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## Validation of the Automated Readability Index for Use with Technical Materials

Leroy John Delionbach

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VALIDATION OF THE AUTOMATED  
READABILITY INDEX FOR USE WITH  
TECHNICAL MATERIALS

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Leroy John Delionbach

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D45



VALIDATION OF THE AUTOMATED READABILITY INDEX  
FOR USE WITH TECHNICAL MATERIALS

by

Leroy John Delionbach

A Thesis Submitted to the Faculty of  
Georgia Southern College  
in Partial Fulfillment of the Requirements for  
the Degree of Master of Arts  
in the Department of Psychology

Statesboro, Georgia

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The necessity to present written materials compatible with the reading level of the target audience has led to a great deal of research into techniques for determining the readability of printed matter. Since Klare (1963) has given a comprehensive review of the history and development of readability formulae, an exhaustive literature search will not be given. In brief, readability formulae are used to control and access difficulty level of narrative material. They typically use a measure of word difficulty (such as the average number of syllables per word) and sentence difficulty (such as the average sentence length).

In 1943 Flesch published his first readability formula. This formula utilized sentence length, number of affixes, and the number of personal references in a regression equation to determine the grade level of the material (Flesch, 1943). Flesch later revised his original formula and derived new formulae to determine Reading Ease, Human Interest, and Readability (Flesch, 1948, 1950). Farr, Jenkins and Paterson (1951) modified Flesch's Reading Ease formula by substituting the number of one syllable words per 100 words for the syllable count. Their New Reading Index

used the number of one syllable words and the average sentence length in a regression equation. These two measures represented word difficulty and sentence difficulty, respectively.

Dale and Chall (1948) published a formula designed to correct some of the shortcomings of the original Flesch formula. Using the average sentence length as a measure of sentence difficulty, and the percentage of words per 100 words not on the Dale list of 3,000 common words as a measure of word difficulty, the Dale-Chall formula proved to be simpler than the Flesch formula which had included a count of personal references and which used a complicated formula.

McElroy devised the Fog Count which is described in the Guide for Air Force Writing (1963). It is a formula based on the count of syllables in sentences selected at random for analysis. Although the Fog Count appears to be reliable, McElroy gives no statistical data on its development (Klare, 1963), and Kincaid (1970) was unable to find a validation of the formula.

The Flesch formulae, the Fog Count, and the Dale-Chall formula have been most commonly used to evaluate the readability of textbooks, manuals, technical materials, and magazine articles, all with some measure of success.



The main objection to the traditional readability formulae is they are laborious and time-consuming. Each of them necessitates manual procedures (Kincaid, Yasutake & Geiselhardt, 1967). Furthermore, none of the traditional formulae lend themselves to computer application (Kincaid, et al., 1967), although there have been several attempts to use computers for calculating reading difficulty level (for example, Danielson & Bryan, 1963).

Smith and Senter (1967) introduced the Automated Readability Index (ARI). The ARI uses the average word length as the measure of word difficulty and the average sentence length as the measure of sentence difficulty. These two values are used in a regression equation to predict the reading difficulty in terms of Grade Level Equivalency. The data are gathered by having the material typed on an electric typewriter which has been slightly modified by the installation of three microswitches attached to cumulative counters. (For a detailed description of the equipment utilized in the derivation and implementation of the ARI see Smith and Senter, 1967). The advantages of such a method of evaluating material are immediately obvious. The first is ease and speed of application. Any typist, using a modified typewriter, can gather the data to be inserted into the regression equation while typing at production speeds. The

second is that a typist, while preparing a draft of a manuscript, can provide the writer with the ARI of the material, thereby facilitating the control of readability of materials. A third benefit is the accuracy of the measure taken. It has been demonstrated that the reliability of the Fog Count, for example, is low, due to the manual procedures necessary to gather the raw data (Kincaid, 1970), whereas the ARI has been found to be highly reliable (Kincaid, et al., 1967). Finally, the ARI can be made available to educational institutions, offices and companies. The modification of existing typewriters to permit the application of the ARI in no way interferes with the normal functioning of the equipment.

