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About this issue...

All articles in this issue were written by leaders in the field of training. The authors represent different sectors, including manufacturing: Frank Hart—Xerox Corporation, and Dennis Sarenpa—Control Data Corporation; service: Richard Davis—The Bell System, and Gearold Miles—Arthur Andersen & Co.; proprietary and custom development: Joseph Durzo—The Forum Corporation; beverage: Larry Kroh—Coca-Cola USA; the military: William Terrell—Navy training; and academic research: William Becker—Indiana University. Their articles reflect the rapid increase in ID being conducted by business, industry, and government.

Those of us who prepare instructional developers have been aware that, for several years, the best placement opportunities for our students are increasingly outside education. Not only is the pay better (we have become accustomed to that), but the resources and readiness to accept ID are often greater. Application of sophisticated hardware (simulators, videodiscs, teleconferencing, computers, etc.) is far more advanced in this sector of society than in schools. While some of the applications represent using "heavy" hardware to perform "light" tasks, it is also fair to say much cutting edge ID and instructional research is being conducted in business and the military. The authors and guest editor welcome your comments.

—Kent L. Gustafson
Guest Editor
Getting Down to Business
Instructional Development for a Profit

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David Maister (1982), writing about professional service organizations, observed that the subject of managing professional service firms (such as law, consulting, investment banking, accounting, architecture, engineering, and others) has been relatively neglected by management researchers. In our own field of instructional development, this is also true. Very little has been written about those firms which do instructional development as a business. In recent years the instructional development literature has seen more and more contribution by those authors working in industry or writing about the world of instructional development in industry, but few articles have been concerned with doing instructional development for a profit. This article focuses on several issues important to professional service firms which sell instructional design services and custom developed training programs to clients in the private sector:

- Profitability
- Selling the Service
- Competition
- Defining the Need/Proposing the Solution
- Project Management
- Project Mix and Staffing
- Quality

Profitability

First things first. A company which sells training programs and instructional design services exists to make a profit on the work it does. Whether the company is owned by stockholders, is privately held, or is a subsidiary of a larger company, the goal is the same—to make a profit after taxes which meets or exceeds the amount projected at the beginning of a given fiscal year. When all is said and done, the sales effort, design work, client contact, and production work all flow to the bottom line of the company’s balance sheet.

Working toward targeted profitability affects every function in a proprietary training and development firm. Sales personnel must achieve targeted orders goals to assure that sufficient work is generated. Project managers must keep timelines and costs in control so that each project makes its required contribution to the profit line. Sufficient project work must be completed within a year to permit billing for work completed so that revenues may be recognized on that year’s balance sheet. Staffing levels and other fixed costs must be based on projected levels of business expected so that fixed costs do not outrun incoming revenues. Project decisions such as who to use on a project, how to produce a videotape, and how many revisions are “enough” are also business decisions since they all affect the profitability of the firm.

This all adds up to a different “climate” for a profit-making ID and training company from that found in the in-house training and development operations of companies or in universities and public sector organizations. The in-house training and development operation is certainly aware of the profit and loss requirements of the overall company but usually does not operate as a profit center itself. Rather, it is usually a cost center operating in a staff capacity similar to a long-range planning or public relations office. Staff in such operations are no less competent, quality oriented, or concerned with costs than their counterparts in profit-making ID and training companies. They simply have different organizational goals. ID centers in universities and public sector organizations usually operate on a similar cost-center approach, providing services within the limits of budgeted costs. The difference is not so much sensitivity to costs but reason for being.

Selling the Service

Unless a company is a “Mom and Pop” operation operating on a comfortable level of referral business, the lifeblood of the organization is the sale of services and products. Unless an ID and training company is engaging in the development of an “off the shelf” product, (e.g., a generic training course) which it can sell, the task is to sell the professional services of a group of people capable of solving problems for clients. Companies such as The Forum Corporation, Wilson Learning Systems, Tratec, Spectrum Training Corporation, National Training Systems, and others sell both “off the shelf” programs designed with general training needs in mind and custom program development services to solve specific training problems. These organizations excel at sales and marketing with staffs of professional salespeople whose responsibility it is to prospect for new business, collect data about customer needs (general information), present proposed solutions, and close orders. A key question is how professional services are sold and who sells them.

