OPTIMIZING MEDIA SELECTION

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This paper presents a procedure for optimizing the selection of study session and device session media up to but not including life cycle costing. The procedure is presented as a detailed sketch, rather than a complete guide to the process, since the process must be adjusted to fit individual situations.

Media selection involves three components: (a) determination of media requirements for each objective, (b) analysis of the requirements for individual objectives into optimized mixes of training media, and (c) selection of a final mix based upon cost and availability. This paper presents a number of steps to accomplish the first two components. The steps are flowcharted in Figure 1.

Objectives follow different paths after they are sorted into study session and device session (hands-on) types. Study session objectives are evaluated for special requirements like audio or motion portrayal, and all media which satisfy those requirements are listed. A set of alternate study session media plans is then prepared, with each plan giving priority to some media over others. For each plan, in turn, the highest priority medium which satisfies the special requirements for each objective is selected. The number of objectives for each medium is then totalled for each plan, and any adjustments caused by overemphasizing one medium are made. Device session objectives are classified by their instructional presentation/response requirements and then by the particular hardware/software requirements of the device being trained. Objectives are consolidated to yield descriptions of trainers. The outcome of the present procedure is a list of training devices which is optimized for the particular set of objectives being analyzed.

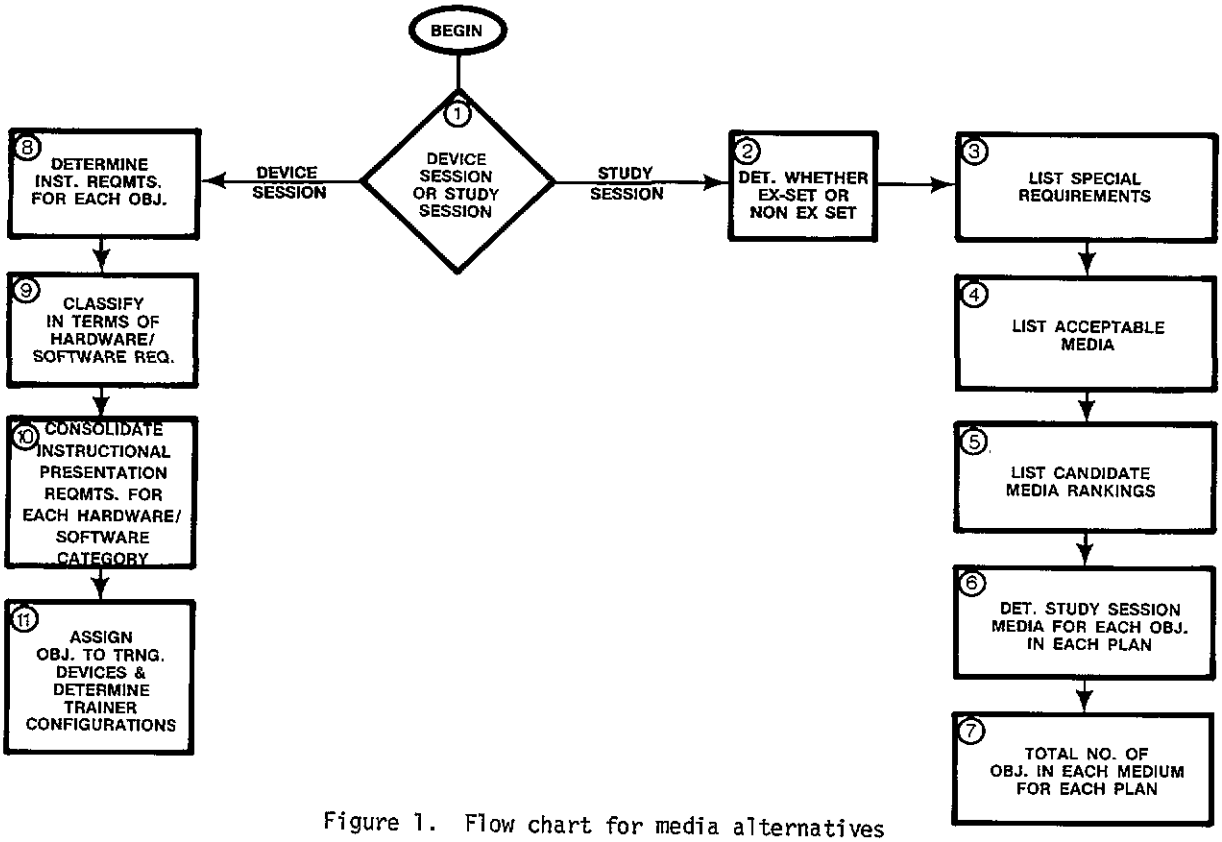

Figure 1. Flow chart for media alternatives

Each step will now be described in more detail.

