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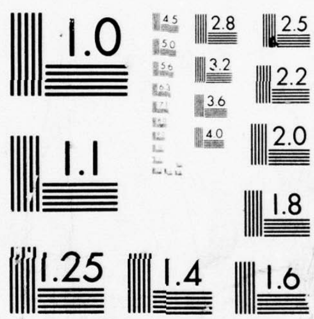
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Computer-based Education Research Laboratory

University of Illinois Urbana Illinois

AN OVERVIEW OF CHANUTE LESSONS

JOSEPH A. KLECKA

MTC REPORT No. 10 JANUARY 1977

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER MTC # 10	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER 710
4. TITLE (and Subtitle) (6) An Overview of Chanute Lessons		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER 710
7. AUTHOR(s) (10) Joseph A. Klecka		8. CONTRACT OR GRANT NUMBER(s) (15) US Army DAHC 15-73-C-0077, NSF-C-723
9. PERFORMING ORGANIZATION NAME AND ADDRESS University of Illinois Computer-based Research Lab. 252 Engineering Reasearch Lab. Urbana, IL. 61801		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS University of Illinois Grants & Contracts Office Davenport Hall, Champaign, IL 61820		12. REPORT DATE (11) Jan 77 13. NUMBER OF PAGES (12) 78p.
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

~~Unrestricted~~

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

(14) MTC-10, 710

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

~~Unrestricted~~

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

CAI Computer-aided Instruction
CBE Computer-based Education
PLATO
Training
Courseware
Chanute AFB

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Examines a representative sample of automotive repair lessons written at Chanute Air Force Base. Analyzes and describes these lessons desinged for use in a technical/vocational enviroment.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

An Overview of Chanute Lessons

MTC Report #10
January 1977

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This research was supported in part by Advanced Research Projects Agency of the Department of Defense under U.S. Army Contract DAHC-15-73-C-0077 and indirectly by the National Science Foundation (USNSF C-723).

Acknowledgements

Special acknowledgement is made to Larry Francis for his frequent assistance and helpful critiques throughout the writing and revising of this report, to Jim Krakower for his constructive criticism and the techniques of lesson review and analysis in the crucial preliminary stages, and to Al Avner for his critical comments and his readability study. Many thanks to Lynn Misselt and Esther Steinberg who have contributed their time, effort, and many valuable suggestions during a review of the report in draft form. Thanks also to the other members of the MTC and PEER groups for reading this report, especially Eileen Sweeney, Kumi Tatsuoka, Mark Swenson, Alec Himwich, and Kathy Geissler. Special thanks to Elaine Avner for editorial comments, to Wayne Wilson for his excellent graphics, and to Julie Garrard for her patience in typing the manuscript.

Abstract

A survey of current lesson development was considered essential to determine the quality and effectiveness of instructional material produced on the PLATO IV computer-assisted instruction system. The trial period lasted for several years. Both civilian and military personnel developed the lessons, in consultation with the Military Training Centers Group at the Computer-Based Education Research Laboratory, University of Illinois, for the Defense Advanced Research Projects Agency. Eight representative lessons were selected by a Chanute staff member. Then an evaluator prepared in-depth reviews of each, both in the formative and summative stages. Data gathered from the individual analyses formed the basis for the final report. It indicated general trends and isolated problem areas in the instructional design. The study resulted in an assessment of the instructional effectiveness and utilization of the pedagogical capabilities of the PLATO system in one training environment.

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Introduction

Background and Objectives

In writing this report, the following preparatory work was required:

1. copies of the selected lessons were made to preserve them in a relatively fixed form, and

2. in-depth reviews of each of the eight lessons were prepared.

This version of the lessons under evaluation had been in use for approximately nine months and were utilized by about 150 students, all military trainees. They are still in use at the present time. In general, each lesson was considered a structural entity so that the significant aspects and component parts were surveyed as they related to the instructional whole.

It should be noted that the MTC copies of the lessons represent a "snapshot" in the developmental process. That is, they were preserved in a version that has not been subjected to intermittent editing, as the other Chanute lessons have been and still are. Thus, if an MTC copy is attached to one or more Chanute lessons, comments on the latter must be considered with the following in mind: the reviewer's remarks about the attached lessons were made as they existed in the period December 1975 to February 1976 (see remarks in Appendix I for specifics on which are active vs. fixed lessons). Also, it is significant that "active" lessons, (i.e., continually under revision) can undergo alterations of a moderate or an extensive nature at any time without the reviewer learning of it. Hence, some of the features and characteristics of the lessons surveyed by this report no longer exist.

The goal of this composite review is to present a detailed picture of Chanute lesson development based on a select group of lessons. The selection was done by an evaluator stationed at Chanute and was presented to the MTC group as a representative sampling of lessons which spanned a spectrum of validation dates from April until August 1975. (See Appendix IV for further details on the exact dates of particular lessons as well as the actual Chanute account number of which these lessons are earlier copies.) The reviewer intends that the conclusions made from this survey will provide an adequate portrait of the instructional design and general appearance of these lessons.

Method of Approach

This report will examine each lesson to determine its success in fulfilling its own stated objective. Various specific categories will be considered separately, since they are crucial components in the fulfillment of the lesson objective. The survey will not be concerned with what the lesson could have been if conceived with different teaching strategies, author perspectives, or methods. Rather, the constraints and conceptions of the author and the instructional system development (ISD) team will be taken as a given. The comments are presented with these limitations in mind.

On occasion the reviewer must comment on matters strictly outside the discussion of the structure and content of a particular lesson, i.e., the prior knowledge of the students in relation to the definitions of key terms and concepts. Since such data are rarely available to the reviewer (due to the amount of time elapsed since the lessons were prepared, the departure of authors from the site, curriculum changes, and varying backgrounds of new students), they must be inferred from the lesson itself. To assess the need for definitions, some crucial questions must be asked. Are the subject matter and terminology self-explanatory or do they demand prior knowledge? If the latter, was the prior knowledge included in previous lessons?

It is apparent that no single study of eight lessons can encompass the scope of lesson development at a site. However, this limited perspective can give some indication of the areas covered and the problems encountered. The selection process employed attempted to insure an overall survey of different types of lessons, and the report may provide a broad survey of techniques, albeit a somewhat limited one when it is compared with the total number of lessons produced. An approach of this kind is more feasible at this time than a comprehensive review of every completed lesson. In addition, a draft of this report was submitted to the Chanute staff for their critique. All their suggestions, corrections, and additions were resolved or included in this version. It should also be noted that another report deals with the process of revision in the same series of lessons.

Structural Analysis

Procedure

The information in this section is largely drawn from the analysis of detailed schematic drawings, or flowcharts, made of the individual lessons. These charts (only one of which is included in this report) represent the way the lesson is put together and how it actually functions when a student goes through it. A schematic of this type provides the following information on the lesson's physical layout:

1. the approximate length;
2. the presence/absence of an index or table of contents;
3. the distribution of interaction or questions requiring responses from the students;
4. the presence/absence of forced/optional review;
5. the individual modules that compose the lesson;
6. the distribution and quantity of the material in the modules;
7. the presence/absence of auxiliary units used for adaptive strategies, student controlled branching, or additional help.

The study of these drawings has facilitated the analysis of individual lesson structure. A segment of one of the charts has been included (Figure 8 a-b, pp. 76, 77).

General Aspects

The implication of individualizing the lesson by allowing the student-controlled branching (with branching to the index page as an additional option) can perhaps be seen in an analogy. When reading a book, the student can skim lightly over the material the first time, go through it carefully a second time, and then review selected sections for remedial work on a third reading. However, the CBE (computer-based education) format differs from that of a book: failure to provide an index with choice of entry is akin to requiring a student to go through a book from beginning to end without the option of reviewing or skipping as determined by his interest. Even though in some selected cases there may be one "best" way to go through the subject matter, student study habits vary and it may be reasonable to offer the option of some choice. The use of an index might possibly lead to faster completion times and improved attitudes.

The following can be considered some of the instructional advantages of an index with choice:

1. greater individualization and freedom of choice for the student;

2. opportunity to review difficult concepts without the danger of forgetting them due to intervening text until the student feels he is adequately familiar with them;

3. opportunity for "soft" or "selective" failure--less time needed for review, as well as allowing the student to "redeem" himself without officially failing--an important motivational factor;

4. sense of accomplishment by student for completing the subsection(s), also a motivational factor.

Specifics

Five of these lessons--"starter", "transmission", "diesel", "drive shaft", and "PTO" offer a choice page for students as they enter. The remaining three, "emission", "hydraulics", and "electricity", do not. However, in the last two lessons, "hydraulics" and "electricity", after the student goes through the lessons once, he has the option of reviewing specific sections (either by his choice or as selected by the computer on the basis of his performance on the end of lesson test.)

The indexed linear format (used in the first five lessons mentioned above) has the following characteristics:

1. the student can start in the lesson at several different points (indicated on the choice page as sections), but can exit only at specified termination points in the sections;

2. within a section, movement is either forward until reaching a termination point or back to the beginning of a section;

3. at the end of a section there is a return to the index for a new choice.

Thus there is limited freedom of movement within this kind of lesson.

In lieu of such an index, an outline of what the lesson is to cover has sometimes been included. Thus, "electricity" gives such an outline without the option of entry point choice. This "roadmap" may be useful to the student, but may not be as useful as a choice page. Each of the sections is a separate aspect of the study of electricity, and thus the subject matter seems to be adaptable to a breakdown into its component parts: electron theory, series circuits, parallel circuits, series-parallel circuits, and magnetism and induction. As the lesson stands now, without choice, it requires two to three hours at one sitting for the student to complete. This is in contrast to the usual lesson completion time of approximately 41 minutes. (This figure was computed from data on all lessons supplied by Chanute listing average lesson completion times.) The length of the lesson may have caused at least one student studying it to request multiple entry points.[1]

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[1]This information was obtained during a visit to that campus.

The subject matter expert is the one to decide whether the indexed linear format is appropriate for a specific lesson. However, the majority of the eight lessons under review do in fact offer this type of format. In some cases though, the choice is not available until the student has completed each section of the lesson: then he may review individual sections before taking the final test. Though the ISD principles practiced at Chanute did not provide for the indexed linear format, the authors came to an agreement with the ISD personnel and included this feature.