The present study is an extension of the validation study conducted using the Automated Readability Index with technical material conducted by Kincaid, et al. (1967). That study was made to determine whether the ARI could be used as a quantitative measure of the reading difficulty of technical materials. United States Air Force Technical Orders (maintenance manuals) were the source of technical material used in the study. Narrative passages of approximately 250 words each were taken from Technical Orders on the C-141A aircraft and rewritten at three levels of difficulty (16th, 12th and 8th grades, as determined by the ARI). These passages, along with questions relating to them, were

presented to a sample of airmen who were students in technical training classes. Answers to the questions indicated that passages that were rewritten for the lower levels of difficulty were easier to comprehend.

The present study is an extension of that of Kincaid, et al. (1967). As such, it has two objectives: (1) to extend the generalizability of the previous study to a different, non-homogeneous sample; and (2), to attempt to determine a relationship between the difficulty of narrative material (as measured by the ARI) and the reading ability level of the intended audience (as measured by the AFQT).

## METHOD

### Test Materials

Two passages of material, each containing approximately 250 words, were taken from C-141A maintenance manuals. One passage pertained to the windshield rain removal circuit and one to the electrical circuit of the aircraft. Each passage was rewritten using the ARI until three difficulty levels were obtained, 8th grade, 12th grade, and 16th grade. Technical experts verified that all versions of each passage contained the same amount of information. A multiple choice test was devised to measure comprehension; the questions were the same for each difficulty level of a passage. The testing material (two passages, three levels each, with associated questions) is included in Appendix A.

Table 1 presents the analysis of the three versions of the passages. The average word length, average sentence length, and the ARI are included.

### Subjects and Testing Procedure

Subjects were 110 male enlisted men in the Army National Guard. A variety of Military Occupational Specialties from Medical Aidman to Senior Communications Specialist

TABLE 1  
Reading Difficulty Analysis of Tests\*

Measure	Version		
	Hard	Medium	Easy
Average word length	5.2	5.1	4.8
Average sentence length	25.3	17.9	13.8
ARI grade level equivalency	15.9	11.9	8.2

\*Adapted from Kincaid, et al. (1967)

was represented. Personnel ranged in rank from Private (E-2) to Platoon Sergeant (E-7), and in educational level from 7th grade to the doctorate. This is a non-homogeneous sample.

Each subject was given one version of each passage and its accompanying questions. He then had 20 minutes (10 minutes per passage) to read the passages and answer the questions. A subject was not permitted to return to the first passage after completing the second one. The order of presentation of the versions of the passages, and the order of presentation of the passages, was randomly determined. Test booklets were made up according to this random order and were passed out to the subjects as they were seated in the test center.

#### Apparatus

The apparatus used to devise the tests consisted of an IBM Selectric typewriter and a Readability Index Tabulator. The typewriter was modified slightly by the installation of three Micro-switches. The Readability Index Tabulator consisted of three counters (Sodeco TCeF4E.25, TCeF5E.50, and TCeF6E.50). As the keyboard was activated, the microswitches tripped, and the counters tabulated the number of words, strokes, and sentences in the passage being evaluated.

Smith and Kincaid (1970) reported that the ARI has

been successfully adapted to computer application. In the course of the present study, a program was developed for the IBM 360-65 computer, which was used to re-evaluate the grade level equivalency of the test materials. A description and a print-out of the program are contained in Appendix B.

## RESULTS

The mean number of correct answers for the hard (16th grade level) versions was 3.93; for the medium (12th grade level), 4.44; and for the easy (8th grade level), 4.50. These scores were out of a total possible of 8 for each passage. Comprehension of the medium version was 12.9% greater than on the hard version, and the easy version represented an increase in comprehension of 14.4% when compared with the hard version.

Two statistical tests were applied. A t-test was applied to the combined means of the grade levels of each passage to determine whether comprehension differed significantly on the easier versions. The t-test showed that the difference between the easy and hard versions was significant at the .05 level ( $t = 2.04$ ), as was the difference between the medium and hard versions ( $t = 1.82$ ). There was no significant difference in comprehension between the easy and medium versions.

Table 2 summarizes the analysis of variance conducted. The F-test for readability was significant beyond the .05 level ( $F = 3.56$ ,  $df = 2,214$ ). The passage factor was significant beyond the .01 level ( $F = 14.06$ ,  $df = 1,214$ ).



