ABSTRACT

A MODEL FOR PREDICTING THE UNIT COST
OF DEVELOPING SELF-INSTRUCTIONAL MATERIALS
IN HIGHER EDUCATION BIOLOGICAL AND PHYSICAL SCIENCES

by

Walter Grove Chappell

Need Budgeting for the cost of developing self-instructional materials for higher education biological and physical science courses is difficult, since instructional planners, administrators and funding agencies have had few guidelines to use in making accurate development cost predictions.

Purpose The purpose of this study was to design a predictive unit-cost model which could be used after behavioral objectives have been initially stated and a slide-audio tape and film or an audio tape only media strategy has been chosen by the instructional planner(s). All relevant costs for the initial development of the hardware and software systems prior to the first use of the materials to grant course credit to students should be able

Application A predictive, unit-cost model in budget planning guide form was designed and validated in this study. It will predict development costs when applied in existing higher education institutions by biological or physical science instructional planners who anticipate designing a self-instructional system which utilizes a slide-audio tape and film or an audio-tape-only media strategy. The cost and non-cost categories included in the predictions are faculty and related content personnel costs, carrel equipment costs, software production and duplication costs, consultant costs, facilities modification costs, validation and revision costs, the amount of time required for faculty involvement in the materials development, and the number of months for the development process prior to implementation. Costs not accounted for in these predictions include developing the initial statement of objectives, the selection of an appropriate instructional strategy and the involvement of non-development faculty and staff to the extent that optimal use of the self-instructional materials can occur once they are developed. However, though not included in the model's predictions, these costs should be planned and budgeted for as necessary expenditures if the materials developed are to be effective and optimally utilized.

to be predicted within plus or minus fifteen per cent of the actual development costs.

Procedures A faculty interview instrument was designed and validated during a pilot study. After revision, the instrument was used to gather aggregate data for unit development cost calculations which represented a sample of nine courses in two higher education institutions. A predictive, unit-cost model was then designed and adapted for use as a budget planning guide by instructional planners beginning to project the unit costs of self-instructional materials development. The model's predictability in planning guide form was validated on the unit development costs of self-instructional materials initially developed in a project at a third institution. The validity of the predicted costs was determined by comparing these estimates with the results of a cost analysis of the same project.

Findings The findings of this study indicate that a predictive cost model of higher education self-instructional materials development in the biological and physical sciences can be designed with a predictive accuracy within plus or minus fifteen per cent of costs analysis results which are determined at the end of a development project.

Once cost estimates have been made with the aid of the planning guide, it is suggested that project costs may be controlled by identifying cost centers and assigning appropriate administrative responsibility for each center. For effective cost control, however, this responsibility must be assigned to individuals at the point of functional cost incurrance.

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by

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TABLE OF CONTENTS

TABLE OF CONTENTS--continued

TABLE OF CONTENTS--continued

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES--continued

LIST OF FIGURES

LIST OF APPENDICES

I. INTRODUCTION

Need for the Study Use of self-instructional materials in the biological and physical sciences is increasing. With this increase, faculty, administrators, and funding agencies are finding it necessary but difficult to make accurate budget estimates of development costs. Experience with mediated self-instructional strategies has been limited, due partially to the fact that only recent technological advances have made them feasible. Therefore, comparative data have not had time to accumulate in sufficient quantities to be reported for cost predictive purposes. In addition, those data which might be present appear to be buried in departmental requisition orders, with few records kept of actual cumulative costs. Where data have been reported, they often deal with hardware systems exclusive of software development. Higher education's combined lack of long-term experience with self-instructional materials development and lack of reported cumulative data make cost comparisons and estimates difficult for instructional planners who are writing development project budgets. A predictive, unit-cost model would

therefore be helpful as these planners attempt to project the cost of self-instructional materials development in various curricular areas.

Purpose The purpose of this study is to design a predictive unit-cost model which can be used after behavioral objectives have been initially stated and a slide-audio tape-film or an audio-tape-only media strategy has been chosen by the instructional planner(s). All relevant costs from that point on until the self-instructional units are ready for student use should be able to be predicted within plus or minus fifteen per cent of cost analysis results which are determined at the end of a development project. These cost predictions should include faculty and related personnel costs, carrel equipment costs, software production and duplication costs, consultant costs, facilities modification costs and validation and revision costs.

General Design A full, relevant, functional, job cost analysis of development was conducted on selected biological and physical science, self-instructional programs, which have been completed on the Michigan State University and Lansing Community College campuses. On the basis of aggregate data collected during this cost-analysis phase, a

predictive unit-cost model was constructed and adapted so that instructional planners may use the model as a budgetary planning guide. Once adapted, the planning guide was validated on the development costs of a biological science course taught with self-instructional materials at Purdue University.

Overview Chapter I of this dissertation has contained a clarification of the need, purpose, and general design of the study. Chapter II contains a review of unit-cost analyses as they have been applied to education, a discussion of cost-benefit models and a review of various studies which attempt to clarify the cost of various mediated instructional systems. Chapter III reviews current systems theory, outlines the research design in further depth and discusses the construction and validation of the predictive model developed as a result of this research. Chapter IV is a review of the research results and model validation, while Chapter V contains the conclusions and educational implications of the research findings. Appended are the interview instrument, a simulation of the predictive model, and example software and hardware costs for self-instructional systems.

II. PERTINENT LITERATURE

The Use of Unit-Cost Data Private business organizations were the first to use cost analysis on a program-by-program basis.[1,2] By 1965 the federal government had instituted program planning budgeting systems (henceforth referred to as PPBS), as a means of analyzing costs for specific programs in its major departments.[3] Recently, some educators have been applying a few of these systems analysis techniques such as program evaluation and review technique (henceforth referred to as PERT), linear programming, and utility/cost sensitivity analysis.[4]

As educators become more aware of the functional educational system parameters and thereby more clearly

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[1]Francis Keppel, "Operations Analysis --- The Promise and the Pitfalls," Socio-Economic Planning Sciences, Vol. 2 (Pergamon Press, 1969), pp. 121-125.

[2]Roger L. Sisson, "Can We Model the Educational Process?," Socio-Economic Planning Sciences, Vol. 2 (Pergamon Press, 1969), pp. 109-119.

[3]Keppel, Loc. cit.

[4]C.K. Tanner, "Techniques and Application of Educational Systems Analysis: PERT, Linear Programming, and Utility/Cost Sensitivity Analysis," Audio-Visual Instruction, Vol. 14 (March 1969), pp. 89-90.

identify the educational system within which these parameters operate, it will undoubtedly become obvious that a systematic analysis of that system and its subsystems must be carried out in detail. These systematic analysis techniques will undoubtedly include functional unit-cost (costs related to specific instructional objectives and strategies) analysis as the basis for any eventual cost-benefit analysis.

Witmer points to a number of basic reasons why unit-cost studies are essential to higher education decision making.

> "If the general ignorance of policy makers is not sufficient reason for continuing study of the unit cost of higher education, the many wastes and inefficiencies in higher education are."[5]

In addition, Dr. Witmer suggests another reason

> "...for studying the unit costs of higher education is to accumlate information which can be used in making allocations to and within education. The fact is that crucial decisions on such

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[5]David R. Witmer, Unit-Cost Studies (Madison, Wisconsin: Board of Regents of State Universities, 1967), ERIC #ED 013 492.

> matters as how much to spend on education, and on what programs, are not made in any rational manner. Although much of this irrationality can be blamed on excessive political influences and poor organization for planning and administration, some of that is due to inadequate data."[6]

Various authors stress the importance of making decisions concerning resource allocations on the basis of program unit costs. With these data, work-load requirements and different levels of support may be projected. Combined with desirable quality standards, these data can help develop an understandable, objective budget procedure in which budget decisions are related to clearly defined goals. Knowledge concerning the effects and value of alternative investments is useless unless one also

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[6]Witmer, Loc. cit.

knows the relative costs of alternatives.[7, 8, 9, 10, 11, 12]

To further clarify how unit-cost data might be used, Dr. Witmer indicates that

> "Formulas are designed to form the basis for estimates on future budgetary requirements through the use of pre-determined program cost relationships coupled with estimates of future levels of program activity. Cost relationships are derived from unit costs which result from cost studies and analysis."[13]

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[7]Witmer, Loc. cit.

[8]Clarence Scheps, "Systematic Financial Analysis and Budgetary Planning as Aids in the Attainment of College and University Purposes." In Smith, G. Kerry (ed.) Current Issues in Higher Education, 1961: Goals for Higher Education in a Decade of Decision. (Washington: Association for Higher Education, National Education Association, 1961), pp. 185-188.

[9]John Dale Russell and James I. Doi, "Analysis of Institutional Expenditures," College and University Business, 19 and 20 (September 1955 to August 1956), various pages.

[10]J. Harvey Cain, "How Unit Cost Accounting Can Serve the College Field," College and University Business, 32 (March 1962), pp. 63-65.

[11]M.M. Chambers, Financing Higher Education. (Washington: The Center for Applied Research in Education, Inc., 1963), pp. 84-91.

[12]Robert W. Peden, "Is There an Educational Industry?" College and University Business, 21 (November 1956), pp. 50-51.

[13]Witmer, Loc. cit.

Jurisdictional Cost Analyses in Higher Education

Though educators have been generally slow to adopt functional, unit-cost analysis and modern systems analysis techniques, such as PERT and PPBS, there is a long history of attempts on their part to develop uniform procedures to record the jurisdictional costs (costs within specific academic administrative units) of education and, specifically, higher education. The first of these steps was taken by the Carnegie Foundation in a bulletin published in 1910. Since many of the institutions of higher education were trying to qualify for Carnegie Foundation grants, the Carnegie procedure had the effect of establishing a national accounting system for colleges and universities. In 1917, Christensen headed a committee which recommended that a standard classification of receipts and expenditures be established so that these records were more compatible with the common practice of municipal government accounting.

By 1922 Arnett was emphasizing the desirability of separating current, endowment, and plant funds. This was perhaps the first attempt to get at some of the overall program categories in higher education. Lindsay and Holland in 1930 argued that accounting builds an audit trail for fiscal procedures and legal review. As such, they

suggested using accounting data in the decision-making process on the basis of teaching loads, class size, floor space and various other comparisons. By 1935 a National Committee on Standard Reports had added loan funds and auxiliary funds to the 1922 proposals of Arnett. The American Council on Education, in 1938, suggested separating four categories of activity from other institutional operations. These categories consisted of auxilliary enterprises, student financial aids, hospitals and contract research. In some ways, these recommendations were not far afield from those of Arnett. However, by 1955 Russell and Doi were arguing for the revision of the previously used definitions and for a greater degree of uniformity in data collection for higher education. They further suggested dividing the major categories previously recommended in an effort to get more concise data. Presently a national committee is attempting to revise the College and University Business Administration Forms #1 and #2 so that they take on more uniform and concise means of fiscal evaluation.[14, 15]

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[14]Witmer, Loc. cit.

[15]Russell and Doi, Loc. cit.

Unit-Cost Studies in Higher Education Though there are, as yet, no reliable inter-institutional means to evaluate unit costs, there is a fairly long history of studies dealing with jurisdictional instructional costs on an institutional basis; these date as far back as 1894. Both Strayer and Elliott did unit-cost studies in 1905, and jurisdictional cost studies in various forms have been conducted since. Allen attempted a study in 1914 of the University of Wisconsin state system on the basis of cost per full-time student. A study in the state of Washington in 1916 went a step further in attempting to analyze the cost of instruction in various disciplines on the basis of student clock-hour units. The concept of placing costs on the basis of full-time faculty and then cost per student credit hour has been in effect for most of the time since that 1914 study.[16]

For example, the National Committee on Standard Reports for Institutions of Higher Education recommended in 1935 that unit costs be computed on the basis of "costs per full-time-student equivalent" and costs per student

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[16]Witmer, Loc. cit.

credit hour.[17] In 1938, McNeely reinforced the National Committee's recommendations by suggesting to the United States Office of Education the use of "student-credit-hour" as the basic unit of instruction for departments, schools and colleges.[18] By 1960 the basic unit of analysis had not changed. This stability was exemplified by the Florida Cost Study Committee's use of "student semester hour of instruction" and "full-time equivalent student" as its basic units of analysis.[19] In the same year, Walker was using "semester-credit-hour" to calculate turnover rates of direct instructional expenditures, permanent plant investment, and indirect instructional expenditures.[20] Minor

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[17]National Committee on Standard Reports for Institutions of Higher Education, Financial Reports for Colleges and Universities. (Chicago: University of Chicago Press, 1935), pp. 177-249. (Reprinted under the title Computation of Unit Costs. Washington: American Council on Education, 1955).

[18]John H. McNeely, University Unit Costs, U.S. Office of Education, Bulletin 1937, No. 21 (Washington: U.S. Government Printing Office, 1938), 35pp.

[19]Florida Cost Study Committee and the Office of the State Board of Control, A Manual for Analyzing University Expenditures by Function. Revised 1960-61. (Tallahassee: State Board of Control, n.d.) 66 pp.

[20]Ernest W. Walker, "To Measure Operating Efficiency," College and University Business, 29 (August 1960), pp. 24-29.

alterations were made in 1962 by the Executive Secretary's Office of the University of Montana System of Higher Education in using "student credit hour registered for" as the basis for its study.[21] It was not until later in that year that noticeable changes in Allen's 1914 recommendations appeared in the form of Tyndall and Barne's study in which they used "weekly teaching hours," "weekly student hours," and "semester hourly rate" for calculating workload and costs.[22]

Several authors have raised concern about the validity of unit-cost data and its use in appraising higher education spending. Rand, for one, cautions that precision and accuracy need to be used when classifying and distributing expenditures, and determining the number of cost units, while Hull raises concern with the misuse of unit-cost data by administrators and faculty.[23] He points out

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[21]University of Montana System of Higher Education, Master Plan Study: Status Report. (Helena, Montana: Office of the Executive Secretary, State Capitol, Room 139, October 8, 1962), pp. 51-53.

[22]D. Gordon Tyndall and Grant A. Barnes, "Unit Costs of Instruction in Higher Education," The Journal of Experimental Education, 31 (December 1962), pp. 114-118.

[23]Edson R. Rand, "If Unit Cost Calculations Are to be Valid," College and University Business, 19 (August 1955), pp. 25-26.

that unit-cost data are quantitative and not qualitative and that present quantitative measures of faculty performance are not accurate. Further, the use of unit costs may give the false impression that costs are the most important variable in the instructional setting.[24] Pike also raised concern over the misuse of unit-cost data and proceeded to provide faculty with a means of analyzing standard costs and comparing them to actual costs.[25]

Research to Date Though a number of studies claim to deal with unit costs, it is quite obvious in reading their findings that their major parameters of analysis are jurisdictional rather than functional and are therefore far too general to be applicable to PERT, PPBS or other means of analyzing program costs, and eventually cost-benefits. Most of the studies cited deal with implementation costs per department and rarely give much more than passing attention to comparative costs between institutions or specific developmental costs for the

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[24]L.E. Hull, "Pitfalls in the Use of Unit-Cost Studies," Journal of Higher Education, 32 (October 1961), pp. 371-376.

[25]Walter L. Pike, "What You Can Learn from Unit Costs," College and University Business, 37 (July 1964), pp. 39-41.

instructional strategies used. This absence of developmental cost and functional data may be due in part to the fact that modern, media systems require some instructional development, and the standard lecture-lab approach often operates on the principle that relatively little instructional development is needed and therefore little is accounted for in the cost studies.

For example, School Management Magazine has been attempting to gather cost data since 1962 on various types of instructional strategies and has developed a means by which they feel they can compare costs across K-12 districts. Their basic unit of analysis is expenditure per pupil. This unit of analysis is then used to determine a cost-of-education index. However, none of their studies apply to higher education, or include more than the most general reporting variables.[26]

A very extensive unit-cost study was done by Witmer for the University of Wisconsin system in which he attempted to use cost studies to identify information related to policy formulation, to evaluate efficiency, to

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[26]"How to Use the Cost of Education Index, 1968-69," School Management, Vol. 13 (January 1969), pp. 52-54.

study alternatives and to prepare for the use of PPBS. His findings were reported in terms of contact periods, credits, major programs, curriculum, and students. The major analysis variables included faculty salaries, number of students per section, units per day, and the instructional strategy mix. No mention was made, however, of attempts to analyze instructional development costs per course.[27]

In 1966 a study similar to the Wisconsin study was carried out for the State of Michigan. The basic unit of analysis for this study was cost per student credit hour by department and student level. Only the eleven state universities were involved in this study and a vast number of assumptions were used, making the data difficult to compare to other colleges within the state and in other parts of the country.[28]

This and other research findings suggest that attempts to compare costs across institutions may be quite difficult. For example, Witmer reports that an attempt to apply the 1935 National Committee's standards

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[27]Witmer, Loc. cit.

[28]Linn Peltier, Institutional Research Office, Michigan State University; interviewed January 1970.

to a study of nine universities, found great variation from institution to institution. He cites the 1966 study by Kilzer who found that among seventy-eight junior colleges which presumably had the same mission some had costs which ran as high as six times those in others.[29]

Attempts to compare costs to quality between institutions have also met with ambiguous findings. Reeves and Russell, for example, mention the need to correct cost data to account for enrollment size variations before using costs as an indicator of quality in making inter-institutional comparisons.[30] In analyzing the relationship between cost and quality, Ikenberry notes that course proliferation is a detriment to quality programs and that class size is the crucial variable in reducing costs. As such, he contends that lower instructional costs per student need not lead to a proportional decrease in instructional quality.[31]

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[29]Witmer, Loc. cit.

[30]Ibid.

[31]Stanley Ikenberry, "Instructional Cost and Quality," College and University, 37 (Spring 1962), pp. 242-250.

Cost and Cost-Benefit Models of Education Model building is a frequent outgrowth of systems analysis. With the analysis of educational systems have come recent attempts to develop cost models and cost-effectiveness models of instruction. Most of these are based on fairly large parameters and do not deal with the specific functional concerns of individual courses. Likewise, Francis Keppel cautions that there is little sense in trying to build a model of broad scope with inconclusive or incomplete data. Furthermore, once any model is developed, it needs to be adapted to the system being analyzed.[32]

Model building procedures have been used by guidance and counseling professionals for years. Predictive models used as a means of advising prospective employees of their probable area of employment success are good examples of the outgrowth of these procedures. As part of the model-building process, linear regression and stepwise, multiple regression equations have been used to determine the relevant predictive variables. However, as Cronbach and others point out, discriminate and stepwise, discriminate analysis may be much more effective in determining the relative success of an employee in one

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[32]Keppel, Op. cit., pp. 121-125.

job or another.[33, 34, 35, 36]

Discriminate and regression analysis techniques may have application in building predictive models of successful instructional development. However, major problems are encountered when attempting to use these procedures in analyzing instructional systems in that the criteria for successful instruction are not clearly defined, and to carry out the longitudinal studies necessary to indicate whether benefit has actually been derived from the instruction developed would take considerable time and a large data base.

One large-scale attempt was made to determine the cost-effectiveness of the projects funded during 1965-66 under Title I of the Elementary and Secondary Education Act. In this case the systems model for cost-effectiveness of the

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[33]Henry Borow, Man in a World at Work, (Houghton, Mifflin Co., 1964), pp. 389-406.

[34]Wm. W. Cooley and Paul R. Lohnes, Multivariate Procedures for the Behavioral Sciences (John Wiley and Sons, 1965), pp. 17-59.

[35]Lee J. Cronbach, Essentials of Psychological Testing, 2nd Ed. (Harper and Brothers, 1960) pp. 247-268, 325-359.

[36]N.R. Draper and H. Smith, Applied Regression Analysis (John Wiley and Sons, 1967).

resource input of Title I funds was broken down into five sub-models: the schools affected, the community, the instructional process, the costs, and the cost effectiveness. These five major sub-models were used as input to a cost-effectiveness simulation model and the predicted outcome of the resource input was projected on the basis of data contained in the five sub-models. It is worth noting that most of the variables used in this attempt at cost-benefit analysis were operational, rather than capital costs. As such, most of the cost-benefit outputs represented the implementation and operation of new programs, rather than the development of materials to go into those programs.[37]

The Cost of Media Systems There have been several recorded attempts to ascertain the unit cost of mediated instruction. One such attempt was the 1968 cost study of the Michigan State University Closed Circuit Television system in which the units of analysis were divided far below those of the previously mentioned Wisconsin and Michigan studies. Rather than using general departmental

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[37]Clark C. Abt, A Cost-Effectiveness Model for the Analysis of Title I ESEA Project Proposals, Part I-VIII, ERIC #ED 014 018.

records as the main source of data, interviews were conducted, and records from various sources were analyzed to calculate the cost of producing, distributing and receiving the ITV programming being produced at Michigan State. Very little of this study, however, was inclusive of developmental costs of the instructional units produced.[38]

Another attempt to establish unit costs for media systems was made by the General Learning Corporation. In it data were compiled for numerous instructional strategies involving media components. Their data are representative of a number of years, and express trends rather than specific unit costs. Their units of analysis were the average length of the instructional unit, the type of program, the quality of the production, and the physical format of the medium used. Facility costs were ignored unless the facilities were being built specifically to house the instructional strategy utilized.[39] This

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[38]Gardner Jones, CCTV Cost Study, 1968-69, (East Lansing, Michigan: Michigan State University, Educational Development Program) Project #I-073.