In general, the lessons consist of several moderately long segments connected to an index: each segment takes approximately 10 minutes to complete. Help units are provided in three of the lessons: "diesel", "hydraulics", and "electricity". These auxiliary units consist of the optional review of materials seen previously. In addition, all the lessons make extensive use of a forced review technique, making the student re-read material whenever a question is answered incorrectly and/or an inadequate score on the end of lesson test is achieved. (See Appendix V for more details on this technique.)

See Appendix VI for a more detailed analysis of the lessons with emphasis on student control and individualized choice within the lesson.

General Comments

Components

It is noteworthy that an outline of the lesson is accessible to an author from the objective page via DATA but is not available to a student going through the lesson. The outline is much more detailed than the brief one found in the index. In two lessons ("drive shaft" and "electricity") there are no indications of its existence; it was discovered by an examination of the coding. The reason the Chanute ISD staff gave for not allowing the student access to the teaching points was: "The student will eventually see the information there when he takes the lesson." Nonetheless, the teaching points may be useful to the student, and broadening their access could at least be investigated. (For more information on the occurrences of "teaching points", see Appendix III.)

Organization

All lessons except one consist of several modules (i.e., sections, as listed on the index page) containing a series of coding units (i.e., basic building blocks of the programming language). "Emission" did not use the modular structure; by contrast, it consisted of various topics in crankcase ventilation, pcv valve operation, and emission control. The material in the modules usually pertains to a single topic of the more comprehensive lesson subject matter; for example, the planetary gear module contains the discussion of that gear assembly, and that only ("transmission").

The modular arrangement breaks up the material into its component parts and allows the student to assimilate it in small increments. It is an alternative to presenting an amorphous mass of material in which he may feel he is adrift, as in "emission". (See Appendix VI.)

The student must complete the whole lesson before he is allowed to take the end of lesson test, a practice which allows him to become exposed to all the material in the lesson and will give him a certain familiarity with the subject matter covered. This exposure may improve his chances for success on the end of lesson test. On the other hand, since every student sees every display, these eight lessons employ only rudimentary adaptive strategies.

Summary

In summary, the lessons have the following organizational characteristics:

1. the normal progression involves a pass through all the individual sections before trying the end of lesson test (except for "diesel", where it is accessible at any time from the index page);

2. the customary result of a wrong response to a question is being forced back through one or more of the previous units for remediation (see Appendix VI);

3. the usual consequence of an unsuccessful attempt to pass the test is a forced review of selected sections in the lesson;

4. the student cannot retake the test until the indicated sections are reviewed;

5. the lesson is not considered completed until the end of lesson test has been passed (usually with 80% or better accuracy).

Specific Comments

Teaching to an Objective

Every lesson objective was stated as follows:

Without reference identify the basic facts and (state) general (operating) principles of _______ with 75% (80%) accuracy.

The blank space contains the subject matter of the particular lesson (e.g., automatic transmissions). The objective is stated at the beginning of each lesson. The student learns in the end of lesson test that his "accuracy" is shown by achieving the percentage score; when he has done so, he has fulfilled the author's pre-stated objective.

In general, the lesson objective is not delineated further. No enabling objectives or sub-objectives are specified. For each lesson there is a three-part behavioral objective which "indicates what the student should be able to do or say when he has finished the lesson . . . the main verb in a behavioral objective is active" (Anderson & Faust, 1974, p. 20). However, it is presented only in general terms. Thus, it can neither guide the student in his study of the material, nor can it be used by a subject matter specialist to construct questions for the end of lesson test. The best that can be said of these objectives is that they can be considered statements of the topics of the lessons (Merrill, 1974; Barnes & Clawson, 1975).

More specific objectives (e.g., "Given a photograph of an engine, the student will locate the air cleaner on the first attempt"), if used by the author, have not been provided for the student. Likewise, the student is not informed as to what types of performance criteria (i.e., knowledge of terminology, identification of components, listing and knowledge of functions) are expected of him. In some cases, very substantial subjects are addressed relatively briefly: for example, all knowledge pertinent to the subject of automatic transmissions is taught within an average time of less than 50 minutes ("transmission"). However, according to Chanute personnel, this brief treatment is adequate because "All defective automatic transmissions are shipped away for repairs."

For each of these lessons, an objective could be drawn up based on the usual form of the end of lesson test. Stated in behavioral (and therefore demonstrable) terms, a typical objective would read as follows:

> Given a list of 10 components and 12 component functions within an automotive ______ system, the student will match each of the components with its function. Eight or more of the components must be matched correctly on the first attempt in order to pass the test.

The blank would contain the relevant subject matter of the lesson (e.g., emission control). A specific objective of this kind has been determined for the majority of cases since a matching drill, end of lesson test is used in approximately 3/4 of the Chanute lessons.

The author has chosen to analyze these lessons by comparing the content of the individual lesson to the end of lesson test rather than by comparing the content to the objectives or the course control documents. These documents and the objectives agree that when the lesson is completed the student's proficiency will be such that he can "explain [the] relationship of basic facts and state the general principles about the subject" (level B). (ISD, AF Manual 50-2, pp. 3-6, 3-7; see also ATC Form 23A, May 1971, and ATC Form 362A, April 1969). In fact, the lessons do not require this level of knowledge; it is closer to level A, which requires only that the student can "identify basic facts and terms about the subject."

The lowering of the knowledge standards for the vehicle lessons seems appropriate for four reasons:

1. Because 70% of the students' training time is spent in laboratory sessions, many of the "knowledge items" (e.g., names of parts, basic principles of operation) are rehearsed (implicitly) in the course of the laboratory training. It is not necessary therefore that these be taught to a high degree of mastery in the classroom (i.e., PLATO) sessions.

2. Affective objectives are perceived by the MTC group as some of the most important elements of training (e.g., the Air Force philosophy that it may be cheaper to replace than to truly repair, or a "go ahead and get your hands greasy" attitude). Since these objectives may be more easily achieved in the laboratory environment, it seems reasonable to limit the time spent in cognitive areas which may be less relevant to job performance than these affective outcomes.

3. The performance of the graduates, based on the field evaluation forms returned by the supervisors at on-the-job training sites, indicates that the current training materials lead to satisfactory job performance.

4. The knowledge expected and required of a graduate of the course is rather basic. He will rapidly learn a great deal from on-the-job experiences, and he is expected to be dependent on more experienced staff initially.

The MTC author points up the discrepancy between the materials in order to provide a sound basis for his decision to judge the intent of the lessons based on the end of lesson tests. This is an alternative to assuming that the stated objectives describe the lesson's purpose. Awareness of this situation is significant. It is then not inconsistent to maintain on the one hand that the lessons do not teach to the objectives and on the other that they apparently are effective teaching instruments.

The general terminology used in the objectives implies a more extensive treatment than the training environment demands. The fact that the lessons represent only an introductory treatment reflects the lesson developers' awareness of the difference between the stated scope of training and that which is actually required.

Summary of Above

In outward appearance, the lesson consists of a series of excerpts from a technical manual on the particular subject matter and a test on selected items at the end. It is of course open to debate whether such breadth of subject matter can be adequately covered given the constraint of lesson-time length. Though the subject matter experts at Chanute have judged that this amount of time is sufficient to treat the material in the depth needed for their students, the objectives provide no further guidance about the specific facts to be learned or the thoroughness of the training. Hence, on the basis of the "teaching points" and the objectives available to the reviewer, little more can be said about the match between objectives, test, and instruction. (See the section on General Comments: Components, and Appendix XI for a discussion of military guidelines for the writing of objectives.)

Terminology

In general, there is an appreciable lack of concern for defining key terms and ideas. Since all the prerequisites for beginning the lessons were not available to the reviewer, the students' familiarity with the important terms cannot be determined with certainty. However, definitions of these terms would serve to refresh their memories if they do not have prior knowledge of the subject or to bring them up to the same level as more experienced students if they are unfamiliar with the subject matter. From the emphasis given to certain terms, it appears that they are new to the students entering these lessons. Thus, some benefits might accrue from a thorough discussion and/or definitions of the terms.

This is an important matter since it is unlikely that authors will be present to provide assistance when the students go through the lessons. Students may be reluctant to seek help even if a proctor is available during the PLATO/CBE session. However, at a minimum, definitions of key terms/concepts or even a question requiring the student to pick out a sentence in which the term/concept is used correctly would tend to reduce uncertainty or confusion resulting from lack of familiarity with the terms.

It seems likely that the extra time a student would spend reading concise definitions inserted into the text would be more than compensated for by increased reading rates and decreased re-reading of difficult passages throughout the lesson. The author can then confidently build upon a solid foundation as he develops a comprehensive approach to the particular subject matter. This can be done easily by putting all key terms and concepts into an auxiliary unit, accessible at any time via a branching routine. This reviewer found out only recently that according to Chanute personnel, an attempt to build such a glossary was begun and abandoned. The reason for the decision to abandon this task is unknown.

These ideas are in no way profound or novel. They are merely an example of a basic solution to a problem that is often overlooked during the development of a lesson. Defining terms may not be as stimulating as presenting a complex argument or graphic display, but it is of vital importance nonetheless. The impact of a CBE presentation can be seriously weakened, if not lost entirely, if the student fails to understand the important terms in the lesson.

Some examples of undefined terms or phrases may illustrate the problem. The following are in all cases important to understanding the relevant subject matter of the lesson. This list is not exhaustive.

Lesson	Term or Phrase
emission[a]	vacuum; non-positive system, positive system
starter[a]	(ignition) switch; electromagnetic switch
transmission[a]	fluid coupling; torque converter; servo; friction-type clutches
diesel	injector; glow plug; multifuel; Roots-type blower; TDC
hydraulics	(majority of terms defined)
drive shaft	transfer case; final drive components
PTO	(majority of the few terms adequately explained)
electricity	(majority of terms defined)

Except for the two introductory lessons, "hydraulics" and "electricity", defining of key terms and ideas within the lesson in which they are used is the exception rather than the rule. Possible results of undefined terminology:

1. extended lesson completion time due to slower reading;
2. hesitation to ask for a proctor's help or, alternatively, slower completion time due to waiting for a proctor to attend to a question;
3. uncertain attempts by the student to arrive at the definition by himself;
4. misconceptions of key terms or omission of them to preclude an impasse.

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[a]According to Chanute staff, important terms in these lessons were defined in other lessons which were prerequisites. These latter were not selected for review in this study. The retention of terms from these earlier lessons is a subject for further research.

Interaction

The term "interaction" refers here only to question and answer interchanges. The amount and type to be included in CBE are matters of lively discussion (Anderson & Faust, 1974). Interaction is a fundamental and unique capability of such a system: the student can interact with the author via the program and the computer; in addition, the student's understanding may be tested and corrected.