TABLE 2  
Analysis of Variance of Comprehension Scores

Source of variance	<u>df</u>	Mean square	<u>F</u>
Passage	1	28.17	14.06**
Readability	2	7.14	3.56*
Interaction	2	3.66	1.83
Within	214	2.004	

\*\*p < .01

\*p < .05

Correlation coefficients were computed on scores obtained on the test used in this study and on AFQT scores taken from the subjects' personnel records. Correlations for the hard versions of the two passages were .64 and .43, indicating a positive relationship between performance on the AFQT and reading ability. These were significant beyond the .01 level. Correlations between AFQT scores and the comprehension scores for the 12th and 8th grade versions were not significant. These correlations are presented in Table 3.

TABLE 3  
Pearson Product Moment Correlations  
Between AFQT Scores and Passages

Grade level of difficulty	Passage	
	Windshield	Electrical
16th	.43*	.64*
12th	.00	.13
8th	.15	.18

\*p < .01

## DISCUSSION

The present study is concerned with two issues. First it extends the generality of an earlier finding of Kincaid, et al. (1967) using a different population. Whereas the previous study used a highly homogeneous group of airmen, the present study used a widely varying group of Army National Guardsmen, differing in rank, age, educational attainment and military specialties. In both cases the tests were the same and the testing conditions were very similar. The results obtained were remarkably similar at each level of reading difficulty, as is seen in Table 4. In both studies, the performance on the 16th grade level passages was not as good as that on the easier passages.

The second issue with which the present study is concerned is the establishment of a relationship between a measure of reading ability level and a measure of comprehensibility. The measure of reading ability level of choice is the Armed Forces Qualification Test (AFQT), which is administered to all persons entering military service. It has been in use more than 20 years. A similar test used by the United States Air Force is the Airman Qualifying Examination (AQE). Madden and Tupes (1966) developed a formula

TABLE 4

A Comparison of Test Scores\* of  
the Present Study and of the  
Kincaid, et al. (1967) Study

Grade level	Study	
	Present	Kincaid, et al.
16th	3.93	3.89**
12th	4.44	4.60
8th	4.50	4.60

\*Reading tests in Appendix A.

\*\*Maximum possible score is 8.0.

converting the AQE score to reading ability level. These conversions are based on correlations of scores obtained by Air Force personnel on the AQE, the AFQT, the California Reading Test, and the Davis Reading Test. All of these tests show a high correlation with each other. The correlation between performance on the AQE and the AFQT is .70. The correlation between performance on the AFQT and the California Reading Test is .61. It is therefore reasonable to assume that the AFQT scores are an indication of reading ability level.

It is interesting to note that the correlations obtained between the AFQT scores and the scores obtained on the six passages were highest in the case of the 16th grade level passages and were significant beyond the .01 level. In the other four cases (the two 12th grade and two 8th grade level passages), the correlations were not significant. This suggests that the easier passages do not favor the better readers (as inferred from the AFQT scores), but the most difficult passages do favor the better readers.

The significant difference between the comprehension scores for the hard and the easy versions indicates that the ARI is in fact sensitive to differences in difficulty level of technical material. The fact that there were no significant differences between the medium and easy versions may be

interpreted in one of two ways: (1) The ARI is not sensitive to lower difficulty levels; or (2) simplification of technical material beyond the reading ability level of the intended audience does not increase comprehension. In view of the high correlation of the ARI to the Flesch obtained by Kincaid, et al. (1967) and the ability of both formulae to discriminate between passages written at lower grade school levels, it appears that the second interpretation is more reasonable.

Reading material should be written at the level of difficulty that fits the intended readership. It is clear from the data of this study that technical material written at too high a level degrades comprehensibility. The data also indicate that lowering the difficulty level beyond the reading ability level of the reader has no further effect on comprehensibility. It appears that attempts to write at too elementary a level penalize the writer: comprehension is not increased, the passage becomes longer, and the time required to read the passage increases.

