DOCUMENT RESUME

ED 074 739 EM 010 924

AUTHOR Carpenter, Polly
TITLE An Overview of MODIA: A Method of Designing Instructional Alternatives for Air Force Training.
INSTITUTION Rand Corp., Santa Monica, Calif.
SPONS AGENCY Air Force Directorate of Operational Requirements and Development Plans, Washington, D.C.
REPORT NO R-1018-PR
PUB DATE Nov 72
NOTE 20p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS Computer Oriented Programs; *Curriculum Development; *Instructional Design; Instructional Improvement; *Instructional Innovation; *Instructional Systems; Military Training; Systems Approach
IDENTIFIERS *Method of Designing Instructional Alternatives; MODIA

ABSTRACT

In a series of four interrelated reports, Rand work to date for the Air Force on the development of methodologies for designing programs of instruction is reported. This report, the first of the series, describes MODIA (A Method of Designing Instructional Alternatives), a comprehensive methodology for designing an instructional system. MODIA consists of a sequence of procedures and semiautomated tools (some developed and some in the planning stage) that allow a designer to examine many alternative structural approaches before he puts an actual system into use. A manual test of MODIA on an Air Force training course indicated that systematic, generalized methods can be developed for designing programs of instruction; these techniques encourage examination of alternatives; and that a comprehensive, systematic approach stimulates insights into the design of instruction that would otherwise not occur. (Author/RH)

R-1018-PR
November 1972

An Overview of MODIA: A Method of Designing Instructional Alternatives for Air Force Training

Polly Carpenter

A Report prepared for

UNITED STATES AIR FORCE PROJECT RAND

Rand
SANTA MONICA, CA. 90406

This research is supported by the United States Air Force under Project Rand—Contract No. F44620-73-C-0011—Monitored by the Directorate of Operational Requirements and Development Plans, Deputy Chief of Staff, Research and Development, Hq USAF. Views or conclusions contained in this study should not be interpreted as representing the official opinion or policy of Rand or of the United States Air Force.

R-1018-PR
November 1972

An Overview of MODIA: A Method of Designing Instructional Alternatives for Air Force Training

Polly Carpenter

A Report prepared for

UNITED STATES AIR FORCE PROJECT RAND

Rand
SANTA MONICA, CA. 90406

Bibliographies of Selected Rand Publications

Rand maintains a number of special subject bibliographies containing abstracts of Rand publications in fields of wide current interest. The following bibliographies are available upon request:

Aerodynamics • Arms Control • China • Civil Defense
Communication Satellites • Communication Systems
Computer Simulation • Computing Technology
Decisionmaking • Game Theory • Maintenance • Middle East
Policy Sciences • Probability • Program Budgeting
SIMSCRIPT and Its Applications • Southeast Asia
Space Technology and Planning • Statistics • Systems Analysis
USSR/East Europe • Weapon Systems Acquisition
Weather Forecasting and Control

To obtain copies of these bibliographies, and to receive information on how to obtain copies of individual publications, write to: Publications Department, Rand, 1700 Main Street, Santa Monica, California 90406.

Published by The Rand Corporation

PREFACE

This is one of four interrelated reports describing Rand work for the Air Force to date on the development of methodologies for designing programs of instruction. The reports in the series are:

R-1018-PR, *An Overview of MODIA: A Method of Designing Instructional Alternatives for Air Force Training,* Polly Carpenter.
R-1019-PR, *The MODIA Decision Process for Developing Strategies of Air Force Instruction,* Polly Carpenter and Barbara Horner.
R-1020-PR, *The MODIA Questionnaire for Curriculum Analysis,* Rudy Bretz.
R-1021-PR, *MODIA applied in the Design and Cost Analysis of an Innovative Air Force Course,* Robert L. Petruschell and Polly Carpenter.

The first of these provides an overview of the methodologies being developed; the second and third describe some of the major analytical tools used to provide inputs to the design process; and the last sets forth the results of a completed design cycle, parts of which were carried out manually, applied to a specific course in Air Force technical training.

This work has been conducted under a Rand project entitled *Analysis of Systems for Air Force Education and Training.* Emphasis has been on the use of technology in designing instruction for formal technical training or for higher education, as at the Air Force Academy. The results will support the activities of the Director of Personnel Plans, Headquarters USAF; DCS/Technical Training and the Training Development Directorate, headquarters Air Training Command; and the Air Force Human Resources Laboratory, especially the Technical Training and Professional Education divisions. It will be of particular interest to those working on the Advanced Instructional System.