STEP 1

Sort objectives into study session or device session types

The first major activity in the media selection process (Step 1) is to sort objectives into two groups: those which are study session type objectives, and those which should be presented in a "hands-on" device session exercise. Objectives are sorted because a different process is applied to the objective, depending upon which category it is in.

Study session objectives are those like stating a fact or steps of a procedure, which require self-study materials, or do not require major devices. Study session objectives may require additional materials (e.g., logs, charts, calculators, or protractors). So long as these additional materials can be stored and issued from the learning center, the objectives should be considered of the study session type. Objectives which require a particular spatial layout, tactile sensations, or movement, or which require a device which cannot easily be used in a learning center are classified as hands-on.

Study Session Media

STEP 2

Designate objectives as example-set or non-example set types

The next step for study session objectives (Step 2) is to determine whether the objective is an example-set objective or a non-example set objective. Example-set objectives are those which require multiple examples in order to present the full range of possibilites for the objective. A concept in which the student must classify an item, or a complicated rule which requires the student to use many types of inputs are example-set objectives. On the other hand, facts or procedures which are always performed the same way may be taught by presentation of a single statement of the fact or procedure (perhaps with a clarifying figure or illustration) and do not require an example set.

STEP 3

Identfy special requirements for Study Session objectives

In Step 3, special requirements are noted. These may include audio, color, visual motion, manipulation of two dimensional simulated hardware, direct instructor evaluation, automated right-wrong scoring, and high rate of revision.

Objectives which require an audio component are those based upon aural discrimination or identification such as recognizing a particular missile warning tone or voice communication. Audio, like other special requirements, should be specified only if it is essential to the performance of the objective.

"Nice-to-have" characteristics should not be specified at this point. Color should be specified as an instructional requirement only when the learner must make a discrimination or identification based upon color. Visual motion (e.g., film or videotape) is required when the student must evaluate or identify a motion change as such. For example, rapid changes in gauge readings or in targets which are to be tracked require visual motion.

The objective must also be evaluated in Step 3 for the special response requirement of manipulating hardware controls as represented on a flat screen or picture. That is, a student may be required to push buttons, read dials or flip switches where the fidelity of the system is less important than the location and sequence of the actions. For example, setting up a complex piece of equipment may be taught using a computer-driven cathode-ray tube to simulate the face of the equipment and a light pen for the student to indicate switch settings and button pushes.

Special response detection and evaluation requirements must also be specified in Step 3. Occasionally an objective will require direct instructor evaluation. Automated right-wrong scoring should be used where the student requires immediate feedback about an action which can be relatively easily evaluated. For example, the student may be required to solve a series of problems where partial answers must be evaluated before the student progresses to the next portion of the problem.

Expected rate of revision must also be specified since media have differing ease of revision. For example, very frequently changing material may best be delivered by lectures or on a computer-assisted instruction system (CAI), where a single change to the disk automatically produces changed copies each time the material is used. More stable material might be presented by workbook, where the material may be edited, typed, proofread, pasted-up, and printed. Slide tapes and video tapes are usually the least appropriate media for rapidly changing material.

STEP 4

List acceptable media for each Study Session objective

Once the special requirements of each objective have been identified, they are compared to the capabilities of already known and existing study session presentation media (Step 3). The result of the comparison is a list of all study session media which can be used for presentation of the instruction for that objective. One of the outputs of this matching of objective requirements to media capabilities may be the identification of some objectives for which no existing presentation media is acceptable. New types of media or combinations of media must be identified to handle the requirements of these objectives, for which the precise characteristics have been delineated in steps 2 and 3.

Figure 2 presents a matrix of special characteristics by study session media. Figure 2 is used by placing a check beside each special required characteristic for the objective, then locating each media column which includes all special required characteristics. In this way all candidate media will be identified which can support the particular objective.

STEP 5

Rank media in alternate plans

A result of Step 4 will be a number of media which are all capable of presenting instruction for a given objective. In order to choose between media, it is necessary to rank the different media. In step 5, a number of plans for utilizing media are developed based on alternate media rankings. Figure 3 presents a sample media ranking.