[39]General Learning Corporation, Cost Study of Educational Media Systems and Their Equipment Components: Technical Report (ERIC #ED 024 286, 1968).

procedure was undoubtedly wise on their part, as facility costs vary greatly from region to region, depending upon the trade unions and the availability of materials.[40]

In categorizing their costs, the authors of the General Learning Corporation study separate costs into production, distribution and reception. They further classify costs as capital (those which are incurred during the initial planning and development stages) and operational (those costs which are incurred on an annual basis to implement the programs). Production costs were subdivided into duplication costs and general production costs.[41]

In analyzing the detailed, technical report, published to coincide with the General Learning Corporation study, one finds that media cost estimates were based primarily on the equipment systems involved, rather than the planning and production. Although some account was made of instructional planning as simple line items in the cost itemization, the software production did not include faculty time and other key components in the

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[40]"Ten Deceptions in Building Cost Comparisons," Overview Management (July 1962).

[41]General Learning Corporation, Guidelines for Determining Costs of Media Systems (ERIC #ED 024 273, 1968).

development process.[42]

After searching numerous sources for possible related studies, the General Learning Corporation research and a cost analysis of instructional systems by Jones were the only references found which gave any indication of the relative unit costs of various instructional strategies involving media. These data do serve, perhaps, as first approximations for some of the major mediated instructional systems such as ITV, dial access, and 16mm film libraries, but they do not include any of the costs related to self-instructional materials strategies.[43, 44] The only closely related reference found was reported in School Management of costs for media systems which dealt strictly with the media equipment expenditures for K-12 districts based on expenditure-per-pupil unit comparisons.[45]

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[42]General Learning Corporation, Loc. cit.

[43]Ibid.

[44]Gardner Jones, A Procedural and Cost Analysis Study of Media in Instructional Systems Development, (East Lansing: United States Department of Health, Education and Welfare, Office of Education Grant #OE-3-16-030, September 1, 1965).

[45]"Cost of Audio-Visual Instruction, 1962-63, 1968-69," School Management, Vol. 12 (October 1968), pp. 67-72.

Summary of Pertinent Literature To summarize, it appears that private business was the first major segment of our society to use cost analysis as a means of analyzing program development. The federal government and local and state branches of government were quick to follow with the advent of numerous publicly funded contracts. Only late in the 1960's did some educators attempt with much success to use sophisticated cost analysis procedures in their budget and program evaluation.

Unit costs are the basis of most cost analysis procedures, and permit such techniques as PERT, PPBS and linear programming to be successfully utilized by the systems analysts if they contain functional program cost data. Cost/benefit analyses may follow and be used in conjunction with these various analysis procedures, but in the field of education the benefits section of the analysis are still quite speculative. Various attempts have been made to categorize jurisdictional costs in higher education since the Carnegie Foundation standardized its granting procedures back in 1910. These analyses are in reality not of functional units which lend themselves to instructional systems analysis. Furthermore, the unit costs of instructional development are generally unknown for any

given strategy.

Instructional model building as an outgrowth of educational systems analysis is still in its infancy. Predictive models have been built and used by occupational counselors for a number of years and have been derived with the aid of a variety of sophisticated statistical equations, but predictive models of instructional costs are quite limited. One major attempt in this area was made, however, in relation to the Elementary and Secondary Education Act, Title I programs, but its results were only applicable to K-12 districts and do not take into consideration the constraints of the higher education instructional system. First approximations of the functional costs of implemented mediated instructional systems have also been exclusive of developmental costs and have been geared primarily at the K-12 level.

III. RESEARCH DESIGN

Present Systems Analysis Theory Systems theory may be clarified by describing the flow of activities involved. The first step is to define the system under study. The next step involves the development of a theory to explain the system defined. From this point, research is necessary to clarify the constraints and parameters of the system. On the basis of the data derived from such research, a model may be designed in an attempt to predict the interaction of these parameters and constraints. Once the model has been put to the predictive test, an evaluation of its validity and reliability must be carried out. After model validation, the procedure starts again with a re-definition of the system and appropriate modification of the theory.[46]

Cost-benefit analysis is a means of studying two basic aspects of a system. Before benefits can be assessed, it is necessary to analyze the system's costs. Benefits are much more difficult to determine, due to the length of time necessary to carry out the benefits analysis, as well as the subjective nature of the criteria

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[46]Sisson, Loc. cit.

used to indicate what has been beneficial. For these reasons, cost benefit analyses become quite lengthy, and at present, their results are general in nature.[47]

Some authors have pointed out that before systems theory can function on an operational level, it is necessary to develop analysis techniques which can be used to clarify cost data. Once these techniques are refined, then PERT (program evaluation and review technique), PPBS (program planning budgeting systems), and other means of systems analysis can be utilized with maximum effectiveness.[48] For example, since PPBS links long-range planning with fiscal planning, it is essential that adequate data be made available before decisions can be made as to either fiscal or long-range goals.[49] This need for concise data requires that when analyzing an educational setting, the institution's objectives and behavioral objectives for

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[47]Alexander Mood and Richard Powers, Cost-Benefit Analysis of Education (1967) #ED 012 519.

[48]Desmond L. Cook, Interview re: PERT and Systems Analysis Applications to Instructional Development (Columbia, Ohio: Ohio State University, October 1969).

[49]Charles J. Hitch, "What are the Programs in Planning, Programming, Budgeting," Socio-Economic Planning Sciences, Vol. 2 (Pergamon Press, 1969), pp. 465-472.

specific instructional programs must be taken into account. Without this balance between institutional and behavioral objectives, the cost of attaining the latter will have little meaning.[50]

Hypothesis to be Tested The system under analysis has been defined as those functions relating to the development of self-instructional materials in the biological and physical sciences at the higher education level. As stated above, there is a body of theory relative to systems analysis, but few attempts have been made to analyze the developmental aspects of self-instructional systems.

Therefore, the major hypothesis of this study was that the parameters and constraints of the system which encompass the development of biological and physical science self-instructional materials in higher education can be analyzed, and that once these parameters and constraints have been identified, unit-costs of development can be computed and a predictive unit-cost model for use in future cost estimates can be constructed and validated.

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[50]Paul Harmon, "Curriculum Cost-Effectiveness Evaluation," Audio-Visual Instruction, Vol. XV, No.1 (January 1970), pp. 24-26.

Population The population to which the results of this analysis might be generalized includes those self-instructional material development projects which occur in the biological and physical sciences at the higher education level.

Sample A selective sampling technique was used to select four biological science and two physical science courses which are taught primarily by self-instructional materials at Michigan State University, and one biological science and two physical science courses which are using self-instructional materials at Lansing Community College. The main selection criteria were: (1) the program chosen for study had to be in either the biological or physical science curriculum and (2) the program had to have a history of continued development and use by students for at least two years. Programs at two separate institutions were chosen to help reduce the influence of parameters and constraints which might be limited to a specific institution.

To provide a valid test of the unit-cost model's general predictability across institutions, a validation of the model was carried out on the development costs of

the Introductory Botany course taught with self-instructional materials at a third institution, Purdue University.

Definition of Terms The following terms are used in the study:

1. Full, relevant, functional, job cost analysis: an analysis of those direct and indirect functional costs which were considered by the development director and the researcher to be relevant to the initial self-instructional materials development project.
2. Project unit costs: the total cost of the self-instructional materials developed, divided by the number of credit hour equivalents which the materials replaced in the previous instructional strategy.
3. Functional costs: costs related to the achievement of specific instructional objectives and strategies, including both development and implementation aspects.
4. Jurisdictional costs: costs associated with the administration of various institutional subdivisions.

5. Development unit costs: those separate total costs for equipment, software development, software duplication, faculty, consultants, content assistants, facilities modification or validation and revision, divided by the number of units developed and/or the number of carrels used.

6. Self-instructional materials: those self-paced media used by the student to learn course concepts with little or no direct assistance from faculty or teaching assistants.

7. Developmental production costs: those expenditures for the demonstration and special development equipment, software production, faculty, consultant and content assistants time, and facilities modification which were incurred in the process of producing the first copy of an instructional unit.

8. Developmental duplication costs: those costs incurred in duplicating the originally developed materials and providing carrel equipment for the use of those materials.

9. Instructional unit: any self-contained package of materials used to teach a given conceptual segment of the course. For example, a unit might contain any combination of films, tapes, slides, hand-outs, and demonstration materials used as integral parts to teach the concepts of a particular course segment.
10. Initial development: that development which takes place prior to the first student use of the materials being developed. Once students are using the materials developed for course credit, costs are not assigned as being part of the initial development.
11. Self-instructional setting: the instructional facility or location where students use self-instructional materials with little or no formal contact with faculty or teaching assistants.
12. Non-departmental funds: those financial resources which are derived from college, university, foundation or federal grants. These funds are not assumed to be a part of the normal departmental operating budget.

13. Materials for student use: when the faculty developing the self-instructional units are satisfied that the materials are sufficiently valid and reliable to instruct students with academic credit in a self-instructional mode, then the materials are considered ready for student use.

14. Student station: any location within the instructional setting where a student can use the materials developed. These student stations may be individual areas containing individually assigned hardware and software, or locations at a demonstration area.

15. Carrel: a student station containing an assigned number of hardware and software components which are used to transmit the concepts in a specific instructional unit.

16. Demonstration area: student stations which are not individually assigned but are meant for all students in the course who are progressing through a given unit of self-instruction. Demonstration materials may be assigned to individual carrels, but those materials in

the demonstration area are relatively few in number and are meant for all students to observe.

17. Models and demonstration equipment: special equipment which is considered as part of the unit costs if it is specifically developed or purchased for the self-instructional unit to which it is assigned.

18. Facility modification costs: any costs resulting from a change in the instructional setting which is necessitated by the development of the self-instructional materials. Such modifications may include wiring, lights, special carpet and the removal of existing equipment. However, the cost of installing carrels is included under developmental duplication costs rather than as facility modification costs.

19. Production Technicians: any individual assigned the responsibility of producing or contributing to the production of a medium, such as cameramen, directors, editors, sound and light technicians, artists and other non-content specialists.

20. Locally produced and/or processed software: any software which is produced and/or processed by members of the materials development team or by on-campus production service centers.

21. Validation: an evaluation of the validity of instructional materials prior to the use of said materials in the instruction of students for academic credit.

Assumptions As may be apparent from the previous review of systems theory, this attempt to develop a predictive model for the unit-costs of self-instructional materials development was a first approximation. Many other significant variables will obviously be found to operate as other parameters and constraints not included in this study are taken into consideration.

Some of these parameters and constraints might include the psycho-sociological characteristics of the individual(s) carrying out the development, and the academic environment in which that individual or group of individuals is located. More specifically, motivational factors, rewards, tenure status, age, previous instructional development experience, the proportion of non-departmental

development funds and the quality of technical and consultant assistance might all influence the costs as well as the success of the development. However, these parameters and constraints were assumed to have an insignificant influence on developmental unit costs.

There may also be some question as to a model's reliability based on a relatively small sample size. (Seven development projects comprise the sample in this study.) However, conducting research prior to the initial construction of a predictive cost model requires that the original parameters and constraints be inclusive of a fairly generalized view of the system and, if possible, be representative of the costs, irrespective of benefits. The first design of the model may, therefore, be attempted, following the analysis of data from a limited, heterogeneous sample. Future research may then increase the sample size to test the assumptions of the model and to analyze the on-going process and success of the self-instructional materials developed. Using common business management work-sampling techniques, for example, might provide more accurate faculty and consultant time data as it relates to the

development process.[51]

Other assumptions which were made in relation to this study include the following:

1. Instructional development is a continual process involving the initial development phase, followed by student use, evaluation and further revision. For the purposes of this study, only the initial development phase is being analyzed.
2. Developmental costs are divided into those costs incurred in the development, equipment procurement, and production of a master copy of a given medium. Duplication costs, a subset of the total development, are those costs incurred in reproducing the master and procuring additional equipment units to satisfy the instructional needs of the students enrolled in a given course.
3. The self-instructional material developed must replace, or add content to, the instructional strategy traditionally used to teach the course

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[51]Charles H. Backstrom and Gerald D. Hursh, Survey Research (Northwestern University Press, 1963), pp. 28-35.

concepts.

4. The developmental costs for self-instructional materials in the biological sciences are similar to those costs of development in the physical sciences in that both areas use a variety of equipment and expendable supplies in the instructional process, and their concepts are relatively easy to visualize.
5. There is a significant difference in the amount of, and hence the cost of, instructional materials used by those curricular areas which are highly visual, such as the biological and physical sciences, and those areas of the curriculum which are more conceptually abstract, such as the humanities.
6. The experimental sample containing projects which developed self-instructional materials for five biological science courses and four physical science courses is sufficient, as an initial sample, to represent the costs incurred in the development of self-instructional materials for these curricular areas.

7. Faculty responding to specific interview questions give a reliable estimate of the time which they and their colleagues spent in the development of the materials under study.
8. A fair appraisal of each unit's software production quantity and costs can be derived from an accounting of the total number of software items produced during the initial development and dividing this total by the number of instructional units initially developed.
9. Commercial software production and processing costs may be determined once the materials produced have been carefully described to appropriate vendors.

Limitations The research design, and therefore the results and conclusions of this study, are subject to the following limitations:

1. The initial development of self-instructional materials is the unit of analysis, including the refinement of enabling objectives, the selection of appropriate media strategies to meet the objectives, but not the creation of a climate of acceptance among non-development faculty, or the

implementation and operation of a self-instruc tional setting. (It is recognized that these activities are not discreet processes and that overlapping costs will necessarily exist.)

2. The experimental sample is drawn from biological and physical science curricular areas within higher education, and therefore the results do not attempt to generalize to broader spectra of curricular or academic levels.
3. Use of the predictive model for self-instructional materials development at the higher education level for biological and physical science course development will project costs to the extent that the input data and step-wise decisions made in using the budget planning guide accurately reflect local conditions. Furthermore, the instructions in the planning guide must be used to adapt the accompanying tables so that they will reflect the economic environment in which the model is to be used.

Instrumentation Interviewing the major faculty developers in charge of each of the selected development projects was considered the most accurate method of

gathering most of the aggregate cost data. Therefore, an interview questionnaire was designed and a pilot study to validate the interview questions was conducted with the faculty who developed the self-instructional materials used in the media utilization section of the educational methods course for teacher preparation at Michigan State University. As a result of that pilot study, modifications were made in the interviewing instrument to help clarify the few ambiguities which arose from the original instrument, and to expand those areas where more data were needed to make a thorough analysis of all relevant costs. (Appendix A contains a copy of the interviewing instrument.)

Data Gathering Once the interview items were tested, full, relevant, functional job cost data were gathered during interviews with the key faculty developers involved with each of the following completed self-instructional materials development projects at Michigan State University: anatomy, soil science, nursing, physiology, Lyman Briggs College (beginning biology), and biochemistry. Similar data were gathered on the three basic science courses using self-instructional materials at Lansing Community College. (Full, relevant, functional job costing was

chosen rather than marginal or period process costing, due to the terminal aspects of the initial development projects. If implementation or operational unit costs had been the units of analysis, then marginal or period process costing would have been more appropriate.)[52]

Additional supportive data were compiled from catalogue price quotations, funding agency proposals and media production specialists. The aggregate cost data collected from the faculty and supportive sources were then divided into two separate groups consisting of developmental costs and duplication costs. Developmental costs were summarized under five major categories: (1) equipment, (2) software, (3) faculty and assistant, (4) consultant, and (5) revision costs. Duplication costs included those expenditures which resulted from the production of duplicate sets of the original software. (Since most previous unit-cost studies of higher education courses have been relative to jurisdictional rather than functional costing, their main input data have been faculty salaries. However,

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[52]Jones, A Procedural and Cost Analysis Study of Media in Instructional Systems Development, Loc. cit.

for those experienced with the development of self-instructional materials, it is obvious that faculty salaries --- and equipment costs for that matter --- are only a part of the parameters and constraints to be included in a cost analysis of the development process.)[53]

Those parameters and constraints for which aggregate data from each project were gathered and later analyzed in determining the unit costs of development were the following:

Developmental Production Costs

Instructional Units:

(1) The number of self-instructional units used with students after the initial development

(2) The date the initial development started

(3) The date the initial development was completed for student use

(4) The average student time per week spent in the self-instructional setting

(5) The number of total credits offered for the course in which self-instructional materials were used

(6) The percentage of the total course credits taught by the self-instructional materials

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[53] Jones, A Procedural and Cost Analysis Study of Media in Instructional Systems Development, Loc. cit.

developed

Software Production Costs:

(7) The average number of slides developed per instructional unit

(8) The number of silent films developed as opposed to the number of sound films developed

(9) The number of films developed for reel-to-reel projection as opposed to the number developed for cartridge projection

(10) The average running time per film

(11) The average cost per film

(12) The average number of photoprints developed per instructional unit

(13) The size of the photoprints produced

(14) The number of photoprints per unit in the student handouts, as opposed to the number per unit in centralized displays

(15) The average cost per photoprint

(16) The average number of audio tapes developed per instructional unit

(17) The number of tapes on cassettes as opposed to the number on reels

(18) The average audio or video tape playing time per unit

(19) The amount and type of other demonstration materials or equipment developed or purchased for the instructional units, but not included in the carrel setting

(20) The average cost per model built for instructional use

(21) The average number of student handouts developed for each instructional unit

(22) The number of pages included in each handout

(23) The type of graphic illustrations, if any, included in the student handout

(24) The average cost per student handout

(25) Whether the software was locally produced or purchased by type of software and quantity in each category

(26) Whether the software locally produced were processed locally or whether they were processed commercially

(27) The number of production technicians employed during the initial development of the software

(28) The salary these technicians were paid

(29) The amount of time they spent on the initial development

(30) The financial support received from non-departmental sources, as opposed to the support from departmental operating funds

(31) The percentage of the total development costs received from non-departmental sources

(32) The total cost of the software developed

Faculty and Content Assistant Costs:

(33) The number of faculty who worked on the development of the self-instructional materials

(34) Their tenure level

(35) The number of months per year of their appointment

(36) Their yearly salary

(37) The amount of faculty time assigned to the development of the instructional units

(38) The number of content assistants, such as graduate assistants and secretaries, who were used during the development of the instructional units

(39) Their salary level

(40) The amount of time they were assigned to spend on the initial development

(41) The amount of faculty time required to train the carrel room operators on the use of the equipment and distribution of materials

(42) The number of self-instructional units previously developed by the major faculty developer

Consultant Costs:

(43) The number of consultants used during the development of the instructional units

(44) Their area of expertise

(45) Their tenure level

(46) Their salary

(47) The amount of time spent by each consultant during the development

(48) The amount of travel cost incurred by consultants coming to the development site

(49) The amount of travel cost incurred by content faculty traveling to exemplar projects

Revision Costs:

(50) The type of validation, if any, conducted on the materials prior to student use for course credit

(51) The per cent of the software revised as a result of the validation

(52) The method of production and processing used for materials revised as a result of the validation

(53) The number of faculty and staff involved in the validation

(54) The amount of time they were involved in the validation

(55) The number of students who validated the materials, and the rate paid per student, if any

(56) The estimated revision costs

(57) The cost of modifying facilities as a result of the initial self-instructional materials developed

Those parameters and constraints for which aggregate data from each project were gathered and later analyzed to determine the unit costs of producing duplicate sets of the originally produced software and providing carrel equipment for the students enrolled were the following:

Developmental Duplication Costs:

Software Duplication Costs:

(1) The number of students per term the initial self-instructional materials were developed to teach

(2) The number of students per term using the materials developed at the time of the interview

(3) The number of carrels the materials were originally planned to fill

(4) The number of carrels using the initially developed materials at the time of the interview

(5) The number of carrels which had been and were at the time of the interview being used for review units

(6) The number of hours per original instructional unit for which the carrels were available for student use

(7) The frequency with which the units were rotated in the carrel facility and the type of rotation schedule

(8) The duplication cost for the software materials developed

Equipment Costs:

(9) The type and model of instructional equipment and/or carrels used at each student station and in any adjacent demonstration area

(10) The amount of each type of equipment used in the student station, adjacent demonstration area or as special development equipment

(11) The per item costs for each type of equipment used

(12) The equipment purchased new, as opposed to the equipment drawn from existing sources

(13) The total cost of the instructional equipment

(14) The list-price discount given for the equipment purchased

Data Analysis As noted in the literature review, unit costs in higher education have traditionally been recorded as costs per student credit hour, cost per full-time equivalent student or a variation thereof. These units of analysis serve some utility in making jurisdictional comparisons and decisions. However, the purpose of this study was to construct a predictive unit cost model of self-instructional materials development. As such, the data and unit costs had to reflect functional, rather than jurisdictional, relationships. Further, since developmental rather than implementation or operational parameters and constraints were necessary in the construction of this predictive model, greater emphasis had to be placed on costs per carrel, and particularly cost per instructional unit, than cost per student credit hour. If the traditional units of analysis had been chosen, there would be little

opportunity to compare and use developmental project costs, since an increase or decrease in student course enrollment would affect only the duplication, implementation and operation costs, not the development costs which are content and strategy related.