This report is part of a continuing Rand effort to apply systematic methods of analysis and synthesis to issues and problems in education and training. Related work in education, both military and civilian, concerns Air Force pilot training and management of the pilot force, evaluation of programs of compensatory education, design of information systems for local school districts, and other diverse concerns. A special bibliography of Rand work in education is available on request.

3-2-73

ERRATUM

R-1018-PR AN OVERVIEW OF MODIA: A METHOD OF DESIGNING INSTRUCTIONAL ALTERNATIVES FOR AIR FORCE TRAINING, Polly Carpenter, November 1972, Unclassified

The Professional Education Division of the Air Force Human Resources Laboratory, mentioned in the Preface, was disbanded in July 1972 and no longer exists as an organizational unit.

SUMMARY

Since 1968, Rand has been working on the design of instructional programs for the Air Force, especially for the Technical Schools in the Air Training Command. This report, one of a series of four, presents an overview of that work to date. To our knowledge this is the first attempt to devise a comprehensive and coherent methodology of instructional program design.

BACKGROUND

The Air Force expends several billion dollars annually on education and training; in technical training alone, it spends over half a billion dollars and graduates more than 150,000 men a year from five technical schools and numerous on-the-job training courses. The high cost of traditional methods of technical training has stimulated Air Force research on new educational methods.

As in the public sector, until recently the process of instructional system design in the Air Force has still been guided largely by intuition, judgment, and an implicit acceptance of current operational procedures in the school and classroom. Many new teaching methods and instructional technologies have been developed and validated for their contributions to effective instruction. Their implementation has been slow and limited, however, mostly because it is so demanding a task to introduce change in established schools.

The Air Force has been aware of the potential that these innovations offer and has instituted a process of instructional system development to help assure the relevance of *subject matter* in technical curricula. Rand's role has been to develop a similarly systematic process for designing the *mix of instructors, facilities, materials, and students,* and the processes by which all of these elements will work together to effect student mastery of the subject matter.

RESULTS

As a result of this work, Rand has developed MODIA (A Method of Designing Instructional Alternatives), a comprehensive methodology for designing an instructional system. MODIA consists of a sequence of procedures and semiautomated "tools" (some developed and some still in the planning stage) that allow a designer to examine many alternative structural approaches *before* he puts an actual system into use. He can rapidly plan a program for a particular approach and—still at the planning stage—assess its utility in terms of production of graduates or consumption of human and material resources. If the program is unacceptable on one of these counts, the designer may quickly construct and assess an alternative approach.

The MODIA process consists of eight steps:

1. Analyze characteristics of the learner population that will affect the way the course will be taught.
2. Use the Questionnaire for Stating General Policy to specify the broad goals underlying the teaching institution's operation.

3a. Use the Curriculum Analysis Questionnaire to typify each lesson in system-oriented terms and to characterize each lesson's requirements for communication media.

3b. Specify instructional strategies with the help of DISTAF. Each strategy identifies the teaching agent and the way students will interact with this teaching.

4. Specify design criteria input from the teaching institution, such as least course cost, shortest course length, or maximum student graduation rate.
5. Describe local resources, such as the number of students entering the school and the school's resources and constraints.
6. Design the instruction using as direct inputs information from the Curriculum Analysis Questionnaire, DISTAF, the design criteria, and the local resource description.
7. Analyze the costs to determine the system's time-dependent dollar requirements.
8. As necessary, depending on the acceptability of the outputs, repeat steps 1-7 (with different inputs) until the most desirable system emerges.

Some major tools must be developed before MODIA is complete, namely, a generalized computer model of student flow, a computer model for estimating resource requirements, and a questionnaire for detailing local resources. Although work remains, MODIA was tested manually on part of a basic still photography course at Lowry Air Force Base, allowing us to draw three broad and important conclusions with confidence:

- Systematic, generalized methods can be developed for designing programs of instruction;

- These techniques encourage the examination of alternative approaches to instruction;
- A comprehensive, systematic approach stimulates the development of insights into the design of instruction that would otherwise not occur.

CONTENTS

PREFACE.......... iii

SUMMARY v

INTRODUCTION 1

THE PROBLEM 1

MAJOR BENEFITS OF MODIA 2

THE GENERAL APPROACH 3

CONCLUSIONS 10

AN OVERVIEW OF MODIA: A METHOD OF DESIGNING INSTRUCTIONAL ALTERNATIVES FOR AIR FORCE TRAINING

INTRODUCTION

This report is an overview of the direction and scope of Rand work on instructional program design. Readers who wish to pursue the subject in more depth should refer to the detailed reports cited in the Preface and at several points below. This series of reports will make results to date more accessible to people involved with the theory and practice of instructional program design and will provide a vehicle for critical comment.