SPECIAL CHARACTERISTICS	Workbook	Workbook with color photographs	Lecture &wkst.	*Lecture & wkst. & overhead sessions*	Lecture & wkst. & and audio tape	Lecture & wkst. & slides & tape	Lecture & wkst. & VT	Lecture & wkst. & model	Audio tape & wkst.	Slides & wkst.	Slides & audio tape & wkst.	Random access slides & wkst.	Videotape & wkst.	Film & wkst.	CAI	CAI & wskt.	CAI & wkst. & VT
Audio					●	●	●		●		●		●	●	4	4	●
Color graphics		●		●		●	●			●	●	●	●	●	4	●	●
Visual motion							●						●	●	4		●
Manipulate hardware (2-D)								3							●	●	●
Direct instructor observation	1	1	●	●	●	●	●	●	1	1	1	1	1	1	1	1	1
Automated right/wrong scoring	2	2	2	2	2	2	2	2	2	2	2	2	2	2	●	●	●
Example set	●	●	●	●	●	●	●	●				●			●	●	●
High Revision Rate			●	●											●	●	

NOTES TO MATRIX

1. Direct instructor observation can be available in these media. However, this implies an additional resource requirement not normally associated with these media.

2. While an automated response detection and evaluation system is not normally present with these media, it is possible to add this capability. However, this addition in capability requires an increase in the resources needed to support the medium.

3. This capability depends on the characterisitcs of the model used.

4. Whether or not a CAI system has these display capabilities is highly dependent on the characteristics of the CAI system. As a general rule these characteristics are NOT normally available.

Figure 2. Matrix of Special Characteristics by study session media

Study Session Media Ranking A

MEDIUM	CEILING PERCENTAGE
1. Workbook	(70%)
2. Workbook with color photographs	(70%)
3. Audiotape with worksheet	(50%)
4. Slides and worksheet	(50%)
5. Random access slides and worksheet	(50%)
6. Slides, audiotape, and worksheet	(50%)
7. Videotape and worksheet	(25%)

An automated test-scoring and recording device will also be included in this plan to handle record-keeping requirements.

Figure 3. Sample Media Ranking

Each medium which is a candidate is listed in priority, so that an objective which can be satisfied by several media will be assigned to the medium of highest priority. In addition, an arbitrary ceiling percentage is established for each medium within the mix so that one medium (like workbook) is not assigned too large a percentage of the objectives to achieve high effect.

The rankings should be based upon present availability of media, estimated cost, need for central control, abilities and preferences of the target audience and the rapidity and extent of revisions. If the client has a variety of good equipment available (e.g., word processors, drafting tables, stat camera, printing press, slide facilities, TV studio), one of the alternate media mixes should maximize use of present equipment. One mix should minimize estimated front-end costs. The costing must be rough at this stage but can involve acquisition of production equipment, or for example, an expensive CAI system. Another mix may emphasize centralized control using CAI and minimize lectures which tend quickly to become non-standardized. Yet another mix may optimize ease of revision using lectures and CAI while severely limiting videotapes.

The developer must also consider student ability and effect. For example, students with a low-reading level should not be given large amounts of workbooks. The developer must consider how students will feel if a large portion of the study session instruction is in workbook or any one medium, and limit the total percentage for each medium in the mix (this applies primarily to the high-priority media in each mix).

STEP 6

Determine study session media for each objective for each plan

Once the media mixes have been established, they can be used along with the list of acceptable study session media for each objective to determine the study session medium, since each mix lists the media by priority.

STEP 7

Total number of objectives in each medium for each plan

Step 7 totals the number of objectives presented in each medium for each media plan.

If the total for any medium is greater than its allotted percentage, the developer must decide whether to accept the overage, to add effective elements (like cartoons to workbooks), or to reassign objectives. Reassignment can be based, for example, on selecting lessons which are likely to be revised frequently and presenting them in lectures, or selecting lessons which do not require color but would be enhanced by it and presenting them on slide/tape.

Choice between alternative plans can be based upon management factors like cost, need to accomplish rapid revisions and need for central control. Each media mix includes every study session objective, with a justification for the objective's assignment to a given medium.

