

C-O-N-F-I-D-E-N-T-I-A-L

WHAT DOES IT COST TO DEVELOP A UNIT OF
PROGRAMMED ASSISTED
INSTRUCTION (PAI)?

JOB NO. _____ BOX NO. _____ FILE NO. _____ DOC. NO. 19 NO CHANGE
IN CLASS (DECLASS) / CLASS CHANGED TO: TS S C RET. JUST. 22
NEXT REV DATE 9 REV DATE 7 / 80 REVIEWER 09725 TYPE DOC. 30
NO. PGS 8 CREATION DATE _____ ORG COMP 11 OPL 11 ORG CLASS C
REV CLASS C REV COORD. _____ AUTH: HR 70-3

Perhaps some of you have recently gone through the exhausting process of having a building contractor tell you how much it will cost per square foot to build the dream house of your choice. Unless you lifted your house plan, complete with drawings and specifications, from AMERICAN HOME, HOUSE BEAUTIFUL, etc., or paid a fat fee to an architect for such plans, you will know why I used the word exhausting! If, like me, you are the know-it-all type, you've said, "I know exactly what kind of house I want; I don't need an architect." Then you've paid the penalty. You've spent hours, days, satisfying the contractor on exactly what it is you want. He has insisted that you be most specific as to size of house and rooms, materials, fixtures, appliances and a host of other detail. Only then does the contractor come up with the shocker--a cost of \$20.00 per square foot!

Much the same process must be gone through in answering the perfectly legitimate question of how much does it cost to write or develop a unit of Programmed Assisted Instruction (PAI). Only it is far more complicated! The professional programmer has to contend with six or more variables which do not plague the building contractor. I shall discuss some of them.

Variable I

The length of time required to arrive at detailed course objectives or desired student terminal behavior objectives will affect the cost of developing a unit of PAI. But this requirement is so basic to sound teaching and learning that it should not properly be costed against the development of a unit of PAI. It should be undertaken by all instructors who have responsibility for conducting courses of instruction, irrespective of the method of teaching employed. A recognized authority, Ralph W. Tyler* has described this basic step:

*"Evaluation--The Ultimate Reality," EDUCATIONAL TECHNOLOGY, September 30, 1966, page 13.

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" The purpose of this first step in identifying the objectives sought is to obtain a list of the kinds of behavior which the course seeks to develop. This means an actual listing of such goals as: the things the students are expected to understand as a result of instruction, the skills they are expected to acquire, the interests they can be expected to develop, the values it is hoped they will appreciate and the habits it is expected they will form. This listing is basic to planning an evaluation program. One cannot select appropriate measures until he knows what it is he is trying to appraise. "

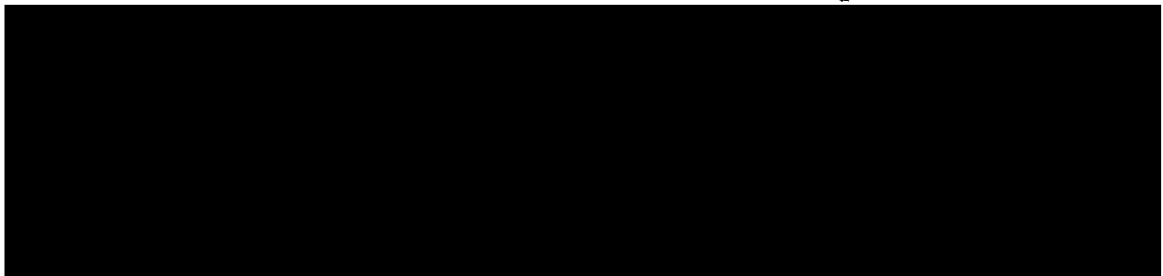
And yet experience shows that while most teachers know what they want to teach, a surprising number become vague as to precisely what the student must learn if the desired behavioral change is to take place; i. e., what must the student learn in order to perform at maximum efficiency upon completion of a course? The answer to this question must precede any study on why the student has difficulty in learning what he is taught.

The point in all this is that management will have to take into account the time factor, and therefore the cost, involved in determining meaningful course objectives. Only after this has been completed can one begin to develop a unit of PAI.