Unlike lists of questions at the end of chapters in a standard textbook, which are really optional as far as progress through the book is concerned, the student cannot proceed in most PLATO lessons until the questions have been answered successfully. But the author can aid the student's progress by providing:

1. the correct answer after a pre-determined number of incorrect responses with the missed item(s) brought back again at some later point, or

2. additional information or forced reviews for incorrect answers.

A controlling assumption in these lessons seems to be that the student will be aided in his learning of the subject matter if he must recall what he has just learned before moving on to new material. As stated in the section on 'Structural Analysis: Procedure,' the flowcharts of these lessons indicate graphically the frequency of questions. But in most cases, the discussion of terms, concepts, and principles far outweighs the number of questions inserted to test recall and understanding, as seen in Table 1.

It would be possible here to compare the quantity of questioning in these lessons to a standard, if one existed. In any case, frame after frame of mere text tends to turn the lesson into a "page turner"--an electronic form of the traditional textbook. This format does not require the complex hardware and higher cost of the PLATO system to accomplish a relatively simple teaching technique. Likewise, nearly all the more efficient strategies by which a CBE system can justify its cost rely on substantial input from the student.

The type of question is important as well, as seen in the research conducted by Rothkopf and Bisbicos (1967). Questions should be of some significance and have a direct connection with the test items, and the lesson objective must always be reflected in the questions.

The questions in these lessons should do the following:

1. help the student understand the material,
2. assist him in retaining the important concepts for later use,
3. aid in discriminating between similar but different concepts, and
4. in some cases, give help in passing the end of lesson test.

The last is most relevant to the author's objective.

The types of interaction and the quantity may be useful for comparative purposes. Table 1 provides some documentation. Types of questions include fill-in, multiple choice, and true/false. The last column lists the number of questions out of the total number of frames and the percentage of questions to total frames.

Table 1

Quantity and Type of Interaction in Eight Chanute Lessons

Lesson	Fill-in	Multiple choice	True/ false	Totals and percentage
emission	2	12	1	15 out of 41 = 36%
starter	13	33	0	45 out of 95 = 48%
transmission	0	14	11	25 out of 43 = 58%
diesel	8	6	0	14 out of 74 = 19%
hydraulics	3	20	5	28 out of 74 = 38%
drive shaft	3	8	1	12 out of 32 = 38%
PTO	1	2	4	7 out of 16 = 43%
electricity	1	7	0	8 out of 24 = 33%

The counts of the numbers of questions and the numbers of frames are provided for the reader's use with this caveat: the lessons are of varying lengths in time and computer space (ECS). Further, the "attached" lessons have not been included in the tallies; due to their "non-fixed" state they were not broken down into their component parts as were the "fixed" lessons. Hence, the absolute values are more difficult to interpret than are relative values. However, the lessons sampled are representative of the whole lesson sequence. Though there is some disagreement over what constitutes a "frame," given the display and interactive capabilities of the PLATO system, the frames counted here correspond closely to the number of "main units" in the lesson.

The average percentage for the eight lessons surveyed is about 39%: one question appears for about every three frames. This figure suggests one important characteristic of the lessons: a large number of textual passages and the low frequency of interaction. (See Appendix X also.)

The following are additional aspects of interaction in these lessons:

1. the number of distractors (incorrect alternative choices) is frequently less than three--thus improving the odds of guessing the correct answer;

2. if the student guesses correctly, he can avoid remediation and feedback in a substantial number of cases;

3. use of different types of questions--multiple choice, fill-in, and true/false--may help to ascertain aspects or depth of understanding as well as to add variety or maintain interest.

The Chanute authors stated a preference for the multiple choice question in the body of the lessons reviewed. They noted that their students had trouble with the standard typewriter keyboard, considering it a random arrangement of letters and other symbols. However, this problem can be effectively minimized by using numbers located in a row at the top of the keyboard, a procedure which eliminates the need to use letters. Incidentally, the MTC-supplied matching drill could have been easily modified to accept numbers rather than letters. The alphabet form was chosen as standard by MTC because of the relative ease in utilizing it with more than 10 possible answers. (See the section on 'Specific Comments: Tests' and Appendix VII.)

<u>Visual Presentation</u>

The term "visual presentation" usually calls to mind graphic displays--drawings on a plasma screen. But there are other considerations as well: margins, spacing, presenting the question on the same frame as the text including the answer, and the utilization of slides as a visual aid. In order for each of these to permit or enhance learning, a display must be clearly explained and presented. The following must be taken into account: arrangement of text and/or graphics on the screen, choice of type fonts, plotting speed, and drawing accuracy. If the display portrays *significant information*, one or more questions about it are appropriate.

A select group of displays may be illustrative at this point, with commentary as to their presentation and impact.

<u>"Emission"</u>. Operation of a Diverter Valve.

A lengthy period is spent constructing this diagram (about 20 seconds due to the complexity of drawing and use of sized writing) to show the operation of the diverter valve. Arrows simulate movement of fluid through it. The motion is almost imperceptible, and the impact is thus rather insignificant. (See Figure 1, p. 69.)

<u>"Starter"</u>. Description of the Starting System.

The drawing is inadequately stylized, composed of a square representing a battery and a circle with a rotating "x" inside to depict the starting motor. The drawing is of limited value for representing the starting system, the subject of the lesson. (See Figure 2, p. 70.)

"Transmission". Diagram of Planetary Gear Unit.

The gears of this unit are NOT in constant mesh, although the accompanying text emphasized that constant meshing was always the case. The drawing may cause some confusion in the student's mind as to what really IS the norm. (See Figure 3, p. 71.)

"Diesel". Several allusions are made to diagrams in a handout that was unavailable to the reviewer. For the student, this would necessitate going beyond the CBE material for help that may not be readily available. On the other hand, microfiche depicting the total complement of diesel components are frequently referenced. Such illustrations are effective in giving students a clear picture of the subject.

"Hydraulics". Cut-away View of a Centrifugal Pump.

It is a stylized and static display. Since the function of a pump is to move fluids, the center vanes could spin as if fluid were flowing by. Moving arrows here could simulate motion. (See Figure 4, p. 72.)

"Drive shaft". Several Drawings of the Power Train of a Vehicle showing the Post-transmission Drive Apparatus and its Chassis.

These are static displays. Some movement of the drive shaft in operation might make a greater impact. (See Figure 5, p. 73.)

"PTO". Frequent Graphic Displays of the Chassis and its Components.

All are fairly clear except for the puzzling presentation of the sprag unit (?). It is difficult to determine what is being depicted here. (See Figure 6, p. 74)

"Electricity". Several Displays of the Structure of Various Atoms, Complete with Protons, Neutrons, and Electrons.

The frequent animation makes a strong visual impact. (See Figure 7, p. 75.)

These specific examples give some feeling for the approach used by the individual authors in regard to the use of graphics. Copies of actual displays will be attached to this report for additional information.

Graphic displays can thus be used as a pedagogical tool to offer an explanation of material in a visual form. However, many displays at Chanute were static. When motion was attempted, by moving arrows or circles to represent fluids or air, the animation was stilted. There were either too many cycles of movement or the motion was lost amid the larger display. "Emission" contained examples of both types of ineffective motion.

Copy Frames

Another observed pedagogical approach is the inclusion of both text and a question on that text on the same page. In the simplest form of copy frame, all the student need do to answer the question is to look up, read the answer, and write it in the space provided. Several examples of this technique are found in "emission". Interaction is reduced to the student's ability to search out and copy the correct answer. Although, in strictest terms, copy frames are a form of interaction, their effectiveness as a learning device is questionable (Anderson & Faust, 1967). They stress visual recognition rather than cognitive processing. Therefore, they are discussed in this section rather than in the section on "interaction."

Utilization of Color Slides

Another type of visual presentation is the use of slides to depict schematic diagrams of components and/or systems or photographs of them in operation. A picture of the actual part or a drawing of a circuit with components added is very effective for showing the student what to look for when he is on the job. But for maximum impact, the slides must be placed in proper relation to the text. Improper superimposition of slides and plasma display drastically reduces the legibility of the display, a condition especially apparent in the uses of the slides in "starter". Superimposed upon white or light-colored portions of the slides, the text is washed out and virtually illegible. The strong back-lighting from the rear projection of the slide reduces the background content. The text could be relocated to areas of greater contrast by simple coding changes.

Unannotated presentation of a visual display, microfiche, or plasma drawing is typically insufficient to insure that the student will learn the appropriate information. He must understand why he is looking at the display. Unless he is given specific guidance, he may be confused by the amount of information that graphic displays can present. To insure comprehension, one or more questions on the display should be presented to test the student's understanding, as is done occasionally in "starter".

Since a drawing or particularly a photograph contains a bewildering quantity of information, much of which is generally irrelevant to the author's objective, discrimination between what is important and what is marginal is often difficult. For example, the color of paint on various automotive components may seem irrelevant, but may be part of a color-coding scheme. Students have been observed to overlook information far more obvious than the colors in the display. The author's job is to guide the student's attention with arrows, circles, labels, and questions. (Specific examples of both kinds--good and bad--are found in "starter" and "diesel".)

The following is a summary of the previous comments on visual presentation.

1. in general, the visual displays are used to explain the subject matter of the lesson;

2. plasma drawings are clear, very detailed and carefully drawn, but often stylized;

3. the use of animation is ordinarily appropriate, but could be used to greater advantage (i.e., by using more movement);

4. the placement of text on the screen at the same time as the slide could be changed to improve legibility, and

5. the explanations that accompany the visual displays need to be improved.

(See also Dwyer, 1967.)

Feedback

In the eight lessons under discussion, there is limited use of feedback, a term which includes any comment that appears after the student has typed in an answer to a question and pressed NEXT. Often, feedback is presented below the line on which the student responds. Only a few questions are provided with different types of feedback for several specific wrong responses. In general, feedback does not appear for each question after interaction; even when it is used, it is often similar to the automatic response that PLATO provides (i.e., "ok" or "no" after an answer is judged).

Feedback occurs in several forms. First is the customary compliment for a correct answer, which may influence the attitude and motivation of the students. In Table 2 this category is labeled "pos." The compliment usually takes the form of "Well done!", "Good!" or a similar expression. Because the same response is given regardless of the number of attempts the student needed to answer the question, it may at times seem incongrous. For example, after responding incorrectly to a multiple choice item three times, the student finally answers correctly on the fourth try and is told "Nice job!" After multiple tries and final success, a simple "ok" or "that's it" might seem less sarcastic.