THE PROBLEM

Annual Air Force expenditures on education and training are on the order of several billion dollars. In technical training alone, the Air Force spends over half a billion dollars and graduates more than 150,000 men a year from five technical schools and numerous on-the-job training courses. Consequently, improvements in teaching effectiveness or savings in instructional costs can provide the Air Force with far greater benefits than those for individual students and classes.[1]

As in the public sector, until recently the process of instructional program design in the Air Force has still been guided largely by intuition, judgment, and an implicit acceptance of current procedures of operation in the school and classroom. Many new teaching methods and instructional technologies have been developed and validated for their contributions to effective instruction. Some of these use material and personnel resources more efficiently, some improve the quality of the instruction, some shorten training times. But their implementation has been slow.

[1] An analysis of a similar magnifying effect of changes in the pilot training and retention process may be found in W. A. Stewart, *Pilot Management Policy and Pilot Training Rates*, The Rand Corporation, R-690-PR, March 1971.

and limited, mostly because it is a demanding task to introduce change in established schools.

Because instruction is a [illegible] process, those who want to change even a few of its aspects should ide[illegible]itude of variables, most of whose interrelations are difficult to [illegible] to unravel these complexities, most designers proposing cha[illegible] simply assume that other aspects of in[illegible]uction will behave as usual. Yet even this approach can involve the designer in a protracted exercise. More effective or less expensive instruction may result, but there is no assurance (1) that the resources required will not overtax the school; (2) that other changes could not have been made along with the changes of primary interest; and (3) that the designer has not overlooked more desirable combinations of techniques, operating procedures, personnel, materials, and equipment.

The Air Force has been aware of the potential that the new teaching innovations offer and has instituted a process of instructional system development to help assure the relevance of *subject matter* in technical curricula. Rand's role has been to develop a similarly systematic process for determining the *mix of instructors, facilities, materials, and students* and the processes by which all of these elements will work together to effect student mastery of the subject matter.[2] The purpose of the work described here is to help implement changes in the instructional process in actual school situations through a process called MODIA (A Method of Designing Instructional Alternatives). MODIA consists of a sequence of procedures and semiautomated "tools," some of which have already been designed and are described in this series of reports.[3]

MAJOR BENEFITS OF MODIA

We use the term tools because every attempt has been made to avoid prescribing *who* is to be taught *what* and *how*. Instead, given that the designer has established or been given general policies on these matters, these tools should help him put his policies into operation. Each tool performs tasks that can enhance the effectiveness of the others in achieving the final goal. At the same time, each one can be useful in its own right because it makes explicit various features of the instructional process that direct teaching in the classroom or workshop.

[2] We have emphasized technical training in the Air Force in developing the design methodology, and the detailed example described in the other reports draws from that area. The general structure of the methodology will also be useful, however, in other educational settings such as elementary and secondary education as well as civilian vocational training. Some revisions in details (particularly in the questionnaire eliciting the Statement of General Policy) will be necessary for these latter applications.

[3] Users of such tools should be those responsible for selecting, designing, and implementing new instructional programs. Such people are found in the Training Research Applications Branches of the Technical Schools in the Air Training Command, in the administrative offices of large school districts, and in the teams that develop instructional programs for firms in the education industry. As the tools are more fully developed, they will enable these people to become more effective in shaping instruction to the needs of schools and students.

Probably MODIA's most important single contribution is that it encourages the examination of alternative approaches to instruction. The designer can rapidly plan a program for a particular approach, and—still at the planning stage—assess its utility in terms of production of graduates or consumption of human and material resources. If the resulting instructional program is unacceptable on one of these counts, the designer may quickly construct and assess an alternative approach. Providing this kind of feedback will help assure that many promising approaches are tried out, so to speak, *before* one is chosen for actual implementation.

Another valuable contribution is that the method requires the designer to articulate his judgment of what constitutes effective instruction and to translate it into specific terms that direct the design in an orderly fashion. In this way, the professional experience of the designer (or an educator working with him) becomes an integral part of the design process. Thus, even though methodology for predicting the specific outcomes of instruction in terms of student learning is currently lacking, judgment on this matter is an integral part of the methodology. In this way we hope to enlist the designer's support for the program he designs.

