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ABSTRACT

The nonprofit special organization as a developer of computer-administered instruction (CAI) is advocated in this paper. The organization of universities and their mode of operation do not lend themselves to instructional product development. Faculty members engage in such efforts on a part-time basis and in competition with higher priority concerns. Also, universities and their faculties tend to have few incentive structures to promote compatibility and widespread dissemination for their instructional products. While commercial publishing houses have such interest, their profit-making needs mitigate against expensive cyclical product developments aimed at maximizing instructional effectiveness. Because the nonprofit special organization's mission orientation, internal organization, and reward structure tend to serve this end, it is proposed as the appropriate developer. (Author/JK)

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Who Should Develop Instructional Materials for CAI?

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16. Abstracts

The nonprofit special organization as a developer of computer-administered instruction (CAI) materials is advocated in this paper. The author points out that universities' organization and mode of operation do not lend themselves to instructional product development. Faculty members engage in such efforts on a part-time basis and in competition with higher priority concerns. Also, universities and their faculties tend to have few incentive structures to promote compatibility and widespread dissemination for their instructional products. While commercial publishing houses have such interest, their profit-making needs mitigate against expensive cyclical product developments aimed at maximizing instructional effectiveness. Because the nonprofit special organization's mission orientation, internal organization, and reward structure tend to serve this end, it is proposed as the appropriate developer.

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Prefatory Note

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WHO SHOULD DEVELOP INSTRUCTIONAL MATERIALS FOR CAI?

Robert J. Seidel

In this paper we ask: Is it necessary or desirable that a specialized organization—whether one needs to be established or already exists--be the focal point for production of materials for computer-administered instruction (CAI) in higher education? The affirmative answer is based on two premises:

(1) Currently, the time a university professor spends in learning how to interact with the computer and to take advantage of its capabilities, and in producing materials to be administered at a terminal, usually comes about as an adjunct to his teaching requirements and his administrative duties. Thus, it is a part-time, secondary effort that he can give to the problem of material construction.

(2) The very nature of using computer capabilities involves a totally comprehensive and new look at the world of education as a system if we are to fully utilize this electronic device.

The areas of expertise required are indeed multidisciplinary. Furthermore, a specialized organization with the necessary disciplines available, permits a perspective much broader in scope and much more useful than the narrow view that may result when a subject-matter scholar himself attempts to develop these materials, or when he works with a group, such as a publisher, having a commercial interest in turning out a product for profit. I believe the profit-oriented company is inappropriate to the task because its very nature involves it in a conflict of private versus public interest.

Nonprofit research and development organizations do not have a particular vested interest, and some have had a history (nearly 20 years in HumRRO's case) of improving the instructional development for one user by means of helping the user to see that *what* to teach is equally important with *how* to teach it.

The concept and techniques of task analysis had its roots in, and for decades has been used effectively by, industrial and military organizations. Perhaps in this military/industrial origin lies at least a partial reason for the lag in adoption of the concept by the educational establishment. But with the term, "programed instruction," this same engineering process—the careful determination of objectives, development of tests to measure those objectives, and successive try-out of materials until students learn from them--has become more acceptable. This engineering of the design of instructional systems for training has also benefitted from complementary strategies developed to improve the organization of the materials for presentation (Shoemaker, 1). For example, placing the instructional materials in a functionally outlined context to represent the tasks in microstructure as they are eventually to be performed in the larger, end-of-training context, has been quite beneficial. It also serves to screen irrelevant subject matter from courses of instruction. In like manner, an analysis of the situations our students will face after they leave college and begin working, enables us to define the performances they must develop while students.

The techniques of computerized job analysis which Dr. Raymond E. Christal and his associates at the Personnel Research Laboratory, Air Force Systems Command, Lackland Air Force Base, Texas, have developed (Morsh, 2; Archer, 3; Harding and Downey, 4; Morsh, Giorgia, and Madden, 5) can determine with considerable precision the most

commonly performed tasks. These techniques can also cluster position descriptions into job types, and can determine how jobs differ when occupied by people of differing experience. These procedures have been developed by organizations of specialists outside educational institutions. However, the detailed procedures are all available for determining the demands for job-oriented higher education (Smith, 6), as are methods for specifying objectives precisely (Mager, 7; Ammerman and Melching, 8). With liberal arts courses, similar techniques can be applied (Smith, 6), although with less precision.

The effort to develop objectives by looking outside educational institutions can lead to revolutionary changes in instruction. HumRRO research cites instances in which instruction has been shortened by half and then has yielded higher levels of proficiency as compared to a standard course. The keys have been (a) analysis of required job behavior and the learning tasks involved, (b) appropriate course design, and (c) improved organization of instructional materials based on diagnostic evaluation and repeated redesign to achieve desired effectiveness and efficiency.