Device Session Media

The procedure used to specify device session devices is different from that used for study session media, because device sessions must usually model a specific device and, therefore, the devices must be designed from scratch rather than using off-the-shelf systems like video tapes or slide tapes. Study session materials usually are relatively independent of the particular equipment being trained: A slide tape can present the procedures used to preflight any number of a set of pieces of gear, while a device session requires much greater fidelity to the individual pieces of equipment.

STEP 8

Determine instructional presentation requirements for each "device session" objective.

Those objectives which were identified in Step 1 as requiring a hands-on exercise are examined during Step 8 to determine their instructional presentation

requirements. The worksheet shown in Figure 4 can be used to record the information for each objective. The types of devices should be specified in advance. Possible device types are:

A. Schematic representation (e.g., of system flow) with line drawings, photos, or visual motion but not in proper spatial orientation.

B. Schematic representation with tactile sensation, manipulation of hardware, and real-time interaction.

C. Two-dimensional static display with the same spatial layout as actual equipment.

J. Simulator with motion base and performance playback.

STEP 9

Classify each "device session" objective in terms of its hardware/software system capability requirements.

In addition to classifying each hands-on objective in terms of its instructional presentation requirements, it is also necessary that each be classified in terms of its hardware/software system capability requirements. This is important since hands-on devices are often expensive to develop and costly to operate. For this reason, the training devices must possess the right combination of instructional and hardware/software capabilities to allow for maximum utilization of the devices, accomplishment of all objectives, and minimum development and operating costs. The procedure presented in this step is not algorithmic, in that it results in one correct answer which satisfies all of the above criteria. It is analytic in that it allows for systematically examining the variables which go into determining the "optimal solution." The final grouping of requirements and identification of a trainer suite should be based on the results of this procedure together with knowledge of cost and availability of present trainers. For example, it may be less expensive to modify an existing complex device or to stimulate the actual equipment than to design and build a less complex device. Moreover, it may be less expensive to design and build two copies of a complex device than to design and build two separate devices, one which is complex and another which is simpler.

In order to determine hardware and software requirements, a table is constructed which lists the course objectives down the side and hardware/software systems and subsystems across the top. Figure 5 presents

CATEGORIES (INPUT)	DEVICE TYPES (OUTPUT)									
	A	B	C	D	E	F	G	H	I	J
Audio							●	●	●	●
Visual motion	●	●				●	●	●	●	●
Tactile sensations		●		●	●	●	●	●	●	●
Spatial layout			●	●	●	●	●	●	●	●
Movement sensations									●	●
Manipulate hardware (3D)		●			●	●	●	●	●	●
Direct instructor observation	●	●		●	●	●	●	●	●	●
Delayed instructor evaluation & scoring							●	●	●	●
Automated right/wrong scoring	●	●				●	●	●	●	●
Automated tolerance data collection							●	●	●	●
Branch to new display		●				●	●	●	●	●
Real time interaction		●				●	●	●	●	●
Performance playback								●		●

Figure 4. Matrix of Characteristics of Device Sessions Types

an example of a small portion of such a table. The proper column headers can be identified using the following procedure:

First, for each training track, each hardware/software component directly utilized, inspected, or serviced in a hands-on mode is listed. Components directly utilized or manipulated by the person are included as well as integrated components at the level of detail normally utilized on the job. For example, integrated panels rather than single switches are included for a pilot.

Following the list of single components above, all hardware combinations commonly utilized simultaneously can be listed. An example for a pilot of two hardware systems commonly used simultaneously is the Head-Up Display (HUD) and the Flight Control System. First, list all pairs, then all triples (e.g., the HUD, Flight Control System, and communication panels), then all four types, etc., until all common combinations have been enumerated. If several people work as a team, include all equipment required by the team.

Once this table has been constructed for all training tracks, the hardware/software system requirements can be identified. To do this, for each objective find the simple column which represents the mix of hardware and software systems and subsystems needed to adequately perform the objective. If no column corresponds to the necessary hardware and software requirements, then a new column should be added to the table. Once the appropriate column has been found, the letter of the acceptable device presentation/response type is entered in that box. For example, in Figure 5, objective 1.2.2 requires the Flight Control System (FCS). The letter of the device presentation/response type (Type A) is written in the intersection of objective 1.2.2 by FCS. Only one column is used for each objective.