The usual rejoinder for an incorrect response ("no, try again"), described in Table 2 as category "neg.", appears quite frequently in the lessons, but its value to a student is debatable. It does not indicate where the student went wrong nor in what direction he should go to discover the right answer. Moreover, PLATO's answer judging will automatically provide the simple "no" to incorrect answers without the necessity of special coding.

On occasion, the student may even be subjected to intimidating or abusive feedback for a wrong response (see "antag." in Table 2), i.e., "Your head is RIDGED [sic] for selecting 'c'!" ("transmission"). This type of feedback can decrease motivation or antagonize the student, and it may be unfair. One can not be certain that the fault in giving a wrong response lies in the student's understanding rather than in the presentation of the material.

In come cases, information in the "feedback" position (below that of the student response on the screen) is used to introduce new material after a correct answer has been given. This is equated with "new mat." in Table 2. It can be missed (intentionally or unintentionally) due to a desire for rapid movement from one section to the other. To illustrate, some students habitually press NEXT twice after an answer is given, with the following results: if they were right, they move quickly to the next frame; if not, they are ready to make another guess. Students have even assumed that feedback for correct answers contained only review material (unpublished study, Avner, 1970). Thus, important explanatory material may be lost if placed in this position.

The scope of material that the feedback may include is thus rather broad. It ranges from the simple negative to the correct answer itself ("answer" in Table 2). Neither extreme is likely to benefit the student as much as a middle course, offering hints or additional information to guide him away from error and/or toward the correct answer. A simple negation offers little help: he only finds out that he is wrong. Giving him the answer is also of dubious value: all he has to do then is type it in. He may not even understand why it is correct nor why it is important for him to retain it (if in fact it is).

The student may want to get the answer on his own and will not be receptive to its being given to him without his even requesting it. Of course the answer should be available after several attempts so that the student can move on and not get hopelessly mired in one spot and frustrated. This is of course very similar to moving him on automatically after he has made several attempts to answer the question. Both effect the same result.

Guidance toward a correct solution is another alternative (R. Anderson, 1970; Lindzey & Aronson, 1968; J. Anderson, 1970) (described as "help" in Table 2). Given aid, he realizes he is wrong and is put on the right path. But he still has to do some of the detective work in discovering for himself the correct response. Neither a bland rejection nor spoon-feeding offer the satisfaction that one can gain by searching out, with adequate supervision, the suitable answer for oneself. This is another area where CAI can excel if only the authors are given adequate training and time to produce quality material.

Drawing on the Navy document (Spencer, Hausser, et al, 1975) which lists the "rules" for effective feedback, the following summary is presented. It discusses the various aspects of feedback and its delivery, with examples drawn from the series of lessons being considered. It should be noted that these are guidelines for "tutorial" approaches and may not be appropriate for simulations.

Rule 1: Feedback should be immediate (within a few seconds).

Observation: True for all individual interactions, not true in some cases for judging on end of lesson tests. (See Appendix VII for specific occurrences.)

Rule 2: Feedback should be descriptive, rather than evaluative.

Observation: The former is true for a smaller percentage of cases than the latter.

Examples:

a. Descriptive: "This Bendix drive engages like a nut on a bolt." ("starter")

b. Evaluative: "I thought you said you were ready." ("emission")

Rule 3: Feedback should be specific rather than general.

Observation: True in only a minority of the cases.

Examples: a. Specific: "This starter uses the over-running clutch." ("starter")

b. General: "Try again" ("emission")

Table 2

Types of Feedback

Lesson	Pos.[a]	Neg.[a]	Antag.	New Mat.	Answer	Help
emission	X	X	X	X		
starter	X	X		X		X
transmission[b]	X	X	X	X		X
diesel[c]	X	X		X	X	X
hydraulics	X	X	X		X	
drive shaft	X	X				
PTO	X	X	X			
electricity	X	X	X		X	

Note. An "X" under a heading indicates that examples of each kind are found in that lesson.

[a]This feedback is general and not specific for particular answers. The positive feedback (i.e., "Good work") appears whether the correct answer is given on the first or subsequent attempts; it is not related to the actual performance of the student.

[b]The right answers for the interaction are usually stressed by the use of bold-face type before the question is asked (not on same page).

[c]The feedback for certain correct answers consists of strong hints to remember the information for later use. See Appendix II for a detailed treatment of use of feedback in this lesson.

Summary of Table 2

1. Guidance or help is provided in only a few instances in these lessons;

2. The footnotes above indicate rather questionable types of feedback to "assist" the student;

3. the occurrence of general, non-specific feedback (both positive and negative) is widespread in these lessons.

Tests

As was stated in the section on 'Specific Comments: Teaching to an Objective', the end of lesson test and lesson objective are rather closely connected. That is, the objective is not met until the student passes the test with a score of 75%-80%, depending on the individual lesson. The final test then becomes the major focal point of the lesson because of the singular importance given to it by the lesson objective.

The customary format of the tests is a matching drill consisting of one column containing the functions and/or types of components (usually 10), and another column listing the components/types (between 12 and 15). This is the format for the lessons on starters, transmissions, diesels, and power take offs.

Some additional aspects of the matching drill are worth mentioning. In two lessons ("transmission" and "PTO") the sequence of items in the left hand column (A) is not fixed: the descriptions are presented in random order. Also, the directions are not stated in any uniform fashion: often the student is just told to match up the items (as in the lessons on starters, transmissions, hydraulics, power take offs, and electricity). Only in two lessons, "emission" and "diesel", do the directions point out that one or more items in the left-hand column can be used more than once or remain unused. Thus, in the remaining five cases, the student may plausibly conclude that he can improve his odds at guessing by eliminating those items used once.

The other lessons differ in test format as follows.

"emission":	Five items to be matched from a selection of 8 possible.
"hydraulics":	Two sets of 8 items each to be matched with 10 possible in each set.
"drive shaft":	Ten multiple choice items, each with 3 distractors.
"electricity":	Twenty items total, of which the first 7 are matching (8 choices), and the last 13 are multiple choice with 1 to 3 distractors.

These data can be summarized as follows:

1. the matching drill appears in the test in all but one of the lessons in this series;
2. the usual number of items to be matched is 10 from a list of 12 to 15, and
3. the usual sequence is to select a component or type of part/system from the right hand column and match it to its description in the left hand column.

When a student selects either an item to be matched with its function/type or one of the multiple choice items, he presses NEXT, but no individual answer judging takes place. After he proceeds through the test, he is given an opportunity to recheck and change or fill-in any of the questions answered or unanswered on his previous pass, before the test is scored for record. When he elects to have his test graded, he is only given a numerical percentage (e.g., 60%) with a comment as to whether or not it is satisfactory. In most cases, the criterion is 80%. If the score is unsatisfactory, he is sent back to take all or part of the lesson again before retaking the test.

As part of the testing procedure, the knowledge of results is not usually given; however, in the lessons on transmissions, power take off, and electricity, there is individual answer judging (i.e., feedback about which questions were missed, but no feedback about why the answers were wrong or what answers were correct) when the test is scored.

The withholding of this individual judging in the other lessons may be due to a desire for preserving test integrity. It may help to insure that test items are not passed on from one class to another. In addition, if the same test is used when the student retakes the test, detailed feedback on the first pass might reduce the effectiveness of the instructional material the student reviews before his second try.

This procedure obviously contains some hazards. If the student is unsure of his answers and guesses on some of them, he cannot tell if his guesses are correct or not. He may erroneously assume that some answers were correct when in fact they were not; he may go away with faulty knowledge of the subject matter seemingly confirmed. Giving him the option of seeing at least the correct responses for incorrect answers would point out to him where he went astray. At the very least, he should not go off with questions on important parts of the subject matter still unclear in his mind. While the purpose of this testing system may be understandable, it does have these undesirable side effects.

When Chanute evaluators reviewed this section, they argued that it was unnecessary to supply the correct answers to a student who passed the end of lesson test but missed 20% of the items. Since the test only sampled the student's knowledge, correcting the 20% would therefore have been only a small contribution to the student's overall knowledge. This explanation may have been accurate but it contradicted the notion of a criterion-referenced test, which is what these end of lesson tests were designed to be.

One way of avoiding some of these negative aspects can be found in the utilization of a matching test routine with all its available options. Most of the end of lesson tests in this series of lessons employ some version of this routine: it was originally written for Chanute AFB (and other ARPA users) by the MTC group. This programming device, used to facilitate the construction and scoring of the end of lesson test, was employed in several forms in these lessons. However, the original (i.e., MTC-supplied) routine contained these options:

1. all questions must be answered OR individual items student does not know may be left unanswered,

2. the percentage of correct answers may or may not be shown,

3. the wrong responses may or may not be indicated,

4. the correct answers (for items student has wrong) may or may not be shown.

Explanatory material accompanied the description of the driver. This material provided some "instructional guidelines" to be "considered when writing the matching lists" (Sweeney, 1974, p. 1):

1. State clearly the relationship between the two lists (i.e., tool to machine, part to function, etc.) . . . only one relationship in any one matching drill . . . [which should imply] a consistent grammatical structure within each list. (p. 1)

2. Use more "answers" than "questions", and, wherever possible, use the same answers twice (remembering to tell the student answers may be used more than once . . . Students must weigh each question separately without using a "process of elimination". (p. 1)

The suggested guidelines are followed to a considerable degree. For specifics on the use of directions, see Appendix VII.

Since the original form of the driver clearly contained the above options and directions, it must have been decided (while other modifications were made) not to retain all the available options. That is, the options were not missing because they were difficult to program or were overlooked, but were present and purposely removed from the original coding. (For further discussion of the modified drivers used in these lessons, see Appendix VIII.)

Table 3

Relationship of Test Items to Interaction

Lesson					
emission	70%	stressed	previously	via	interaction
starter	100%	"	"	"	"
transmission	90%	"	"	"	"
diesel	50%	"	"	"	"
hydraulics	100%	"	"	"	"
drive shaft	70%	"	"	"	"
PTO	40%	"	"	"	"
electricity	85%	"	"	"	"

In "PTO" (see Table 3), there is one question not covered at all via interaction or text. Examination of the test data for individual items shows that the performance of the students on this question was about the same as their performance on other items: this may indicate that the students had prior knowledge of some aspects of the subject matter before beginning the lesson.