Both the *what* and the *how* aspects of instruction become even more important because of expense, complexity, and potential of the system involved when a computer is to be used in the instructional loop. One of the most pressing needs in the field of instructional development involving the use of the computer (whether it be drill-and-practice use or for other adjunctive uses, including tutorial) is a commonly accepted basis for determining costs. Preliminary experiences at various educational institutions (Bunderson, 9) clearly indicate the wide variety in production costs per hour of CAI instruction. These figures sometimes are as much as three to four times greater from one installation to another and at least some of the variation stems from differences in the complexity of the materials produced, use of revision costs in the analysis, inclusion of evaluation, and inclusion or exclusion of development costs for languages, systems, and authoring techniques. The director of a leading university-based CAI laboratory made this statement recently:

> "Based on the experience gained on these and other projects, we see how many costly aspects of development could be reduced by the application of better management, design, and production techniques and better CAI languages and systems. There are certain irreducible human costs for management, authoring, and evaluation-revision which cannot be automated, however, and for which there appear to be no dramatic shortcuts." (Bunderson, 9)

The question concerning the role of the computer in producing materials can be asked in another way: Is it desirable to progress in the field of instructional development by an approach that is basically a trial-and-error, small-scale attempt to incorporate the computer within the current folklore of instructional development? Or will we recognize the need to fully utilize the capabilities of the computer within a changing environment of instructional development and administration? If the latter is accepted, the specialized organization is a desirable candidate. The investment will be much greater in dollar resources required and in personnel, but the "payoff" can be much, much greater in terms of the development of a new educational system.

Why is the specialized organization needed? For one reason, the talents required are not present in any given university department. For another, as indicated above, talents that do exist in multidisciplines to attack the problems of developing material require a full-time effort. Whether a specialized organization handles the development of instructional materials, or whether an already existing structure is used, nevertheless the full-time talents of subject-matter scholars, behavioral scientists, computer science specialists, and hardware experts are required (Seidel and Kopstein, 10). Moreover, existing reward structures in universities do not support repetitive product improvement of course materials (e.g., "publish or perish" requirements, departmental dogma).

A summary of the obstacles found in one university installation when an attempt was being made to introduce some CAI materials for needed prerequisite skills lists the following:

"1. The lack of a cost-effective, service-oriented terminal facility.

2. The problem of "grafting on" an individualized, adjunct course to the lock-step, tightly scheduled course structure of universities.

3. The lack of fundamental interest and incentive of teaching assistants and other faculty in meeting the basic needs of freshman students." (Bunderson, 9)

These difficulties may arise because the departmental and disciplinary structures do not lend themselves to crossing these lines to promote inter-disciplinary collaboration. Finally, even if such interest could be created, there would be no interest in achieving compatibility of the computer-based materials with computer installations at other universities. The lack of interest in compatibility—a crucial but widely ignored problem—derives from the lack of incentives for widespread dissemination of the instructional materials. This holds for the potential receiving institution as well as for the sender.

The CAI development effort at HumRRO has made us intensely aware of the need for, and the current lack of, compatibility among existing CAI installations. This concerns us because the rewards of a nonprofit institution are continued acceptance and use of the results of research and development that is well done not only for a particular sponsor, but also for general use by, and acceptance for, the public good.

The next topic: What are the resources required in order to accomplish the goals of instructional development in the use of the computer? Many people now think that computers are becoming very inexpensive and that one can be purchased for on the order of a few thousand dollars. This may be possible and may indicate the fantastically efficient development of electronic technology. However, instructional technology is not nearly developed to that point (Seidel, 11, 12,). Let me say here that I thoroughly agree with the value of having a creative faculty member, using a system of trial-and-error, and after having had free contact with the computer and a terminal, perhaps discovering an innovative way to teach something in his field. The creative graduate student can contribute in the same way. Such serendipitous findings can be of tremendous value in developing the technology. However, they do not provide a substitute for methodological development of a practical technology of instruction, nor for the massive task of preparing volumes of good quality instructional content.

The issue is serendipity versus professional reliability and full-scale, long-term commitment to instructional design and development. The teacher-scholar in the university or college cannot be counted upon to function as a full-time instructional designer; instructional design can be best accomplished in an organizational structure established for this purpose. Also, the individual teacher-scholar is no substitute for an interdisciplinary professional team with competence in the psychology of learning, the mathematics of models and their optimization, information science, technical writing, and visual presentation.

It is difficult to perceive the profit-oriented company as an appropriate structure for such a development effort because it is structured to serve the stockholder, gain annual income, and sell products. Unlike the university, the commercial publisher is intensely interested in widespread dissemination of materials produced by him and in their prolonged use, so he has to pay attention to compatibility. However, the survival of the publisher depends on a frequency of profit over loss. If one looks at experience with programed instruction, one finds a reluctance on the part of commercial publishers to invest in costly cyclical or long-term product developments. I doubt whether, at present, one can buy very many commercially published instructional programs for which adequate performance data are available and which have been frequently revised and improved in terms of diagnostic indications from such data. It is reasonable to assume that CAI will follow the pattern of programed instruction.

