character response  Corresponds to L (linear) response specification.

wait  Performs WAT.

restart  Performs RST.

give answer after  Performs GAA.

set time  Performs TIM.

finish  Terminates the lesson, gives summary information, and writes performance information on student history file.

test block  Clears an indicator which will be set should a response be typed incorrectly or timed out.

remedial block  Checks the above indicator and either continues into the remedial block or scans texts until the matching fin-block.

fin-block  Marks the end of a remedial block.

end of record  Notes the end of a record on the disk and causes additional lesson material to be read in the program buffers.

reset  Reset text-pointers to the start of the text-buffers. This is the only op-code that is not generated by Processor-II, but by the run-time program itself.

10. Processor-I

Processor-I is basically a macro expander. It reads the INPUT and converts each op-code to a series of basic SCRIPIT operations, supplying standard instructions that correspond to the action desired.
11. Processor-II
The second processor is used first to convert the SCRIPT into run-code, and second to detect syntax errors in the material. Thus, for example, the unbalanced parentheses of

\[ LE \text{ complete -[on duma(1),/but[ona dumala)} \]

would be detected. Processor-II can be run to generate run-code and syntax check or simply to syntax check.

12. Processor-III
Processor-III stores run-code previously generated onto a scratch file at the next available area of the permanent run-code file. It also is used to garbage collect the run-code file of unneeded lesson material and to determine what lessons are currently available to the run-time program.

13. Student Histories
In much the same manner as the text of the lessons, information about the students is initially typed onto a text-file via the standard editor program and then converted to a history file accessible to the run-time program. Files and programs pertaining to this aspect of the system are:

Name List. This is a text-file containing the names (in English and in Russian) of each student in the course, as well as several additional persons, such as the writer, who also take the lessons. It also indicates the number by which each student identifies himself to the program when he signs on.

Namer. The NAME LIST is read by a NAMER program which prepares two binary files. One is the CLASS LIST used in data analysis and the second is the HISTORY file, which will contain such items as the student number and name, his current lesson, his score and the duration of his previous lesson, as well as miscellaneous information used by the system.

R. STAT. A daily report of each student's performance is prepared for immediate evaluation and to indicate which tape is to be mounted on the audio unit when that student reports for his next machine session. If a student does poorly on a lesson (under 70 per cent), he is automatically scheduled to repeat that lesson.

Patch. At any time, the current status of the student's HISTORY can be displayed on the READ scope and changed if necessary.

14. The Run-time Program
The run-time program accesses 3 disk-files (the run-code, student histories, raw data file), maintains a display on a READ scope, and uses 7 Model-35 teletypes as I/O devices.

There are two distinct sections of the run-time program. The first is the program that processes a student's lesson. This could be considered as a separate program running by itself, but is actually a micro-timed shared user. This user reads the student's sign-on as he types his designated sign-on number. It looks up his history file, determines what lesson to run, and then runs that lesson using the run-code stored on the run-code file. As it proceeds, it continually writes out raw data on a data file to be used later for analysis of performance. Finally, when the student reaches the end of the day's lesson, it updates his history, gives him a brief summary of his performance for the current lesson, and signs him off. This entire procedure is performed using re-entrant code with pointers to individual variables and calling special subroutines to perform input and output interface to the teletype.

The second part of the run-time program is a self-contained time-sharing system. It includes the features that read characters from the teletypes, sets the
appropriate pointers for the user who is operating on the teletype just seen, and then allows that user to run until he either requests additional input or requests output of text to the teletype.

Thus, the micro-users run as input-activated programs in a time-sharing system. With the number of users at any given time limited to seven by the availability of teletype-audio student stations, it is possible to run using one 4K block of memory for the machine code and a second 4K block for text-buffers. The Zeus time-sharing system allows each user a maximum of 12K, so there is no problem with machine memory limitations, although a similar program currently being used at IMSSS, by swapping 4K core-loads of memory onto a high-speed drum storage unit, is able to run over 75 students at a time taking mathematics drills on Model-33 teletypes.

**APPENDIX C**

**EXAMPLES OF DAILY SUMMARY SHEETS**

**DAILY RUSSIAN REPORT AS OF 10 APR. 1968 21:12**

<table>
<thead>
<tr>
<th>PREVIOUS LESSON NO.</th>
<th>PREVIOUS LESSON PCT. TIME</th>
<th>NEXT LESSON STUDENT NUMBER AND NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>73 53</td>
<td>96 LIZ BABCOCK</td>
</tr>
<tr>
<td>97</td>
<td>86 51</td>
<td>98 JANIE BONHAM</td>
</tr>
<tr>
<td>97</td>
<td>91 44</td>
<td>98 DOUGLAS BROZ</td>
</tr>
<tr>
<td>97</td>
<td>85 46</td>
<td>98 LEE BUSH</td>
</tr>
<tr>
<td>94</td>
<td>86 43</td>
<td>95 ANNE CHIAPPELLA</td>
</tr>
<tr>
<td>97</td>
<td>72 46</td>
<td>98 KERI CHRISTENFELD</td>
</tr>
<tr>
<td>97</td>
<td>82 48</td>
<td>98 THOMAS CHUN</td>
</tr>
<tr>
<td>97</td>
<td>90 49</td>
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**DAILY RUSSIAN REPORT AS OF 22 MAY 1968 20:53**

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<td>121</td>
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<td>122 RONALD HARRIS</td>
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</table>
A. Translate into Russian (80 minutes)