Therefore, the aggregate data from the faculty interviews and supportive sources were grouped under the development and duplication cost parameter and constraint categories and sub-categories. Totals for each category by project were computed, and the mean for all projects by category calculated. Unit costs per carrel and unit costs per instructional unit were then computed from each project category total, and the mean unit costs per carrel and instructional unit recorded for all projects.

Model Construction A predictive, unit-cost model was designed after the data were analyzed. A budget planning guide was then constructed, based on the model. High, low and average unit costs per category were grouped and criteria written for the user selection of the proper value for each category. Opportunities for the planning guide user to modify estimates due to inflation factors and local parameter or constraint variations from the aggregate data

were also made. The planning guide was designed to permit the user to answer a variety of questions about his local instructional and economic conditions, decide which value under each category is appropriate for his development project, modify that value to fit his economic environment and multiply the subtotals by the number of carrels and instructional units to be used to determine the total development cost estimate. The user is also able to make an estimate of the amount of faculty time and the number of months needed to develop the materials.

Model Validation A validation of the model (in planning guide form), and the cost selection criteria was conducted on the Introductory Botany course at Purdue University. The validation was conducted in conjunction with a cost analysis of the initial development costs of the same project for which the model was attempting to predict. The results of the cost analysis were then compared to the model predicted costs to determine the validity of the model. The two-stage validation used the same parameters and constraints to analyze the development costs of the Purdue project as were used in analyzing the Michigan State and Lansing Community College projects. It

was decided that the model would be considered valid if it predicted the Purdue development costs within fifteen per cent of the costs resulting from the cost analysis of the same project. This value was chosen since: (1) correlations for predictive purposes are seldom considered significant unless they are greater than plus or minus .60, (2) the sample from which aggregate data were collected was relatively small, thus leaving the possibility of skewed results due to biased sampling, and (3) the nature of the input data in some cost categories was based on faculty estimates of time. Further, an override of ten per cent is often written into contracts to cover unexpected costs. It was therefore decided to accept a model with predictive accuracy of plus or minus fifteen per cent so that a first approximation could be derived by an instructional planner and leave the task of developing greater accuracy for research based on more exact input data.

Summary A pilot study was conducted to standardize the interviewing instrument. Following this phase of the research, data were gathered from seven completed self-instructional projects representing five biological science courses and four physical science courses. Interviews

were conducted with the major faculty developers for each project, and software production specialists. Additional supportive data were gathered from equipment specialists and hardware catalogues. The resulting aggregate, full, relevant, functional job cost data were analyzed and a predictive model of the self-instructional materials development costs was constructed and adopted as a budget planning guide. Validation of this model took place at Purdue University on the self-instructional materials used to teach the Introductory Botany course.

IV. ANALYSIS OF RESULTS

Full, Relevant, Functional, Job Cost Analysis Results

Gardner Jones once described the frustration of gathering instructional cost data by comparing the process to attempts to put a rubber band around a cloud. The sense of frustration behind his analogy must be shared by all those who attempt to analyze instructional systems and begin to place unit costs on the out-puts of the instructional process. Though the creative aspects of the instructional process balk at being standardized by unit-cost analysis, attempts to clarify the cost of various strategies for comparison purposes and decision making are nonetheless becoming more and more essential as attempts are made to use limited resources more effectively. Craig Johnson noted a ray of hope when he reported that "While no one argued that evaluation of education ought to be restricted to cost effectiveness, many programs found that cost data could be collected and analyzed meaningfully to evaluate instruction projects." [54]

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[54] F. Craig Johnson, An Evaluation of Educational Development Programs in Higher Education. USOE Grant No. OEG-0-8-070114-1856 (010), Project No. 7-E-114 (1968).

"Because of differing relationships of individual expense categories to the volume (of production in industry, or of enrollments in education) it is necessary, for planning purposes, to make studies of individual expense categories separately."[55] Therefore, to arrive at an accurate appraisal of the development costs for self-instructional materials, separate expense categories were established and full, relevant, functional, job costs were analyzed in each category. Full costs imply both direct and indirect costing of the instructional development, and that labor and materials costs to carry out production and duplication in "service-oriented" audio-visual centers should be included, even though the department for which the services were rendered was not charged. Faculty costs are also included in the full costing analysis, due to the fact that their involvement in the development process removes them from other productive activity. Relevancy indicates that only those direct and indirect costs which were specifically relevant to the development process were included. For example, indirect overhead expenses which would

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[55]Jones, A Procedural and Cost Analysis Study of Media in Instructional Systems Development, Op. cit., p. 28.

be assumed by the institution, regardless of the facility use, were not included in this analysis. Functional development costs, as opposed to jurisdictional costs, were also isolated in gathering and analyzing the data. Finally, a terminal point was sought for the analysis. Therefore, job or project costs for the initial development phase were used.

Once the aggregate cost data were compiled, the parameters and constraints in each expense category were analyzed. As Table 1.0 illustrates, there were numerous variations from project to project in the number of units developed, the length of the development period, and the way in which the self-instructional materials were used. Projects 4 and 5, for example, used the materials they initially developed in addition to the existing instructional strategies, rather than as replacement for those strategies. Project 7 combined the faculty talents of a full department and developed three courses simultaneously, while the development on the rest of the projects studied was carried out by primarily one faculty member on each project. In addition to the way in which the initially developed materials were used, and the talents were used on the development team, variations in the length of the

Table 1.0 Instructional Unit Data Development

Parameter or Constraint	Project							Average Per Course
	1	2	3	4	5	6	7[a]	
Number of instructional units developed/course	9	14	6	10	2	2	30	10/course
Months of initial development	9	3	6	8	9	3	9	6.7 months
Instructional hours/student/unit	3.60	1.50	3	.56	1.7	4	4	2.6 hours
Number of credits in course	5	5	3	6	3	5	4	4.4 credits
% of course taught by self-instructional materials initially developed	33	75	75	0	0	18	66	38 per cent

[a]Project seven (7) involved the development of self-instructional materials for three (3) separate courses. Therefore, parameter and constraint totals were divided by nine (9) to reflect averages per course.

initial development period were also noted and seem to be due to the development competence demonstrated by the major faculty developer, and the availability of existing software to illustrate the concepts he wished to teach.

As would likely be apparent to anyone familiar with the instructional media field, the cost of various hardware systems vary quite greatly, depending on a number of factors such as the sophistication and amount of the equipment used. The strategy of instruction also plays a significant role, as indicated in Table 1.1. For example, those projects which used film in the strategy mix had the additional expense of a Technicolor Super 8mm silent or sound projector, or in some cases a Fairchild Mark IV projector. In most cases these hardware items were used in demonstration areas rather than in carrels, and therefore their costs were distributed over a larger number of students.

Since three equipment categories were established, notice in Table 1.1 that carrel equipment, demonstration equipment and special development equipment were first analyzed as an aggregate body, then carrel equipment was separated. This procedure was partially due to the fact that in a few cases developers chose to produce their own

Table 1.1 Carrel, Demonstration and Special Development Equipment Data

Parameter or Constraint	Project							Average Per Course
	1	2	3	4	5	6	7[a]	
Number of carrels/ course	10	16	10	10	10	5	84	16
Cost of carrel equipment	$6650	$6193	$6190	$4100	used existing	$3901	$33,566	$7590
Cost of special development and demonstration equipment	0	866	760	640	carrels	500	5,729	$1210
Total Equipment cost	$6650	$7059	$6950	$4740	$ 0	$4401	$39,295	$8650

[a]Project seven (7) values represent development costs for three (3) separate courses. Therefore, parameter and constraint totals were divided by nine (9) to reflect averages per course. This procedure was used throughout the data analysis process.

software rather than use campus (i.e. local) instructional media center facilities or commercial producers. In such cases, cameras for photomicroscopy, tape recorders for recording and duplicating tapes and an apparatus to freeze-dry tissue were examples of special development equipment which was purchased in addition to the carrel equipment per se. Further equipment cost variation was exemplified by Project 5 where materials were developed for use in an existing carrel facility and therefore there were no appreciable equipment costs to be recorded. (Average equipment costs were therefore computed on the basis of eight courses rather than nine, due to this variation.)

Another factor influencing the cost of the carrel equipment was the sophistication of the carrel itself. For example, if a rear-projection reflex system was used to project the slides to the learner, as opposed to a home-made screen on the side of the carrel, there was a considerable increase in expense. Likewise, if carrels were made by campus craftsmen out of plywood and existing laboratory tables, the cost of the carrel itself was diminished considerably. Another

cost-reducing factor noted was that most of the projects studied were somewhat experimental in nature and there was a tendency on the part of carrel manufacturers to work quite closely with the project faculty. For the opportunity to design and work with a self-instructional program using carrels, these manufacturers made project bids rather than per-item bids, and reduced the carrel costs. This procedure gave them an outlet for their product, experience in carrel design, and gave the faculty the opportunity to reduce carrel costs for that particular project.

Further variations in equipment costs were illustrated by one case where the tape recorders purchased did not have the proper out-put amplifiers for the headphones to be used. Specially adapted amplifiers had to be made by a local sub-contractor to accomodate this mismatch. As equipment manufacturing procedures become more standardized to meet the needs of self-instructional systems, variations in carrel and instructional equipment costs due to local conditions should be minimized.

Software production costs were separated from duplication costs since the development and production of the original set of software for the self-instructional units

would necessarily be more expensive than the duplication thereof. As those experienced with instructional development are well aware, there are many variables which influence the cost of software production. It was necessary, therefore, to arbitrarily place some constraints on the influence of a number of these parameters. For example, the per-unit costs of producing various types of software were derived from interviews with various software producers, both commercial and university-service oriented. Then the average number of slides, films, tapes, models and handouts per unit were determined from the faculty during the interview. The average number of a given medium was then multiplied by the appropriate unit cost and number of instructional units to determine the total cost of producing a given type of software.

To illustrate, if slides were to be shot without art work, they were given a standard unit cost. However, if art work was involved attempts were made to ascertain the length of time necessary for the artist to do the work and then ascribe a labor and materials charge to the particular work. (Examples of software unit costs used are appended in Appendix D.) The average number of slides with

artwork per instructional unit were then multiplied by the unit cost of producing slides with artwork. This value was then multiplied by the number of units, to estimate the total cost of producing slides with artwork. The same procedure was used with slides without artwork, and the rest of the cost parameters.

As one will notice in reviewing Table 1.2, three of the projects did not engage in film production at all. Of the four projects which did have some film involved in their instructional strategy, only Projects 3, 4 and 5 actually produced their own. Project developers on Project 3 shot their own 8mm footage and Projects 4 and 5 had a media center shoot 16mm footage which was then reduced to 8mm. Project 7 bought commercially produced 8mm footage and added their own sound to magnetic stripping.

Photoprints were used sparingly by most projects, if at all, and models were usually purchased as part of the realia rather than locally developed and produced. It is important to note that Project 6 had an exceptionally high realia cost, due to the use of freeze-dried tissue samples and models which were purchased. Hand-out production costs were primarily included under secretarial labor,

Table 1.2 Software Production Data

Parameter or Constraint	Project							Average Per Course
	1	2	3	4	5	6	7	
Slide production costs	$242	$ 88	$216	$135	$384	$ 38	$2472	$ 386
Film Production costs	0	0	240	4000	722	0	1200	$1025
Photoprint production costs	0	21	360	200	0	0	60	$107
Audio tape production costs	20	182	15	220	75	5	66	$65
Realia production costs	468	0	0	139	60	2388	40	$440
Hand-out production costs	0[a]	0[a]	15	0[a]	0[a]	0[a]	300	$79
Total software production costs	$730	$291	$846	$4694	$1241	$2431	$4138	$1580

[a]Hand-out production costs included under secretarial labor.

unless there was some graphic art to be done in preparing the hand-outs. In most cases where illustrations were used, these were simple line sketches done by the faculty or secretaries, and included under their time rather than under a graphic artist's production time.

Software duplication was a reflection of both the number of students and therefore the number of carrels and the number of instructional units produced. Obviously the materials for a strategy of instruction which included numerous slides and films would cost more to duplicate than a strategy which relied entirely, or at least substantially, on audio tape. However, as noted in Table 1.3, none of the projects studied duplicated films for individual carrel use, and therefore no duplication costs were ascribed for that particular item. Photoprints were also used primarily in demonstration areas and therefore limited if any duplication was involved. The one project which did duplicate photoprints for individual carrel use was primarily concerned with specific laboratory techniques, and the student's ability to study a specific print at length and compare it to a number of slides being presented was felt essential. Realia were also used primarily in demonstration areas and therefore no duplication costs were incurred. Audio tape

Table 1.3 Software Duplication Data

Parameter or Constraint	Project							Average per course
	1	2	3	4	5	6	7	
Slide duplication costs	$316	$1312	$458	$2033	$313	$188	$2362	$ 775
Film duplication costs	0	0	0	0	0	0	0	$0
Print cuplication dosts	0	0	0	2060	0	0	0	$0
Tape duplication costs	297	650	182	413	59	30	5040	$740
Realia duplication costs	0	0	0	0	0	0	0	$0
Hand-out duplication costs	530	45	137	55	23	17	5070	$650
Total software duplication costs	$1143	$2007	$777	$4561	$395	$235	$12472	$2400

duplication costs were a factor of the number of units and the number of carrels involved. Hand-out duplication costs were a reflection of the stencils and paper, and that secretarial time which was used on the production of hand-outs per se.

One of the expense categories in the cost of instructional systems design and the eventual implementation of that design is the use of faculty and other personnel in the development process. Jones, in his analysis of instructional systems development, clarifies the need to analyze this resource by stating:

> "Some major university should undertake a continued, large-scale study in detail of faculty time usage, to determine really where this high-priced resource goes, and what tasks could be passed on to lower-cost personnel. To our way of thinking, this kind of data is the largest gap in the measurement of costs of university 'products.'"[56]

In attempting to analyze the cost of faculty involvement in instructional development, the process through which the faculty went in their development of materials

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[56]Jones, A Procedural and Cost Analysis Study of Media in Instructional Systems Development, Op. Cit., p. 88.

was broken down, and they were asked to ascribe an estimate of the time which they spent on individual activities. Estimates of secretarial time and graduate assistant time were also received in the same manner. Wage and salary data sheets were then used to determine the specific cost of the time which was used by these individuals. Where faculty members were involved in the development process, time estimates were gathered on each participant's amount of involvement, his tenure status, and the length of his yearly appointment. From these data calculations were then made as to each participant's hourly wage and consequently the cost of his involvement.

Table 1.4 represents the cost values on these time estimates. As will be noted, faculty development time per course was separated from the secretarial and content assistant time. Heavy use of associate or full professors for consultation or development logically caused the cost of the faculty increment to increase if the amount of time necessary to carry out the development was the same as those projects which used primarily instructor-level faculty. Another factor in the total cost of the content-related personnel was obviously the length of the development project.

Table 1.4 Faculty, Secretarial and Content Assistant Data

Parameter or Constraint	Project							Average per Course
	1	2	3	4	5	6	7	
Hours of faculty development time/ course	1520	800	875	256	840	540	4420	1030 hrs
Cost of faculty development time/ course	$6200	$6930	$6110	$1845	$3560	$3240	$19150	$5240
Cost of secretarial time/course	240	362	960	1290	450	1708	1876	$765
Cost of content assistant time/ course	1312	900	1000	3340	0	960	2046	$1180
Subtotal for secretarial and content assistant costs	1552	1262	1960	4630	450	2668	3922	$1830
Total faculty, secretarial and content assistant costs	$7752	$8192	$8070	$6475	$4010	$5908	$23072	$7050

Instructional development and content consultant personnel were separated from the major faculty developers and primary content assistants so that a clearer understanding of the consultant role in the instructional development process could be determined. As will be noted in reviewing Table 1.5, the services of these consultants, both instructional development and content, were used sparingly by most developers. In a few cases extensive use of instructional development consultants was found as a result of faculty participating in a fairly extensive and detailed instructional development program without prior experience.

It must be noted that instructional development consultants consisted of evaluation and learning theory specialists, as well as graphic and hardware systems specialists. In some cases faculty used a small portion of the wide variety of these talents; in other cases the faculty keyed on specific consultants and used substantially more of their services in developing the instructional materials. These variations in the type and variety of consultants used are not reflected in the Table 1.5 results.

The validation of the instructional materials developed, and the subsequent revision of those materials,

Table 1.5 Instructional Development and Content Consultant Data

Parameter or Constraint	Project							Average per Course
	1	2	3	4	5	6	7	
Instructional development consultant costs	$293	$219	$ 76	$1025	$978	$111	$ 0	$450
Content consultant costs	0	144	325	0	673	357	360	$266
Total consultant costs	$293	$363	$401	$1025	$1651	$468	$360	$506

Table 1.6 Validation and Revision Data[a]

Parameter or Constraint	Project							Average per Course
	1	2	3	4	5	6	7	
Faculty and student validation costs	$0	$0	$0	$326	$0	$0	$ 0	$---
Software revision costs	0	0	0	69	0	0	413	$120
Total validation and revision costs	$0	$0	$0	$395	$0	$0	$413	$202

[a]Few projects studied actually validated the instructional materials before students used the materials to earn course credit.

was a process carried out by very few of the projects studied. Therefore in analyzing the data as presented in Table 1.6, it becomes evident that most of the materials were presented to students for credit prior to any revisions and that the validation process itself was an evaluation of how well the students learned from the materials during the term in which they were first used.

Facilities modification was necessary in only one of the seven projects studied, inasmuch as most of the modification, if any, was due to the installation of the carrel equipment within an existing space. Only one project, as reported in Table 1.7, reported any appreciable

Table 1.7 Facilities Modification Data[a]

Parameter or Constraint	Project							Average per Course
	1	2	3	4	5	6	7	
Facilities modified	0	0	0	$1015	0	0	0	----------

[a]If instructional facilities were modified due to the materials developed, they were usually modified to install the carrels. Carrels installation costs are included in the carrel equipment costs in Table 1.1 The one project reporting other modifications needed lights and wiring changed to accomodate the instructional equipment, and work study students were hired to clean old lab tables.

modification costs. This cost resulted from re-wiring and lighting an old laboratory facility which was not adequate for the instructional equipment being implemented.

The aggregate data in Table 1.8 reflect the totals involved with each major expense category. It is fair to say that each project was an individual entity unto its own, and showed variations from the "norm" even though the strategy of self-instructional presentation was basically the same in each case. Project-by-project comparisons of total costs are inappropriate at this point, however, due to the fact that these totals do not reflect how much each unit cost. The results of calculations with knowledge of how many units of materials were developed and how many carrels were equipped are reviewed in the next section of this chapter.

In addition to total costs per expense category, Table 1.8 also includes a description of the amount of time taken by the faculty during the development process, as opposed to the time taken by other personnel. This differentiation was made so that a clearer understanding of the amount of faculty involvement could be ascertained.

Table 1.8 Summary of Aggregate Development Data

Parameter or Constraint	Project							Average per Course
	1	2	3	4	5	6	7	
Number of units initially developed	9	14	6	10	2	2	30	10
Number of carrels used	10	16	10	10	10	5	84	16
Total equipment costs	$6650	$7059	$6950	$4740	$ 0	$4401	$39295	$8650
Total software production costs	730	291	846	4694	1241	2431	4138	$1580
Total software duplication costs	1143	2007	777	4561	395	235	12472	$2400
Total faculty, secretarial and content assistant costs	$7752	$8192	$8070	$6475	$4010	$5908	$23072	$7050

Table 1.8 - Continued

Parameter or Constraint	Project							Average per Course
	1	2	3	4	5	6	7	
Total instructional development and content consultant costs	$293	$363	$401	$1025	$1651	$468	$360	$506
Total validation and revision costs	0	0	0	395	0	0	413	$202
Total facilities modification cost	0	0	0	1015	0	0	0	---
Total development costs	$16568	$17912	$17044	$22905	$7297	$13443	$86707	$20208
Total hours of faculty development time	1520	800	875	256	840	540	4420	1030 hrs.
Total months for initial development	9	3	6	8	9	3	9	6.7 mo.