## SUMMARY

This study utilized 110 Army National Guard personnel who were presented one version of each of two passages of technical material and a multiple-choice test designed to measure comprehension of the material. Each of the passages had been rewritten using the Automated Readability Index at three reading difficulty levels, 8th grade, 12th grade and 16th grade. Comprehension scores on the tests were correlated with scores previously obtained on the Armed Forces Qualification Test (used as a measure of reading ability level). Comprehension scores obtained in the present study are similar to those obtained by Kincaid, et al. (1967) in a similar study. It appears that the results obtained in the earlier study are replicable with a very different sample of subjects. A positive relationship exists between scores on the AFQT and comprehension of technical materials, particularly when that material is written at a high level of difficulty.



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## APPENDIX A

ate \_\_\_\_\_  
 ame \_\_\_\_\_ Rank \_\_\_\_\_  
 erial Number \_\_\_\_\_  
 rimary Specialty \_\_\_\_\_ Secondary specialty \_\_\_\_\_  
 umber of years in service \_\_\_\_\_  
 umber of years of formal education \_\_\_\_\_  
 (do not include trade and service schools)  
 umber of service schools attended \_\_\_\_\_  
 length of total service school training (months) \_\_\_\_\_  
 list service schools: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Do not write in  
this space

Wind  
 Inst \_\_\_\_\_

Total \_\_\_\_\_

Instructions: This test consists of two passages, each followed by 8 questions.  
 You are to read each passage and decide which choice (a,b,c or d) best answers  
 the question. Then on the answer sheet (on the lower portion of this page)  
 circle the appropriate letter which you think is the best answer (there is only  
 one best answer for each question). Try to answer each question. You may refer  
 back to the passage while you are answering the questions. The two passages are  
 titled "Windshield Rain Removal Circuit" and "Instrument Power Switch". Be sure  
 to use the proper answer column. You will have 20 minutes to finish the test.

CIRCLE CORRECT ANSWER HERE

WINDSHIELD RAIN REMOVAL CIRCUIT

1	a	b	c	d
2	a	b	c	d
3	a	b	c	d
4	a	b	c	d
5	a	b	c	d
6	a	b	c	d
7	a	b	c	d
8	a	b	c	d

INSTRUMENT POWER SWITCH

1	a	b	c	d
2	a	b	c	d
3	a	b	c	d
4	a	b	c	d
5	a	b	c	d
6	a	b	c	d
7	a	b	c	d
8	a	b	c	d

The lever lock INST POWER switch located on the right side of the pilot's instrument has three positions: "OFF", "NORM" and "EMER". Under normal conditions the switch is set to the "NORM" position providing a ground to the emergency bus power relay. The emergency bus power relay is located behind the emergency bus circuit breaker panel and is energized by voltage from essential AC bus No. 1. If a malfunction occurs in the normal AC system and essential AC bus is de-energized, the emergency bus power relay will be de-energized, its open contacts will disconnect the hydraulic motor control solenoid from the emergency bus, the hydraulic motor control solenoid will be de-energized and the emergency generator will be activated. The "EMER" position of the INST POWER switch is used to manually activate the emergency generator. This is needed because, if the AC system is functioning satisfactorily and the DC system malfunctions, the emergency generator will not be automatically activated. Setting the INST POWER switch to the "EMER" position removes the ground from the emergency bus power relay allowing the emergency bus power relay to de-energize. From this point on, the sequence of events that transpire to bring the emergency generator on the line is the same as those events described for a normal AC system failure. Positioning the INST POWER switch to "OFF" disables the emergency generator system.

A three-position, lever lock INST POWER switch is on the right side of the pilot's instrument panel. The switch positions are "OFF", "NORM" and "EMER". Under normal conditions the switch is set to the "NORM" position. In this position the switch provides a ground to the emergency bus power relay. The emergency bus power relay is behind the emergency bus circuit breaker panel and is energized by voltage from essential AC bus No. 1. If a malfunction occurs in the normal AC system and essential AC bus is de-energized, the emergency bus power relay will be de-energized. With the emergency power relay de-energized, its open contacts disconnect the hydraulic motor control solenoid from the emergency bus. The hydraulic motor control solenoid will be de-energized and the emergency generator will be activated. The "EMER" position of the INST POWER switch is used to manually activate the emergency generator. If the AC system is functioning normally, the DC system malfunctions, the emergency generator will not be automatically actuated. Setting the INST POWER switch to the "EMER" position removes the ground from the emergency bus power relay and allows it to de-energize. From this point, the sequence of events that take place to bring the emergency generator on the line is the same as those described for a normal AC system failure. Positioning the INST POWER switch to "OFF" disables the emergency generator system.

