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COMPUTER BASED TRAINING

COST BENEFIT MODEL

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COMPUTER BASED TRAINING

COST-BENEFIT MODEL

This model was constructed by Training to cost-justify the acquisition of a Computer Based Training System at Westinghouse Hanford Company. The paper was written at the request of the Training Resources and Data Exchange Committee, a group of Department of Energy contractors, for dissemination to training organizations throughout the DOE contractor system.

prepared by Patrick R. Gardner
FFTF Operations Training

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COMPUTER BASED TRAINING

COST-BENEFIT MODEL

1. Definitions and Notation

- A. Conversion Course: course for which some or all of current course material is to be converted to Computer Based Training.
- B. For each conversion course, compute the following quantities (reasonable approximations are sufficient).
1. S = annual enrollment.
= expected number of students taking the course each year.
 2. H = present number of hours to be converted to CBT.
Example: If 8 hours of a 16 hour Orientation course are to be converted to CBT, then $H = 8$ for this conversion course.
 3. T = number of times course taught each year.
- C. Approximation for the following costs are usually available through Personnel Management.
1. CS = average cost to the company for each student.
= average annual student salary + benefits + overhead + any additional charges.
 2. CI = average cost to the company for each instructor per year.
 3. CA = average cost to the company for each author per year.
- Discussion: It may be that $CS = CI = CA$.
- D. A particular company may use a fixed number of years for the life span of all ADP equipment. Suggestion: use 5 or 10 years in absence of other direction.
- LS = life span of the system.

II. Assumptions

1. For each lesson available on CBT student training time is reduced an average of 25%.

Discussion: the H hours now being spent by each student in the course will, following conversion to CBT, be reduced to

$$.75 \times H$$

hours per student, on the average. This time-savings is well documented and, indeed, 25% savings is usually the minimum realized following conversion to CBT.

2. The only instructor time saved is actual classroom time.

Discussion: course administration, record reviews, report writing, student counseling, lesson updating, etc., are assumed to consume as much instructor time in a CBT environment as not. CBT may reduce an instructor's ex-classroom load but this seems hypothetical at present.

3. 1 year = 1 working year

$$= 1800 \text{ hours}$$

$$= 52 \text{ weeks} \times 40 \text{ hours/week} - \text{average vacation time} - \text{average sick time} - \text{average personal business time.}$$

Discussion: Thus, the cost to the company for each student hour spent in training is:

$$\frac{\text{Company Cost}}{\text{Student hour}} = \frac{CS}{1800 \text{ hrs}}$$

Similarly, the cost to the company for each instructor hour is:

$$\frac{\text{Company Cost}}{\text{Instructor hour}} = \frac{CI}{1800 \text{ hrs}}$$

4. CBT courseware development requires 80 author hours for each student instructional hour.

Discussion: This figure is consistent with military experience in "programmed text type" courses. More elaborate courses will require more development time.

5. No physical plant changes or additional costs are involved. (Any such modifications would affect both initial costs and continuing costs.)

6. No benefits of CBT other than the equivalent monetary benefits from the conversion courses are assumed. Thus, no monetary benefit is computed for improved student performance nor for personnel upgrade in courses which would not be offered if CBT were not available.
7. No "off-the-shelf" courseware is being purchased; all courseware is being internally developed.

III. Initial Cost

Initial Cost = Hardware + Software

+ Installation + Training (assumption 5)

- A. Hardware cost is somewhat dependent on the number of terminals required. An estimate of this number can be found as follows:

1. This calculation is performed for each course.

$X = .75 \times H \times S$ = annual number of student hours to be spent on the terminal for the course.

Then $N = \frac{X}{1800}$ = minimum number of terminals needed for that course assuming perfect scheduling.

In this case, 1800 estimates the number of hours per year that the terminals will be available to students; i.e., it accounts for author time, report generation time, system failure time, reconfiguration time, etc.

2N corresponds to about 50% usage and should keep "busy terminals" frustrations to a minimum.