Variable 2

When students are paid to learn as in most Government training courses (versus instruction given in academic institutions where the students pay to learn), the biggest single cost of training (or in our case the use of a unit of PAI) is the salary paid the student while he learns. Take the case of the Introduction to Intelligence Course.

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It can be seen therefore that if the use of PAI units in the Introduction to Intelligence Course could cut the total time of the course by one 8 hour day, the saving to the Agency would be over \$26,500.00! But the point brought out here is that the variable of number and grade of students strongly affects the cost of a unit of PAI.

Variable 3

Entire Programmed courses or units of PAI will vary in cost depending upon the difficulty of the subject to be programmed. The building contractor can tell you with considerable accuracy the difference in the cost of roofing your house with a certain ply asphalt shingle as against roofing it with redwood shakes (shingles, to you!). But we can only estimate the difference in the cost of developing an hour of learning for a unit of PAI in Mandarin Chinese as against a similar unit of PAI in a clerical typing course. The commercial developers of off-the-shelf PAI courses are for the most part silent on costs of development, perhaps because this is a "trade secret" or because they do not wish to disclose their methods of bookkeeping!

Variable 4

If the Program developer is an Agency staff or contract employee the cost of a unit of PAI will dominantly depend on the salary of the developer. R. W. Walker* of the Martin Company of Denver, Colorado, said,

"The qualities of the most successful programmers include an above average intelligence, perseverance, detail-consciousness, ability to emphasize, creativity, flexibility and management identification."

*"Martin Company, Denver Division," PROGRAMED INSTRUCTION, A GUIDE FOR MANAGEMENT, by Gabriel D. Ofiesh, 1965, page 292.

My "ideal" programmer, for what it's worth, would have taken a Ph.D. in Logic, have an interest in the phenomena of learning behavior, not be antagonistic to change, per se, know thoroughly his subject specialty, be able to write clear English and have been a dedicated teacher--though not one who had become overly enamoured by the sound of his own voice!

Either of these definitions could well describe an Agency Super-grade, in which case the cost of PAI would be high. Or it could equally well describe some of the highly qualified women Career Trainees whom I've seen go through the CTP in the last several years, in which case the cost would be lower.

Variable 5

The cost of training the "in-house" programmer and the terminal behavior skills achieved by the "graduate" programmer will appreciably affect the cost of developing a unit of PAI, but not be a recurring cost. Obviously great care must be taken in selecting the "candidate" programmer. He can't be "good old honest Joe" who has been marginally successful as a lecturer or an instructor. To develop good PAI units requires a skilled programmer, just as a well built house requires skilled artisans. The skilled programmer should be thoroughly conversant with his subject specialty. If, in spite of this, good old honest Joe is selected to develop a unit of PAI in the clerical typing course but must first be taught how to use a typewriter, this added training burden should not be a cost factor charged against the development of the unit of PAI!

There are two ways to train the candidate programmer--externally and internally, and each will have varied cost factors. The candidate programmer can be sent outside the Agency to any one of a score of good programmer training courses varying in length from one week to six months. Or, ideally, he can be trained in-house by an expert program instructor in classes of 5 or 6. This training would be a combination of formal class instruction and supervised on-the-job PAI writing. Over-all elapsed training time, approximately six months.

At the end of this period the graduate programmer should be ready to work on his own. But we all know that this in itself is a variable. Will the graduate programmer really be able to work on a unit of PAI without some supervision after six months? Some will,

but good old H. J. --? And how rapidly does the programmer work? Does he work happily with power tools or has he resisted change and is comfortable working only with hand tools?

Variable 6

No unit of PAI, whether developed internally or contracted for externally, should be accepted by management until it has been thoroughly tested and validated on a sample of the Agency population. And of course this constitutes another cost variable. The County Building Inspector has got to get his cut!

A good programmer will normally test his program each step of the way against the stated course objectives or desired terminal behavior. Testing is an inherent cost factor of any acceptable unit of PAI. But be sure it has been accomplished. Though testing will add to the time cost of a program, you simply haven't got a program unless it meets the course objectives.