Likewise, a clarification of the length of time for the initial developmental process was analyzed separate from faculty time to note the average duration of the initial development process.

As previously mentioned in reviewing the totals in Tables 1.0 - 1.8, it is very difficult to make comparisons between projects without knowing the number of units and carrels involved. The next section of this chapter will therefore attempt to analyze the data from a unit-cost standpoint so that meaningful comparisons can be made.

Unit Costs of the Self-Instructional Materials Developed

Once the aggregate, full, relevant, functional, job cost data were analyzed and grouped under appropriate parameters and constraints in separate expense categories, calculations were made of the unit costs and related data per self-instructional unit and carrel. The results of these calculations are noted in Tables 2.0 and 2.1 and give an appropriate means of comparing the costs of the projects studied. For example, the range of instructional units developed went from two to thirty. If one chose the aggregate data in Table 1.8 in an attempt to make a project-by-project comparison on the basis of

Table 2.0 Unit Costs Per Self-Instructional Unit and Related Data

Parameter or Constraint	Project							Average per Course
	1	2	3	4	5	6	7	
Number of units initially developed	9	14	6	10	2	2	30	10
Instructional hours/student/unit	3.6	1.5	3	.56	1.7	4	4	2.6 hrs.
Carrel, demonstration, and special development equipment costs/unit	$739	$504	$1160	$474	used existing carrels	$2210	$1310	$1063
Software production costs/unit	81	21	141	469	623	1215	138	$246
Software duplication costs/unit	127	144	130	456	197	117	415	$226
Faculty costs/unit	$690	$495	$1020	$184	$1780	$1620	$640	$920

Table 2.0 - Continued

Parameter or Constraint	Project							Average per Course
	1	2	3	4	5	6	7	
Secretarial and content assistant costs/unit	$173	$90	$326	$463	$225	$1330	$131	$234
Faculty, secretarial, and content assistant costs/unit	862	585	1340	647	2040	2960	770	$1315
Instructional development and content consultant costs/unit	32	26	67	102	825	234	12	$79
Validation and revision costs/unit	0	0	0	40	0	0	14	$27
Average development costs/unit	$1840	$1280	$2840	$2290	$3640	$6720	$2890	$2460
Hours of faculty development time/unit	169	57	146	25	420	270	147	109 hrs.

Table 2.0 - Continued

Parameter or Constraint	Project							Average per course
	1	2	3	4	5	6	7	
Months of initial development/unit	1	.24	1	.8	4.5	1.5	.3	1.33 mo.

Table 2.1 Unit Costs Per Carrel, and Related Data

Parameter or Constraint	Project							Average per Course
	1	2	3	4	5	6	7	
Number of carrels	10	16	10	10	10	5	84	16
Students/carrel	10	5	15	15	8	6	12	10
Carrel, demonstration, and special development equipment costs/carrel	$665	$441	$695	$474	used existing carrels	$883	$468	$605
Carrel equipment costs/carrel	665	386	619	410	existing	780	399	$543
Software production costs/carrel	73	18	85	469	$124	488	49	$186
Software duplication costs/carrel	114	125	78	456	40	47	148	$144
Faculty costs/carrel	$620	$432	$611	$184	$356	$650	$228	$440

Table 2.1 - Continued

Parameter or Constraint	Project							Average per Course
	1	2	3	4	5	6	7	
Secretarial and content assistant costs/carrel	$155	$79	$196	$463	$45	$533	$47	$216
Faculty, secretarial, and content assistant cost/carrel	775	510	807	647	401	1180	575	$698
Instructional development and content consultant cost/carrel	29	23	40	102	165	94	4	$65
Validation and revision costs/carrel	0	0	0	40	0	0	5	$22
Average development cost/carrel	$1657	$1120	$1704	$2290	$730	$2690	$1060	$1610
Hours of faculty development time/carrel	152	50	87	25	84	108	52	80 hrs.

Table 2.1 - Continued

Parameter or Constraint	Project							Average per Course
	1	2	3	4	5	6	7	
Months for initial development/carrel	.9	.19	.6	.8	.9	.6	.11	.59 mos.

total costs, it would be impossible to say which project made the most efficient use of the investment made.

Once placed on a per-unit basis, the data begin to show less variation. Where variation does exist, however, these differences can be analyzed with much more accuracy. For example, software duplication costs in Tables 2.0 or 2.1 show Project 4, which used a wide variety of media, including prints, audio tapes, hand-outs, and 2X2 slides, with a relatively expensive per-unit cost. Where several faculty were involved in the development of a single course, as in Projects 3, 5 and 6, the faculty costs were substantially higher than in the other projects studied. In addition, Project 6 had substantially higher unit costs for secretarial and content assistants, due to the increased use of secretarial assistance, and the relatively few number of units resulting from the development effort.

It is worth following Project 6 results through to the total unit cost of development. It will be noted that the unit cost of producing those two units was approximately twice the amount of any other development project. This increase is due almost entirely to the fact that the faculty chose to spend their own time producing software, plus there was an increased use of models and expensive,

sophisticated carrels. It will also be noted that Project 6 was next to the highest in terms of the amount of time it took to carry out the development process.

Project 5, as Table 2.0 illustrates, took the longest of any project to develop each of its two units. This time factor may be due to a lack of development experience on the part of the project director, plus the time consumption to coordinate schedules and meet with numerous instructional development consultants and other departmental faculty. This heavy use of departmental faculty time is reflected under faculty unit costs in Table 2.0 for Project 5 which had the highest per-unit costs in this category.

Model I Validation Results After a thorough analysis of the aggregate data and a review of the unit-cost per instructional unit and carrel, a predictive unit-cost model was designed, based upon the parameters and constraints analyzed. This model will hereafter be referred to as Model I. Once designed, Model I was adapted for use in the form of a budget planning guide. (The budget planning guide for Model I is appended in Appendix B.) High, low and average values were provided for selection from each expense category in the planning guide and criteria for their selection

were written.

Once this model was constructed, it was validated by the key faculty developer of the self-instructional materials developed for use in the Introductory Botany course at Purdue University. The validator took thirty minutes to complete the decision steps in Model I, during which time the planning guide provided estimates as to the total development costs, the length of time for the development process and the amount of faculty time necessary to carry out the development. The development time period analyzed and for which Model I predicted costs was the initial development which took place during 1961-62. Prior to the model validation, data from the Validation Project were gathered with the same procedures which were used in collecting the aggregate data from the original seven sample projects. Also, the same parameters and constraints in each expense category were analyzed. Table 3.0 provides a summary of the aggregate development data from this Validation Project. In comparing these data with Table 1.8, it is apparent that far more carrels were used in this project, and yet the total development cost was substantially lower than any of the projects in the initial sample. Likewise, though the length of the

Table 3.0 Summary of Aggregate Development Data from the Validation Project

Parameters or Constraints	Data
Number of units initially developed	14
Number of carrels used	22
Total equipment costs	$3036
Total software production costs	$143
Total software duplication costs	$889
Total faculty, secretarial and content assistant costs	$1611
Total instructional development and content consultant costs	$250
Total validation and revision costs	$0
Total facilities modification cost	$0
Total development costs	$5929
Total hours of faculty development time	274 hrs.
Total months for initial development	13 mo.

initial development was four months longer than any of the projects initially studied, the number of hours spent by the faculty during this development period was only eighteen hours short of being equal to the lowest of those initially studied projects.

In comparing those data in Tables 3.1 and 3.2 with the data in Tables 2.0 and 2.1, it becomes apparent that the unit costs of the validation project were substantially less than any of the other projects studied. When these data were further analyzed, it became obvious that this difference was due to primarily three factors. First, the development was done during 1961-62 at a deflated price, as compared to the development expense during the 1967-68 period when the sample projects were being developed. Two, the strategy of instruction included primarily audio tape only, with the exception of botanical specimens given to the students in the carrels. And, three, the carrels were made by a craftsman in the university at a reduced labor and materials rate.

Model I provided for the deflation influence and the self-made carrels, but no exclusive values were available for a model user anticipating the use of an audio tape-only instructional strategy. This oversight contributed

Table 3.1 Unit Costs Per Self-Instructional Unit and Related Data from the Validation Project

Parameters or Constraints	Unit Costs and Related Data
Number of units initially developed	14
Instructional hours/student/unit	2.5
Carrel, demonstration, and special development equipment costs/unit	$216
Software production costs/unit	$10
Software deuplication costs/unit	$64
Faculty costs/unit	$113
Secretarial and content assistant costs/unit	$2
Faculty, secretarial, and content assistant costs/unit	$115
Instructional development and content consultant costs/unit	$18
Validation and revision costs/unit	$0
Average development costs/unit	$424
Hours of faculty development time/ unit	19.5 hrs.
Months of initial development/unit	.93 mo.

Table 3.2 Unit Costs Per Carrel and Related Data from the Validation Project

Parameters or Constraints	Unit Cost and Related Data
Number of carrels	22
Students/carrel	18
Carrel, demonstration, and special development equipment costs/carrel	$138
Carrel equipment costs/carrel	$138
Software production costs/carrel	$7
Software duplication costs/carrel	$40
Faculty costs/carrel	$72
Secretarial and content assistant costs/carrel	$2
Faculty, secretarial, and content assistant costs/carrel	$74
Instructional development and content consultant cost/carrel	$11
Validation and revision costs/carrel	$0
Average development cost/carrel	$270
Hours of faculty development time/ carrel	12.4 hrs.
Months for initial development/carrel	.59 mo.

to an increased cost prediction, since less equipment and development time is necessary when audio tape is the main medium of instruction. Likewise, the assumption was made in designing Model I that the unit-cost/carrel would be the best means of anticipating expense fluctuations caused by the increase or decrease in student enrollment. As was found after analyzing the validation results, this assumption was accurate to a point, in that it was a good indicator of equipment costs, but a poor indication of the software development costs per instructional unit. Therefore the predicted costs were substantially increased when the validator was forced to select per-carrel unit costs for software production and then multiply those unit costs by the number of carrels, as opposed to the number of instructional units. As a result of these two basic flaws, the first validation of Model I predicted the total costs for the development process to be $9,995.00, as opposed to $5,929.00 as determined by the cost analysis.

Revision of Model I The first validation results made it apparent that a number of revisions would be necessary to make Model I more predictive of the cost of development. A revised model resulted from these revisions.

Rather minor revisions included a more explicit introduction to the use of the model, and a clarification of the assumptions and limitations to which the model should be subjected. Of a more serious nature, a basic assumption in Model I was challenged. It stated that the costs per carrel should be the main unit cost for prediction. The Revised Model, however, provides for costs per carrel to be used in determining carrel equipment costs, but that costs per instructional unit should be used as the unit of analysis for the remainder of the parameters and constraints in each expense category. The exception to this procedure is the prediction of software duplication costs, which after further analysis were determined to be influenced by both the number of carrels and the number of units produced.

Further modification provided for the Revised Model user to select either an instructional strategy which utilized slides, tapes, photoprints and film or a strategy which was comprised of primarily audio tape, with a few photoprints and specimens. A third strategy category was also provided for a user who anticipated no faculty salaries, graduate assistant or secretarial wages, consultant

fees, validation or revision costs, or faculty time.

As with Model I, a high, low and average per-unit cost was provided under each of the two major instructional strategies, those being the combined strategy mix of: (1) slide-tape and/or film, and (2) an audio tape strategy. The criteria for selecting the appropriate instructional strategy and the expense category values under each strategy were modified to accomodate these revisions.

In addition to changing (1) the basic unit costs from carrels to a combination of carrels and instructional units and (2) the ability to select from two basic instructional strategies, an opportunity is provided for the user to use his own value for the number of carrels needed. This choice is made by the user based upon the unique constraints of his present instructional setting. In the final analysis, the Revised Model provides three methods for the user to ascertain which carrel quantity he should select and use in calculating the equipment and software duplication costs: (1) a selection from values which represent the previous experience of other developers, (2) a calculation of the number of carrels needed, based upon the average anticipated time for a student to use each instructional unit, the amount of time the carrel

facility will be open for student use, and the number of students needing to use the carrel facility, and (3) a prior determination of the number of carrels needed made from an appraisal of the local facility constraints.

Figure 1.0 shows a schematic of the major steps in the Revised Model, and Figure 1.1 shows the sequential decisions in the Revised Model. A simulation of the revised planning guide is in Appendix C.

Revised Model Results Following the revision of Model I, a validation of the Revised Model was conducted and the results of its predictions compared with the same aggregate and unit-cost data collected during the validation of Model I. The second validation used the same selections as chosen by the key faculty developer in the original validation at Purdue. The Revised Model predicted the total development costs to be $5,096, as compared to the cost analysis results of $5,929. This value compares favorably with the decision model specified in the research design, in that it predicted the "actual costs" within 14%.

Table 3.3 illustrates a side-by-side comparison of the Model I validation results, the cost analysis results, and the Revised Model validation results.

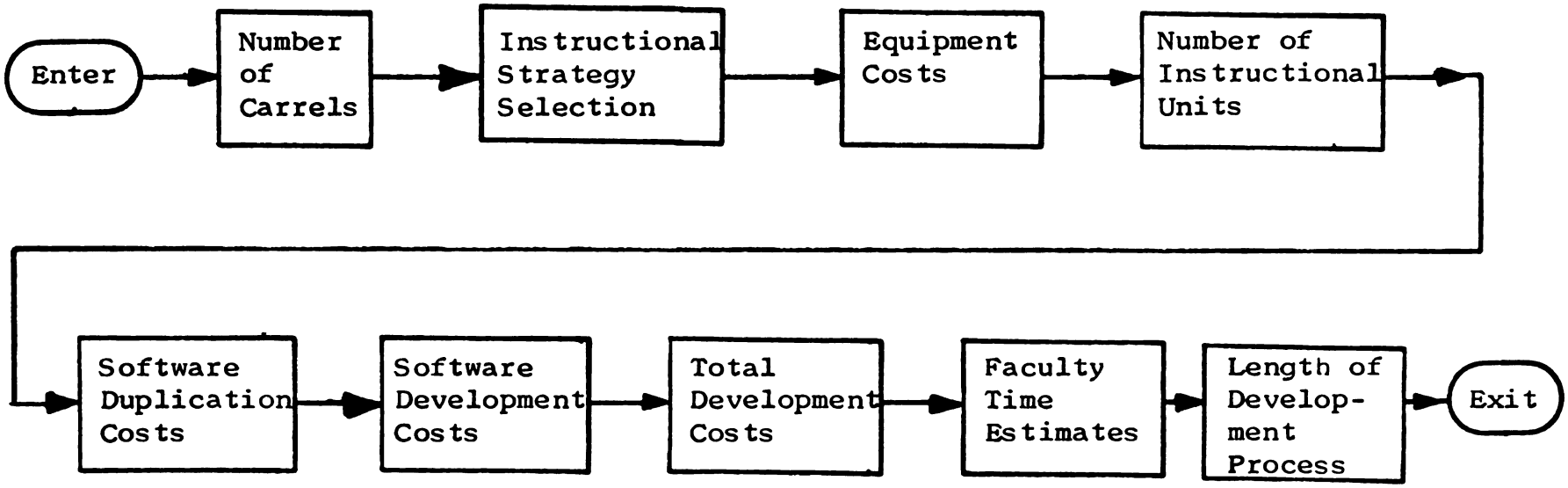
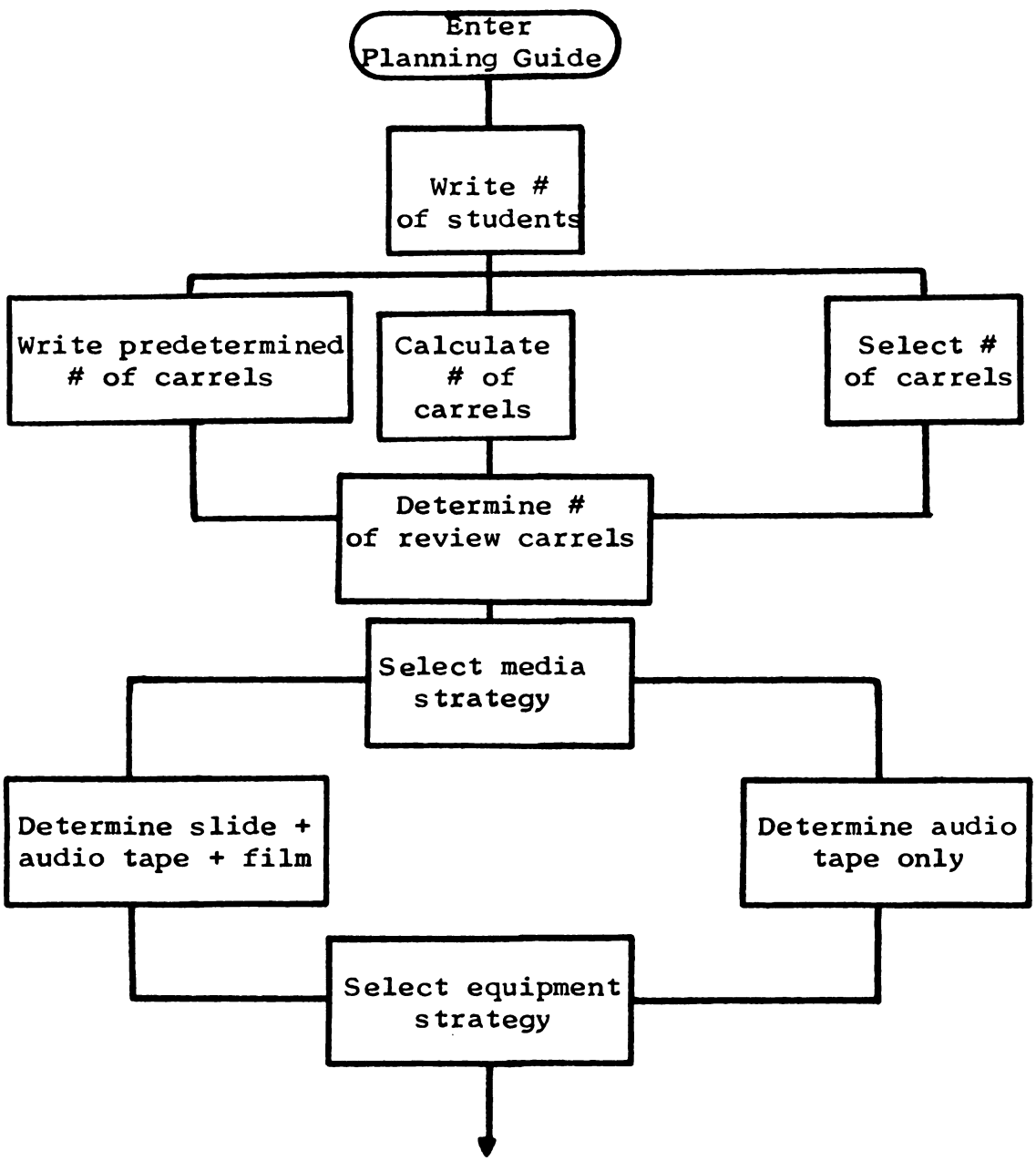
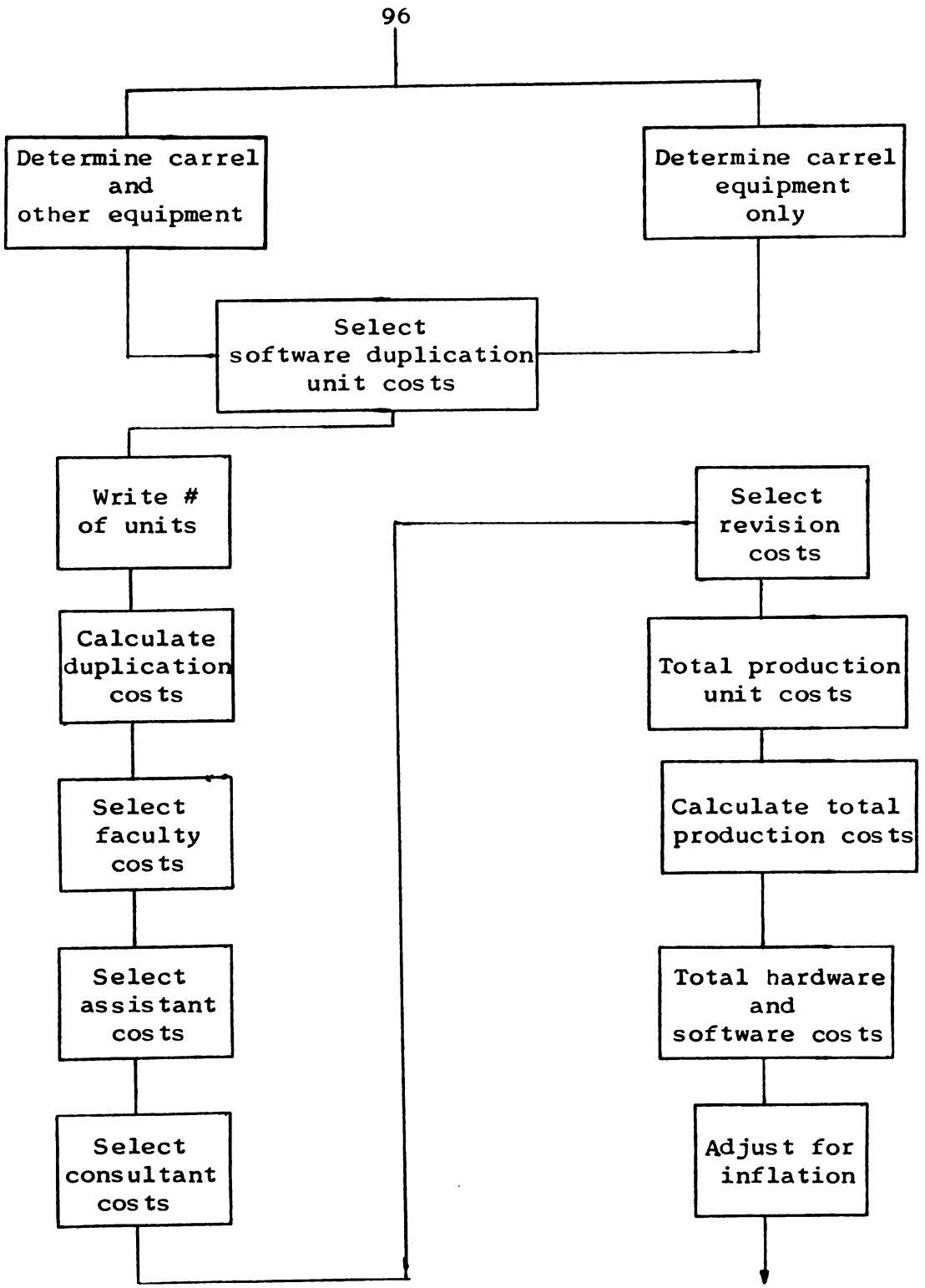