Unlike the profit-oriented company, the nonprofit organization has no vested corporate interest in product sales. The nonprofit organization works to solve problems of its sponsors and science and society at large. Thus, it is most likely to facilitate mass *dissemination* of the materials to many users. In making the case for the nonprofit developer of CAI material, I cite again HumRRO experience with users of instruction. HumRRO teams have dealt with the traditional subject-matter experts, explaining in great detail and repeatedly the value of stipulating one's objectives not only in behavioral terms, but in terms relevant to the context of the job that the student was to enter after training. All of the HumRRO research products are documented and available to the public (HumRRO Bibliography of Publications, 13). For the moment let us put aside all reservations concerning the similarities and dissimilarities between education and training. The point at issue is that while teachers today, as well as trainers, have become aware in most instances of the value of stating behavioral objectives, they have not done this in isolation. Furthermore, although this awareness may exist in the field of education, there is often a failure to take advantage of the knowledge that *what* to teach and *how* to teach are equally important.

An interesting illustration is the large-scale study in Texarkana, Ark., where both the *what* to teach and the *how to* to teach are fantastically different from what was known to be the vogue or the customary practice. When it was discovered that incentives used for teachers and students were not the normal or traditional ones, the accepted way of rewarding, providing reward structure for students and teachers alike, many of the traditionalists became upset. But the point is that it took an outside organization specializing in the development of instructional materials to propose these radical ideas, to view the situation from a different point of view than the field of education and the board of education and its traditionalists had viewed it. Some of the problems publicized recently may also illustrate the difficulties when a profit motive is introduced. One wonders whether need for profit may be coloring either the user's perspective and/or that of the developer. The case applies well to the use of the computer for instructional purposes whether one is going to use it for drill-and-practice mode, problem solving, simulation, or tutorial CAI.

A final point I wish to emphasize is the need for adequate *evaluation* whenever instructional materials are developed. Here again it seems that the structure of educational institutions today is geared more toward a classic grading system, based upon normative approaches to measurement, and upon extrinsic and perhaps irrelevant indicators of achievement. As, Bs, Cs, and so forth, are not readily translatable into degree of achievement of specified objectives. Furthermore, such grading systems do not take into account the need for more appropriate diagnosis of individual students and the distinct possibility that all students should achieve 100% and receive As in a given course. Changes are beginning to take place, however, in limited occurrences. Some universities and colleges, and some professors within a small number of colleges, are becoming aware of the necessities for objectives, diagnosis, evaluation, and revision of course materials to enable all students to achieve to the maximum. On the other hand, within existing specialized, instructional development organizations there is a large capability and experience in this type of evaluation.

One possible way to accomplish this type of evaluation, and perhaps a reasonable model to use for a different type of specialized nonprofit organization, acceptable to policy makers and educators alike, would be the establishment of experimental stations, such as proposed recently (Rothkopf, 14) before the Subcommittee on Education (also, Bunderson, 9). Analogy is made to agricultural experimental stations established to provide for planned analysis, evaluation, and improvement in understanding in that area. At the present time, education can be viewed as a high labor intensive area with a low yield. Making instructional practices and activities explicit, providing for the use of the

computer within such experimental stations to aid in the improvement of instructional transactions, might well be the means for long-term involvement of the computer in production, evaluation, and dissemination of improved instruction.

At this point, it is appropriate to quote from my HumRRO colleague, Dr. Robert G. Smith, Jr. His admonition to all of us who are engaged in CAI work is to avoid CAI parochialism.

> "My casual impression which I hope is wrong, is that people working in CAI have a tendency to get so involved with their terminals, interfaces, operating systems, and other hardware and software problems, that they forget that there is a great deal of sound research in psychology and education which has a bearing on the engineering of instruction. I have just been reviewing this literature, and I am very impressed with it."

In other words, in our enthusiasm for developing better instruction, we may tend to get too close to the computer to see beyond the peripherals.

To summarize, I have tried to state the case for a nonprofit special organization as the candidate of choice for developing CAI materials. The most salient point of this argument has been the fact that universities are not basically "mission-oriented." Their organization and mode of operation do not lend themselves to instructional product development. Faculty members engaging in such efforts do so on a part-time basis and in competition with higher priority concerns. Also, universities and their faculties may tend to be somewhat self-centered with few incentive structures or interests in promoting compatibility and widespread dissemination of their instructional products. While commercial publishing houses have such interests, their profit-making necessities mitigate against expensive cyclical product developments aimed at maximizing instructional effectiveness. Because the nonprofit special organization's mission orientation, internal context, and reward structure tend to serve this end, it is proposed as the proper type of candidate to develop CAI materials. Lest we think that our problems today are rather unique and novel, let me conclude with the following:

> "There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things."

This, of course, was stated by that well-known educator—Machiavelli.

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