Other comments related to the testing procedure in these lessons are found in sections 'General Comments: Teaching to an Objective' and 'Summary and Conclusions.'

Coding

Errors in coding can be of two types: major or minor. The former are restricted to execution errors which terminate a student's progress in the lesson. The latter arise from faulty or careless programming: these lead to improper displays of text or may cause minor problems for the student in the lesson. Some examples of these are found in Table 4.

A significant problem is the matter of condense errors. Though invisible to the student, they are clearly flagged for the author when the lesson is selected for student use. These errors can be of various kinds: missing units or duplicate unit names, undefined variables, and uninterpretable statements being some of the more common ones. In this group of lessons, these errors did not affect the operation of the programming, but they could hide other, more serious errors (e.g., missing units).

Some specific examples may be illustrative: "starter" has two minor condense errors, and "drive shaft" contains 16 condense errors. In the latter lesson, only 11 appear on the first page of the condense

condense error list. The second page of the list, which might contain more serious problems, was not visible at that time. Thus, there was a danger in not clearing these up as they were pointed out.

From a coding point of view, the lesson can often be improved with a relatively small expenditure of time and effort. The coding needed to add specific feedback or a helping unit is relatively simple and could be added in a matter of minutes. Implementation of such changes can make an operational lesson more useful for the student. As always, it is for the author to decide which of the suggestions he wants to incorporate in his lesson.

The suggested changes (indicated on the prints for the examples that appear later in this section) are thus very appropriate for the "lean" approach of lesson development advocated at Chanute (Dallman, 1975; Misselt, 1975). It matters little whether the coding is simple or complex, unless the author is producing a whole series of lessons: in that case, sophisticated coding will save time and computer memory space over the long run.

Coding Problems Encountered in these Lessons

"Emission". While the student is in the sections on pcv valve and emission control, he might hit the BACK key in search of review material or inadvertently by pressing the wrong key. Consequently, he will be returned to the beginning of the lesson involuntarily! He cannot return to his former position in the lesson without redoing all the material, about 20-25 minutes worth. A small change, indicated on the printout but not included in this report, would eliminate this interruption of normal progress.

"Starter". Due to some faulty coding, part of the section on "Control circuits" is not functional. It omits part of the discussion on two types of starters, and thus the student may lose potentially valuable information. Since it occurs in the middle of some text and is not a dramatic break, the student may not be immediately aware that something has been omitted.

"Transmission". There is some minor non-erasure of part of the feedback to a wrong response when NEXT is pressed to re-try the question; there is also some overprinting of one set of feedback over another.

"Diesel". There is some minor overprinting of lines of one bit of text onto the closing lines of the preceding paragraph. In one instance, a slide is available via LAB but no indication of its presence is given to the student.

"Hydraulics". For one question the feedback to a wrong response overprints the student response.

"Drive shaft". On the index page, if a student presses a key designating any letter other than the ones allowed (i.e., a-e), an execution error occurs: the student's progress through the lesson is interrupted and he is immediately deleted.

"PTO". A frame seemingly designed as an introduction (as determined both by its content and its name--"intro") is in fact invisible to all students except those who fail a particular question. Then they are sent back to this unit as part of a forced review.

One question requests the student to name two kinds of transfer cases but the judging sequence will count either half of the answer as completely correct. A very minor change will prevent this from occurring.

A "PRESS NEXT" appears at the bottom of the page, but a student response must be made before the student can move on from this place. In essence, the NEXT key is non-functional at this point, and the directions can confuse the student.

"Electricity". The student may be confused by "DO NOT PRESS NEXT" in large size writing printing over "Press NEXT to continue" in normal size writing.

Summary

It is of course obvious that there are other factors affecting the successful presentation of a CAI lesson. Some of these (i.e., the readability level, design of end of lesson tests, etc.) may be considered later. However, some comments can be made which sum up what has been presented in the preceding sections.

Drawing upon the specific categories, the following general trends become apparent.

1. The end of lesson test cannot be attempted until all the individual sections have been completed in every lesson except "diesel"; allowing it in this one case may have been an oversight.

2. The format of the stated objectives is identical in all lessons, subject matter being the only variable.

3. For the most part, dictionary-type definitions are not included for important terms/concepts; rather the components are usually defined in terms of how they function within the given mechanism.

4. The number of questions not directly related to items on the end of lesson tests is small.

5. There is an extensive use of visual displays depicting moving parts, which tend to be static and stylized.

6. Various types of feedback are used in these lessons with different effects, but all are an attempt to aid the learning process.

7. With certain exceptions, coding problems have ceased to be an important factor in this series.

8. All lessons are adequately operational.

Readability Study

In order for a student to comprehend a PLATO lesson completely, his reading skill must match or exceed the reading level of the instruction. Although measurement of reading skills and reading levels remains imprecise (particularly in the case of technical instruction and in situations where short passages such as those used in typical CBE presentations are involved), several approaches have gained general acceptance.

One of these has been used for this analysis: the standard definitions and procedures for readability of R. Flesch (1949). In the MTC study, in order to speed processing and reduce computational errors, a computerized analysis routine (contained in the PLATO lesson "evaluate" written by R. A. Avner) was used to convert raw data to grade-equivalent scores. For the eight lessons analyzed

1. the mean grade level was 9.0;
2. the highest grade level was 15.0;
3. the lowest grade level was 5.5.

Although the average reading level is a useful measure, perhaps even more important is the highest reading level of a lesson. Because of a "bottleneck" effect, the part of a lesson which is most difficult to read may have the greatest impact on a student in terms of his frustration and his lesson completion time. The highest grade levels can be described as "easy" to "very difficult" for these students. The range of grade levels for each category is given as follows:

easy	some difficulty	difficult	very difficult
8-9.9	10-11.9	12-13.9	14 and above
PTO	starter	transmission	emission
drive shaft	hydraulics	diesel	electricity

See Appendix XII for additional information on

1. how the reading study was carried out, and
2. specific reading grade levels for the lessons analyzed.

Conclusions

The average reading level of material produced for students taking technical training is geared for the sixth grade level, in theory. In practice, the grade equivalents of a group of students at Chanute ranges from 6.8 to 13.6 with the average being 11.78 (AFHRL/ATC Joint PLATO IV Evaluation Report #5, August 1975, attached raw data sheet); the figures were calculated according to the California Reading Achievement Test (Madden & Tupes, 1966).

Specifics

The following are observations on particular lessons.

"Emission". The loose organization and the failure of this lesson to follow its own objective may cause problems for the students in their attempt to follow the thread of the author's argument. At various points in the lesson, the student has the opportunity to review previously seen material before moving on, which is a limited form of choice. The first section of the lesson, on crankcase ventilation, has extremely limited interaction and tends to be a "page-turner" (i.e., a lesson made up of many frames of text only).

"Starter". Students are likely to do well on this lesson due to the stressing of test items by interaction. Within the individual sections, there is no roadmap to indicate where the student is nor where he is going: this may lead to a feeling of loose organization. A substantial amount of the material is presented with the aid of slides.

"Transmission". There are well thought-out sequences of interaction and complimentary feedback. There is extensive use of plasma line drawings and the forced review technique to aid comprehension. Names of components (i.e., SERVO) appear as bold-face, over-sized capital letters.

"Diesel". Ostensibly it is an introductory treatment to the whole subject of diesels. In fact, it does not discuss all the aspects of all types of the compression ignition engine, although this might be expected from a reading of the objective (same as that mentioned in the section on objectives). This lesson also makes extensive use of slides to display the actual components of the transmission which are then described and/or their functions discussed.

"Hydraulics". For the most part, this is a well-planned and well-executed lesson that proceeds from a brief theoretical discussion to the practical aspects of hydraulics in a balanced and organized fashion. Several review quizzes are employed to bring the student up to a certain performance level before allowing him to proceed in the lesson.

"Drive shaft". The limited feedback for a wrong response may greatly hamper or halt the student's progress, if he does not know the correct answer. In general, the student must reach a solution by himself before moving on. This situation can lead to frustration for the student. Plasma drawings are frequently used to depict the various components of the automotive propeller/drive shaft.

"PTO". This is a short lesson, but its very brevity might aid student comprehension, and retention of the material might help him pass the end of lesson test. In style, organization, and related subject matter as well as having the same author, it follows "transmission" very closely.

"Electricity". Another example of a reasonably well-prepared lesson. A very basic approach to the study of electrical fundamentals is given in small increments (e.g., matter → molecules → atoms → free electrons → current flow and related matters.) The author tries to tailor his material to the student's needs, which is to be commended. There is extensive use of diagrams and interaction to stress important concepts for understanding and retention.

For more information on two other aspects of these lessons, use of humor and personal address, see Appendix IX.

Appendix I

The Lesson Designations Explained

emission (mtcc10) = cha3 + some material from cha63

starter(mtcc11) = cha41

transmission (mtcc12) = cha73

diesel (mtcc13) = cha74 + end of lesson test in cha13

hydraulics (mtcc14) = cha78 + some material in cha80/84

drive shaft (mtcc15) = cha82

power take off (PTO) (mtcc16) = cha86

electricity (mtcc18) = cha97 + other lessons listed in index as sections: cha37, 100, and 43

Additional Comments

1. The sequence of movement of the student is from the first "cha" lesson to the other(s) of the attached lessons; then back again to the original "cha" lesson for the end of lesson test in "emission" and "electricity".

2. All the "cha" lessons have been exposed to continual editing and revision; thus, they are not exact equivalents to their "mtcc" counterparts, but they are very similar.

Appendix II

The Relationship of Interaction, Feedback, and the Test Items in "diesel"

This lesson was chosen for detailed study because of the particular way in which test items are stressed in the body of the lesson. Presentation of information related to the test items falls into definite categories:

%	= percentage of students answering question correctly (79 cases total).
i/a(dir)	= virtually identical questions in the body of the lesson.
i/a(indir)	= related question/answer stressed by interaction.
text	= information for answer provided in text, but not emphasized.
f/b	= answer to question provided in feedback to another question.
memory	= feedback to a question gives "Remember this for test".
blatant	= strong warning in text: "Don't forget (this)" and/or answer set off from normal text via unusual positioning on screen or special characters.
X	= one occurrence of this type of stress.

Question	%	i/a (dir)	i/a (indir)	text	Feed-back	Memory	Blatant
1	100			X			
2	85	X		X		X	
3	99			XX			
4	94		X	X	X		
5	75			X			X
6	71						X
7	90			XX			
8	89			X			
9	85		X	X	X		
10	85			X			

Summary and Conclusions

1. Extra assistance is provided in the form of strong hints to remember certain bits of data.

2. Some of the answers to test items appear at oblique places in the lesson (i.e., within textual passages, in related questions).