Figure 1.0 Major Steps in Revised Predictive Cost Model

REVISED MODEL'S SEQUENTIAL STEPS




Determine carrel and other equipment
Determine carrel equipment only
Select software duplication unit costs
Write # of units
Calculate duplication costs
Select faculty costs
Select assistant costs
Select consultant costs
Select revision costs
Total production unit costs
Calculate total production costs
Total hardware and software costs
Adjust for inflation

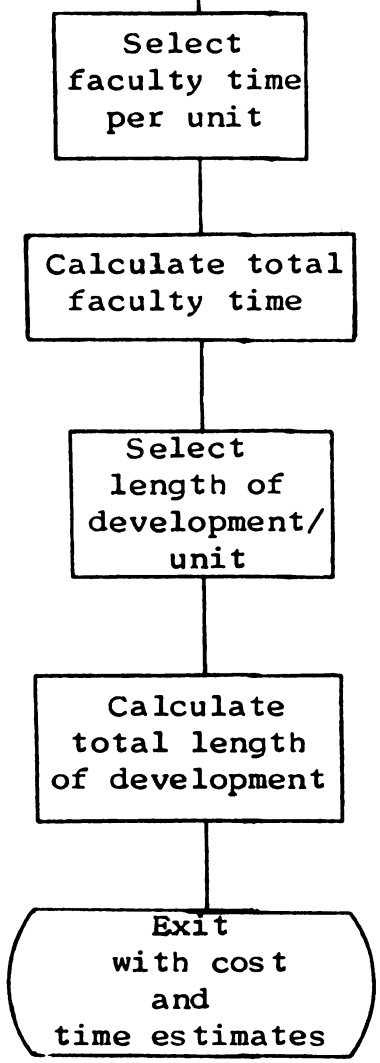


Figure 1.1 Revised Model's Sequential Steps

Figure 1.2 represents the basic equations used to predict development costs, faculty time and the months necessary for development.

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1. $\frac{\text{(\# of Students) (Avg. Time/Student/Unit)}}{\text{\# of Hours Carrel Room Open/Unit}}$ = \# of Carrels needed for Regular Instruction

2. (# of Carrels needed for Regular Instruction) + (# Review Carrels needed) = Total number of Carrels needed

3. (Equipment costs/carrel) (Total # of Carrels needed) = Total Equipment Costs

4. (Software Duplication costs/Instructional Unit/Carrel) + (# of Instructional Units to develop)+(# of Carrels needed for Regular Instruction) = Total Software Duplication Costs

5. (Software Production costs/Instructional Unit) + (Faculty Salary costs/Instructional Unit) + (Content Assistant and Secretarial Wage costs/Instructional Unit) + (Consultant costs/Instructional Unit) + (Validation and Revision costs/Instructional Unit) = Development Costs/Instructional Unit

6. (Development costs/Instructional Unit? + (# of Instructional Units being developed) + (Total Software Duplication Costs) + (Total Equipment Costs) = Total Development Costs

7. (Total Development Costs)+(% Inflation) = Cost Increase due to Inflation

8. (Cost Increase due to Inflation) + (Total Development Costs) = Adjusted Estimate of Total Development Costs

Figure 1.2...continued

9. (Faculty Time/Instructional Unit) + (# Instructional Units) = Total Estimated hours of Faculty Time

10. (# Months for Development/Instructional Unit) + (# Instructional Units) = Total Estimated # of Months for Development

Figure 1.2 Basic Prediction Equations

TABLE 3.3 A COMPARISON OF THE UNIT COST-ANALYSIS RESULTS OF THE VALIDATION PROJECT WITH THE PREDICTED COSTS FROM MODEL I AND THE PREDICTED COSTS FROM THE REVISED MODEL

Parameter or Constraint	Model I Prediction	Cost Analysis Results	Revised Model Predictions
Number of students	400	400	400
Number of carrels	27	22	22
Number of instructional units	14	14	14
Total development costs	$9,995	$5,929	$5123[a]
Hours of faculty time spent on initial development	1350 hr	274 hr	294 hr
Months for initial development	24.3 mo	13 mo	13.3 mo

[a]This value is within 14% of the value as determined by the unit cost-analysis of the validation project.

Summary Full, relevant, functional, job cost data were collected from seven self-instructional materials development projects. The parameters and constraints of these aggregate data were then grouped and analyzed under eight expense categories and four non-expense categories. Following an analysis of the aggregate data, unit costs per carrel and per instructional unit were calculated for each of the seven projects. Model I was then designed, based upon the sample project unit costs. The Model provided the user with the opportunity to select high, low and average unit costs per carrel for each of the expense categories. Criteria for the proper selection of these unit-cost values were also provided. Once designed, Model I was validated in a two-step process which included (1) a trial run of the Model by the faculty developer of the initially developed self-instructional materials used to teach the Introductory Botany Course at Purdue University, and (2) a unit cost-analysis of the initial development period for this validation project which was conducted, and the results of the cost analysis compared with the predicted costs suggested by the Model. An analysis of the first validation results showed that a number of oversights

and fallacious assumptions had been made in the design of Model I. Therefore a Revised Model was constructed, which took into account a more accurate view of the system for which predicted development costs were being made. The selection criteria were appropriately modified, branching possibilities which permitted greater selection flexibility were added and additional instructional strategy options were included. Once Model I was revised, a second validation was conducted, and the predicted costs again compared to the results of the validation project unit cost-analysis. The Revised Model predicted costs within 14% of the validation project's cost analysis results.

CHAPTER V SUMMARY AND CONCLUSIONS

Study Design and Model Construction The purpose of this study was to design a model for predicting the unit costs of self-instructional materials development in higher education biological and physical science curricula. Prior to collecting aggregate sample data, a pilot study was conducted to test an interview instrument. Once modified, this instrument was used to interview the key faculty developers from each of seven self-instructional development projects, six self-instructional materials development projects at Michigan State University and one self-instructional materials development project at Lansing Community College. Materials for nine courses were developed as a result of these seven projects. In addition to the full, relevant, functional, job cost and related data collected during the faculty interviews, supportive data were gathered from production specialists, equipment catalogues and other participants in the initial project development.

Once the aggregate data were gathered, various parameters and constraints were grouped and analyzed under eight expense categories and four non-expense categories. Cost per carrel and cost per instructional unit developed were then calculated from the aggregate data for each parameter and constraint. Unit cost comparisons were then made between projects to note their similarity and differences.

Once the analysis was complete, a predictive model (Model I), was designed and modified for use as a budget planning guide for instructional planners. This model took into consideration the aggregate, supportive and unit-cost data from the seven projects. Criteria were written for selection between high, low or average unit costs for each development parameter.

Results After Model I was designed and adapted, its predictive validity was tested on the self-instructional materials initially developed to teach the Introductory Botany course at Purdue University. A unit-cost analysis of the validation project was simultaneously conducted so the validity of the costs predicted by the model could be determined. Since the assumption was made in designing

Model I that costs per carrel would be the best source of predictive values for projects with wide variations in student enrollment and since provisions were made for only a slide, tape and film self-instructional strategy, the Model I predicted costs of the validation project's initial development were approximately $4,000 more than those costs resulting from the unit cost-analysis. This value was not accurate enough and it was apparent that revisions were essential for the model to be valid.

Therefore, revisions were made in Model I to make it more responsive to individual variations within projects. Cost per carrel values were used as predictors of carrel costs and as factors in the software duplication costs instead of for all expense categories. Costs per instructional unit were used to predict the cost of producing and duplicating software, faculty time, content and secretarial assistant time, consultant time, validation and revision, and the amount of faculty involvement, plus the number of months for the development process.

In addition to the above, the Revised Model permitted the developer to select between two basic strategies: (1) slide, audio tape and film or (2) audio tape only. A third strategy category was also provided for

those planners who would be using no faculty time, consultant time, content or secretarial assistant time or doing any validation or revision.

Due to the flexibility provided by the design modifications, the Revised Model predicted development costs during a second validation within 14% of those development costs determined by the unit cost-analysis conducted at the time of the first validation. Since acceptable predictive accuracy had been pre-determined to be within a range of ±15% of the results of a cost analysis of a given project, the Revised Model was concluded to be a valid predictor of self-instructional materials development costs.

Limitations A number of limitations must be considered in using the Revised Model budget planning guide to predict development costs. One of the most important of these limitations is the approximate nature of the aggregate data upon which the model was designed. Jones has clarified the reason for the approximate nature of cost-analysis data in stating that:

> "Cumulative costs are embodied in the product and passed along with the product as it progresses through departments toward completion. The end result is an agglomeration of some carefully detailed experienced costs and some allocations and re-allocations, to reach what we call 'final product cost.'

> No one knows better than the accountant that this product costs is an approximation, even in the best of cost accounting systems. The process of cost allocation makes it so."[57]

With this background, it should be clear that basing a predictive model upon approximations makes that model's predictions approximations by definition.

Second, the model was developed from aggregate data which reflect costs for only higher education biological and physical science development projects. Therefore, generalization to other curricula and other levels of academia is not possible. Third, the Revised Model also assumes that where film is used the footage will be reduced from 16mm to 8mm.

Fourth, due to the fact that the Revised Model is designed for inexperienced developers who are starting the development of self-instructional materials, the input data can only be relatively general in nature. The vagueness of this input data contributes to the approximate nature of the predicted costs. In addition to the generalities surrounding the initial decisions, it is important to note that standardized costs for a creative process such as

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[57]Jones, A Procedural and Cost Analysis Study of Media in Instructional Systems Development, Op. cit., p. 21.

instructional development are difficult at best, and therefore allowance for project variation from the model estimate should be made as the development progresses.

A fifth limitation exists in that only two instructional media strategies were accounted for in collecting aggregate data and developing the model and planning guide. Therefore planners who anticipate using strategies which rely heavily on programmed, printed material or video transmission are excluded from using this budget planning guide in making cost estimates until such time as unit costs are available for these strategies as well as the ones studied. Sixth, the aggregate data and the basic assumptions in the model are reflective of the development, rather than the implementation or operation of self-instructional systems. Therefore, predicted cost estimates are for only development activities, rather than implementation or operation cost parameters.

Another limiting factor of a rather minor nature is the fact that the aggregate data and the assumptions in the model are based upon the use of reel-to-reel audio tape recorders. As advances in cassette recorder technology occur, modifications of various standard unit costs within the model will likely be necessary.

The model user should be aware of the above-mentioned limitations, and if major diversions from the assumptions in the design of the model are planned, these modifications should be taken into consideration in developing a project budget.

Conclusions It is concluded that a cost model with a predictive validity of within 14% of cost analysis results of the same initial development period can be designed for specific mediated strategies of self-instruction in the biological and physical sciences at the higher education level. It is also concluded that the predictions resulting from the use of this model reflect present concepts of self-instructional systems theory, and that as technological and procedural changes modify the system upon which that theory is based, the model will need revision to be valid.

Implications for Future Research There are numerous questions resulting from this initial attempt to analyze and model the self-instructional materials development system.

A summary of future research implicated by this study includes the following:

1. The extent to which development costs may be controlled by assigning administrative

responsibility to cost centers revealed by the use of predictive cost models.

2. Whether unit costs go down as faculty development experience increases with each additional instructional unit.
3. Whether multiple course use of common self-instructional settings will reduce development and operation costs.
4. The variations in development costs which result from academic departments establishing decentralized graphic production centers.
5. Whether development costs are reduced by publishers assuming the responsibility of producing software components for insertion into self-instructional development projects.
6. Whether breakthroughs in cassette recorder and other technology will reduce the equipment costs for non-print strategies of self-instruction.
7. At what stages of instructional development should consultants be involved to optimize the learning effectiveness of the materials developed while keeping the development costs

at a minimum.

8. How development costs vary in new as compared to existing higher education institutions.
9. The extent to which released time for faculty developers results in reduced development costs and more effective self-instructional materials.
10. The extent to which an increased sample size improves the predictability of the model designed in this study.
11. The extent to which the model is adaptable to other media strategies other than slide-audio tape-film or audio tape only.
12. The extent of implementation and operation costs of self-instructional systems as compared to other strategies of instruction.

Inasmuch as the model designed as a result of this study provides a cost control function, in that it suggests cost centers to which administrative responsibility at the point of cost incurrence can be assigned, it would be interesting to note the way in which prior knowledge of functional costs are able to control the

overall costs of instructional development. Research comparing (1) development projects which have been budgeted without the use of the predictive model with (2) those projects which have made use of the functional cost parameters revealed by the model expense categories to assign cost control centers throughout the development phases should be of great benefit to instructional systems designers and have application in other aspects of academic institutional management.

Another area needing further research is the comparative difference between the initial time to get started and produce one instructional unit, as opposed to the amount of time necessary to develop two or more instructional units. As will be noted from Table 2.0, Projects 5 and 6 had relatively high unit costs in nearly all phases of the development. This increase may be due to the high initial costs of developing any instructional unit, rather than an efficient use of the development time. Previous experience with self-instructional materials development may also decrease the amount of time, and therefore the costs of future development projects. Therefore, since the study

reported dealt with initial development costs and with faculty who had generally no previous development experience, it would be important to note the influence on costs resulting from previous experience on (1) the later development of instructional units within the same project and (2) additional future projects.

Another area for unit cost-analysis research would be to clarify any reduction in development costs which result from the use of learning resources centers in which various self-instructional units from different courses can be taught in the same instructional facility. A multiple-use facility, as illustrated by Project 5 in Table 2.0, would obviously reduce equipment and facility costs, but if the cost of coordinating such a facility would eventually outweigh the savings in development costs, it would be a questionable practice.

Software development, production and duplication is, as is noted in Tables 2.0 and 2.1, a relatively expensive process, particularly as one gets into a large carrel system with numerous instructional units. Simple duplicating processes for audio tape or slides, which can be done by technicians in the academic departments, may provide an

eventual savings in total development costs. It will be important for research to note, however, the relative increase in labor costs which result in shifting these roles to the departments, rather than maintaining these functions in a media service center or a commercial outlet. As was noted with Project 6, in Table 2.0, the average costs of development per instructional unit were nearly twice that of any other project, due in part to the fact that the project faculty did most of their own software production, rather than hiring it out to media center or commercial technicians. Therefore a close cost analysis of decentralization expenses for production and duplication services should be carried out before this shift in function is recommended as a cost savings to developers.

Other research related to the software production and duplication cost aspects would attempt to indicate the cost benefits derived from mass production of various components for self-instructional systems by publishers or by academic institutions. These components could be available for purchase by developers in various colleges and universities and should therefore reduce local development costs by distributing these costs over a much larger number of individual projects. Some publishers and universities

seem to be producing software components for incorporation in local development projects. As more individuals become aware of, and satisfied with, the results of using a self-instructional strategy in the biological and physical sciences, significant moves in this direction will likely take place. However, the costs and marketability of published software will likely need to be identified by research before publishers will get into the market in sufficient depth to provide the type of software which has been adequately validated for the concept areas being developed.

Along the line of commercial manufacturer-developer relations, the use of cassette recorders as opposed to reel-to-reel recorders may reduce the costs of equipment considerably if the reliability of the cassette and the recorder can be improved. At the present time, reports from the field indicate that some cheaper cassette recorders are not reliable, and that much student and faculty time is lost in trying to repair or modify the system to accomodate for their inefficiency. If technological breakthroughs in the cassette field are able to be made within the next few years, research may show that these improvements will modify the equipment cost parameters of the development system.

To those experienced with instructional development, it is obvious in looking over the aggregate data in Tables 1.5 and 1.8 that evaluation, learning theory and production consultants were used in varying degrees. As the parameters and constraints of instructional development become clearer through future research, it would be important to know when the input of a professional instructional development consultant would be most beneficial in reducing the costs of the development while maintaining or improving the quality and effectiveness of the developed materials. Indications from Projects 4 and 5 seem to suggest that inappropriate use of this expensive resource will increase the costs of development considerably without much appreciable increase in quality. Techniques need to be developed to train faculty in the basic aspects of instructional development so that consultants are in fact consulting, rather than carrying out most of the development for the content faculty. Research which would identify the key stages in the development process in which the input of instructional development consultants would be most cost effective would provide a direct service to instructional systems designers.

As this study dealt with existing institutions only, future research is needed which involves new junior colleges and four-year institutions which are developing self-instructional programs. Though some phases of the development, particularly in the area of the software development, should remain the same in either an existing or new institution, it is suspected that there will be an increase in facility modification, and equipment costs incurred by new institutions which are not present in existing systems development. Therefore the similarities and differences between these two instructional settings should be researched, and modifications in the predictive model be made to accommodate both types of instructional settings.

Released time for faculty has been recognized as a worthwhile investment in some institutions, but with the exception of Projects 3 and 7 this study revealed relatively little assigned time for faculty to develop self-instructional materials. The results of these two projects seem to indicate, however, that more effective materials may be developed at a reduced cost as a result of the faculty's freedom to concentrate their time for development. Table 2.0, for example, shows that Project 3 and 7, both of which provided some released time for faculty developers, were able to produce a substantially

well-balanced instructional system with an average cost per instructional unit. Inasmuch as most faculty seem to be unable to develop instructional systems as effectively if they are asked or take on the responsibility of developing materials in addition to their regular duties, research would be of great benefit to administrators if findings showed what an investment in released time should produce in terms of a more effective and efficient development process. If, in fact, reduced costs for the materials developed will make up the difference in cost due to faculty released time from other duties, this information should supply greater incentive for administrators to release faculty for development. Industry has been profiting from investments in research and development for years. Investments by educational institutions in instructional research and development may also be found to be cost effective over time.

In addition to the above suggestions for future research, it is important to note that this study deliberately chose to limit the sample size and to design a predictive cost model from the sample aggregate data so that the interaction of the various self-instructional systems

parameters and constraints could be analyzed upon further testing of the model. This procedure has several advantages as reported by Sisson:

> "It will tend to consolidate the few miscellaneous concepts we have learned about the educational process. It will focus attention on the kind of data which must be gathered; the data required to obtain parameters for the model and to validate them. More important, perhaps, it will indicate which kinds of data are not important. Finally, the model will fix our attention on the key parameters which might have universality."[58]

New research should now increase the sample size and use random sampling techniques to reduce the sampling bias inherent in the study reported. Research which keys on the parameters identified and used in the Revised Model should modify and improve the model's predictability over a more generalized population.

Once the Revised Model is refined, several of the limitations to its use should be eliminated by parallel studies conducted on other instructional media strategies than (1) slide, audio tape and film or (2) audio tape only.