The INST POWER switch is on the right side of the pilot's instrument panel. This switch has three positions and is a lever lock type switch. The switch positions are "OFF", "NORM" and "EMER". The "NORM" position is used under normal conditions. In the "NORM" position, the switch is grounded to the emergency bus power relay. The emergency bus power relay is behind the emergency bus circuit breaker panel. The emergency bus power relay is energized by voltage from essential AC bus No. 1. If something goes wrong in the normal AC circuit, five steps occur in sequence. (1) First, the essential AC bus loses power. (2) This causes the emergency bus power relay to lose power and its contacts to open. (3) This disconnects the hydraulic motor control solenoid from the emergency bus. (4) This in turn, causes the hydraulic motor control solenoid to lose power. (5) Finally, the emergency generator goes on. Turning the INST POWER switch to "EMER" also causes the emergency generator to go on because the ground is removed from the emergency bus power relay. This causes the relay to lose power which is step 1 above. Then exactly the same steps happen as described above. Thus, both a normal AC failure which occurs when the switch is in the "NORM" position, and setting the switch to "EMER" cause the same series of events to happen. These events finally result in the emergency generator going on. If the AC system is working all right and something goes wrong with the DC system, then the emergency generator will not automatically go on. When the switch is in the "OFF" position, the emergency generator will not work.



## INSTRUMENT POWER SWITCH

1. If the "NORM" switch position is working but the "EMER" switch position is not working, this could be caused by.
  - a. the master generator not working.
  - b. the INST POWER switch not working.
  - c. the emergency bus power relay not working.
  - d. both the INST POWER switch and the emergency bus power relay not working.
2. If neither the "NORM" nor the "EMER" switch positions are working this could be caused by:
  - a. the INST POWER switch not working.
  - b. the master generator not working.
  - c. the hydraulic motor control solenoid not working.
  - d. both the INST POWER switch and the hydraulic motor control solenoid not working.
3. If the "NORM" switch position is not working but the "EMER" switch position is working, this could be caused by:
  - a. the master generator not working.
  - b. the emergency bus power relay not working.
  - c. the hydraulic motor control solenoid not working.
  - d. none of the above choices is correct.
4. If the INST POWER switch is turned to "OFF" this will:
  - a. cause the master generator to go on.
  - b. cause the master generator to go off.
  - c. stop the emergency generator from going on.
  - d. cause the emergency generator to go on.
5. The INST POWER switch is of what type?
  - a. level-lock
  - b. spring loaded
  - c. guarded toggle switch
  - d. unguarded toggle switch
6. When the INST POWER switch is in the "OFF" position.
  - a. the center solenoid will be activated.
  - b. the emergency generator will not work.
  - c. the emergency generator automatically goes on.
  - d. the ground is removed from the emergency bus power relay.

7. How many different buses are mentioned in the passage?
- a. One
  - b. Two
  - c. Three
  - d. Four
8. Which types of electrical systems are mentioned in the passage?
- a. Only AC
  - b. Only DC
  - c. Both AC and DC
  - d. Neither AC nor DC

The windshield rain removal system delivers blasts of hot air to either the pilot's or co-pilot's front windshield or both. The air is diverted from the ducts leading from the primary heat exchangers. The temperature of the air leaving the primary heat exchanger when the aircraft is in a cruise condition is approximately  $232^{\circ}\text{C}$  ( $450^{\circ}\text{F}$ ). In ordinary operation, the system diverts air from both primary heat exchangers: the left-hand regulator valve takes air from the No. 1 system and the right-hand valve from the No. 2 system. The rain removal selector switch on the overhead panel allows each pilot's windshield to be cleared separately or together. Window overheat protection is provided through use of windshield thermistors which are wired to overheat relays which can close a circuit to the RAIN REMOVAL OVHT light on the annunciator panel and to the CO-PILOT OVHT or PILOT OVHT lights on the overheat panel. The thermistors close the circuit when the temperature of the windshield is between  $79.4^{\circ}$  and  $85^{\circ}\text{C}$  ( $175^{\circ}$  and  $185^{\circ}\text{F}$ ). The windshield anti-icing system control circuit is wired through the RAIN REMOVAL selector switch "OFF" position, so that the windshield anti-icing system will not activate when the RAIN REMOVAL switch is not in the "OFF" position.