In addition, MODIA encourages the designer to consider alternatives at many points in the design process, not simply at the end of one design cycle. This exposes him to many options (most of which he may have been unaware of at the outset), thereby greatly increasing the variety of approaches he may wish to consider. At the same time, he may be encouraged to challenge some of the conventional methods that he has tacitly assumed apply.

Finally, MODIA is comprehensive, in that it brings into explicit consideration all aspects of instruction that affect the instructional program; and it is coherent, in that wherever possible the interrelations of various aspects of the instructional process have been traced out. By means of MODIA, planners should be able to design an instructional program efficiently and with confidence that its features are acceptable to the teaching institution and that it is appropriate to the learners.

THE GENERAL APPROACH

The remainder of this report describes our overall process of instructional program design. Throughout, it is assumed that the learning objectives of the course are given, so that MODIA will complement current Air Force interest in systematizing instruction as described in Air Force Manual 50-2, *Instructional System Development.* The manual describes a series of interrelated steps leading to the conduct and evaluation of instruction as illustrated in Fig. 1. After the requirements for system operation have been analyzed in terms of numbers of personnel with defined job skills (step 1), the training requirements are defined (step 2) and the objectives of instruction are developed (step 3). At this point (step 4), actual instruction must be planned, developed, and validated. This is the step the Rand team has been working on.