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[58]Sisson, Loc. cit.

The unit costs of developing printed, programmed instructional materials, video-taped and film-chain materials, computer-aided instruction materials and dial-access materials for self-instructional strategies are also needed. Analysis techniques, having been tested and refined by this and other research, should permit future analyses of other instructional media strategies to build new models or adapt this one to fit the parameters involved.

Other areas for future research are implied by the results of this study. However, one last suggestion should be given special note. As previously mentioned, this study dealt with only development costs and therefore the eventual cost of implementing and operating a self-instructional system needs to be known so that informed administrative decisions can be made. The Jones study of media in instructional systems development in higher education as well as the General Learning Corporation study should permit comparisons between self-instructional operation costs and other instructional strategies.

In conclusion, it would appear from the results of this study that the cost of developing self-instructional materials represents a substantial investment

in money and time. For example, the cost of producing a unit of instruction in the projects studied averaged $2795. There were many parameters and constraints affecting this value, but thirty-eight per cent of the investment went for carrel, demonstration and special development equipment, with faculty costs close behind with thirty-three per cent. The rule-of-thumb used by some media specialists which calls for every dollar of hardware costs to be matched by a dollar of software production and duplication costs did not seem to hold in practice, for only seventeen per cent of the development costs went to these latter two expense categories. Secretarial and content assistant costs comprised nine per cent, with consultant, validation and revision costs representing relatively small investments of three and one per cent respectively. Time investment averages of 109 hours of faculty time per unit and seven months per project represent committment which developers and administrators need to take seriously so that costs are controlled, and an instructional "profit" results from the continued use of the materials developed. This "profit" can be achieved if quality and cost control procedures are implemented during the development and operation process to make certain that the materials produced are indeed

valid and continue as an effective strategy of instruction.

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APPENDIX A

Aggregate Data Interview Instrument

SELF-INSTRUCTIONAL MATERIALS DEVELOPMENT
UNIT COST-ANALYSIS INTERVIEW FORM

I. DEVELOPMENTAL COSTS:

A. Instructional Units: (Describe an Instructional Unit as those materials which are used and sequenced as a package to teach one or more concepts.)

QUESTIONS	RESPONSES
1. How many self-instructional units were used with students after the initial development?	_____units
What date was the initial development started?	_____started
What date was the development completed for student use?	_____completed
2. What was the average student time per week spent in the self-instructional setting?	_____hours
3. How many credits were offered for the course in which self-instructional materials were used?	_____credits
4. What per cent of the total course credits were being taught by the self-instructional materials developed?	_____per cent

B. Equipment Costs:

5. What type and model of instructional equipment and/or carrels were used at each student station and in any adjacent demonstration areas? (Type, Model, Car., Dem.)

6. How many of each type of equipment were used in the student station or adjacent demonstration area? (#)

7. What were the per/item costs for each type of equipment used? ($/I)

8. What equipment was purchased (P) new, and what equipment was drawn from existing sources (E)?

#	Type	Model	$/I	P	E	Car.	Dem.	Total
	slide							
	tape							
	sup. 8							
	reg. 8							
	carrel							
	headset							
	F/S							
	O.H.							
	16mm							
	screen							

GRAND TOTAL _____

9. How much did all the instructional equipment cost? _____dollars

10. What per cent discount, if any, was given on the list price of the equipment purchased? _____discount

11. What was the average number (#) of films developed per instructional unit?

    Were these films silent (Si) or sound (So)?

    Were these films reel-to-reel (R) or cartridge (C)?

    What was the average running time (X) per film?

    What was the average cost ($) per film?

12. What was the average number (#) of photoprints developed per instructional unit?

    What size (Sz) were these prints?

    How many per unit were in the student hand-outs (H) and how many per unit were in centralized displays (D)?

    What was the average cost ($) per print?

13. What were the average number (#) of audio tapes developed per instructional unit?

    Were these tapes on cassettes (C) or reels (R)?

    What was the average playing time (X) per unit?

    What was the average cost ($) per tape?

14. How many (#) and what (type) models and other demonstration materials were developed for these instructional units?

    What was the average cost ($) per model?

15. What was the average number (#) of student hand-outs developed for each instructional unit?

    How many pages (pg) were included in each hand-out?

Were graphic illustrations (ill) included in the student hand-outs?

What was the average cost ($) per hand-out?

16. Which of the software were locally produced and which were purchased?

17. Which of the software locally produced were processed locally and which were processed commercially?

(See "Software Response Form" next page.)

18. How many (#) production technicians were employed during the initial development of the software?

What salary were they paid?

How much time did they spend on the initial development?

#	Salary	Time

19. How much financial support was from non-departmental sources such as federal, foundation, or university grants? _____dollars

20. What per cent of the total development costs were from non-departmental sources? _____per cent

21. How much did the software cost? _____dollars

SOFTWARE RESPONSE FORM

	Slides/U		Films/U							Prints/U					Tapes/U					Realia			Handouts			
	#	$	#	X	Si	So	R	C	$	#	Sz	H	D	$	#	C	R	X	$	Type	#	$	#	pg	Ill	$
TYPE																										
PROD Loc																										
Pur																										
PROC Loc																										
Com																										

D. Faculty and Content Assistants:

22. How many faculty worked on the development of these self-instructional materials?

#	Level	Months Assigned	Spent
	Instr		
	Asst.		
	Assoc		
	Prof.		

What was their tenure level?

How many months per year was their appointment?

23. How much faculty time was assigned to the development of these instructional units?

How much faculty time was actually spent on the development of these units?

24. How many content assistants such as graduate assistants and secretaries were used during the development of these instructional units?

#			
G.A.	SEC.	LEVEL	TIME

What was their salary level?

How much time were they assigned to spend on the development?

25. How much faculty time was required to train the carrel room operators as to the use of the equipment and distribution procedures? _____hours

26. How many self-instructional units had you helped develop prior to these units? _____units

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E. Consultants:

27. How many consultants were used during the development of these instructional units?

What type of expertise did they possess, i.e., media, evaluation and/or learning theory?

What was their tenure level by type?

How much time did each spend during the development?

#	Type	Tenure	Time	Trav $

28. What travel costs were incurred by consultants coming to your campus or for you going to their location?

F. Revision Costs:

29. Was a validation conducted on the materials developed? Yes_____ No_____

30. What per cent (%) of the software materials were revised?

%	Type	Change

Was the same method of production and processing used for materials revised as was used during the initial production? If not, what procedures were changed?

31. How many faculty and other staff were involved in the validation of the materials developed?

How much time were they involved in the validation?

What tenure level of faculty or staff were involved?

How many students were the materials tried on?

#Fac.	Time	Level 10	Level 12	#Stud.	$

What do you estimate the revision costs to be?

32. What facilities were modified as a result of the materials initially developed? _____facilities

How much did these modifications cost? _____dollars

II. DUPLICATION COSTS:

33. How many students per term were the materials developed to teach?

Original #	Present #

34. How many students per term are presently using the materials developed?

35. How many carrels were the materials originally planned to fill?

Originally	Present	#Review	
		W	P

How many carrels are presently being used?

How many of these carrels were (W) and are presently (P) used for review units?

36. How many hours per original instructional unit were these carrels available to the students? _____hours

37. How often were the units rotated in the carrel facility?

Day	Week	Request	Other

By the day, week, or on request?

38. What was the duplication cost for these software materials? _____dollars

APPENDIX B

Model I

SELF-INSTRUCTIONAL MATERIALS DEVELOPMENT BUDGET
PLANNING GUIDE FOR A FIRST APPROXIMATION

ITEM	VARIABLE	AMOUNT
I.	The number of students who will be using the self-instructional materials developed equals	____ students
II.	Using the criteria in Figure 1.0, select the number of students per carrel from Table 4.1.3	____ students per carrel
III.	Divide the number of students under Item I by the number of students per carrel under Item II to determine the number of carrels needed.	____ carrels
IV.	Using the criteria in Figure 1.1 select an appropriate cost estimate from Table 4.3.1	____ carrel, demonstration and special equipment costs
V.	Using the criteria in Figure 1.3, select an appropriate cost estimate from Table 4.3.3	____ software production
VI.	Using the criteria in Figure 1.4, select an appropriate cost estimate from Table 4.3.4	____ software duplication
VII.	Using the criteria in Figure 1.5, select an appropriate cost estimate from Table 4.3.5	____ faculty salaries

SELF-INSTRUCTIONAL MATERIALS DEVELOPMENT BUDGET PLANNING GUIDE FOR A FIRST APPROXIMATION (continued)

ITEM	VARIABLE	AMOUNT
VIII.	Using the criteria in Figure 1.6, select an appropriate cost estimate from Table 4.3.6	____ graduate assistant and secretarial salaries
IX.	Using the criteria in Figure 1.7, select an appropriate cost estimate from Table 4.3.7	____ consultant fees
X.	Using the criteria in Figure 1.8, select an appropriate cost estimate from Table 4.3.8	____ validation and revision costs
XI.	Add the unit cost/carrel from Items IV through X	_____ total cost per carrel
XII.	Since the baseline for the data in Tables 4.1, 4.2 and 4.3 is 1967, subtract 1967 from the year which your development will take place and multiply the difference by the average inflation factor of 7.7% per year.	____% inflation
XIII.	Multiply the total cost per carrel under Item XI by the inflation percentage determined under Item XII.	____ amount increased
XIV.	Add the amount of increase under Item XIII to the total cost per carrel determined under Item XI.	____ adjusted cost per carrel
XV.	Multiply the total cost per carrel by the number of carrels under Item III.	____ total development costs
XVI.	Using the criteria in Figure 1.9, select an appropriate time estimate for faculty involvement from Table 4.3.9	____ faculty time per carrel

SELF-INSTRUCTIONAL MATERIALS DEVELOPMENT BUDGET
PLANNING GUIDE FOR A FIRST APPROXIMATION
(continued)

ITEM	VARIABLE	AMOUNT
XVII.	Multiply the number of hours of faculty time per carrel under Item XVI by the number of carrels under Item III.	____ total hours of faculty time
XVIII.	Using the criteria in Figure 1.10, select an appropriate time estimate for the number of months of development/carrel from Table 4.3.10	____ months for development per carrel
XIX.	Multiply the number of months per carrel for development under Item XVIII by the number of carrels under Item III.	____ total # of months for development

APPENDIX C

A Simulation of the Revised Self-Instructional Materials Development Budget Planning Guide

A SIMULATION OF THE REVISED SELF-INSTRUCTIONAL MATERIALS DEVELOPMENT BUDGET PLANNING GUIDE

Dr. Edgar P. Pennyworth is an Assistant Professor in charge of developing ten self-instructional units during the 1971-72 academic year for two hundred basic biology students at XYZ University. He has had no experience with self-instructional materials development but feels that those biological concepts which lend themselves to self-instruction are best taught with a balanced audio and visual media strategy. He anticipates some content and secretarial assistance and moderate consultative support from the campus media center, and his faculty colleagues. He also plans to validate the materials with the help of some student volunteers. Appropriate revisions are then anticipated.

The following is a simulation of Dr. Pennyworth's use of the "Self-Instructional Materials Development Budget Planning Guide."

HOW TO USE THE SELF-INSTRUCTIONAL MATERIALS BUDGET PLANNING GUIDE

Introduction The following budget planning guide is based on a predictive cost model for self-instructional materials development in higher education for the biological and physical sciences. In using this planning guide, you will be asked to make a variety of decisions based upon input data which reflect your local conditions. The guide will take you step-by-step through the various cost parameters and will refer you at each decision point to a numbered criteria Table which will help you make the appropriate selection of specific values from the accompanying data tables. Once a value is selected, you should write it down and then proceed to the next step on the planning guide for instructions as to how to proceed. (The following sequence is used: (1) read the first item in the planning guide, (2) then read the appropriate criteria Table before making a decision, (3) decide which value to select from the appropriate data Table, (4) write down the value in the guide and (5) proceed to the next step in the planning guide.)

Assumptions It must be emphasized that instructional development is a relatively creative process and to ascribe standard costs to specific items is difficult at best, since individual programs and local economic conditions will vary from institution to institution. Therefore the user should realize that the cost estimates derived from the use of this planning guide should be considered approximations, rather than exact values. Further, it is assumed that your instructional planning is in the initial phases, meaning that instructional objectives and strategies are still quite general. Specific quantities of tape, slides, films or hand-outs are yet to be determined, and as the instructional planner, you are likely at the stage where you are attempting to determine a cost estimate for a specific number of units and students before proceeding with the development.

A third assumption used in this budget planning guide is that you are developing materials in an existing institution which is changing an instructional strategy for a specific series of biological or physical science concepts. Therefore, this guide does not include cost estimates of building and equipping a new biological or

physical science laboratory facility. If the planning guide is to be used by new institutions, the cost of adding additional equipment and laboratory supplies should be added to the cost estimate determined by the use of this planning guide. It is also important to realize that the model upon which this planning guide is based was designed from higher education biological and physical science program data, and therefore the use of this planning guide is limited at the present time to those projects in these academic curricular areas.

Finally, only two basic media strategies are accounted for in this planning guide. The first strategy consists of a mix of slide, audio tapes, hand-outs and film production. Films, however, are optional, depending upon the concepts to be taught. The second media strategy involves the use of audio tapes, with only a few photoprints. Microscope slides and other materials to be included in the carrel may be a part of this second strategy, but no other hardware or visual software is involved. It should be noted that there are other strategies of self-instruction available to the biological and physical sciences such as programmed texts, computer-aided instruction, closed-circuit video recordings, and motion picture films.

If you are interested in a strategy of instruction other than the slide-tape-film combination, or tape-only strategy, then this particular planning guide will not suit your purpose. If you feel that the concepts which you are developing materials for will be effectively taught by either of the two strategies included in this planning guide, you are on your way.

SELF-INSTRUCTIONAL MATERIALS DEVELOPMENT
BUDGET PLANNING GUIDE

ITEM	PARAMETER OR CONSTRAINT	VALUE
(1)	How many students will be using the self-instructional materials developed?	200 students
(2)	If you have already determined the number of carrels which you will need for the materials you intend to develop, enter that value to the right, and proceed to Item 9.	_____carrels needed
(3)	If you are undecided about (1) the approximate length of time each student will need to spend per instructional unit, but do know (2) the length of time which the carrel room will be open for student use, then enter this value and use the criteria in Table 7.1 to select the proper value from Table 4.0.3. Enter this value also and proceed to Item 7.	2.6 student hours/unit 60 hours carrel room open/unit
(4)	If, however, you are undecided as to the number of carrels you will need but do know both (1) the approximate length of time each student will need to spend per instructional unit, and (2) the length of time which the carrel room will be open for student use, then enter these values and proceed to Item 7.	_____student hours/unit _____hours carrel room open/unit

ITEM	PARAMTER OR CONSTRAINT	VALUE
(5)	If you have neither predetermined the number of carrels needed, nor know (1) the approximate length of time each student will need per instructional unit and (2) the length of time which the carrel room will be open for student use, then use the criteria in Table 7.0 to select the number of students per carrel from Table 4.0.2. Enter the value and proceed to Item 6.	_____students per carrel
(6)	Divide the number of students under Item 1 by the number of students per carrel under Item 5 to determine the number of carrels needed. Enter the value and proceed to Item 9.	_____carrels needed
(7)	Multiply (1) the approximate length of time each student will need to spend per instructional unit by (2) the number of students under Item 1. Enter the value and proceed to Item 8.	520 student hours needed in carrels
(8)	Divide (1) the number of "student hours needed in carrels" by (2) the length of time which the carrel room will be open for student use as recorded in Item 3 or 4. Enter the value and proceed to Item 9.	9 carrels needed
(9)	Will any separate carrels be assigned for review purposes in addition to the carrels being used to present current instructional units? If so, enter the value and proceed to Item 10. If not, proceed to Item 11.	1 review carrels

ITEM	PARAMETER OR CONSTRAINT	VALUE
(10)	Add (1) the number of carrels needed which you determined in Item 2, 6, or 8 plus (2) the number of review carrels determined in Item 9. Enter the total number of carrels needed to the right and proceed to Item 11.	10 total number of carrels needed
(11)	Using the criteria in Table 7.2, select an instructional strategy mix which fits the concepts and behavioral objectives which you wish to achieve with self-instructional materials. Check your decision to the right, and proceed to Item 12.	✓ slide + tape + film (optional) _____ audio tape only
(12)	Using the criteria in Table 7.3, select the equipment mix for which you wish to budget in your planning. Check your decision to the right. (a) If you chose slide, tape and film under Item 11 and carrel, demonstration and special development equipment under Item 12, then proceed to Item 13. (b) If you chose slide, tape and film under Item 11, but carrel equipment only, then proceed to Item 14. (c) If you chose audio tape only under Item 11 and chose carrel, demonstration, and special development equipment under Item 12, then proceed to Item 15.	✓ carrel, demonstration and special development equipment _____ carrel equipment only

ITEM	PARAMETER OR CONSTRAINT	VALUE
	(d) If, however, you chose audio tape only under Item 11 and carrel equipment only under Item 12, then proceed to Item 16.	
(13)	Using the criteria in Table 7.4, select an appropriate cost estimate from Table 4.1.1. Enter the value and proceed to Item 17.	$605 unit cost of carrel, demonstration and special equipment
(14)	Using the criteria in Table 7.5, select the appropriate unit cost estimate from Table 4.1.2. Enter the value and proceed to Item 17.	_____unit cost of carrel equipment only
(15)	Using the criteria in Table 8.0, select an appropriate cost estimate from Table 4.1.1. Enter the value and proceed to Item 17.	_____unit cost of carrel, demonstration and special equipment
(16)	Using the criteria in Table 8.1, select the appropriate unit cost estimate from Table 4.1.2. Enter the value and proceed to Item 17.	_____unit cost of carrel equipment only
(17)	Multiply (1) the total number of carrels needed under Item 2, 6, 8 or 10 by (2) the value you selected under Item 13, 14, 15, or 16. Enter the value to the right. (a) If you selected the slide, tape and/or film strategy mix under Item 11, then proceed to Item 18.	$6050 total equipment costs

ITEM	PARAMETER OR CONSTRAINT	VALUE
	(b) If, however, you selected the audio tape only strategy under Item 11, then proceed to Item 37.	
(18)	Using the criteria in Table 7.6, select an appropriate cost estimate from Table 4.2.1. Enter the value and proceed to Item 19.	$246 software production unit costs
(19)	Using the criteria in Table 7.7, select an appropriate cost estimate from Table 4.2.2. Enter the value and proceed to Item 20.	$18.30 unit software duplication costs/instructional unit/carrel
(20)	How many self-instructional units will be developed during the initial development period? Enter the value and proceed to Item 21.	10 instructional units
(21)	Multiply (1) the value in Item 19 by (2) the number of units in Item 20. Enter the value and proceed to Item 22.	$183 software duplication cost/carrel
(22)	Multiply (1) the value in Item 21 by (2) the number of carrels needed for regular instruction in Item 2, 6, or 8. Enter the value and proceed to Item 23.	$1647 total software duplication costs
(23)	Using the criteria in Table 7.8, select an appropriate cost estimate from Table 4.2.3. Enter the value and proceed to Item 24.	$920 faculty salary unit costs

ITEM	PARAMETER OR CONSTRAINT	VALUE
(24)	Using the criteria in Table 7.9, select an appropriate cost estimate from Table 4.2.4. Enter the value and proceed to Item 25.	$90 content assistant and secretarial wage unit costs
(25)	Using the criteria in Table 7.10, select an appropriate cost estimate from Table 4.2.5. Enter the value and proceed to Item 26.	$79 consultant unit costs
(26)	Using the criteria in Table 7.11, select an appropriate cost estimate from Table 4.2.6. Enter the value and proceed to Item 27.	$27 validation and revision unit costs
(27)	Add the unit cost/instructional unit from Items 18, 23, 24, 25, and 26. Enter the total and proceed to Item 28.	$1362 total software production costs per instructional unit
(28)	Multiply (1) the total software production costs per instructional unit in Item 27 by (2) the number of instructional units in Item 20. Enter this value and proceed to Item 29.	$13,620 total software production costs
(29)	Add (1) the total equipment costs in Item 17, (2) the total software duplication costs in Item 22 and (3) the total software production costs in Item 28. Enter the total and proceed to Item 30.	$21,317 total development costs