3. Some are hinted at so strongly it is as if they were stressed before the student sees them on the final test.

4. Two of the questions (5 and 6) are given very heavy stress by the use of strong hints; their percentage correct figures may have been inflated by this.

Appendix III

Teaching Points

The teaching points occur in all lessons and are accessible to authors only via DATA. However, directions indicating their presence and accessibility are not given in all cases.

Lesson	Directions given?
emission	yes
starter	no
transmission	no
diesel	yes
hydraulics	no
drive shaft	no
PTO	no
electricity	no

These explanatory units are noted since they furnish a detailed outline of what is to come in the lesson, although the student himself never sees the outline.

Appendix IV

Criteria for Choosing these Lessons

The lessons described in this report were selected as representing three types of lessons grouped by validation date: lessons which met the validation criterion 1) very early, 2) near the median point, or 3) rather late compared to other lessons. The Chanute staff member theorized that a later validation date would indicate greater difficulty in achieving that result. A lesson has validated when 90% of the students going through it get 80% of the questions correct on the end of lesson test.

Lesson	Validation date
electricity (cha97)	18 August
starter (cha41)	18 August
emission (cha3/63)	15 August
diesel (cha74/13)	30 June
PTO (cha86)	25 June
transmission (cha73)	18 May
drive shaft (cha82)	17 April
hydraulics (cha78/80/84)	14 April

It should be noted that this list cannot be taken solely as a guide to the quality of the original lesson for at least two reasons:

1. a lesson that did not validate could have been set aside for some time before any corrections were done, thus lengthening the time period before it validated;

2. conversely, another lesson, less likely to validate, could have undergone extensive and more frequent remodeling and could have validated sooner.

Consequently, this listing must be used with proper caution and not be accepted at face value as a reliable criterion for lesson quality.

Appendix V

The Forced Review Technique

Because of the frequency with which the forced review occurs, it seems that Chanute designers adopted this strategy as standard. If an incorrect answer to a question is given or the end of lesson test is not passed, the usual procedure is to march the student back through material he has already seen so that he will presumably get it right the second time through. The technique may have its advantages. It may discourage students from guessing randomly: such an approach generally does not produce genuine learning. There is a real danger that such random selection will occur since multiple choice and true/false questions tend to predominate in these lessons. In addition, Chanute students taking early versions of the tests were observed using a guessing strategy. Presumably, this kind of activity would be lessened when students are aware that incorrect answers lead to another pass through the material.

The technique presents some possible disadvantages. If the student had problems the first time, there is no guarantee that he will not have the same problems again. Then too, the student may feel that he is being punished for poor performance by this forced remediation, as opposed to being given hints in the feedback or extra help units. In addition, in some cases the student is forced to go through material that he has already covered successfully in order to review subject matter that he is not adequately familiar with. This seems like a waste of training time and not in keeping with the frequently mentioned "lean" approach. In any event, the Chanute evaluators stated that the most frequent specific complaint of students about the lesson was a strong objection to the forced review technique.

Appendix VI

The Use of the Indexed Linear Format

Name	Forced review of whole lesson if final test is failed	Index which allows student to choose order	Format of the lesson
emission	yes	none	Completely linear.
starter	no	yes (at start)	All the individual sections must be completed before the end of lesson test can be taken. Inadequate performance on test leads to review of selected sections. A review test is also provided to be taken before the final test.
transmission	no	yes (one module unlisted)	All sections must be completed before taking test. If test is not passed, specific sections must be reviewed before it is retaken.
diesel	no	yes	Choice of sections and end of lesson test are available at any time. If test is not passed, student must go through selected sections again before retaking test.
hydraulics	no	yes (at end)	No choice of which sections are to be done. If test is not passed in course of linear progression, there is a forced review of specific sections (any or all of 12 are possible).

drive shaft	yes	yes	If end of lesson test not passed, forced review of whole lesson
PTO	no	yes	If end of lesson test not passed, selected sections of the lesson must be review before test is retaken.
electricity	no	no choice	The student must go through all the individual lessons that compose "electricity" before taking the final test.

Appendix VII

Directions for Taking the Test

The following are the verbatim directions that a student sees when he begins the final test. Note the wide variation in the quantity and content, from the very complete directions in "diesel" to the omission of any in "drive shaft".

emission	Complete the following by matching the responses in B, with the statements in A. Some of the responses may apply to more than one statement!
starter	Match the components to the proper statement.
transmission	Match the lettered statement or phrase on the right with the numbered statement or phrase on the left.
diesel	Match the components in column B with the applicable statement(s) in column A. Type in the letter of the applicable components in the blank space beside each statement. REMEMBER: some components may apply to more than one statement and some components may not apply at all. To obtain a satisfactory rating you must select eight of ten correctly.
hydraulics	Match the applicable lettered statement or phrase on the right with the numbered statement or phrase on the left.
drive shaft	(No directions stated for test--10 multiple choice questions.)
PTO	Match the lettered statement or phrase on the right with the numbered statement or phrase on the left.
electricity	Match the following statements: (4 item matching drill).
	Match the name to the circuit: (3 diagrams of circuits to be identified).
	Type in the letter of the correct response: (13 multiple choice questions).

Appendix VIII

Selective Utilization of an MTC-Supplied Matching Test Routine

Lesson	Options Utilized
emission	No judging of individual answers after each answer is selected, but a percentage of correct answers is given at the end.
starter	Same comment as above.
transmission	Both correct and wrong responses indicated after test is graded, but no correct answer feedback is provided.
diesel	No individual judging of answers after each answer is selected, but a percentage of correct answers is given at the end.
hydraulics	Same as above.
drive shaft	Same as above.
PTO	Individual answer judging with option to review incorrect answers is provided at the end of the quiz.
electricity	No individual answer judging is provided after each selection, but a percentage of correct answers is given at the end, and there is an option to go back through the ones missed for review.

Appendix IX

Humor and Personal Address

CBE lessons often employ techniques to improve student motivation such as using humor and addressing the student by name or nickname. Some selected examples follow with commentary.

transmission	Student is addressed by name once. Possible attempts at humor (i.e., "That's what I call auto screen change!") at beginning of lesson. Also some heavy handed humor is found in feedback (i.e., "You have a SPLINED mind . . ." for selecting the wrong response).
diesel	Possible attempt at humor (little figure representing "air"). Also, there is a greeting at beginning of lesson: "good morning, afternoon," etc. depending on time of day that student signs in.
drive shaft	Students are addressed by name. A possible attempt at humor (i.e., "wait here to get the shaft").
electricity	Good attempt at humor with portrayal of B. Franklin, lightning, and kite as an introductory graphic to the lesson.

Appendix X

Types of Questions Used and Comments

Lesson	Kind of Question	Comments
emission	Simple fill-in (with answer on same page and multiple choice.	Only two distractors in most multiple choice.
starter	Large quantity of questions of different types.	Only two distractors in many cases.
transmission	Many true/false although the suitability of subject for this type cannot be ascertained.	The multiple choice only have two distractors which may encourage guessing.
diesel	Elementary level, ("What is compression ignition engine?" Ans. "diesel.")	Very plausible distractors.
hydraulics	Thought-provoking multiple choice.	Very plausible distractors.
drive shaft	Several questions of true/false kind are very similar to each other.	Confusing statements in the true/false questions.
PTO	Varied as to type; all three (fill-in, multiple choice, and true/false) are used.	Substantial amount of interaction even for short lesson.
electricity	Interspersing of text and questions of all types (true/false, multiple choice, and fill-in) is well-balanced.	Only 2-3 distractors in several questions.

Appendix XI

Writing of Objectives discussed in Air Force Documents

Guidelines from a Chanute AFB document[1] conclude that non-specific objectives obligate the author to teach all of the information needed within the particular area of the objective (p. 72). Objectives similar to those used by Chanute PLATO project staff were given as examples of those which are "not properly written" (p. 71): e.g., "TASK, repair a flat tire."

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[1] For some discussion of these, see the following sections in Application of the Systems Approach to Training. Chanute Air Force Base, Illinois: Department of Weapons System Support Training, January 1972.

Sec. 5 "Task-subject analysis," pp. 57-86.

Sec. 6 "Preparation of statements of learning objectives," pp. 87-100.

Sec. 7 "Development of learning objectives," pp. 101-110.

See also the more general discussion of writing objectives in Chapters 1 and 2 of Handbook for Designers of Instructional Systems, Vol. III, "Objectives and Tests," (AFP 50-58). Washington, D.C.: Department of the Air Force, 15 July 1973.

Appendix XII

Chanute Readability Study

Only text which presented new information was included in the analysis. Test directions, feedback, labels on graphics, interaction and test questions were excluded.

1. Sample passages containing 100 words were selected. In some cases, three samples were used; one from the beginning, middle, and end of the lesson. If the average fell within a range of 1.5 grade levels (i.e., 7.0 to 8.5), no more samples were taken. If a larger range was found, more samples were taken to insure reliability. In some cases however, five samples exhausted the number of usable passages within the lesson.

2. Counting was started at the beginning of a frame and continued in 100 consecutive word sections. (Hyphenated words, contractions, and abbreviations counted as one word; symbols and dates or other numbers considered as a unit were counted as one word.)

3. The number of syllables in each passage of 100 consecutive words was counted.

4. The number of complete sentences nearest the 100th word was counted. (For example, if sentence #5 stopped at word 98, the average was 98/5 words per sentence.)

Since several passages were analyzed, an approximate range of the reading levels of the lesson has been calculated.

Lesson	# Samples	Range grade level[a]		Mean grade level
		High	Low	
emission[c]	7	14.0	7.0	9.5
starter	9	11.5	5.5	9.1[b]
transmission	6	13.0	7.0	9.4
diesel	8	13.0	6.0	9.4
hydraulics[d]	10	11.5	7.5	9.1
drive shaft	4	9.0	6.5	7.5
PTO	3	8.0	7.5	7.7
electricity[e]	14	15.0	7.0	10.2[b]

[a]The figures in these two columns are based on selected sample passages. The limits of the Flesch system are 5.5-15.0. Anything below or above those limits is given the value of the nearest limit.

[b]These values are only approximate due to limitations in range of possible reading scores.

[c]Also includes cha63.

[d]Also includes cha80.

[e]Also includes cha37, cha43, cha100.