Maister (1982) observed that what a professional service firm sells to its clients is “frequently less the services of the firm per se than the services of particular individuals (or a team of such individuals)” (p. 63). Wittreich’s (1966) work supports this contention by pointing out the difference between selling and buying goods (such as packaged programs) and selling and buying services. He noted that a key difference lies in what the client is buying.

In the case of professional services he argued that the client is buying the professional, not just the service. To Wittreich this meant that it is difficult to separate the selling of the service from the rendering of the service. This distinction is much simpler in the selling and buying of goods such as pre-packaged, off-the-shelf training programs. A
For the firm selling professional ID and training services this means that, in many instances, contact between a salesperson and the buyer during which the salesperson describes the firm's approach to a problem and its resources may not be sufficient. It is often necessary for designers to play an active selling role. This is typically accomplished in one of two ways: (1) having designers take time from their development tasks to assist in specific sales situations; or (2) using personnel with design skills in a full-time sales and marketing support role assisting in custom program sales situations.

**Competition**

Selling ID and training services is a highly competitive business, both for the sale of packaged programs and the sale of custom program development services. A sales opportunity is often highly competitive, with the prospective buyer receiving proposals (bids) from several firms with similar qualifications. There are several large, nationally-known firms doing business selling ID and training programs and literally hundreds of small firms and individuals competing in the marketplace. Each major segment of the marketplace such as technical training, sales training, product training, supervisory training, and management development training has firms actively competing for business in that segment.

A salesperson from Firm A, for example, may call the Vice President for Training and Development at a company to prospect for business only to find that a salesperson from the competition at Firm B has beaten him/her to the punch and has already closed a deal to design a new sales course. This motivates salespeople to prospect aggressively for new business, follow up on leads, and move sales situations from prospects to closed business as rapidly as possible. That same salesperson from Firm A may call a client with whom Firm A has done business for years and find that Firm C has proposed on business which, in past years, might have been "safe." Firm A is thus put in a position of "defending" or "protecting" the account from penetration by competition. Still another telephone call may offer Firm A an opportunity to propose on business which Firm B had considered safe—an opportunity to expand into a new account.

As could be expected, competition results in predictable downward pressure on prices, but price is not the only issue which is important in a competitive situation. Quality of service, the degree to which the proposed solution matches the needs, delivery timelines, company reputation, and other factors play an important role.

Instructional developers working in profit-making ID firms become sensitive to competition's type of work and the competitive advantages of their own firm in given situations. To win business in certain situations requires proposing designs which will be less costly to produce than the competitive proposal. In other situations what is required is to propose a more thorough or comprehensive approach to the problem than the competition. Most of the time, though, what the competition has proposed is not known in detail, and competitive price is often unknown.

In many situations, the competitive win can be ascribed to the careful orchestrating of the sales approach by an account executive who brought the professional resource (senior instructional designer) into the situation early to work with the client in defining the problem and proposing a solution. In such situations the client often has more confidence that the firm understands the problem and is proposing a workable solution since he/she has met and worked with a person who has the professional expertise to solve the problem (as was noted earlier).

**Defining the Need/Proposing the Solution**

Nearly every reference to the ID process begins with the exhortation to first define the problem. Wittreich (1966), in his work on selling professional services, argued that a firm should first identify the problem and define it in meaningful terms. This is known as "needs-based selling." The salesperson collects data about the problem and proposes solutions which will meet the client's needs. This is a deceptively simple concept which is as hard, if not harder, to do in the ID-for-profit world as it is in any other ID context.