ITEM	PARAMETER OR CONSTRAINT	VALUE
(30)	Since the baseline for the data in Tables 4.0, 4.1 and 4.2 is 1967, subtract 1967 from the year which your development will take place and multiply (1) the difference by (2) an average inflation factor of 7.7% per year. Enter the per cent and proceed to Item 31.	7.7% inflation
(31)	Multiply (1) the total development costs in Item 29 by (2) the inflation percentage determined in Item 30. Enter the cost increase and proceed to Item 32.	$1641 cost increase due to inflation
(32)	Add the cost increase in Item 31 to the total development costs determined in Item 29. Enter the value and proceed to Item 33.	$22,958 adjusted estimate of total development costs
(33)	Using the criteria in Table 7.12, select an appropriate time estimate for faculty involvement from Table 4.2.7. Enter the value and proceed to Item 34.	109 faculty time per instructional unit
(34)	Multiply (1) the number of hours of faculty time per instructional unit in Item 33 by (2) the number of instructional units in Item 20. Enter this value and proceed to Item 35.	$1090 total estimated hours of faculty time

ITEM	PARAMETER OR CONSTRAINT	VALUE
(35)	Using the criteria in Table 7.13, select an appropriate time estimate for the number of months of development/instructional unit from Table 4.2.8. Enter this value and proceed to Item 36.	1.33 months for development per instructional unit
(36)	Multiply (1) the number of months per instructional unit development in Item 35 by (2) the number of instructional units in Item 20. Enter this value. Recheck your calculations, assumptions and decisions, then read the following: Items 32, 34, and 36 provide an estimate of (1) the total development costs, (2) the number of hours of faculty time and (3) the total number of months for development. In using these totals, realize that these values are only estimates. As you get into the development, you may want to adjust your budget up or down to meet changes in the behavioral objectives, instructional strategies or economic conditions. Items 34 and 36 should help in determining the faculty time necessary to complete the development and in determining the total number of months you should plan in advance of using the materials you develop.	13.3 total estimated # of months for development

AUDIO TAPE ONLY
(continued from Item 17)

ITEM	PARAMETER OR CONSTRAINT	VALUE
(37)	Using the criteria in Table 8.2, select an appropriate cost estimate from Table 4.2.1. Enter the value and proceed to Item 38.	_____software production unit costs
(38)	Using the criteria in Table 8.3, select an appropriate cost estimate from Table 4.2.2. Enter the value and proceed to Item 39.	_____unit software duplication costs/instructional unit/carrel
(39)	How many self-instructional units will be developed during the initial development period? Enter the value and proceed to Item 40.	_____instructional units
(40)	Multiply (1) the value in Item 38 by (2) the number of units in Item 39. Enter the value and proceed to Item 41.	_____software duplication cost/carrel
(41)	Multiply (1) the value in Item 40 by (2) the number of carrels needed for regular instruction in Item 2, 6 or 8. Enter the value and proceed to Item 42.	_____total software duplication costs
(42)	Using the criteria in Table 8.4, select an appropriate cost estimate from Table 4.2.3. Enter the value and proceed to Item 43.	_____faculty salary unit costs
(43)	Using the criteria in Table 8.5, select an appropriate cost estimate from Table 4.2.4. Enter the value and proceed to Item 44.	_____content assistant and secretarial salaries

ITEM	PARAMETER OR CONSTRAINT	VALUE
(44)	Using the criteria in Table 8.6, select an appropriate cost estimate from Table 4.2.5. Enter the value and proceed to Item 45.	_____consultant unit costs
(45)	Using the criteria in Table 8.7, select an appropriate cost estimate from Table 4.2.6. Enter the value and proceed to Item 46.	_____validation and revision unit costs
(46)	Add the unit cost/instructional unit from Items 37, 42, 43, 44 and 45. Enter the total and proceed to Item 47.	_____total software production costs per instructional unit
(47)	Multiply (1) the total software production costs per instructional unit in Item 46 by (2) the number of instructional units in Item 39. Enter this value and proceed to Item 48.	_____total software production costs
(48)	Add (1) the total equipment costs in Item 17, (2) the total software duplication costs in Item 41, and (3) the total software production costs in Item 47. Enter this total and proceed to Item 49.	_____total development costs
(49)	Since the baseline for the data in Tables 4.0, 4.1 and 4.2 is 1967, subtract 1967 from the year which your development will take place and multiply (1) the difference by (2) an average inflation factor of 7.7% per year. Enter the per cent and proceed to Item 50.	_____% inflation

ITEM	PARAMETER OR CONSTRAINT	VALUE
(50)	Multiply (1) the total development costs in Item 48 by (2) the inflation percentage determined in Item 49. Enter the cost increase and proceed to Item 51.	_____cost increase due to inflation
(51)	Add the cost increase in Item 50 to the total development costs determined in Item 48. Enter the value and proceed to Item 52.	_____adjusted estimate of total development costs
(52)	Using the criteria in Table 8.8, select an appropriate time estimate for faculty involvement from Table 4.2.7. Enter the value and proceed to Item 53.	_____faculty time per instructional unit
(53)	Multiply (1) the number of hours of faculty time per instructional unit in Item 52 by (2) the number of instructional units in Item 39. Enter this value and proceed to Item 54.	_____total estimated hours of faculty time
(54)	Using the criteria in Table 8.9, select an appropriate time estimate for the number of months of development/instructional unit from Table 4.2.8. Enter this value and proceed to Item 55.	_____months for development per instructional unit
(55)	Multiply (1) the number of months per instructional unit for development in Item 54 by (2) the number of instructional units in Item 39. Enter this value. Recheck your calculations, decisions, assumptions,	_____total estimated # of months for development

ITEM	PARAMETER OR CONSTRAINT	VALUE
	and <u>then</u> read the following: Items 51, 53, and 55 provide an estimate of (1) the total development costs, (2) the number of hours of faculty time and (3) the total number of months for development. In using these totals, realize that these values are only estimates. As you get into the development, you may want to adjust your budget up or down to meet changes in the behavioral objectives, instructional strategies or economic conditions. Items 53 and 55 should help in determining the faculty time necessary to complete the development and in determining the total number of months you should plan in advance of using the materials you develop.	

TABLE 4.0 GENERAL DEVELOPMENT DESCRIPTIVE DATA

ITEM	HIGH	LOW	AVERAGE
(1) Months for initial development per course	9 months	3 months	6.7 months
(2) Students/carrel	15 stdts/ carrel	5 stdts/ carrel	10 stdts/ carrel
(3) Student hours in carrel/unit	4 stdt. hours	.56 stdt. hours	2.6 stdt. hours

TABLE 4.1 DEVELOPMENT COSTS PER CARREL

ITEM	DESCRIPTION	Slide + Tape + Film (optional)			Audio Tape Only		
		High	Low	Ave	High	Low	Avg.
1	Carrel, demonstration and special development equipment costs	$883	$441	$605	$420	$270	$300
2	Carrel equipment costs alone	$780	$386	$543	$337	$195	$238

TABLE 4.2 DEVELOPMENT COSTS PER INSTRUCTIONAL UNIT

ITEM	DESCRIPTION	SLIDE + TAPE + FILM (optional)			AUDIO TAPE ONLY			NONE
		HIGH	LOW	AVG	HIGH	LOW	AVG	
1	Software production costs	$1212.00	$21.00	$246.00	$22.00	$14.00	$17.00	----
2	Software duplication per unit/carrel costs	45.60	4.95	18.30	4.80	4.05	4.50	----
3	Faculty costs	1780.00	184.00	920.00	568.00	173.00	352.00	-0-
4	Content assistants and secretarial costs	1330.00	90.00	234.00	85.00	5.00	51.00	-0-
5	Consultant costs	825.00	12.00	79.00	70.00	11.00	18.00	-0-
6	Validation and revision costs	$40.00	$14.00	$27.00	$40.00	$14.00	$27.00	$0

TABLE 4.2 DEVELOPMENT COSTS PER INSTRUCTIONAL UNIT
(continued)

ITEM	DESCRTIPTION	SLIDE + TAPE + FILM (optional)			AUDIO TAPE ONLY			NONE
		HIGH	LOW	AVG	HIGH	LOW	AVG	
7	Faculty time	420 hrs.	26 hrs.	109 hrs	93 hrs.	21 hrs.	57 hrs	-0-
8	Months for development	4.5 mo.	.24 mo.	1.33 mo	2.2 mo.	.28 mo.	.95 mo	---

TABLE 5.0 FACULTY SALARIES
(3.1% increase/year)

ITEM	DESCRIPTION	Avg/ 1967		Avg/ 1970	
		10 mos	12 mos	10 mos	12 mos
(1)	Professor (values include salary plus additional benefits)	18,155	21,291	19,634	23,206
(2)	Associate Professor	13,848	16,585	15,035	18,113
(3)	Assistant Professor	11,558	13,821	12,877	15,283
(4)	Instructor	9,457	11,362	10,545	12,712

TABLE 5.1 CONTENT ASSISTANT AND SECRETARIAL WAGES
(2.2% increase/year)

ITEM	DESCRIPTION	1967 Avg	1970 Avg
(1)	Graduate Assistant (9-month appointment)	$2700	$3200
(2)	Secretary beginning Grade I (12-month appointment)	4536	4656
(3)	Secretary mid-range Grade VI	5364	5508
(4)	Secretary top-range Grade XII	8244	8748

TABLE 5.2 TECHNICIAN WAGES*
(8.1% increase/year)

ITEM	DESCRIPTION	1967 Avg.	1970 Avg.
(1)	Photographer**	4.50/hr	5.50/hr
(2)	Photographic model	4.50/hr	5.00/hr
(3)	Cameraman	8.00/hr	10.00/hr
(4)	Audio technician and studio	10.00/hr	25.00/hr
(5)	Audio editing	5.00/hr	10.00/hr

*Most values in Tables 10.0 - 10.6 include labor charges. Table 5.2 is provided for special cases where comparisons are desired to put local charges in line with the data used to develop the Tables.

**All salaries are based on university-employed technicians. Commercial labor charges are quite variable and commercial sources should be consulted directly if they are producing the software. However, commercial processing, materials and duplication charges are rather consistant from locale to locale and therefore Tables 10.0 - 10.6 may be used to advantage.

TABLE 6.0 FACILITIES MODIFICATION COSTS
(5% increase/year)

ITEM	DESCRIPTION	1967 Avg.	1970 Avg.
(1)	Remove lab benches, repair floor, install two benches with gas, electricity and water	750	862
(2)	Electrical modification only	262	301

TABLE 7.0
NUMBER OF STUDENTS PER CARREL

High	Select the high figure from Table 4.0.2 if the carrel facility will be open on a limited basis or if you have a rather small room in which to place the carrels. Realize in doing so that there will be some periods when students have to wait for carrels to become available with such a high density use per carrel.
Low	Select the low figure from Table 4.0.2 if ample room is available for the carrels and if the carrel facility will be available to the students ten or more hours a day. Remember that carrel size and the space for demonstration areas should also be included in making this decision. (Usually carrel sizes are 4x2, 4x3, or 5x3)
Average	The average figures should be selected from Table 4.0.2 if ample room is available for the size carrel which you are concerned with and if you wish to optimize the carrel facility by scheduling students as close as possible without inconveniencing either the faculty or the students by overloading the system. Since the amount of time which the students take to go through a self-instructional unit is also a factor, if you anticipate the students taking longer than 2.6 hours per unit, you should consider either the average or the low figure for the students per carrel factor.

TABLE 7.1
NUMBER OF HOURS PER STUDENT PER UNIT

High	Select the high value from Table 4.0.3 if numerous demonstration observations or lengthy audio tapes and/or slide presentations are anticipated.
Low	Select the low value from Table 4.0.3 if the materials to be developed are only supplementary in nature to an existing instructional strategy. Few slides and/or minutes of listening to audio tapes would be involved in these units.
Average	The average value in Table 4.0.3 should be selected if a fairly balanced combination of demonstration area observations and one seven-inch reel audio tape is anticipated per unit. No more than thirty slides would normally be found in these units, unless viewed rapidly.

TABLE 7.2
INSTRUCTIONAL STRATEGY MIX

Note: Two basic media strategies are reflected in this budget planning guide. The first strategy consists of a mix of slide, audio tapes, hand-outs and film production. The second media strategy involves the use of audio tapes with only a few photoprints. In deciding between these two basic alternatives, you should realize that though the audio tape strategy is less expensive, it may also be less effective since visual exemplars were not used to illustrate various biological or physical science concepts which need this type of clarification. The best approach is to select a well-balanced instructional program designed to the concepts which you are trying to teach, rather than your anticipated budget. To help finalize your strategy decision, you may want to use the planning guide to simulate your expenses with either strategy. Upon further clarification of the objectives and concepts which you wish to teach, you may then take into consideration the cost-benefit of the two alternatives before making a final determination on the appropriate strategy.

Slide-Tape-Film	Select this strategy if the concepts you wish to teach need both still and motion pictures to illustrate their interrelationship.
Audio-Tape Only	Select this strategy if the concepts to be taught may be learned with verbal description or audio description only. Approximately two photoprints per unit may be included in this strategy selection and still maintain the validity of the cost data in the planning guide.

TABLE 7.3
CARREL, DEMONSTRATION, AND SPECIAL DEVELOPMENT EQUIPMENT
OR
CARREL EQUIPMENT ONLY

Carrel, demonstration, and special development equipment	This equipment combination should be chosen if a special demonstration area is planned in which new equipment not presently existing in your department is needed to teach the concepts included in the self-instructional strategy. Also, if special tape recorders or cameras are needed for production or duplication purposes, then this choice should also be made.
Carrel equipment only	This choice should be made if neither new demonstration nor special development equipment is needed.

TABLE 7.4
CARREL, DEMONSTRATION AND SPECIAL DEVELOPMENT
EQUIPMENT FOR SLIDE, TAPE
AND/OR
FILM STRATEGY MIX

High	Select the high figure from Table 4.1.1 if the carrels need to be specially designed and wired or if more than one slide projector per carrel or film projector per demonstration area is anticipated. If special cameras, tape recorders or production and duplication equipment are needed in the development, this figure should also be selected.
Low	Select the low figure from Table 4.1.1 if a basic carrel, chair, slide projector, play-back tape recorder and front projection screen are anticipated.
Average	Select the average figure from Table 4.1.1 if a medium-priced carrel, chair, tape recorder with play-back and record, slide projector and a small film projector or limited demonstration equipment are anticipated.

TABLE 7.5
CARREL EQUIPMENT ONLY FOR SLIDE, TAPE
AND/OR
FILM STRATEGY MIX

High	The high value in Table 4.1.2 should be selected if sophisticated, reflex projection system carrels are needed with one or more projectors and a play-back and record function tape recorder. The value should also be selected if elaborate modification in the instructional facility is needed to install the carrels.
Low	This value reflects inexpensive carrels with a viewing screen attached to the side of the carrel. One manually operated slide projector and play-back only tape recorder are included.
Average	Select the average value in Table 4.1.2 if a balanced software development project is anticipated, including a moderately priced carrel with a remote control operated slide projector, play-back and record function tape recorder and a simple but well-built projection system.

TABLE 7.6
SLIDE, TAPE AND/OR FILM SOFTWARE
PRODUCTION COTS

High	Select the high figure from Table 4.2.1 if demonstration area films are to be produced from scratch* or special models in each carrel are anticipated.
Low	Select the low figure from Table 4.2.1 if a basic slide-tape format is anticipated. This choice relies heavily on existing slides and does not permit more than 15% new slide development.
Average	The average figure from Table 4.2.1 should be selected if a well-balanced program of software development is anticipated, including slide production, audio tape production, and some photo prints. This value is exclusive of expensive models and project-produced films. Some commercial 16mm or Super 8mm film footage can be purchased or self-made Super 8mm can be produced and stay within this budget figure, however.

*The values in Table 4.2.1 reflect the production of no more than a four-minute demonstration film per unit. If the anticipated accumulation of footage to be produced is longer than an average of four minutes per film, refer to Table 10.1 for cost estimates. Since film production is perhaps the most variable cost factor in self-instructional materials development, if special filming techniques are anticipated, your local film studio or technicians should be consulted for cost estimates once you have a clear idea of how much, and what type of production you will need to illustrate the concepts requiring film.

TABLE 7.7
SLIDE, TAPE AND/OR FILM SOFTWARE
DUPLICATION COSTS

High	Select the high figure from Table 4.2.2 if demonstration* films are to be duplicated or if more than forty slides per unit or two or more audio tapes are anticipated.
Low	Select the low figure from Table 4.2.2 if twenty or less slides and one tape per unit are anticipated.
Average	Select the average figure from Table 4.3.4 if a balanced program of more than twenty slides per unit, plus photoprints, handouts, one or more audio tapes and in-carrel demonstration software or realia are to be duplicated.

*The values in Table 4.2.2 reflect the cost of producing and duplicating films for demonstration area use only. If films are to be used in each carrel, refer to Table 10.1 for values to use in calculating this increased expense.

TABLE 7.8
SLIDE, TAPE AND/OR FILM FACULTY COSTS

None — If no faculty will be involved directly in the materials development, write zero for this expense category in the planning guide. (Faculty may be used as consultants to paraprofessionals, but their cost should be included under consultant costs at a later point.)

Note: Since the faculty salaries from institution vary considerably, if your local faculty salary schedule is comparable to the averages listed in Table 5.0, then read the criteria listed below and make the appropriate selection from Table 4.2.3. If, however, the averages listed in Table 5.0 are ±$1,000 the salary for a similar rank and length of appointment, at your institution, then divide your local value by the appropriate value in Table 5.0. The result of this calculation should then be multiplied by the value you select from Table 4.2.3 to arrive at an adjusted figure which reflects your local economic conditions. For example, (Your local salary/ the appropriate Table 5.0 salary) X (your selection from Table 4.2.3) = "Adjusted Faculty Cost per Instructional Unit." Also, since Table 4.2.3 reflect salaries at the top of the Assistant Professor range, if primarily different tenure level faculty will be developing the self-instructional materials, adjustments using the following procedure should be used: (The salary for your faculty developers/the Assistant Professor value in Table 5.0) X (your selection for Table 4.2.3 or the previously determined "Adjusted Faculty Cost per Instructional Unit) = "Re-adjusted Faculty Cost per Instructional Unit."

High — If your development will involve two or more content or instructional development faculty on a systematic basis during the development, you should anticipate a rather high faculty cost.

Low — Select the low figure from Table 4.2.3 if one faculty member is carrying out the development with a considerable amount of software already

TABLE 7.8
SLIDE, TAPE AND/OR FILM FACULTY COSTS
(continued)

	produced and adequate secretarial and graphic assistance. (This value, of course, also assumes that you are developing materials for one course and approximately ten units.)
Average	Average salary figures should be anticipated if basically one faculty member is carrying out the development of a substantial amount of software which involves a considerable amount of thought and preparation before it can be produced.

TABLE 7.9
SLIDE, TAPE AND/OR FILM CONTENT ASSISTANT
AND SECRETARIAL COSTS

None — If no content or secretarial assistance will be involved, write zero for this expense cateogry in the planning guide.

Note: As with the faculty salaries, the local graduate assistant and secretarial salaries should be compared to those listed on Table 5.1. If a substantial difference is found, the value you select from Table 4.2.4 should be adjusted by the same procedure outlined in Table 7.8.

High — A high figure should be expected if heavy typing is anticipated for scripts or hand-outs or if content assistants such as graduate students are to assume a major portion of the development responsibility.

Low — Select the low figure from Table 4.2.4 if little software production and/or duplication is necessary and if the typing for the handouts is relatively simple and three or less pages.

Average — The average figure from Table 4.2.4 should be selected when a balanced team of faculty, content assistants and secretaries are anticipated to produce a 7 - 10 page hand-out per unit and 25 - 30 slides per unit.

TABLE 7.10
SLIDE, TAPE AND/OR FILM CONSULTANT COSTS

Note: Consultant fees may be broken down into (a) content consultants and (b) instructional development consultants. The former include members of your own faculty or developers within your content area at other institutions. The instructional development consultants may include graphic production specialists, television producers, evaluation specialists and instructional systems design specialists. As with faculty, graduate assistant and secretarial salaries, consultant fees should reflect local conditions and since many of these individuals will hold academic appointments in your institution, Table 5.0 should be consulted in determining whether the figures on Table 4.2.5 need to be adjusted as per the procedures outlined in Table 9.8.

None	If the use of neither content consultants nor instructional development consultants is anticipated, write zero for this expense category in the planning guide.
High	A high value should be selected from Table 4.2.5 if substantial help is needed from either content or instructional development consultants on or off your campus.
Low	A low figure may be selected if one is fairly confident of the content area and the instructional development process needed to complete the development.
Average	An average figure should be included if one or two content and instructional development consultants are asked for evaluation at various stages of your development. The high figure would permit you to take one short trip to another instructional development project on another campus, but the average figure would likely limit the travel to one local visit and some correspondence.

TABLE 7.11
SLIDE, TAPE AND/OR FILM VALIDATION
AND REVISION COSTS

Note: The developed materials should be validated on a student sample and revised as necessary before use by students for credit.