Figure 1

Operation of a Diverter Valve

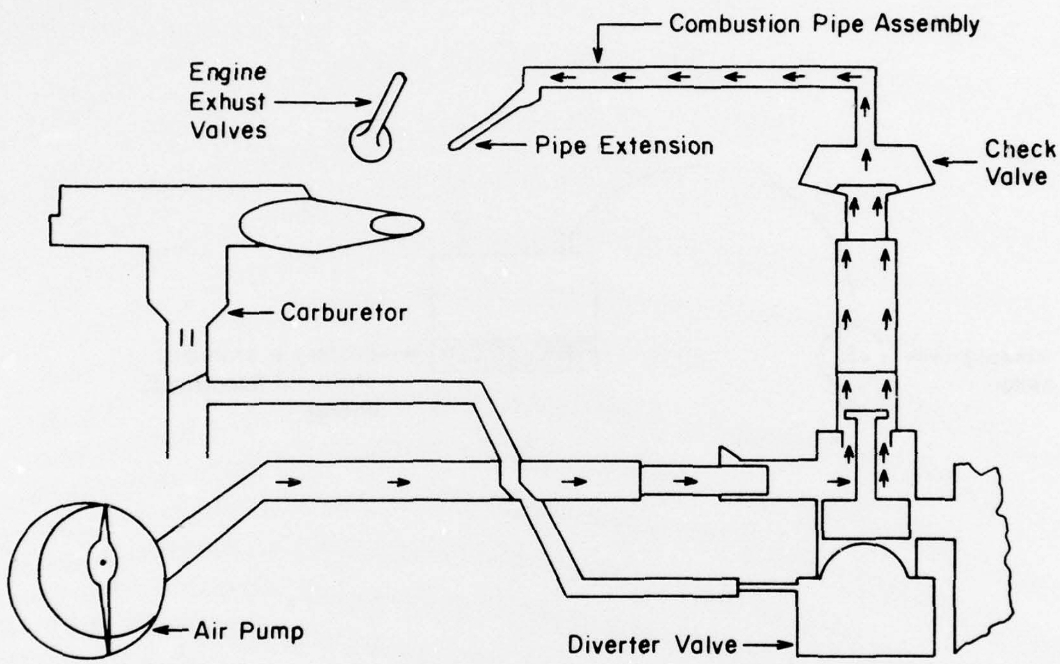


Figure 2

Description of Starting System

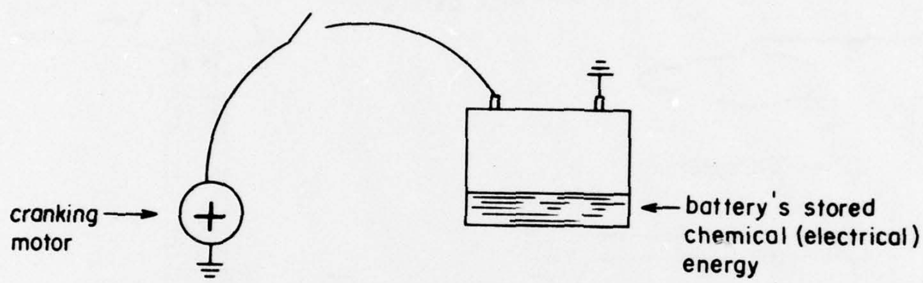
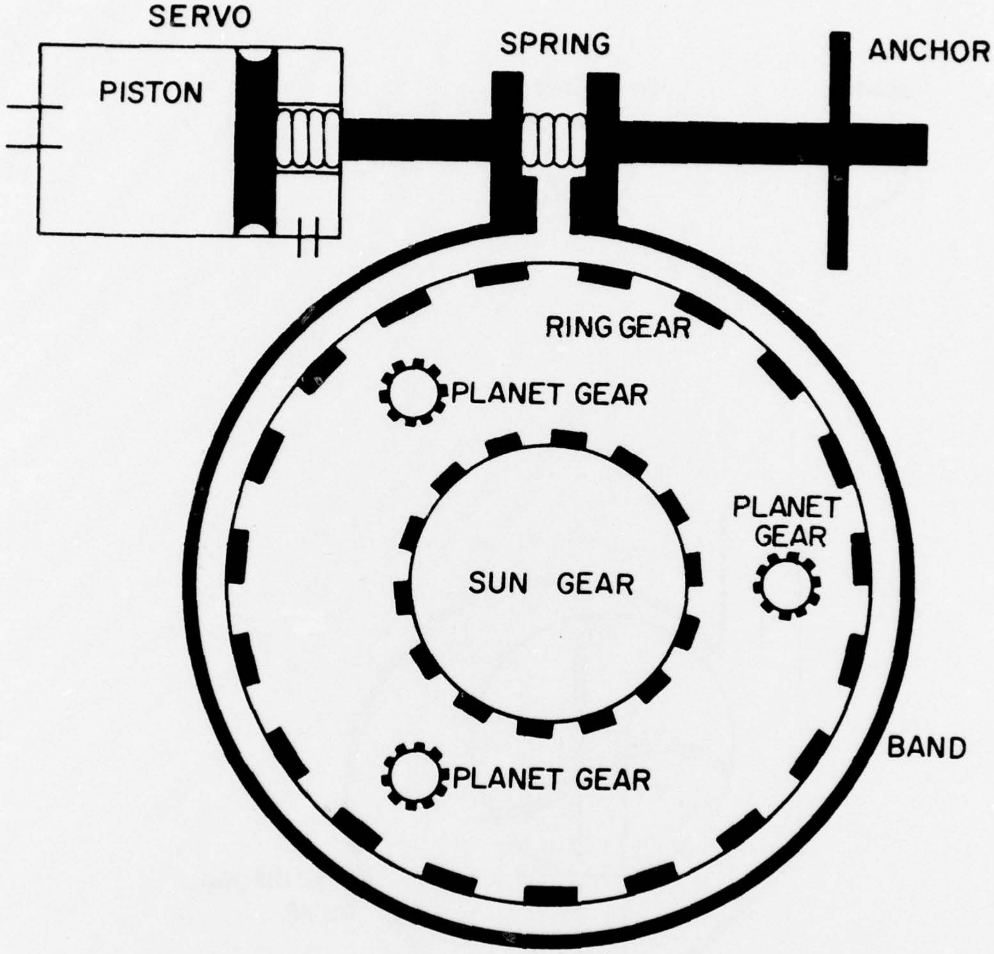


Figure 3

Diagram of Planetary Gear Unit



When the **SERVO** closes the **BAND** around a **GEAR** member it keeps it from rotating.