1. My rich brother often drank a lot of vodka, but he rarely ate much meat.
2. The girl, about whom we were talking, plays the piano very badly.
3. Did you know that this handsome young American is a Russian teacher?
4. Why doesn't he want to write with his pencil? He knows that I don't have a pen.
5. It's easy for you to speak English because your father was an American.
6. The letter, which they were writing to their leader, is lying on the desk in their room.
7. When we lived in England we had neither an automobile nor a house.
8. Tomorrow they will have both a new lesson and a short examination.
9. I like to help him, but I don’t want to talk with him about my lecture.
10. My friend’s home is on this street in that large building.
11. In the summer I live in a cottage in the country with my wife and her sister.
12. Do you remember the old doctor whose son was a student at the university when you worked at the bank?
13. It’s very difficult to talk with this comrade. He’s always smoking and he doesn’t listen to anyone.
14. The woman, who is sitting with the professor and the journalist, thinks that Anna will be a good writer.
15. Don’t you understand that one must never smoke a pipe in her bedroom?
16. Why are you reading that book? It’s mine! And the chair you’re sitting on is mine too.
17. Why don’t you answer her when she asks you about them?
18. They always telephone me in the morning when I’m sleeping.
19. She never explained anything to us, and we never talked about anything with her.
20. The woman in the white dress was formerly a teacher, and the man in the black suit wants to be a rich engineer.
21. In the winter we ate bread and butter and drank good fresh milk.
22. Whose secretary understands English, his or yours?
23. That stupid student works very slowly. Her teacher thinks that she never does anything.
24. She has a very intelligent husband, and her brother has a beautiful and rich wife.
25. I see very well that you don’t want to talk with me about that.

FINAL EXAMINATION — March 21, 1968

A. Translate into Russian (80 minutes)

1. The teachers explain the new rules, and the students write down everything immediately.
2. Do you have any brothers? Yes, I have seven brothers.
3. On this street there are two famous museums and many small but interesting stores.
4. When I am in Russia I shall read only Russian newspapers.
5. As soon as I have supper, I shall write to father.
6. Our professor said that on Tuesday he would speak about English cities.
7. Anna began reading this novel two weeks ago but she still hasn’t finished reading it. She never finishes long novels!
8. I finally asked Zoya where she was going in such a beautiful dress, but she didn’t answer me.
9. I don’t understand a single word in the third lesson!
10. There were only twelve people at the first lecture.
11. How much did you pay for these two Russian dictionaries? I paid only eight rubles for them.
12. We lived in America 20 years.
13. Did you see those beautiful girls who were sitting in the garden?
14. Don’t forget to ask Sonya to come to see me next Friday.
15. When you come home this evening, please buy a bottle of wine.
16. Anna isn't home. She went to Moscow by train three days ago.
17. Ivan wrote that he would leave France in a week.
18. Uncle Andrew used to walk to the bank but now he drives.
19. I am going to a concert tomorrow. Do you (familiar) want to go with me?
20. Never give children cigarettes!
21. Look at that stupid man! He is eating meat with a spoon.
22. In the winter they get up late and go to bed early.
23. Why are your little sisters afraid of Englishmen?
24. Your friends' daughters seem to be intelligent girls.
25. Your skirt is lying there under those old magazines.

FINAL EXAMINATION—June 1968

A. Time: 2 hours.
   1. She wanted me to tell her why their apartment is 10 dollars cheaper than ours.
   2. This examination will end at 4:45 P.M.
   3. I asked the woman sitting in front of me to take off her hat.
   4. Having become interested in Chekov, Igor, the smartest student in our class, read all his writings last summer.
   5. Having dropped in on Anna, I chatted a bit with her about the article written by her husband.
   6. No matter whom I asked, I could not find a single person who knew—use participle!—where they had taken the poor old man.
   7. Having returned from the store Anna told me to put all the things bought by her on the shelf.
   8. Tolstoy died on January 29, 1837.
   9. Although my nephew Andrew is studying mathematics at the university, he rarely studies.
  10. If you are free next week, let's go to the country.
  11. This evening my sister will have dinner at our place.
  12. She often brings her friends to our house.
  13. On Sundays we always carry the table and chairs out into the garden.
  14. I hope they will leave in half an hour, not later.
  15. He asked whether we would be home in the evening.
  16. Which of these armchairs is the cheapest one—the white one or the black one?
  17. It's easier to write with a pen than with this little pencil.
  18. As soon as I began to talk about that, Ivan left.
  19. How do you like your new house? It is just as beautiful as ours and much bigger.
  20. I used to have to get up at six A.M. in order to get—arrive at—to work.
  21. Today is Saturday, the eighth of June, nineteen hundred and sixty-eight.
  22. While standing at the board, the professor said for us to put all our books under our chairs.
  23. I translated the first thirty-one short sentences from English into Russian.
  24. At half past three I suddenly felt like taking a little walk.
  25. Having given my things to the teacher, I went out of the room in which the students were working.
26. Before returning to the examination I bought a glass of fresh milk from a well-dressed young woman. She told me to hurry, because it was already after three.

27. Having understood that I had stayed too long, I put on the table the milk sold to me by the young woman and ran into the school.

28. On the way to the classroom, at five minutes after three, I noticed that thirty-two minutes had already passed.

29. Having entered the room, I went up to the teacher and started to explain why I was late.

30. He answered me with these words—please speak somewhat more slowly—the quieter the better! Here's your notebook, but your place has been occupied by the professor's nephew.

31. You will have to sit on the floor.

32. If I had not been afraid of the man's brothers, I would have left immediately, but having understood that I myself had made the mistake, I took my pencil and sat on the floor.