If, in fact, the terminals will be available and used 24 hours per day then the "50% usage number" will be between N and 1.5 N (recognizing that the day shift usually contains the majority of the student population on any given day).

2. Sum the 50% usage numbers over all conversion courses then round up to get an estimate of the total number of terminals needed.
3. Also affecting the initial cost will be the mass storage requirements.

- a. Lesson storage requirements = sum over all conversion courses of

$$\frac{700 \text{ bytes}}{\text{frame}} \times \frac{1000 \text{ frames}}{\text{lesson-hr}} \times .75 \times H$$

- b. Records requirements. A reasonable first estimate would be the sum over all conversion courses of

$$\frac{2 \text{ KB}}{\text{stu-hr}} \times S \times .75 \times H \times LS$$

Discussion: On the average, if a question identifier requires 5 bytes, the student answer 5 bytes, a right/wrong flag 1 byte, and if the student provides 100 responses per lesson hour, this requires storage equal to

$$100 \text{ responses} \times \left(\frac{5 \text{ bytes}}{\text{quest. ID}} + \frac{5 \text{ bytes}}{\text{response}} + \frac{1 \text{ byte}}{\text{flag}} \right)$$

Additional data, such as response time, cross-matching codes, etc. will raise the mass storage requirements. The figure of 2KB-per student hour is probably an overestimate but on the right order.

- B. The information from A should be sufficient to obtain a rough initial cost estimate from a few vendors for computation purposes.

IV. Annual Maintenance Cost

Annual maintenance costs can usually be supplied by a vendor. An estimated maintenance cost of 10% of the initial (hardware + software) cost is sufficiently accurate for the analysis.

V. Annual Savings

For each conversion course the annual savings is

Trainee Annual Savings + Instructor Annual Savings

$$A. \quad TAS = S \times (.25) \times H \times \frac{CS}{1800 \text{ hrs}}$$

$$B. \quad IAS = H \times T \times \frac{CI}{1800 \text{ hrs}}$$

VI. Cost-Benefit Analysis

This analysis is based on viewing the CBT acquisition as an investment paying annual dividends.

A. Year 1

1. Investment

$$\begin{aligned} &= \text{Initial Cost (item III)} \\ &\quad + \text{first year maintenance cost (item IV)} \\ &\quad + n \cdot CA \end{aligned}$$

where n = number of person-years to be spent the first year on courseware development for conversion courses.

2. Return

a. For each conversion course,

$$\begin{aligned} \text{return} &= \text{Annual Savings (item V)} \\ &\quad \times \text{fraction of year 1 that course is available} \\ &\quad \text{on CBT} \end{aligned}$$

NOTE: The "Net Initial Investment" = Investment - Return.

b. Year One return = sum overall conversion courses of results from a.

B. Years 2 through LS

1. Investment = Annual Maintenance Cost (item IV)
+ n . CA

2. Return = sum (overall conversion courses) of course annual savings x fraction of year course is available on CBT.

NOTE: For part B, a "net return" may be easier to use

Net return = Return - Investment

C. Now compute the "interest rate" using standard financial procedures. Model the CBT acquisition as an annuity having zero value at the end of its projected life span.

COST - BENEFIT

EXAMPLE

Suppose the company initially intends to convert 12 hours of a 16 hour Radiation Safety (RS) course and all of a 4 hour Radiation Safety Refresher (RSR) course to CBT. The following data is gathered

I.B.

		<u>RS</u>	<u>RSR</u>
1.	S	500	300
2.	H	12	4
3.	T	20	12

I.C.

1.	CS	100,000 = 100 K
2.	CI	100 K
3.	CA	100 K

I.D. LS 5 years

III. Initial Cost

A.