Objective	Component					
	HUD	Flt. Control Sys (FCS)	Comm	ECM	HUD-FCS	HUD FCS Comm
	1	2	3	4	5	6
1						F
1.1	D					
1.1.1	D					
1.2		H				
1.2.1		G				
1.2.2		A				
2					F	
2.1					E	
2.2					E	
2.2.1					A	
2.2.1.1.					A	
2.2.1.2					A	
3			C			
3.1			A			
Consolidation						

Figure 5. Sample table of objectives by hardware/software components

STEP 10

Consolidate instructional presentation requirements for each trainer hardware/software systems-requirements category.

The objectives must be grouped in some systematic way in order to arrive at an optimal set of trainer descriptions. The first step in this consolidation process is to determine the presentation/response type which is adequate for all objectives with each given hardware/software system (i.e., columns in Figure 5).

Usually complex devices can accommodate the presentation/response requirements of objectives assigned to simpler devices. Therefore, each hardware/software column is scanned to find the one or possibly two most complex devices, and all objectives in the column are assigned to the complex device. This is done since the device must be constructed in any event to satisfy an objective, and it should be used to its maximum.

STEP 11

Assign objectives to training devices and determine final trainer configurations.

a. Identify hardware/software system requirements of most complex trainer.

In relative terms, the training device which is most expensive to develop and operate is the device which is most critical to use properly. Therefore, the hardware and software requirements of the most complex

device should be determined first to allow maximum flexibility in the assignment of objectives to that device. This is done by examining the training device requirements table which has been consolidated with a column, and identifying the column or columns which contain the largest number of hardware/software (H/S) system requirements.

The instructional presentation/response requirements for that set of H/S system requirements was determined in step 9 and consolidated in step 10.

These two sets of requirements serve as the basis for characterizing the capabilities of the most complex training device. Using this information, a tentative description of the training device is developed to outline the proposed capabilities and features of the device.

b. Estimate trainer time available for each student on the most complex trainer.

Having tentatively specified the required characteristics of the most complex trainer, it is possible to identify hands-on objectives which can be accomplished by using that trainer. However, prior to beginning this, a question which must first be answered is: How many objectives can be assigned to the trainer to fill (but not overfill) the time available on it? A formula to compute time available for each trainer has been developed. Essentially it multiplies number of days in the training program by hours available per day, then divides by number of students. Corrections are made for anticipated downtime and proportion of day used.

c. Assign objectives to the trainer until all available trainer time has been used up.

Once steps a and b have been completed, it is possible to begin making a fairly firm assignment of objectives to the device. To ensure that the most appropriate objectives are assigned to the device, the following priorities may be used.

PRIORITY I

Objectives which require the full range of both the instructional presentation and response (P/R) capabilities, and the H/S system capabilities of the trainer device.

PRIORITY II

Objectives which will require the full range of the H/S system capabilities but less than the full range of P/R capabilities.

PRIORITY III

Objectives which will require somewhat less than the full range of H/S system capabilities but the full range of the P/R capabilities.

PRIORITY IV

Objectives which will require less than the full range of both the P/R capabilities and the H/S system capabilities.

All objectives in Priority I class should be assigned prior to assigning any objectives in Priority II class. When choosing between objectives within priority classes, those objectives which come closest to using the full range of capabilities should be assigned first. When choosing between objectives in Priority IV class, the H/S system requirements should be the controlling factor for assigning objectives.

d. Repeat trainer requirements determination and objectives assignment process for each required trainer.

Once the requirements have been determined for the most complex trainer and objectives have been assigned to it, the process outlined in steps a, b, and c can be repeated with the remaining hands-on objectives for the next most complicated trainer. The process should be repeated again and again until all trainers have been identified and all objectives have been assigned.

At this point, it is useful to examine the entire set of trainer assignments. The procedure recommended in this approach will result in all trainers, except the last of each type, having enough objectives assigned to them to fill all available time. For this reason, the trainer assignments should be examined to see if some minor shifts can be made in the assignments to equalize the usage levels.

e. Develop detailed description of each trainer.

Once satisfactory assignment of objectives to trainers has been reached, it is necessary to prepare a more detailed specification of the required capabilities of each training device. The instructional presentation capabilities and the hardware/software capabilities should be specified in detail. These descriptions should be sufficiently complete so that they can serve as input to the development of the trainer functional specifications.

Following this process, it is necessary to develop a detailed set of functional specifications and detailed costing and support-requirements estimates for each proposed trainer. These steps need to be worked out with manufacturers of the equipment.

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