MODIA is described in terms of its inputs, outputs, major components, and their

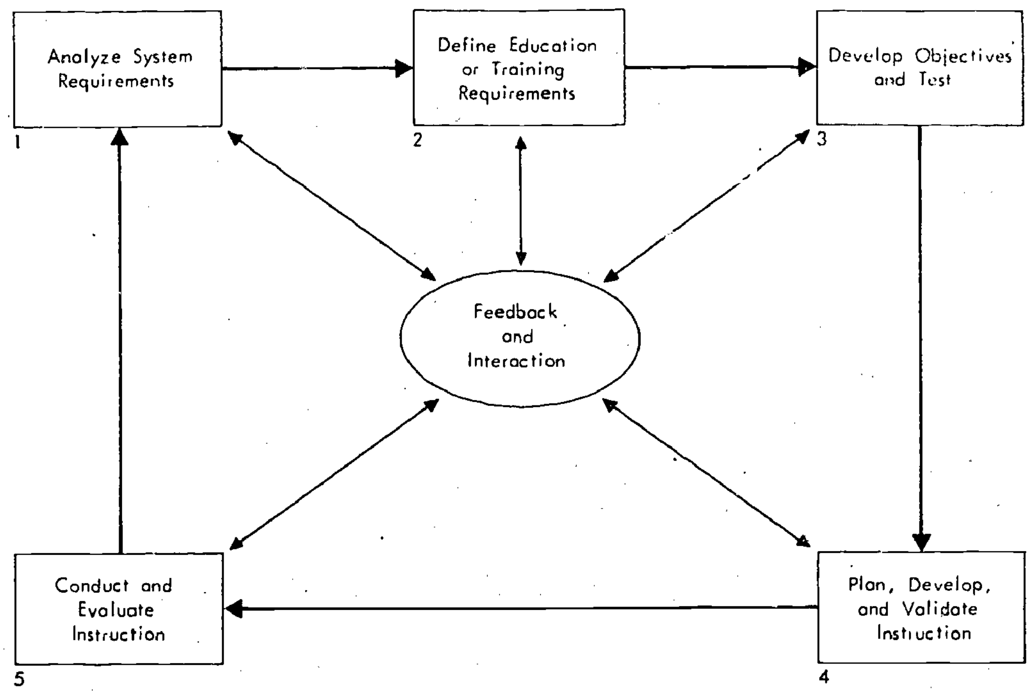

Fig. 1—Steps in instructional system development, from Air Force Manual 50-2

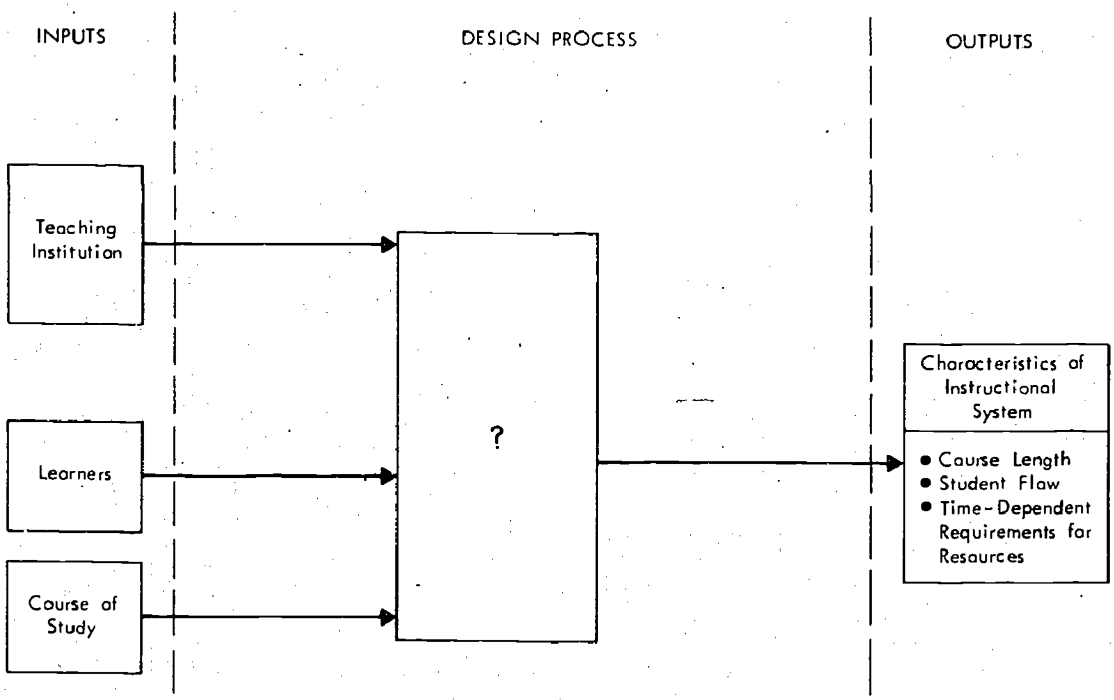

Fig. 2—Framework of design process

interrelations (Fig. 2). We have made some progress in identifying the steps in the design process, determining their sequence, and discovering their interrelationships. *We plan to automate parts of MODIA so that it will take a matter of a few weeks or perhaps even a few days to design an instructional program, rather than several months to a year as it does at present.*

Step 1—Analyze the learner population in terms that will affect the way the course will be taught (Fig. 3). For example, some learners may already have experience in the particular field in which they will be studying. If the percentage of such learners var[illegible] with the time of year, this fact will also be included in the analysis.