1. For RS

$$X = .75 \times 12 \times 500 = 4500$$

$$N = \frac{4500}{1800} = 2.5$$

$$\rightarrow 2N = 5$$

For RSR

$$X = .75 \times 4 \times 300 = 900$$

$$N = \frac{900}{1800} = .5$$

$$\rightarrow 2N = 1$$

2. Total number of terminals = 6

3.a. For RS

$$\frac{700 \text{ B}}{\text{frame}} \times \frac{1000 \text{ frames}}{\text{lesson hr}} \times .75 \times (12) = 6,300,000 \text{ B} = 6.3 \text{ MB}$$

For RSR

$$700,000 \times .75 \times 4 = 2.1 \text{ MB}$$

$$\rightarrow \text{Lesson storage} = 8.4 \text{ MB}$$

3.b. Records Requirements

$$2 \text{ KB} \times 500 \times .75 \times 12 \times 5$$

$$+ 2 \text{ KB} \times 300 \times .75 \times 4 \times 5$$

$$= 54 \text{ MB}$$

Mass storage requirements are on the order of 65 MB.

- B. For this example, assume several vendors quote a price in the neighborhood of \$100,000 for a six terminal system containing CPU, printer, authoring system, instructional management and delivery system, and sufficient mass storage to meet the requirements. Assume that no commercially prepared Radiation Safety courseware is being purchased. Finally, assume that the \$100 K price includes installation and training.

IV. Annual Maintenance Costs

$$.10 (\$100 \text{ K}) = \$10 \text{ K}$$

V. For RS

$$\text{TAS} = 500 \times (.25) \times 12 \times \frac{\$100\text{K}}{1800} = \$83.3 \text{ K}$$

$$\text{IAS} = 12 \times 20 \times \frac{\$100\text{K}}{1800} = \$13.3 \text{ K}$$

For RSR

$$\text{TAS} = 300 \times (.25) \times 4 \times \frac{\$100\text{K}}{1800} = \$16.7 \text{ K}$$

$$\text{IAS} = 4 \times 12 \times \frac{\$100\text{K}}{1800} = \$2.7 \text{ K}$$

Annual Savings ~ \$116 K

VI. Cost Benefit Analysis

1. Development Time is completed as follows:

- a. For RS, each of the $.75 \times 12 = 9$ student hours will require 80 hours of author time (assumption 4). The development time is then

$$9 \text{ stu-hr} \times \frac{80 \text{ author-hr}}{\text{stu-hr}} \times \frac{1 \text{ hr}}{1800 \text{ hrs}} \times \frac{12 \text{ months}}{\text{yr}} = 4.8 \text{ months}$$

Take development time = 5 months.

- b. For RSR, $.75 \times 4 = 3$ student hrs require development time of

$$3 \text{ stu-hr} \times \frac{80 \text{ author-hr}}{\text{stu-hr}} \times \frac{1 \text{ hr}}{1800 \text{ hrs}} \times \frac{12 \text{ months}}{\text{yr}} = 1.6 \text{ months}$$

Take development time = 2 months.

- c. This company will develop RS first then RSR so total development time is 7 months; RS will be available for 7 months the first year, RSR for 5 months.

- d. Then # of person-years spend developing courseware

$$= \frac{7 \text{ months}}{12 \text{ months/yr}} = .58 \text{ yr}$$

Initial Investment

= Initial System Cost + First Year Maintenance

+ Courseware Development Cost

$$= \$100K + \$10K + .58 (\$100K)$$

$$= \$168K$$

2. Year 1 return

Year 1 savings from RS

$$\$96.6 \text{ K} \times \frac{7}{12} = 56.4 \text{ K}$$

Year 1 savings from RSR

$$\$19.4 \text{ K} \times \frac{5}{12} = 8.1 \text{ K}$$

Net Year 1 Investment = 103.5 K

V1. B. Years 2 through 5 (LS = 5)

1. Investment = \$10 K

Assumes no further courseware development

2. Return \$116 K

Net Return \$106 K

Rate of Return

Invest \$103.5 K

Returning 106 K for four years (years 2 through 5)

Value at end of LS = 0

→ rate of return about 95%

Note: this sytem is paid for by the end of year 2.