**Selling ID and training services is a highly competitive business, both for the sale of packaged programs and the sale of custom program development services.**
Many designers working in profit-making firms will report receiving excited calls from salespeople who say things like, "I just met with LeftBank, and they need a two-day customer service program for their tellers!" Questions such as "What problems exist? What can't the tellers do now that they should be able to do? Why two days?" often generate a long, silent pause—no answers.

Textbook ID approaches to needs assessment simply do not work well in the competitive environment as tools to be used prior to a sale. Several reasons can be cited:

1. Such approaches are far too expensive to be used as tools prior to a sale. Firms cannot invest the required effort to produce that level of information.

2. Time often works against prudent needs analysis. In many instances, the competition already has a proposal on the prospect's desk, and there is only one week until the deadline for making a decision.

3. The client believes that he/she already knows quite clearly what the needs are (even though the ID firm may have had only limited access to the client's data or does not trust the quality of the data and would like to do a thorough analysis).

4. A form of solution statement often is required in the sales proposal. A client spending $50,000 to $200,000 or more for the development of a training program has a legitimate interest in wanting to know what the eventual solution will look like. It is usually not sufficient to say in a proposal "We will use the following ID process to define the needs and design an appropriate solution." In many instances, based on the information gathered during the sales call, the designer must sketch out a proposed solution which will be "tested" during the define/design stages of the development process.

5. The client is under pressure to produce something (e.g., a two-day program on performance appraisal). In such situations, it is difficult to generate interest in doing a needs assessment because it is against the political tide of the organization.

How then does a firm cope with this level of uncertainty? Target marketing of its services is one answer. A firm which does a great deal of business developing sales training programs for banks, for example, learns after a while what the key issues are likely to be for sales training in most banks. Consequently, when an opportunity arises to propose to do sales training for yet another bank, a salesperson and/or designer can collect enough data during sales calls to propose a tentative solution that is "more right than wrong." It may then be refined during the define/design stages of a project.

If the same firm is proposing on the development of a supervisory training curriculum for another client and has not done that kind of work before, developing a proposed design becomes much more difficult with limited information. In such instances it is necessary to try to sell the client a define/design contract during which time the problem will be studied and a firm solution proposed along with a price for developing the solution itself. This will work providing that (a) the client is willing to work on such a tentative, yet binding relationship and (b) the competition has not proposed a "hard" design with fixed specifications and costs which may appear attractive to the client.

This lack of formal needs assessment prior to closing on a business deal often comes back to haunt professional service ID and training firms as they find out that what was sold is not what was needed.

This problem can manifest itself in four ways:

1. Creeping Scope Change. In this situation working through the ID process uncovers the need to make small changes in the design and materials specifications as the project unfolds—the kinds of things all instructional developers encounter regularly.

2. Major Scope Change. As the designers work on the project, they discover, through the needs analysis begun after the contract was signed, that there are major problems with the proposed design. This, then, requires the designer and the salesperson to go back to the client to request a change in the contracted price to cover the new specifications. Most times the parties can work out arrangements to meet the new situation. Sometimes, however, the client takes the position of, "You said you would solve my problem for X thousand dollars. It's your responsibility to do the work for that amount." The situation then becomes a difficult negotiation.

3. Underestimated Costs. This situation results from inaccurate budgeting of the project while developing the sales proposal. The result is that, while the scope of work may not have changed, the amount of time and money needed to complete the work was underestimated. Completing the actual work required more than was budgeted, and the project did not make its projected profit margin. Since it was the firm's error, there is no avenue available to increase the price.

4. Poorly Specified Project Deliverables. This situation occurs in circumstances in which the project deliverables have been loosely described to the client. For example, the sales representative may describe the project to the client without specifying (through oversights) whether or not the material will be typeset. Yet if the client had been shown a copy of similar materials which had

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The problem is that in the ID and training firm this can increase the costs of doing the project in little ways which are not passed on to the client because no single change was big enough. For example, the project may have specified 10 photographs and 20 were needed; 8 charts specified and 12 were needed. Such costs are small, but when repeated over the life of a project they can eat away voraciously at the profit margin of the business.

been typeset, it would be logical for him/her to conclude that the firm would deliver typeset materials. It becomes very difficult in such situations to "unsell" the typeset materials or to negotiate a price increase to include the additional costs because the firm would appear to be dealing in bad faith. The result is a cost overrun which has serious profit margin effects.