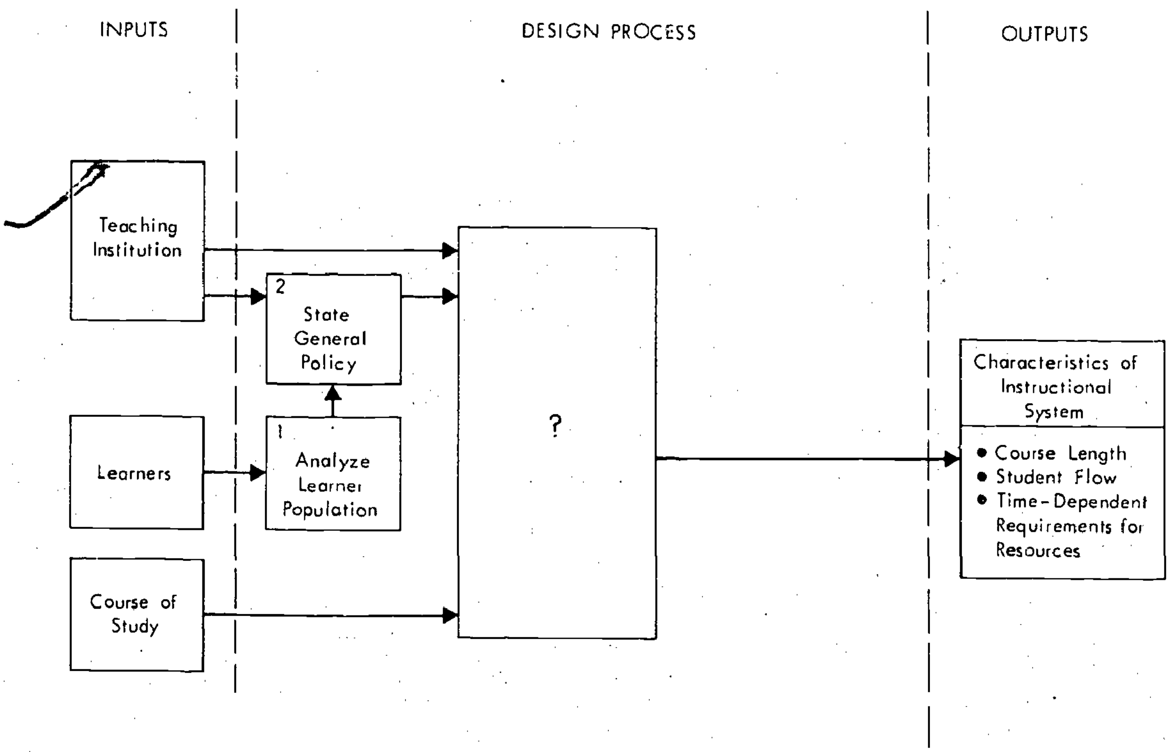

Fig. 3—First steps

Step 2—State general policy (Fig. 3) by means of a short questionnaire described by Carpenter.[4] *Policy,* as used here, concerns three general areas. The first is the

[4] Polly Carpenter, *The MODIA Decision Process for Developing Strategies of Air Force Instruction,* The Rand Corporation, R-1019-PR, November 1972.

broad characterization of the teaching institution's objectives. Many institutions have input-oriented objectives; some have output-oriented objectives. An input-oriented institution might be, for example, a labor union that specifies a certain number of weeks in a vocational course as a membership requirement. Most military and industrial training, however, is output-oriented. Industry and the military want men with particular skills and knowledge; if it is possible to reduce the input required to get the same output, so much the better.

The second policy area is the extent to which the school will adjust to variations in the student population. Does it want a standard or a diverse output? If the learners are fairly homogeneous, this question is not very important, but if they are heterogeneous, it is. The Air Training Command tries to produce standard graduates in the technical center, although no one really believes that all airmen are identically skilled when they have finished a technical course. The third policy area concerns the way in which the school must accommodate its operations to the needs of organizations that supply its students or accept its graduates.

Step 3a—Analyze the curriculum using a branching questionnaire that guides the user in describing his course of study in detail (Fig. 4). Bretz describes this Curriculum Analysis Questionnaire.[5] It typifies each lesson in system-oriented terms, such as whether the instruction must be given in a classroom or in a laboratory, whether it requires special equipment, and whether it requires a monitor to ensure student safety. For example, if the students are learning how to take good pictures, the instruction requires special equipment, namely, a camera. If the students are learning only the theory of operating a camera, the instruction might take place entirely in a classroom with only visual aids to show how the camera operates.

The Curriculum Analysis characterizes each lesson's requirements for communication media. We have focused on communication media for two reasons. First, they are becoming increasingly important in education. Second, many people are unfamiliar with media and their uses and are looking for guidance, which we believe we can provide.[6] However, the design methodology does *not* specify that communication media must be used for every topic even though the Curriculum Analysis describes possible requirements for communication media for every topic.

Step 3b—Specify strategies of instruction (Fig. 4). The framework for this specification is provided by the Statement of General Policy as well as by indirect input from the teaching institution. Step 3b interacts closely with the Curriculum Analysis.

As described by Carpenter,[7] Step 3b is a computer-directed logic tree called DISTAF (Determining Instructional Strategies for Training in the Air Force), with each decision point a logical consequence of the preceding decisions. To exercise it, the designer will have two aids: an interactive computer program written in JOSS,

[5] Rudy Bretz, *The MODIA Questionnaire for Curriculum Analysis,* The Rand Corporation, R-1020-PR, November 1972.

[6] Rudy Bretz, *The Selection of Appropriate Communication Media for Instruction: A Guide for Designers of Air Force Technical Training Programs,* The Rand Corporation, R-601-PR, February 1971.

[7] Carpenter, op. cit.

