THE ROLE OF SIMULATION IN LARGE-SCALE ISD

DR. G. P. KEARSLEY AND DR. A. F. O'NEAL
Courseware Incorporated

The scope and complexity of major Instructional Systems Development (ISD) programs and the sophistication and detailed definition of the particular ISD models being utilized in the military have greatly increased in the last few years. The advanced planning and day to day management required for such programs has become commensurately more difficult and complex. The interactions among the many resources, personnel, and scheduling requirements involved increases the difficulty of identifying specific sources of problems and responding to them without causing other problems elsewhere. In response to this management challenge, interest is greatly increasing in comprehensive, real-time integrated information management systems for ISD which incorporate a variety of flexible management projection and simulation capabilities. It is becoming essential to give managers the tools to test the impact of their decisions before they commit themselves to courses of action whose consequences are not completely understood. This paper discusses the nature and implications of such simulation capabilities in ISD program management with particular reference to two projects recently completed under contract to Defense Advance Research Projects Agency (DARPA) and the Naval Training Equipment Center (NAVTRAEQUIPCEN).

In the context of ISD management systems, simulation capabilities provide two major functions: projection of existing trends and modeling of changes to the present system parameters. Thus, it is possible to determine the estimated start/finish dates for any/all tasks or events in the ISD program. It is possible to ask such questions as "with current personnel and resource conditions when will the course be finished?," "how much of each skill or other resource available will be used?," or "how much time of person X can be released while maintaining the projected completion date?" If a planned media alternative is written out for some reason, what will be the effects on the program? For example, suppose a course being developed has 40 videotapes specified but the project is now running over budget. It would be possible to explore the possibility of replacing those videotapes with a more economical media such as slide/tapes to see what effect they will have on budget, resource utilization, and project completion dates. Another possibility is to furnish the system with a desired completion date and calculate the conditions necessary to meet that deadline including all resource needs. With these types of "what if" capabilities, it is possible to determine the real cause of problems or delays. For example, it may be found that the planned hiring of two more instructional psychologists will have no effect on production rate or completion deadline. With the help of some exploration using the simulation capabilities, it might be revealed that the real bottleneck is in review and editing personnel.

Simulation capabilities such as those described above have been provided in two ISD management systems developed by Courseware Inc. The Author Management System (AMS) is an operational prototype system developed under contract to DARPA implemented on minicomputer in BASIC (1). It provides a set of management support capabilities for the design, development, production, and ongoing curriculum maintenance phases of ISD. It tracks the exact stage of completion of each identified course component and monitors the workloads, current assignments and deadlines of all personnel. A major built-in feature of AMS is the generation of reports which indicate estimated and projected dates of completion or resource expenditures. For example, Figure 1 shows a total course projection report indicating estimated projected resource utilization and Figure 2 illustrates a manpower projection report which indicates overall projected project completion date. If the amount of time estimated to be required of a particular class of personnel on some project activity is altered, it is possible to see the overall effect on project costs and completion date. Thus, AMS allows the investigation of the effects of salary increase, addition or loss of specific personnel or classes of personnel, budget cuts, changes in syllabus or media, changes in project procedures, or changes in the time frame available for developments.

The Computer-Aided Training System Development and Management (CATSDM) project funded by NAVTRAEQUIPCEN (2) has resulted in the specification of a system of programs and databases to support all phases of the ISD process in the military training context. These programs are organized according to

**** TOTAL COURSE PROJECTION ****
USING PRESENT RATE OF COMPLETION
MONDAY, MARCH 6, 1978

RESOURCE		UNITS ESTIMATED	UNITS PROJECTED	MONEY ESTIMATED	MONEY PROJECTED	RATE
01	INSTRUCTIONAL PSYCHOLOGIST	85.00	85.00	1719.55	1719.55	1.000
02	SUBJECT MATTER EXPERT	653.00	653.00	8044.96	8044.96	1.000
03	AUTHOR	511.50	511.50	629.15	629.15	1.000
04	TYPIST	213.00	213.00	928.68	928.68	1.000
05	INSTRUCTIONAL TECHNOLOGIST	82.00	82.00	1260.34	1260.34	1.000
06	EDITOR	317.00	317.00	2396.52	2396.52	1.000
07	ARTIST	944.50	944.50	13733.03	13733.03	1.000
08	PRODUCTION MANAGER	46.50	46.50	609.62	609.62	1.000
09	WORD PROCESSOR	201.50	201.50	1904.18	1904.18	1.000
10	PASTER-UPPER	77.50	77.50	508.40	508.40	1.000
11	MEDIA EXPERT (S/T)	120.00	120.00	894.00	894.00	1.000
12	SCRIPTWRITER	310.00	310.00	4163.30	4163.30	1.000
13	PHOTOGRAPHER	100.00	100.00	345.00	345.00	1.000
14	MEDIA EXPERT (S/D)	89.00	89.00	1098.26	1098.26	1.000
15	LYRICIST	70.00	70.00	241.50	241.50	1.000
16	COMPOSER	70.00	70.00	535.50	535.50	1.000
17	CHOREOGRAPHER	301.00	301.00	1369.55	1369.55	1.000
18	DIRECTOR	91.00	91.00	576.94	576.94	1.000
19	KAZOO PLAYER	91.00	91.00	395.85	395.85	1.000
20	SINGER	91.00	91.00	696.15	696.15	1.000
21	DANCER	91.00	91.00	303.03	303.03	1.000
22	DEC	186.00	186.00	4151.52	4151.52	1.000
				46505.03	46505.03	