These problems are not unique to the for-profit ID firm, but they are very im-
portant. The determination of needs and specification of project costs when preparing sales proposals is very important and difficult to do well with as little information as is often available at the time during the sales cycle when a proposal is being developed. Accurate historical costs from similar projects, experienced staff, well-drawn specifications, and a high level of data gathering to uncover needs during the sales process all play a role in reducing this source of profit drain and help assure project quality.

Project Management

There are two primary keys to profitability in the professional service industry and training firm: (1) excellence in selling, specifying, and pricing business; and (2) excellence in project management. Project management cannot be underestimated as a key to profitability of such firms. Since the primary productive resource of a professional service firm is the time, effort, and skill of its staff, management of this resource is of primary importance. Several areas are worth noting for special mention.

Client Relations. Delivering custom ID and training program design services require frequent interaction between the members of the firm and clients. Consequently, the quality of the service delivered is determined not only by the technical competence of the staff but by the ways in which frontline professionals communicate and deal with clients. The general advice provided by Block (1981), Bratton (1979-80), Coscarelli and Stonewater (1979-80), Davies (1975), Rosenzweig (1978), Rutt (1979-80), Silber (1975), and others about managing client-developer interactions is highly valid in the context of the professional service industry and training firm as well. Since the client buys the professional as well as the professional service, the quality of their interaction is very important. Clients must perceive that the designer understands their needs, is highly competent, and will deliver.

Budgets. As with any business or any project, project managers must work within budgeted constraints. Though budgeted amounts may be larger for the development of a course than would be the case in higher education institutions, for example, the budgets must still be carefully prepared and monitored. Cost overruns in projects can damage project profitability. Accounting systems must be designed to provide timely and accurate reports of accumulating project costs so that project managers may manage from an accurate and timely database.

Use of Resources. The firm's resources are its people, but not all resources are equal in skill or in internal costs. Since all time on projects is charged to the project budget, project managers must carefully select the appropriate mix of senior resources (expensive and widely experienced) and junior resources (less expensive and less experienced) to get the work done.

External Timelines. Projects have very real deadlines both from the client's point of view and the firm's point of view. In many instances the deadlines are set by outside events in the client's organization (a national sales meeting, the opening of a new company division, the introduction of a new product, etc.), and projects must conform to those time constraints. On-time delivery of services is no less important to the reputation of a professional service firm than it is to Federal Express.

Internal Timelines. On-time completion of a project also affects the profitability of the firm. Following generally accepted accounting principles, a firm cannot count income as revenue unless work has been completed. So, for example, if a $100,000 project is scheduled to be completed in a fiscal year in five, $20,000 phases, the company can only "take into revenue" the amount of money equal to the work done. If the project slips behind schedule so that only the first four phases are completed in the fiscal year, only $80,000 of the revenue can be recognized in that year. The firm then has a $20,000 revenue shortfall for the year. Consequently, keeping projects on schedule is a very important task for the project manager. This means keeping things moving internally as well as keeping the client on time for review of materials, scheduling of pilot tests, and the like.

Role Clarity. Since both the project manager and the salesperson become intimately involved in the account, there may be confusion about who is playing what role. The salesperson who sold the business may have been working with the client for several years providing ongoing "off the shelf" business. The project manager who becomes heavily involved in the account knows all the details of the specific project and builds a working relationship with the client. It is important that the firm clarify roles on a project so that the client knows who is responsible for what elements of the project. For example, when something goes wrong, the client is likely to call the salesperson and complain. The appropriate role for the salesperson is to act as a fact-finder and to help work out a solution. If the salesperson promises to have the project manager fix the problem in a certain way (e.g., "We'll revise the chapter." "We'll re-shoot the videotape."). this obligates the company to certain design revisions when the project manager may have had other remedies in mind. The difficulty is to avoid confusing the selling role with the delivery role while keeping the client satisfied. Concepts described by Leitzman, Walter, Earp and Myers (1979-80) in developing working "contracts" and agreements on roles are useful in the business/industry context as well.