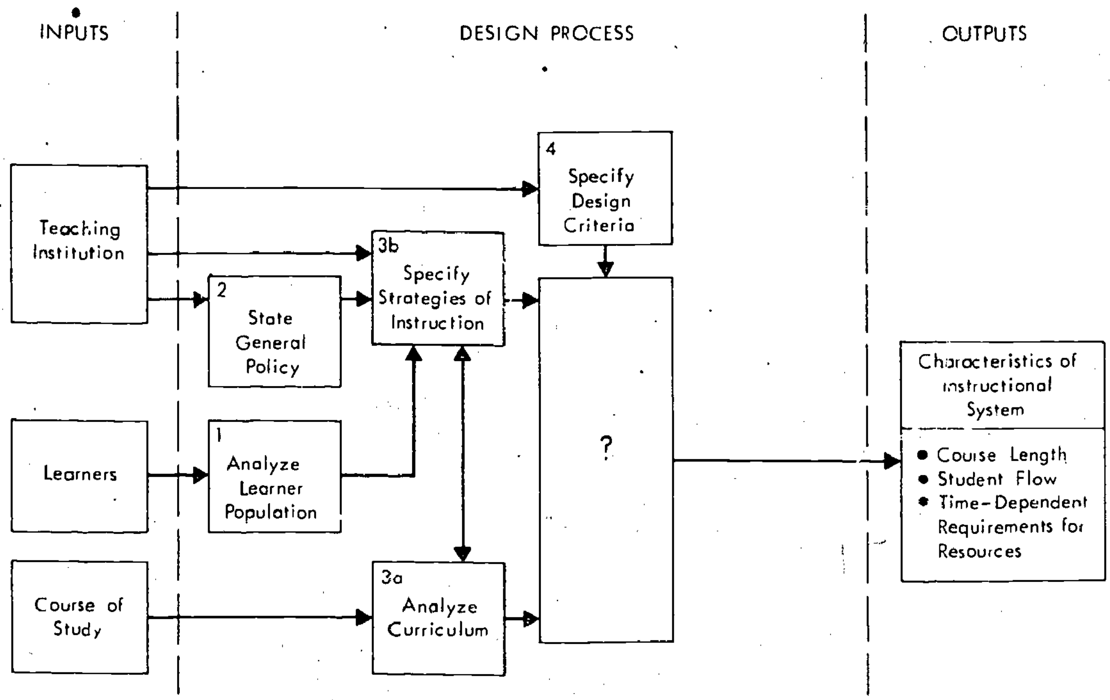

Fig. 4—Setting the stage

and a manual that presents the pros and cons of the decisions to be made at each point, along with some of the logical consequences of each choice.[8]

In Step 3b, specifications of instructional methods are explicitly entered into the design process. DISTAF encourages the planner to consider alternative methods of instruction (up to 57 different teaching strategies for a single course) and to translate his decisions into guidelines for program design. This allows him to take account of different levels of subject matter difficulty, different student abilities, and requirements for different types of student performance. Thus, the process is *not* prescriptive, because it champions no particular instructional method. Rather, it allows the planner to select and apply any method he may think appropriate, from the formal lecture to student-directed role-playing.

As used here, a strategy of instruction has two dimensions. For each type of instruction identified in the Curriculum Analysis, each strategy identifies (1) the teaching agent, and (2) the way students will interact with this teaching. Carpenter discusses how answers to these two questions specify a teaching method. The

[8] JOSS is Rand's on-line, interactive computer system. The JOSS program will be published as a Supplement to R-1019-PR, op. cit., and eventually will be translated into Interactive FORTRAN. The manual appears as an appendix to R-1019-PR.

strategy also permits specification of details of the use of media or personnel for each type of instruction, such as the level of skill the personnel should have.

Step 4—Specify design criteria input from the teaching institution (Fig. 4). They will be of the following sort: least cost, shortest course length, graduation of the most students per unit time, or maximum use of communication media. The designer would assign each criterion an order of importance or a weight. For example, because of the value of student time to the Air Force, shortening the average time a student spends in a course might be weighted more heavily than saving on instructors and training equipment. It is probable that such decisions should be made by school personnel.

Step 5—Gather descriptions of local resources and constraints by means of a logically structured set of questions (Fig. 5). These data will include the number of classrooms, laboratories, or other facilities available; the existence of communication equipment such as television receivers installed in the classrooms; the rate of student entry; the geographic distribution of students, that is, whether they are all in one building or scattered throughout a campus or city; and the number of instructors available. The resulting description of local resources and student loads will be used in the final design process to specify class size, select specific media systems, and serve other purposes.

Step 6—Design the instructional system using as direct inputs data from the Curriculum Analysis, DISTAF, the design criteria, and the description of local resources (Fig. 5). Indirect inputs are characteristics of the learner population, the stated general policy, and the general course features.

At present, Petruschell and Carpenter[9] see the design process as having four main components. First, each lesson is linked to the strategy of instruction that has been chosen for that particular category of instruction. Second, a set of criteria is used to select specific media and facilities. Third, a set of criteria is used to assign personnel. Sometimes a certain number of people will be required to carry out a particular task, such as monitoring for safety; other personnel requirements will depend on existing facilities, such as the number of students that can feasibly be assigned to a teacher in a classroom. Fourth, student flow through the course is simulated by a flow and scheduling model to generate graduation rates and resource requirements.

Step 7—Analyze the costs to determine the system's time-dependent dollar requirements (Fig. 5). This will eventually be accomplished by a computer program.