ORIGINAL ESTIMATE: 46505.03 DOLLARS
PROJECTION AT PRESENT RATE: 46505.03 DOLLARS
WHICH IS 0 DOLLARS DIFFERENT FROM ESTIMATE

Figure 1.

*** MANPOWER FOR COURSE COMPLETION ***
USING PRESENT RATE OF COMPLETION
TUESDAY. MARCH 7. 1978

RESOURCE	— HOURS TO COMPLETE THE PROJECT — ESTIMATED	PROJECTED	AVAILABLE	RATE
01 INSTRUCTIONAL PSYCHOLOGIST	79.00 -	282.82 -	3102.00	3.580
02 SUBJECT MATTER EXPERT	620.00 -	1264.80 -	2831.28	2.040
03 AUTHOR	511.50 -	511.50 -	1942.98	1.000
04 TYPIST	213.00 -	213.00 -	2509.80	1.000
05 INSTRUCTIONAL TECHNOLOGIST	82.00 -	82.00 -	2346.24	1.000
06 EDITOR	317.00 -	317.00 -	1646.88	1.000
07 ARTIST	944.50 -	944.50 -	1229.52	1.000
08 PRODUCTION MANAGER	46.50 -	46.50 -	879.84	1.000
09 WORD PROCESSOR	201.50 -	201.50 -	817.80	1.000
10 PASTER-UPPER	77.50 -	77.50 -	710.64	1.000
11 MEDIA EXPERT (S/T)	119.00 -	505.75 -	924.96	4.250
12 SCRIPTWRITER	310.00 -	310.00 -	902.40	1.000
13 PHOTOGRAPHER	100.00 -	100.00 -	1128.00	1.000
14 MEDIA EXPERT (S/D)	86.00 -	465.26 -	479.40	5.410
15 LYRICIST	70.00 -	70.00 -	676.80	1.000
16 COMPOSER	70.00 -	70.00 -	225.60	1.000
17 CHOREOGRAPHER	301.00 -	301.00 -	338.40	1.000
18 DIRECTOR	91.00 -	91.00 -	141.00	1.000
19 KAZOO PLAYER	91.00 -	91.00 -	338.40	1.000
20 SINGER	91.00 -	91.00 -	180.48	1.000
21 DANCER	91.00 -	91.00 -	112.80	1.000
22 DEC	186.00 -	186.00 -	203.04	1.000
23	0.00	0.00	---NA---	0.000
24	0.00	0.00	---NA---	0.000
25	0.00	0.00	---NA---	0.000
26	0.00	0.00	---NA---	0.000
27	0.00	0.00	---NA---	0.000
28	0.00	0.00	---NA---	0.000
29	0.00	0.00	---NA---	0.000
30	0.00	0.00	---NA---	0.000
31	0.00	0.00	---NA---	0.000
32	0.00	0.00	---NA---	0.000
33	0.00	0.00	---NA---	0.000
34	0.00	0.00	---NA---	0.000
35	0.00	0.00	---NA---	0.000
36	0.00	0.00	---NA---	0.000
37	0.00	0.00	---NA---	0.000
38	0.00	0.00	---NA---	0.000
39	0.00	0.00	---NA---	0.000
40	0.00	0.00	---NA---	0.000

ASSIGNMENTS REMAINING TO COMPLETE: 2046
TASKS REMAINING: 1285

ASSUMING AVAILABLE SKILLS AND
EXCLUDING ANY SKILLS PRESENTLY NOT AVAILABLE
OR NOT APPLICABLE (---NA---). THE PROJECTED
DATE OF COMPLETION IS WEDNESDAY. SEPTEMBER 13. 1978

THE THREE SKILLS TAKING THE LONGEST TIME
WITH THE PRESENT PERSONNEL ARE. IN ORDER: 14 22 17

Figure 2.

five major ISD phases: analysis, design, development, implementation, and evaluation. Simulation capabilities are specified in all five phases; however they are most fundamental to the programs in the design phase. For example, the Media Selection Program assists in identifying the optimal delivery medium and all alternative acceptable media for each objective in the curriculum. When available instructional media are not clearly defined, this program can project possible alternatives. In cases where media changes must be made, the program can make recommendations based upon the instructional requirements of the objectives. For example, the Syllabus Development Program assists the ISD team in sequencing and organizing the objectives, developing course maps or class schedules. The simulation capabilities involved here are the projection of periods of peak resource utilization or of the revised syllabi necessitated by an instructional resource (e.g., instructor, trainer, classrooms) being unavailable.