Project Mix and Staffing

Maister (1982) described the selection of the types of projects that a firm chooses to undertake as among the most important decisions facing the firm. The project mix has important effects on dimensions such as profitability and attracting and keeping high quality staff. Maister observed that while many dimensions characterize the different types of projects a service firm may undertake, one in particular is crucial: the degree of customization required in the delivery of the service. He suggested that projects could be characterized into three types: "Brains," "Grey Hair," and "Procedure" projects.

"Brains" projects are those in which solving the problem or designing a solution requires the cutting edge of technical or professional knowledge. The firm sells "Brains" projects on the basis of the high professional skill of its staff. As Maister puts it, they tell clients, "hire us because we're smart" (p. 176). "Brains" projects require creativity, innovation, and the development of new solutions.

"Grey Hair" projects, according to Maister, require customized output to meet the client's needs but involve a lesser requirement for pure creativity and innovation than would a "Brains" project. "Grey Hair" projects address problems which are generally familiar, and solutions may require activities or approaches similar to those used on other projects. Firms selling "Grey Hair" projects tell clients, "Hire us because we've been through this before; we have practice at solving this type of problem" (p. 176). For example, an ID and train-
of projects, and day-to-day client interface on project work. The junior resources are responsible for completing the work necessary to complete the project (e.g., writing scripts and participant materials, conducting field interviews, analyzing data).

An appropriate mix of projects permits the company to make productive use of all levels of resources, while providing junior level people with the opportunity to learn from working with more senior level staff on projects as well as providing a predictable profit stream.

**Quality**

Earlier in the article the point was made that each project must be profitable. In a sense the rule of thumb is “each hub on its own bottom.” Unless each project is sold and managed to make a profit, the firm as a whole may miss its target profit objectives. How does this relate to quality?

A constant concern for managers in the ID and training firm is balancing the requirement to deliver quality programs and materials with the need to make a profit on each project. Day-to-day project decisions are also business-oriented profit and loss decisions since all project actions eventually affect the bottom line on the balance sheet. The decision to totally rewrite a troublesome unit rather than to simply revise it must be made with the balance of quality and profitability in mind. To ignore quality and maximize profit is untenable. To ignore profit and maximize quality is also a difficult path to follow, for without profit the firm will cease to exist. In cases where a project is in trouble and will fail if more resources than budgeted are applied, the decision to deliver quality must prevail if the firm is to maintain a good reputation. The balance must lie in delivering high-quality programs that meet client needs while making a profit through proper pricing, the clever use of resources, and excellent project management.

**Summary**

Donald Toosti (1982) has pointed out that the reputation of an ID and training firm on building trust with clients. He characterized trust as having three components: (1) trust in information, (2) trust in judgment; and (3) trust in delivery. There are several messages here for ID and training firms.

**Trust in Information.** Clients must believe that you understand their settings and have knowledge of the solutions being proposed. For a firm to work successfully in the sales training area, for example, the client must perceive that members of the firm understand sales training issues and the sales environment.

**Trust in Judgement.** Clients must also believe that representatives of the firm “know their stuff.” As Wittreich (1966) pointed out, the sales interaction with the people who will deliver the service is very important to the purchase of a professional service. In many ways during a sales situation, the client is testing the judgment and information base of the people who will do the work.

"Procedure" projects can be staffed with more junior staff. The "Grey Hair" and "Brains" projects usually require more work by senior level resources.

Trust in Delivery. A successful project is never over until it has been successfully delivered. The best creative ideas and excellent client relationships are often insufficient to save the reputation of a firm whose delivery is poor (i.e., sloppy work, poor quality, late delivery).