The purpose of the windshield rain removal circuit is to actuate and control the hot air system which keeps the pilot and co-pilot windshields clear. It can deliver hot air to either the pilot's or co-pilot's front windshield separately or both at the same time. The circuit is controlled by the rain removal selector switch. The hot air comes from the two primary heat exchangers. The temperature of the air coming from these heat exchangers when the plane is cruising is approximately  $232^{\circ}\text{C}$  ( $450^{\circ}\text{F}$ ). During ordinary operation, air can come from both primary heat exchangers. Air that originates from the No. 1 heat exchange system goes through the left-hand regulator valve. Air that comes from No. 2 heat exchange system goes through the right-hand regulator valve. Windshield thermistors are used to prevent the windshields from overheating and cause connected overheat relay to close when the windshields overheat. This causes two things to happen: (1) the rain removal OVHT light on the annunciator panel goes on, and (2) the pilot OVHT light and/or the co-pilot OVHT light goes on. The circuits close and the lights are actuated when the temperature of either windshield is between  $79.4^{\circ}$  and  $85^{\circ}\text{C}$  ( $175^{\circ}$  and  $185^{\circ}\text{F}$ ). The windshield anti-icing control circuit is connected to the "OFF" position of the rain removal selector switch. The anti-icing system can work only when the rain removal switch is in the "OFF" position.

The purpose of the windshield rain removal circuit is to deliver blasts of hot air to the front windshield. This keeps the windshield clear. It can deliver hot air to either the pilot's or the co-pilot's front windshield separately. It can also deliver hot air to both sides of the windshield at the same time. This circuit is controlled by the rain removal switch. The hot air comes from two primary heat exchangers. When the plane is cruising, the temperature of the air coming from the heat exchangers is approximately 232°C (450°F). Air comes from both primary heat exchangers. If air comes from the No. 1 heat exchanger, it goes through the left-hand regulator valve. If air comes from the No. 2 heat exchanger, it goes through the right-hand regulator valve. Windshield thermistors are used to make sure that the windshields do not become too hot. These thermistors are connected to overheat relays. The relays close when the windshields become too hot. This causes two things to happen. The first is that the rain removal OVHT light on the annunciator panel goes on. The second is that the pilot OVHT light or the co-pilot OVHT light or both lights go on. The circuit closes and the lights go on when the temperature of either windshield is between 79.4 and 85°C (175° and 185°F). Another circuit, the windshield anti-icing control circuit, is also connected to the "OFF" position of the rain removal selector switch. The rain removal switch has to be in the "OFF" position before the anti-icing system will work.

## WINDSHIELD RAIN REMOVAL CIRCUIT

1. The overheat relays are open and the overheat lights are off when the temperature of the windshield is between:
  - a. 80°C and 85°C.
  - b. 75°C and 80°C.
  - c. 175°F and 180°F.
  - d. 160°F and 170°F.
2. If the pilot's windshield is too hot this:
  - a. always causes two lights to go on.
  - b. always causes one light to go on.
  - c. always causes three lights to go on.
  - d. can cause either two or three lights to go on.
3. When the rain removal selector switch is "OFF":
  - a. the windshield anti-icing system can work.
  - b. the windshield anti-icing system cannot work.
  - c. neither the rain removal system nor the anti-icing system can work.
  - d. both the windshield rain removal system and the anti-icing system can work.
4. The windshield system:
  - a. operates at all times.
  - b. can clear only one windshield at a time.
  - c. can clear only both windshields at a time.
  - d. can clear either one windshield or two windshields at a given time.
5. The windshield rain removal system keeps the windshield clear in the following manner:
  - a. it contains windshield wipers.
  - b. it delivers blasts of hot air.
  - c. it heats up small wires in the windshield.
  - d. it uses both heating wires and windshield wipers.
6. The primary purpose of thermistors in this circuit is to:
  - a. control the RAIN REMOVAL OVHT light.
  - b. activate the hot air system.
  - c. control the CO-PILOT OVHT light.
  - d. prevent the windshields from overheating.