Thus, AMS and CATSOM illustrate how simulation can be helpful at many different levels of the ISD process. This includes the level of project administration in terms of the effects of changes in resources on budgets and deadlines; the level of curriculum and instruction where the varying effectiveness of different lesson plans, media selections, or teaching strategies can be explored; and the level of ISD models or principles which involves the use of historical data from past ISD efforts to assess the validity of proposed ISD analysis design, development, implementation, or evaluation models before they are applied to real projects.

The effectiveness and validity of these types of simulation capabilities will be highly dependent upon the adequacy and completeness of the current and historical data bases. Thus, the current data base must provide an accurate picture of available resources, status of the development of project components, specification of ISD event sequences and their resource/personnel requirements and identification of the roles and skills of the ISD team. The historical data base represents a cumulative record of personnel efficiency, resource utilization, instructional effectiveness of part syllabi and media selections, and the amount of time that any ISD task has actually taken, both in specific instances and across all occurrences. The historical data base is clearly a very crucial factor in producing valid simulation results; it is also a feature which is most often lacking in past ISD efforts. Indeed, until the sort of management planning capabilities discussed above are available, there has been no practical way to collect such detailed historical data on ISD efforts.

There are a variety of general-purpose and even of training-program-specific simulation systems becoming available. These are currently finding their most effective use in planning and training support requirements analysis of major programs. Among these are such program/systems as MODIA (3), L-COM (4), and DOSS (5). These programs, while they reflect varying degrees of sophistication and power, do not offer the solutions and support required for the real-time or on-line management of major ISD activities. Characteristics of the management systems which are required now, and which will be required in the near future, are fairly straight forward. Due to the compressed time frames of most ISD activities and the great number of short-term deadlines and simultaneous activities being undertaken, the system must be real-time and should support the capability for routine data collection, project monitoring, and report generation activities at the same time that they support the types of management simulation activities discussed here. Simulation capabilities being added to the new generation of training systems such as the Navy VTS (6) or the Air Force AIS (7) will probably meet these requirements.

These ISD simulation systems must have a number of essential features. One important characteristic of these systems is that they should be human engineered for users such as project managers, secretaries, psychologists and ISD team personnel, not computer programmers. A counter-example here might be MODIA, one of the most powerful and flexible of the simulation/projection systems currently available. The use of MODIA requires at least two expert teams of personnel. One team of personnel should be experts in the system being analysed and the other team must be specifically trained and experienced in the use of the MODIA program itself. In other words, this system, while powerful and sophisticated is not human engineered to the class of users involved in most ISD activities.

It is also important that the simulation and planning capabilities be integrated into a comprehensive ISD management system such as the CATSDM project. Attempting to add simulation or modeling capabilities in a piecemeal fashion can result in a Tower of Babel from a programming and data base organization standpoint and typically makes

the system cumbersome and inefficient. This argues for the general point that simulation must eventually be accepted as an integral component of the ISD management process.

REFERENCES

(1) Contract DARPA 903-76-C-0216

(2) Contract N61339-77-C-0018 (NAVTRAEQUIPCEN)

(3) MODIA: Vol. 1, R-1700-AF, March 1977
MODIA: Vol. 2, R-1701-AF, April 1977
The Rand Corporation

(4) L-COM: RM-5544-PR, May 1968
The Rand Corporation

(5) DOSS: R-1435-PR, July 1974
DOSS: R-1610-PR, January 1975
The Rand Corporation

(6) Integrated Logistic Support Plan for the Versatile Training System
REG 31408-90-76, Naval Weapons Center, China Lake, California, February 1977

(7) Advanced Instructional System (AIS), Functional Specifications
AFHRL, Lowry Air Force Base

ABOUT THE AUTHORS

DR. A. FRED O'NEAL is Director of the Computer Applications Division of Courseware Inc. He has been involved in the field of computer based instruction for over 12 years and has considerable experience in the area of Instructional Systems Developments (ISD) for military, industrial and academic training. He holds a Ph.D. in Instructional Psychology from Brigham Young University.

DR. GREG P. KEARSLEY is an Instructional Psychologist with Courseware Inc. He has experience as a systems and applications programmer in the areas of operations research and simulation and has done research in many areas of cognitive psychology and artificial intelligence.