Validation is something else again. This tells you whether after passing the above test the unit of PAI is the most effective and efficient method of accomplishing student learning. It is entirely conceivable that the conventional classroom method of instruction may be the most effective and efficient means of achieving student learning. The use of closed circuit TV, films, or improved use of visual display techniques or various combinations of all the above may be more efficient and effective than PAI. You can't be sure until you have validated your unit of PAI against your stated objectives.

Validation can be accomplished internally where feasible but it is time consuming and therefore costly. And supervisors don't take kindly to having their employees experimented on! More important, if validation is to be done internally, it must be undertaken by a team of experts--instructors, behavioral psychologists, and statisticians. Also, this team must be completely objective, without bias or prejudice. Else you won't have true validation.

External validation should assure objectivity and professional treatment. It can, however, be expensive if conducted by a consulting firm. Where units of PAI are contracted for externally, validation is

normally an integral part of the contract. There are also university research centers which are prepared to offer validation services at little or no cost to the consumer, especially where the cost of such research is financed by the U. S. Office of Education. Such centers are operating at Stanford, Michigan, Northeastern, Penn State, and Harvard, to name a few, and at the University of Rochester where a most promising project is underway to validate PAI in three foreign languages.

II. Examples of Costs of Programming

A generally accepted cost figure used by many reputable commercial program developers is \$15.00 a frame or \$1,500.00 per hour of learning. An excellent, more detailed, example of costs of in-plant programming was published in 1964 by Rummler and Yaney of the University of Michigan* using the yardstick of "development cost per hour of training per trainee." (The building contractor's cost per square foot!) The study was based on data provided from eleven organizations which had developed in-house units of PAI. The results are summarized on the next page.

*COST OF IN-PLANT PROGRAMMING, Geary A. Rummler and Joseph P. Yaney; Occasional Paper #1. The Center for Programmed Learning for Business, Bureau of Industrial Relations, Graduate School of Business Administration, The University of Michigan, Ann Arbor, Michigan. 1964.

Development Costs per Hour of Training per
Trainee for In-Plant Programs

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<u>Firm</u>	<u>Topic</u>	<u>Cost of Development</u>	<u>Av. Time to Complete Crs.</u>	<u>Development Cost per Hour of Training</u>	<u>Number of Trainees Per Year</u>	<u>Dev. Cost per hour of Training per Trainee</u>
Department Store (1)	Operating Sales Register	\$ 1,932	7	\$280	600	\$0.46
Department Store (2)	Beginning Salesmanship	791	2	400	1000	0.39
Department Store (3)	Sales Systems	5,945	10.5	570	1000	0.56
Department Store (4)	Sales Systems	1,310	5	260	335	1.94
Department Store (5)	Package Delivery	1,747	2.5	700	500	1.39
Oil Refinery	Plant Maintenance	664	1.1	600	475	1.27
Government (1)	Coding and Filing System	3,729	5.3	700	250	2.81
Government (2)	Military Correspondence	3,322	12	280	150	1.84
Equipment Manufacturer	Computer Programming	21,023	24	880	1000	0.87
Automobile Manufacturer	Work Standards	4,993	1.3	480	1500	2.56
Aero-Space	Missile Familiarization	8,101	9	900	1600	0.66

III. Conclusions

A few generalizations can be made relative to the cost of developing a unit of PAI:

Courses in which the content is subject to repeated and infrequent changes may be uneconomical to program.

Off-the-shelf units of PAI, where applicable, are normally the least costly, if they have been tested and validated.

In-house units of PAI probably cost less to develop in the long run than externally contracted for units.


The more students, the lower the unit cost; and conversely.

In the example used in Variable 2 with the Introduction to Intelligence Course it is pertinent to note that coverage on the organization of the Agency and the Agency's place in the Intelligence Community was also given to almost 5,000 students in FY '65 and over 7,000 students in FY '66.

So now you know all you need to know about the cost of developing a unit of PAI (!?) But if you want to play it safe you probably should submit your detailed specifications to half a dozen reputable, honest and skillful commercial program developing firms and accept the lowest bid. Just as you might do with building contractors.

At last you are ready to build your dream house. Or perhaps you'd prefer to take an all-expenses-guaranteed around the world cruise on--a slow boat!

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