PRESS NEXT

Figure 4

Cut-away View of Centrifugal Pump

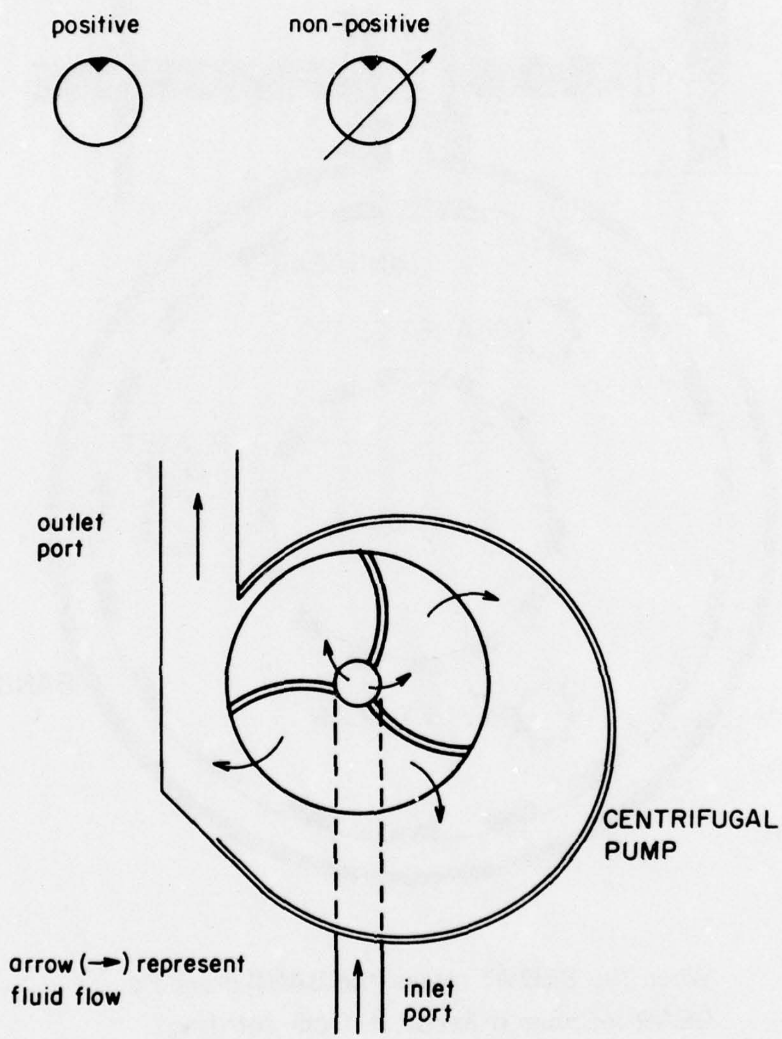


Figure 5

Drawing of Power Train of Vehicle

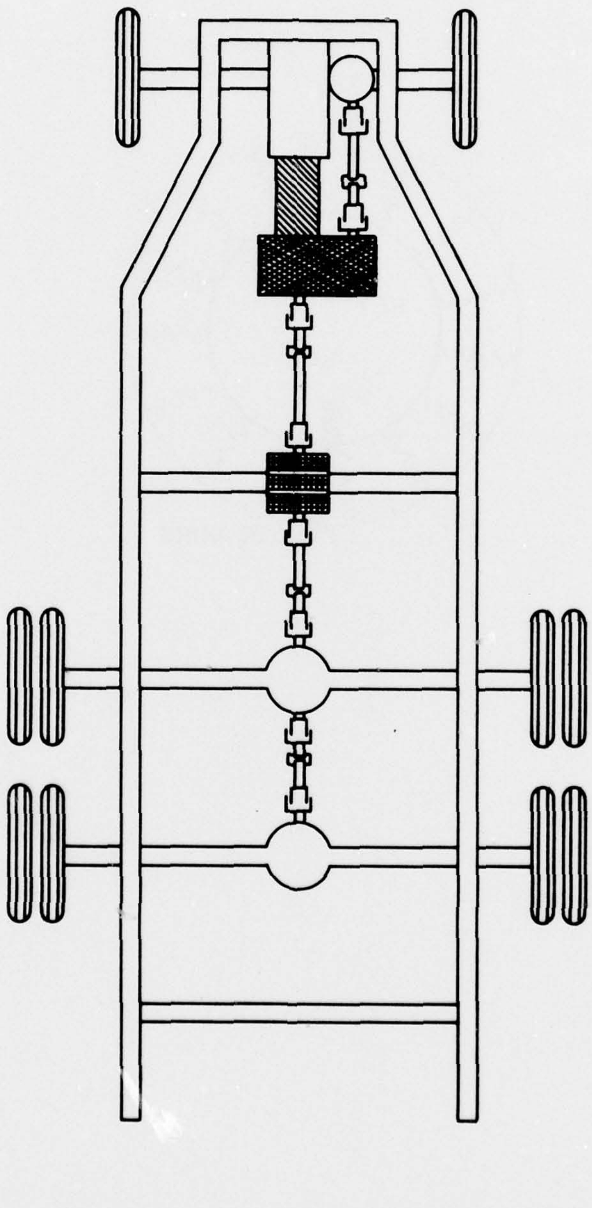


Figure 6

Display of Sprag Unit

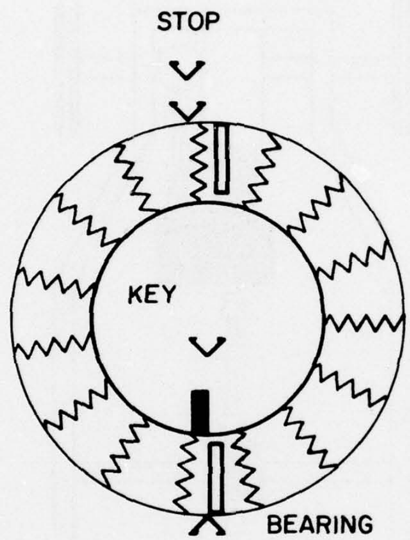
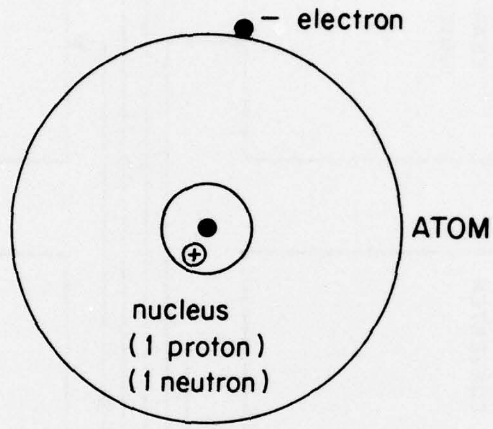


Figure 7

Drawing of Atom



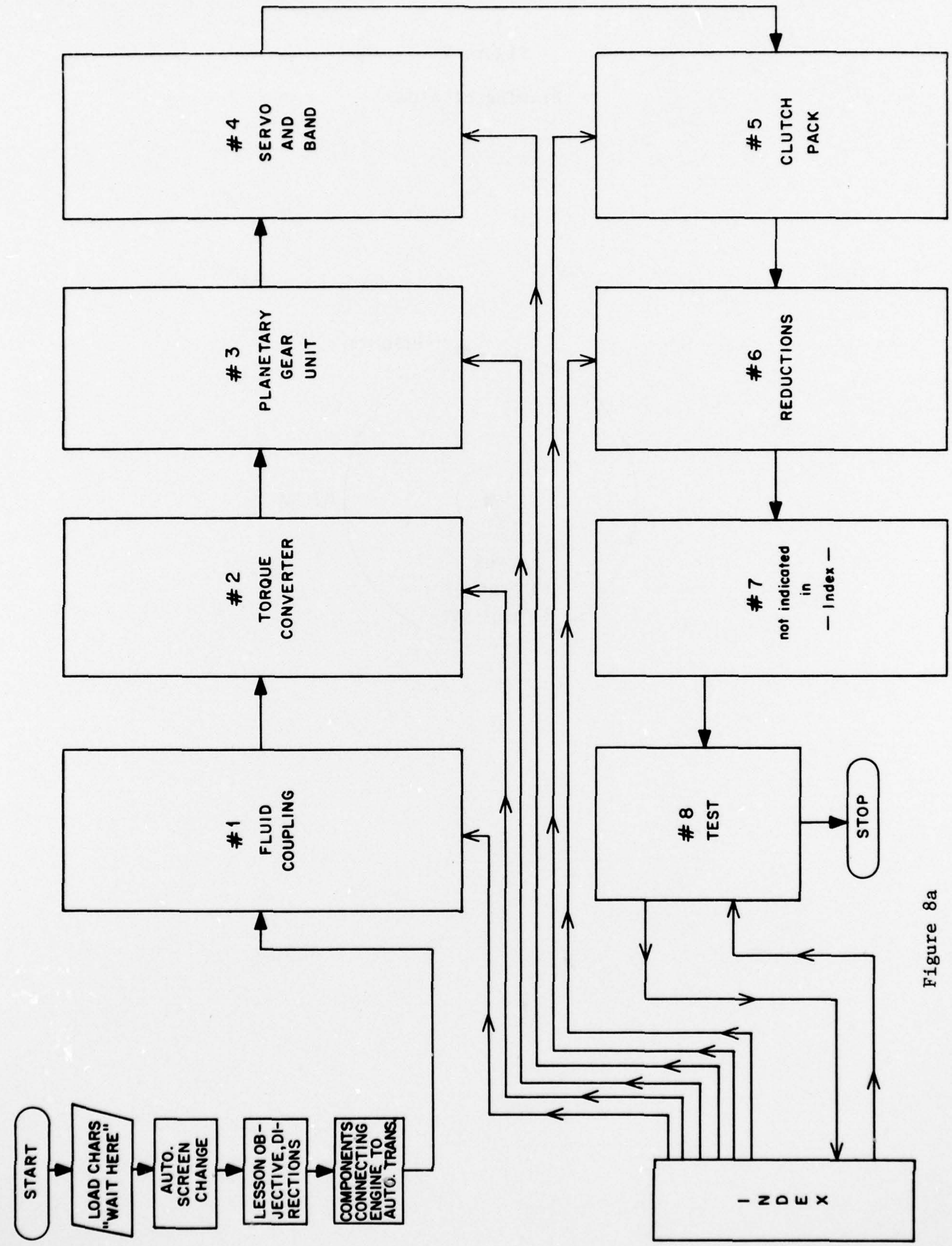
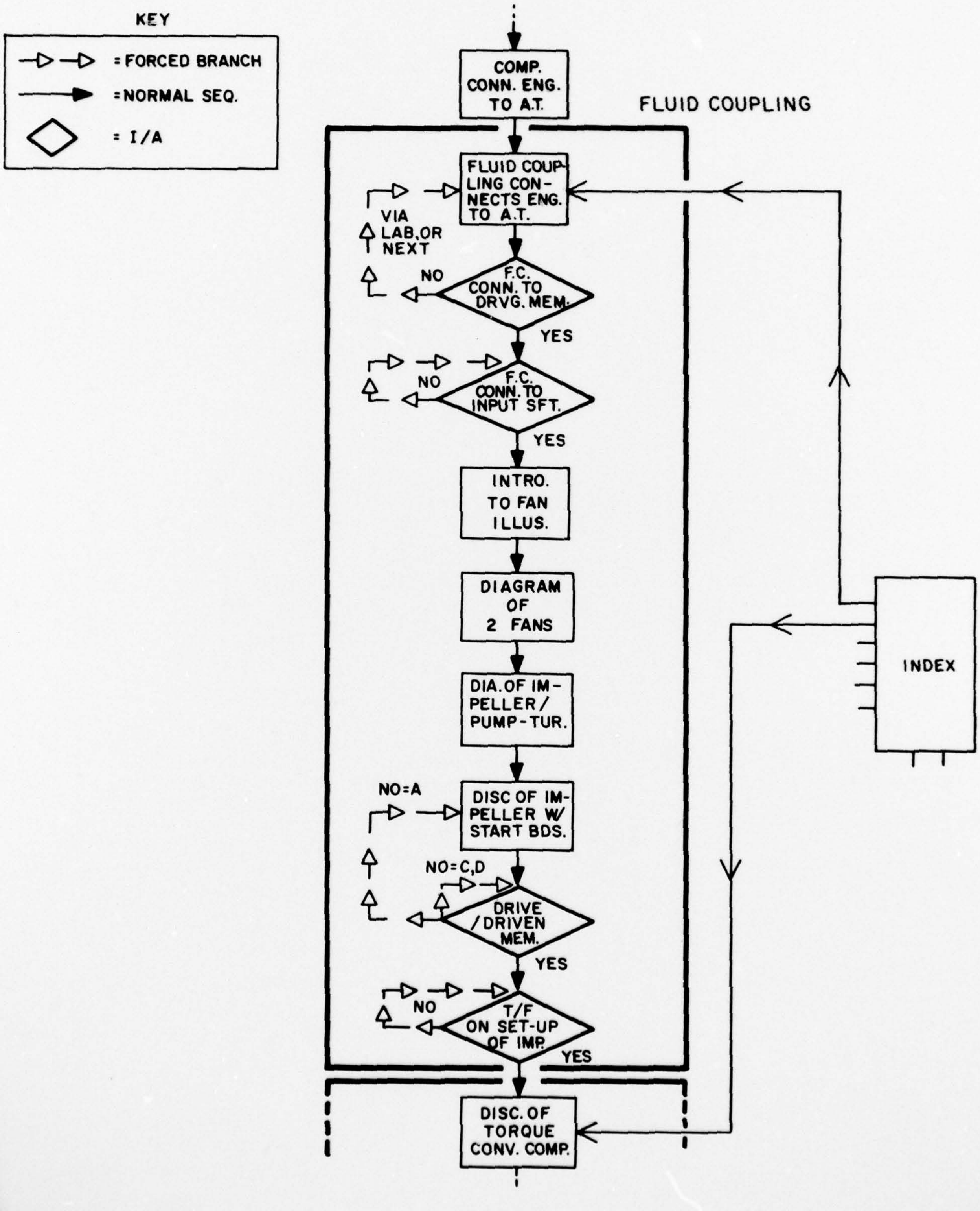


Figure 8a

Flowchart of "transmission"

Figure 8b

Detail of Module #1 of "transmission"



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