The management of a successful ID and training firm must be concerned with delivering quality programs and services at a reasonable profit in a climate which encourages professional growth of staff and provides an exciting and challenging place to work. It is a highly competitive business whose potential marketplace for services is enormous. Managing the firm requires solid business skill coupled with excellent professional staff to design, manage, and deliver high quality projects.

The Forum Corporation provides off-the-shelf programs and custom developed programs to
The Training Department In An Open Market Environment

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Since training is not mandated by the parent company or supplied as a free service, Bottlers must be sold on the value of every program or service developed. Our uniqueness as a supplier is derived from the fact that training products and services are: (1) industry-specific (2) less costly, and (3) of a consistently high technical quality for the price compared to other available options. However, like all staff services, we are continuously being evaluated on the value of the most recent services provided.

This type of open market arrangement has also shaped the way we operate internally in designing programming for employees and managers of our parent company. All programs are made available to employees at a fair market price which reflects only our investment of resources. However, each manager must pay for these services and is given the same option as the Bottler system to go elsewhere if not satisfied.

This open market approach taken within the Bottler and the Company system is perhaps unique in American business. While not a profit-center department, we essentially operate a business within a business that must be responsive, technically competent, and completely aligned with Company goals, yet able to sell products and services to customers that are not obligated to use these services.

Operating in an open market has significant advantages. A training department can better weather the perils of economic downturns which often devastate departments operating under a more traditional centralized budget structure. In many businesses, training budgets are among the first to be cut; however, an open market system generates revenues and, therefore, is generally among the last to be affected. The total training budget is also less vulnerable since it is spread across a broad range of department budgets.
Management has the full range of business options including managing sales volume, pricing, and cost of goods sold. New products and services can be introduced. Marginal products and services can be eliminated. Training professionals can now be measured as professional business managers as well as professional trainers.

What skills must a training organization develop in order to operate in an open market system? First, the unit must be technically competent and clearly demonstrate professionalism in every activity undertaken. Neither customers nor company managers will pay for services that are marginal or unproductive.

Feedback to marginal programs is rapid and direct. Even programs that meet all professional criteria have to meet the acid test. Will participants/plants initially buy the program, and will they continue to buy over time? Paid attendance reflects a consumer's true feeling of a program's value and is far more powerful feedback than the evaluation sheets completed at the end of a session. Therefore, above and beyond traditional evaluation techniques employed by most training departments, our managers must evaluate programs based on usage rates by Bottlers and user departments, repeat business trends, and new business generated.

Secondly, the training unit must develop "sponsors" thus allowing it to be built into the decision-making mainstream of the business. These sponsor departments share in the ownership of each program and are involved in defining needs, funding the development, and approving content accuracy and consistency with company policies. Just as important, is the sponsor's assistance in selling the idea to the larger organization or targeted user groups. This concept is critical to our strategy, and every program is required to have a sponsor.

An example of the power of this approach can be seen in our relationship with the Cold Drink Planning Department, responsible for soft drinks sold through vending equipment. Each year, a major video-based training package, supporting skills essential to this department's marketing objectives, is sponsored by this group. These packages are sold to the Bottlers as part of a large-scale marketing effort designed to increase purchases and placements of vending equipment, by training and motivating those involved in the implementation process. This strategy has been successful as judged by a number of evaluation criteria: Increased vending machine sales, more effective in-outlet placements, and increased numbers of Bottlers buying and using the training.

A third skill, and perhaps one of the most unorthodox, is the need to aggressively sell the system on our products and services. While "selling" has traditionally been shunned by many in the training field as unprofessional, it is a critical skill for operating in the open market environment described.

This customer-driven marketing approach requires training professionals to look at their business in different ways, dividing it into meaningful user segments or "portfolios." Each of these portfolios represent programs common to the needs of specific user groups, i.e., technical, management, marketing personnel, etc. Individual programs each have a specific strategic role to play in the total portfolio depending on the needs of user or sponsor groups involved.