None	If no validation or revision is anticipated before students use the materials for course credit, write zero for this expense category in the planning guide.
High	The high figure from Table 4.2.6 should be selected if a thorough validation program involving students who are paid for their participation is conducted and if approximately 10% of the software produced is revised.
Low	The low figure from Table 4.2.6 can be selected if just a cursory review of the materials is carried out by the faculty developer with two or three students and very minimal amount of revision results.
Average	In some cases, students will volunteer to help validate the instructional units for credit and therefore are not receiving a stipend for their participation in the validation process. If such is the case and approximately 10% of the software is anticipated to be revised as a result of the validation, then the average figure can be selected.

TABLE 7.12
HOURS OF FACULTY TIME SPENT
DURING THE INSTRUCTIONAL DEVELOPMENT

Note: Selection of this figure should give the planner an estimate of the full-time faculty equivalents he will need to request in the proposal. Seldom do faculty who have taken on, or have been assigned the responsibility of, developing self-instructional materials complete the project if they are not given some released time to carry out the development.

None	If no faculty are involved in the development project, write zero for this expense category in the planning guide.
High	A high value should be selected if two or more faculty are involved in the development or if films or other extensive software are to be included in the software production. If the main faculty developer has a considerable amount of time to spend with consultants, and with the software production crews, then this figure should also be anticipated.
Low	The low figure from Table 4.2.7 should be selected if the planner has a substantial amount of software available in the form of slides or commercial film footage and is able to rely upon graduate assistants and secretaries to handle much of the "leg work."
Average	An average figure should be selected for a faculty member carrying out development for the first time on a substantial number of software materials exclusive of films. This figure should also be anticipated if some time is needed by the faculty member to coordinate the software production by carrying on discussions with the graphic artists and various media technicians.

TABLE 7.13
MONTHS FOR INITIAL INSTRUCTIONAL DEVELOPMENT

High	The high figure should be included for faculty who have relatively little time to spend on the development process or if films or extensive work are necessary for the software production.
Low	The low figure from Table 4.2.8 should be selected if much of the software is presently available or if few units are expected to be developed.
Average	An average figure would include a balanced software development program and a faculty member who has some released time to spend on the development process.

TABLE 8.0
CARREL, DEMONSTRATION AND SPECIAL DEVELOPMENT
EQUIPMENT FOR AUDIO TAPE ONLY STRATEGY

High	Select the high figure from Table 4.1.1 if the carrels need to be specially designed and wired or if a special microphone or both record and playback audio tape recorder functions are anticipated. If special cameras, tape recorders or production and duplication equipment are needed in the development, this figure should also be selected.
Low	Select the low figure from Table 4.1.1 if a basic carrel, chair, and play-back only tape recorder are anticipated. This value should also be chosen if simple carrels are to be made locally for use on existing lab tables.
Average	Select the average figure from Table 4.1.1 if a medium-priced carrel, chair, tape recorder with play-back and record, and limited demonstration equipment are anticipated.

TABLE 8.1
CARREL EQUIPMENT ONLY FOR AN AUDIO TAPE STRATEGY

High	The high value in Table 4.1.2 should be selected if a sophisticated response system is built into the carrel or if a play-back and record function tape recorder is anticipated. A moderate to expensive carrel may be included in this estimate depending on the equipment going inside. If extensive facility modifications are needed to install the carrels, then this value should also be chosen.
Low	Select the low value in Table 4.1.2 if an inexpensive carrel and play-back only tape recorder are anticipated.
Average	The average value should be chosen if some facility modifications are necessary to install moderately priced carrels. Inexpensive to moderately priced play-back and record function tape recorders may also be included in these carrels.

TABLE 8.2
AUDIO TAPE SOFTWARE PRODUCTION COSTS

High	Select the high figure from Table 4.2.1 if special models are anticipated for each carrel, or if special sound effects or interviews are anticipated.
Low	Select the low figure from Table 4.2.1 if a basic 7"-reel audio tape format is anticipated. This choice would not permit more than one photoprint/carrel/unit and few illustrations in the hand-out.
Average	The average figure from Table 4.2.1 should be selected if a well-balanced program of software development is anticipated, audio tape production, including some sound effects and interviews and several photoprints/carrel/unit but exclusive of expensive models.

TABLE 8.3
AUDIO TAPE SOFTWARE DUPLICATION COSTS

High	Select the high figure from Table 4.2.2 if two or more tapes per unit are anticipated or if photoprints are to be used in each carrel.
Low	Select the low figure from Table 4.2.2 if one tape per unit and no photoprints are anticipated.
Average	Select the average figure from Table 4.2.2 if a balanced program of photoprints, hand-outs, one audio tape and in-carrel demonstration realia are to be duplicated.

TABLE 8.4
AUDIO TAPE FACULTY COSTS

None — If no faculty will be involved directly in the materials development, write zero for this expense category in the planning guide. (Faculty may be used as consultants to paraprofessionals, but their cost should be included under consultant costs at a later point.)

Note: Since the faculty salaries from institution to institution vary considerably, if your local faculty salary schedule is comparable to the averages listed in Table 5.0, then read the criteria listed below and make the appropriate selection from Table 4.2.3. If, however, the averages listed in Table 5.0 are ±$1,000 the salary for a similar rank and length of appointment at your institution, then divide your local value by the appropriate value in Table 5.0. The result of this calculation should then be multiplied by the value you select from Table 4.2.3 to arrive at an adjusted figure which reflects your local economic conditions. For example, (Your local salary/the appropriate Table 5.0 salary) X (your selection from Table 4.2.3) = "Adjusted Faculty Cost per Instructional Unit." Also, since Table 4.2.3 reflects the salaries at the top of the Assistant Professor range, if primarily different tenure level faculty will be developing the self-instructional materials, adjustments using the following procedure should be used: (The salary for your faculty developers/the Assistant Professor value in Table 5.0) X (your selection for Table 4.2.3 or the previously determined "Adjusted Faculty Cost per Instructional Unit) = "Re-adjusted Faculty Cost per Instructional Unit."

High — If your development will involve two or more content or instructional development faculty on a systematic basis during the development, you should anticipate a rather high faculty cost.

TABLE 8.4
AUDIO TAPE FACULTY COSTS
(continued)

Low	Select the low figure from Table 4.2.3 if one faculty member is carrying out the development with a considerable amount of software already produced and adequate secretarial and graphic assistance. (This value, of course, also assumes that you are developing materials for one course and approximately ten units.)
Average	Average salary figures should be anticipated if basically one faculty member is carrying out the development of a substantial amount of software which involves a considerable amount of thought and preparation before it can be produced.

TABLE 8.5
AUDIO TAPE CONTENT ASSISTANT AND SECRETARIAL COSTS

None — If no content or secretarial assistance will be involved, write zero for this expense category in the planning guide.

Note: As with the faculty salaries, the local graduate assistant and secretarial salaries should be compared to those listed on Table 5.1. If a substantial difference is found, the value you select from Table 4.2.4 should be adjusted by the same procedure outlined in Table 8.4.

High — A high figure should be expected if heavy typing is anticipated for scripts or hand-outs or if content assistants such as graduate students are to assume a major portion of the development responsibility.

Low — Select the low figure from Table 4.2.4 if little software production and/or duplication is necessary and if the typing for the hand-outs is relatively simple and three or less pages.

Average — The average figure from Table 4.2.4 should be selected when a balanced team of faculty, content assistants and secretaries are anticipated to produce a 7 - 10 page hand-out per unit and one to two audio tapes per unit.

TABLE 8.6
AUDIO TAPE CONSULTANT COSTS

Note: Consultant fees may be broken down into (a) content consultants and (b) instructional development consultants. The former include members of your own faculty or developers within your content area at other institutions. The instructional development consultants may include graphic production specialists, television producers, evaluation specialists and instructional systems design specialists. As with faculty, graduate assistant and secretarial salaries, consultant fees should reflect local conditions and since many of these individuals will hold academic appointments in your institution, Table 5.0 should be consulted in determining whether the figures on Table 4.2.5 need to be adjusted as per the procedures outlined in Table 8.4.

None	If the use of neither content consultants nor instructional development consultants is anticipated, write zero for this expense category in the planning guide.
High	A high value should be selected from Table 4.2.5 if substantial help is needed from either content or instructional development consultants on or off your campus.
Low	A low figure may be selected if one is fairly confident of the content area and the instructional development process needed to complete the development.
Average	An average figure should be included if one or two content and instructional development consultants are asked for evaluation at various stages of your development. The high figure would permit you to take one short trip to another instructional development project on another campus, but the average figure would likely limit the travel to one local visit and some correspondence.

TABLE 8.7
AUDIO TAPE VALIDATION AND REVISION COSTS

Note: The developed materials should be validated on a student sample and revised as necessary before use by students for credit.

None	If no validation or revision is anticipated before students use the materials for course credit, write zero for this expense category in the planning guide.
High	The high figure from Table 4.2.6 should be selected if a thorough validation program involving students who are paid for their participation is conducted and if approximately 10% of the software produced is revised.
Low	The low figure from Table 4.2.6 can be selected if just a cursory review of the materials is carried out by the faculty developer with two or three students and very minimal amount of revision results.
Average	In some cases students will volunteer to help validate the instructional units for credit and therefore are not receiving a stipend for their participation in the validation process. If such is the case and approximately 10% of the software is anticipated to be revised as a result of the validation, then the average figure can be selected.

TABLE 8.8
HOURS OF FACULTY TIME SPENT
DURING THE INSTRUCTIONAL DEVELOPMENT

Note: Selection of this figure should give the planner an estimate of the full-time faculty equivalents he will need to request in the proposal. Seldom do faculty who have taken on, or have been assigned the responsibility of, developing self-instructional materials complete the project if they are not given some released time to carry out the development.

None	If no faculty are involved in the development project, write zero for this expense category in the planning guide.
High	A high value should be selected if two or more faculty are involved in the development or if extensive interviews or sound effects are to be included in the audio tape production. If the main faculty developer has a considerable amount of time to spend with consultants, and with the software production crews, then this figure should also be anticipated.
Low	The low figure from Table 4.2.7 should be selected if the planner has a substantial amount of his scripts and illustrative materials available and is able to rely upon graduate assistants and secretaries to handle much of the "leg work."
Average	An average figure should be selected for a faculty member carrying out development for the first time on a substantial number of software materials. This figure should also be anticipated if some time is needed by the faculty member to coordinate the software production by carrying on discussions with the graphic artists and various media technicians.

TABLE 8.9
MONTHS FOR INITIAL INSTRUCTIONAL DEVELOPMENT

High	The high figure should be included for faculty who have relatively little time to spend on the development process, or if substantial amounts of time are involved in gathering interviews and/or sound effects.
Low	The low figure from Table 4.2.8 should be selected if much of the source material for tape production is presently available or if few units are expected to be developed.
Average	An average figure would include a balanced software development program and a faculty member who has some released time to spend on the development process.

APPENDIX D

Example Hardware and Software Unit Costs for Self-Instructional Materials Development Cost Planning

TABLE 9.0 CAMERA EQUIPMENT UNIT COST
(4% increase/year)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
(1)	Angenieux Zoom 12-120	$ 932.00	1044.00
(2)	Arriflex 16mm	2595.00	2905.00
(3)	Battery (Nickle-Cadmium) Large	370.00	314.00
(4)	Case	147.00	165.00
(5)	Close-up Lens (plus 1,2,3) @$25.00	78.00	87.00
(6)	Dual 8mm Camera	312.00	349.00
(7)	Magazine 2400 Ft.	237.00	265.00
(8)	Motor for Zoom Lens	291.00	326.00
(9)	Motor (Governor controlled)	229.00	256.00
(10)	Pro Junior Tripod, Standard Head (with ball level)	224.00	251.00
(11)	Special Eyepiece	310.00	347.00
(12)	Sunshade - Filter Holder	31.00	35.00
(13)	Triangle	42.00	47.00
(14)	Wind Motor for Camera	162.00	182.00

TABLE 9.1 CARREL EQUIPMENT UNIT COST
(4% increase/year)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
(1)	Carrels	$315.00	353.00
(2)	Carrels, Homemade	77.00	86.00
(3)	Chairs	28.50	32.00
(4)	Headsets	22.00	25.00
(5)	Kodak Carousel Projectors	130.00	146.00
(6)	Sawyer Crestline Slide Projector	26.00	29.00
(7)	Slide Viewer	70.00	78.00
(8)	Super 8mm Silent (10 min.) projector	110.00	123.00
(9)	Super 8mm Sound (30 min.) Projector	250.00	280.00
(10)	Tape Playback Only	80.00	90.00
(11)	Tape Playback and Record	141.00	158.00

TABLE 9.2 DEMONSTRATION AND SPECIAL EQUIPMENT
UNIT COST
(4% increase/year)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
(1)	Demonstration Tables and Wiring	$180.00	202.00
(2)	Cadaver Table	800.00	896.00
(3)	Flame Photometer and Galvanometer	700.00	784.00
(4)	Metal Storage Cabinet	80.00	90.00
(5)	Ph Meters	140.00	157.00
(6)	Oven	200.00	224.00
(7)	Polarizing Microscope	550.00	616.00
(8)	Slide Storage Cabinets	509.00	570.00
(9)	Soil Stirrer	180.00	202.00
(10)	Typewriter, IBM Gothic Bulletin Type - Model D	465.00	521.00
(11)	Vacuum Pump	115.00	129.00

TABLE 9.3 PHOTOGRAPHIC LIGHTING EQUIPMENT UNIT COST (4% increase/year)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
(1)	750-Watt Lamps, Clear Q 750T3/4CL	$21.00	24.00
(2)	750-Watt Mole-Richardson Molequartz Super Soft Lite Type 2581, Heads	71.00	80.00
(3)	Packaging	1.50	1.70
(4)	Stands, Pedestal Type 40651A	38.00	42.00

TABLE 10.0 AUDIO TAPE UNIT COST

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
MATERIAL COSTS PER TAPE (no significant increase/year)			
(1)	1200 ft. Scotch Tapes Reel-to-Reel	$ 2.20	2.20
(2)	1800 ft. Scotch Tapes Reel-to-Reel	2.50	2.50
(3)	C-30 Scotch Cassette Tapes (lots 50)	1.40	1.40
(4)	C-60 Scotch Cassette Tapes (lots 50)	2.50	2.50
(5)	C-90 Scotch Cassette Tapes (lots 50)	3.25	3.25
PRODUCTION (increase unclear)			
(6)	Studio Recording Hourly Rate	10.00	25.00
(7)	Editing Hourly Rate	5.00	10.00
DUPLICATION			
(8)	Reel and Cassette Tape Duplication	.75	1.00

TABLE 10.1 16mm REDUCED TO SUPER 8mm FILM UNIT COST (8.6% increase/year)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
16mm PRODUCTION, MATERIALS AND LABORATORY COSTS/MINUTE (36.4 feet/minute) (8.6% increase/year)			
(1)	16mm Color Reversal Film Stock	$ 2.30	3.00
(2)	(b/w) Black and White Film Stock	1.45	1.90
(3)	Color Developing	1.80	2.35
(4)	B/W Developing	1.10	1.45
(5)	Color Work Print	2.80	3.65
(6)	B/W Work Print	2.40	3.10
(7)	Magnetic Film	.074	.095
(8)	Color Internegative from Single Roll	5.60	7.30
(9)	Color Internegative from A-B Rolls	7.00	9.10
GRAPHIC ARTWORK COSTS/MINUTE (7.4% increase/year)			
(10)	Graphic Art, Transparencies and Drawings	9.40	12.20
(11)	Art Work Per Title	25.00	30.55

TABLE 10.1 16mm REDUCED TO SUPER 8mm
FILM UNIT COST
(8.6% increase/year)
(continued)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
	TECHNICAL LABOR COSTS/MINUTE AND HOUR (8.6% increase/year)		
(12)	Cameramen, Soundmen and Editor,	$74.45	93.80
	OR		
(13)	Sound Technician Hourly Rate	10.00	13.00
(14)	Cameraman + Camera Hourly Rate	8.00	10.40
(15)	Editor Hourly Rate	8.00	10.40
	SUPER 8mm MATERIALS AND LABORATORY COSTS/ MINUTE @ 22.8 ft/minute (8.6% increase/ year)		
(16)	2 Answer Print Minimum (assumes 16mm reduced to 8mm on pre-stripped magnetic sound stock)	$ 5.10	6.60
	DUPLICATION		
(17)	2-24 Prints Pre-stripped Magnetic Sound	2.11	2.74
(18)	26-46 Prints	1.40	1.82
(19)	48-106 Prints	1.32	1.71
(20)	Load + Wax + Lubricate for 8mm Cartridges	.35	.45

TABLE 10.1 16mm REDUCED TO SUPER 8mm
FILM UNIT COST
(8.6% increase/year)
(continued)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
	OR		
(21)	Limited 16mm Color Production (inclusive through answer print costs)	$230.00	300.00
(22)	Average 16mm Color Production (inclusive through answer print costs)	385.00	500.00
	(add reduction and print costs as per above)		
(23)	Commercially Produced Films on a Per-print Basis	5.00	7.00
	OR		
(24)	Shoot Own Super 8mm (materials + laboratory)	5.00	7.00

TABLE 10.2 2X2 SLIDE UNIT COST
(5.4% increase/year)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
2X2 SLIDE PRODUCTION			
(1)	2X2 Slide Masters with Art (includes film developing and mounting	$ 2.90	3.35
(2)	2X2 Slide Masters without Art (includes film developing and mounting)	1.20	1.40
(3)	Master Slide Art (labor)	17.00	20.00
(4)	2X2 Ectachrome 36-exposure Film + Processing	.14	.15
PROCESSING			
(5)	2X2 Dupes 1-99 (any combination)	.30	.35
(6)	2X2 Dupes 100 (any combination)	.20	.25

TABLE 10.3 PHOTOPRINT UNIT COST
(3.9% increase/year)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
DUPLICATION			
(1)	5X7 Black and White (single)	$ .60	.65/ mat
(2)	5X7 Black and White (3)	.50	.40/ glossy
(3)	5X7 Black and White (10)	.40	no quantity
(4)	8X10 Black and White (single)	1.00	1.00/ mat
(5)	8X10 Black and White (3)	.80	.75/ glossy
(6)	8X10 Black and White (10)	.65	no quantity
(7)	5X7 Color (single)	1.25	1.50
(8)	5X7 Color (3)	.75	1.00
(9)	8X10 Color (single)	3.25	3.50
(10)	8X10 (3)	2.75	3.00

TABLE 10.4 OVERHEAD TRANSPARENCY UNIT COST
(12.0% increase/year)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
PRODUCTION			
(1)	Graphic Art for Masters	$19.85	20.55
DUPLICATION			
(2)	O.H. Transparency $/Sheet Includes Mount and Labor	1.00	1.35

TABLE 10.5 MODEL UNIT COST
(12.5% increase/year)

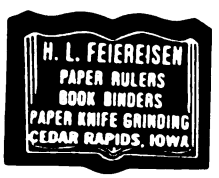
ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
(1)	Cadaver	$125.00	154.00
(2)	Chemistry Molecular Model Set	6.00	8.25
(3)	Ears	48.00	66.00
(4)	Eyes	55.00	75.00
(5)	Head and Neck	54.00	74.00
(6)	Heart	57.00	78.00
(7)	Human Circulatory System	75.00	105.00
(8)	Human Figure with Musculature	620.00	850.00
(9)	Human Skeleton	150.00	209.00
(10)	Human Skeleton, with Stand	255.00	355.00
(11)	Larnyx	105.00	146.00
(12)	Munsell Charts	2.00	2.80
(13)	Orbit, with Eyeball	62.00	85.00
(14)	Pelvis, Female	43.00	50.00
(15)	Pelvis, Male	50.00	70.00
(16)	Skull (la Beauchene)	198.00	277.00
(17)	Spinal Cord	24.00	33.00

TABLE 10.5 MODEL UNIT COST
(12.5% increase/year)
(continued)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
(18)	Stomach, Duodenum and Pancreas	$ 53.00	73.00
(19)	Torso Model and Head	422.00	580.00
(20)	Trachea and Lungs	50.00	69.00
(21)	Urinary Organs	38.00	52.00

TABLE 10.6 MISCELLANEOUS SUPPLIES UNIT COST
(7.3% increase/year)

ITEM #	DESCRIPTION	1967 AVG.	1970 AVG.
(1)	Carousel Slide Trays	$2.75	3.35
(2)	Replacement Projection Lamps 500 Watt	3.00	3.65
(3)	Student Workbooks	.60	.73
(4)	Super 8mm 10 min. Cartridge	5.00	6.10
(5)	Super 8mm 30 min. Cartridge	7.10	9.50


H. L. FEIEREISEN
PAPER RULERS
BOOK BINDERS
PAPER KNIFE GRINDING
CEDAR RAPIDS, IOWA