7. The overheat relays:
- a. close when the windshield becomes too cool.
  - b. close when the windshield becomes too hot.
  - c. open when the windshield becomes too hot.
  - d. remain open at all times.
8. How many heat exchange systems are involved in the operation of the windshield rain removal system?
- a. one
  - b. two
  - c. three
  - d. four





## Program for Automated Readability Index Validation

The Program used in the present study was written by Mr. Merritt Sugg, Assistant Professor of Mathematics, Georgia Southern College, for use with the IBM 360 computer.

The material to be evaluated is punched on standard cards, using only columns 6 - 76. (The other columns are used for control codes.) The material is punched just as it appears on the printed page, with three exceptions: paragraphs are not indented; no hyphenated words may appear at the end of a line; and, the terminal punctuation mark for all sentences is a period followed by two spaces. If more than one passage is to be evaluated at one time an additional card is prepared after the last card of each passage with the number "9" in Column 5. This resets the program.

In the Automated Readability Index, three sources of data are utilized to arrive at the Grade Level of the material: Average Sentence Length, Average Word Length, and the Number of Sentences. The Average Sentence Length is the number of words divided by the number of sentences. The Average Word Length is the number of strokes (letters, numbers, punctuation) divided by the number of words. The Number of Sentences is a simple tabulation of the sentences

in the passage. The Number of Strokes is a tabulation of the number of columns used on each card (75) less the number of blanks on the cards. The number of words is a tabulation of the number of blanks. The number of sentences is tabulated by counting all periods followed by two blanks.

The Grade Level is computed using the formula  $GL = .5(ASL) + 4.71(AWL) - 21.43$ .

Upon completion of the computation, the computer prints out the passage just as it appears on the cards, the Average Word Length, the Average Sentence Length, the Number of Sentences, and the Grade Level of the material. An identifying label, or heading, may also be printed at the beginning of the passage. This label will not be counted in the computation of the Grade Level. It is necessary, however, that either a label or a blank card be inserted in the beginning of the deck.

FORTRAN IV G LEVEL 19 MAIN DATE = 71105 12/20/34

```

0001 DIMENSION A(75)
0002 DATA R,P/1H,1H./
0003 10 READ(5,100,END=99) A
0004 WRITE(6,1000) A
0005 1000 FORMAT('1',T6,75A1//)
0006 ISTRK=0
0007 IWRD=0
0008 ISENT=0
0009 1 READ(5,100,END=99)K,A
0010 IF(K-9)2,50,2
0011 2 DO 5 I=1,75
0012 IF(A(I).NE.B.AND.A(I+1).EQ.B) IWRD=IWRD+1
0013 IF(A(I).NE.P.AND.A(I+1).EQ.B.AND.A(I+2).EQ.B) GO TO 7
0014 IF(A(I).EQ.P.AND.A(I+1).EQ.B.AND.A(I+2).EQ.B) ISENT=ISENT+1
0015 5 CONTINUE
0016 7 ISTRK=ISTRK+1+I
0017 WRITE(6,111) (A(J),J=1,I)
0018 GO TO 1
0019 50 WORDS=IWRD
0020 STRKS=ISTRK -IWRD -ISENT
0021 SENT=ISENT
0022 WRITE(6,222) STRKS,WORDS,SENT
0023 WRDL=STRKS/WORDS
0024 SENTL=WORDS/SENT
0025 GL=.5*SENTL+4.71*WRDL-21.43
0026 WRITE(6,200) WRDL,SENTL
0027 WRITE(6,300) GL
0028 GO TO 10
0029 100 FORMAT(4X,I1,75A1)
0030 111 FORMAT('0',T5,70A1)
0031 200 FORMAT(5X,'AVERAGE WORD LENGTH 'F12.6,' AVERAGE SENTENCE LENGTH'
    1F12.6)
0032 222 FORMAT('///5X,'NO. OF STROKES'F9.0,5X,'NO. OF WORDS'F9.0,8X,
    1,'NO. OF SENTENCES'F9.0//)
0033 300 FORMAT('///5X,'GRADE LEVEL ='F12.6)
0034 99 STOP
0035 END

```