Step 8—If the designer does not find the outputs of his planned strategy acceptable, he may repeat steps 1-7 (with different inputs) until the most desirable system emerges (Fig. 5). For instance, he can compare the resource requirements with the resources he expects the school to have to determine whether the system is economically feasible; he can also compare the outputs with requirements for general policy and other inputs to determine whether they are what he wanted. If not, he can

[9] The design process and an example of its application are described by R. L. Petruschell and Polly Carpenter in *MODIA Applied in the Design and Cost Analysis of an Innovative Air Force Course*, The Rand Corporation, R-1021-PR, November 1972.

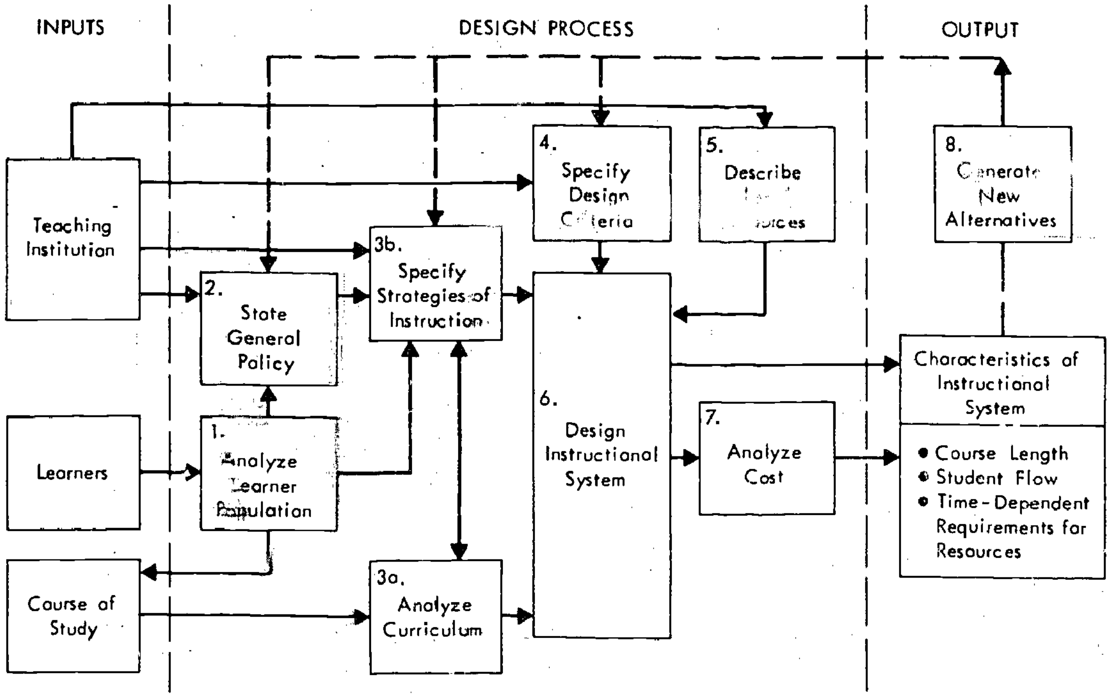

Fig. 5—The design process

change some of the initial specifications, such as the strategies of instruction or the design criteria. Possibly, he would want to change the learner population, the course of study, or even the general policy.

To demonstrate the feasibility and utility of the design process, we manually worked through an example based on an actual course in still photography taught to enlisted airmen in the Technical School at Lowry Air Force Base. For the example, we shortened the course, reducing the amount of data to be treated without losing the essential features of the subject matter in terms of variety of instruction and diversity of instructional sequencing. We also revised the teaching method from the usual Air Force practice to a more individualized approach that is of particular current interest to the Air Force. We then designed a paper program, using MODIA, and estimated its requirements for dollars and other resources.[10] An integral part of this exercise was the development of a model of the flow of students through the course. The resulting requirements for resources suggested that minor changes in instructional methods and design criteria might result in a significantly less expensive course that would largely retain the feature of individualization.

[10] These final steps are described by Petruschell and Carpenter in R-1021-PR.

CONCLUSIONS

There are still some major tools to be developed before MODIA is complete, namely, a generalized computer model of student flow, a computer model for estimating resource requirements, and a questionnaire for detailing existing local resources. Even so, we have reached the point where we can draw three broad and important conclusions with confidence:

- Systematic, generalized methods can be developed for designing programs of instruction;
- These techniques encourage the examination of alternative approaches to instruction;
- A comprehensive, systematic approach stimulates the development of insights into the design of instruction that would not otherwise occur.