For example, in planning with the Cold Drink Department, programs have been developed that address the full range of knowledge and skills required for successful marketing in this area. This includes both executive level strategic planning, and "doer" level sales, merchandising and service skills. The program is designed to accomplish the other, and each plays a strategic part in the total Cold Drink marketing effort.

In addition to program development, managers are also held responsible for developing a marketing plan for each program. How can program sales be generated? How can better usage by target customer groups be obtained? How can repeat business be ensured? Classic marketing questions, yet critical to the success of the training department using the open market system.

The answer to these questions has forced us to look at marketing techniques being used elsewhere in American business and tailor them for the training world. For instance, in launching a video network for our Bottlers in the early 1970's, a "big ticket" sale which included video hardware and software, was broken down into a convenient financing plan option.

In addition, a team of training department representatives initiated a series of one-day visits to bottling plants throughout the country, demonstrating the value of the system to each plant's individual training needs. The focus of the presentations was developing a training plan for each operation. The video system was a convenient means towards that end.

Furthermore, in order to ensure that programs developed for use in the video system were viewed and assessed in a timely manner, the initial marketing plan was modeled after the Book-of-the-Month Club. Bottlers are mailed an instructional package, and given 30 days preview time. At the end of that time, they are charged for the program unless they return the program. A win-win for everybody concerned.

We also looked at the mail order method of selling and developed a variety of selling-oriented publications including annual catalogs, quarterly update newsletters, and program mailings targeted at specific decision makers.

The results speak for themselves. Our video network has expanded from just over 100 Bottlers to close to 500 Bottlers in a five-year period of time. The same is true with our seminars. An estimated five thousand Bottler and Company managers per year will attend 64 different seminars in 1982. The availability of professionally designed programs have been the foundation of our efforts; however, aggressive, targeted marketing efforts have also played an essential role in ensuring success.

How can a training department shift to an open market system? There are three major steps critical to this transition:

1. Renegotiate the training department's mission statement with company management.
2. Redefine working relationships with major sponsor departments and customers.
3. Develop training department staff in managing their activities as business professionals.

The first and most critical step is to redefine the mission statement of the department. This statement needs to clearly define responsibilities, relationships, expectations, and financial arrangements between the training, sponsor and user departments.

It must be negotiated with senior management since in most cases it will represent a significant shift in operating philosophy, operations, and financial arrangements.

The second step, as a direct follow-up to the redefinition of the mission statement, involves negotiating roles with major sponsor and user groups. Even though the mission statement identifies
Evaluating Four Years of ID Experience

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Between June and December 1978, 15 instructional designers began working at the Professional Education Division (PED) of Arthur Andersen & Co., a major international public accounting and professional services firm. The Professional Education Division develops and conducts training in Arthur Andersen & Co. offices around the world, but the division is based at the firm's Center for Professional Education in St. Charles, Illinois.

Not only were these employees apprehensive about their new positions, firm and PED personnel were apprehensive about this new species—instructional designer.

What was instructional design going to contribute to a training program in existence for nearly 40 years at a major international public accounting firm?

Where were these instructional designers going to fit in the diversified but workable course development methodology? What were the responsibilities of these highly rated people going to be?

Four years later, each of these questions has been answered, and the answers are not based on supposition or false hope. Instructional designers have made tangible contributions to training development at Arthur Andersen & Co. More important is the melding of the instructional design group and process with other groups in PED to form one of the most sophisticated and effective course development teams in the field of professional training. This alone has provided a satisfactory answer to the above questions.

The Professional Education Division has come a long way since the first instructional designers joined the division in 1978. Yet, these four years represent only one-tenth of the progress of Arthur Andersen & Co. in its professional education program—a program that began in 1940.

From this perspective, two things are apparent. First, Arthur Andersen & Co. always has placed the professional career development of each individual high on its list of priorities. Second, the firm's progress in the first 38 years compared to the amount in the past four years in PED promises an unbelievably fast-paced, exciting future for professional education at Arthur Andersen & Co.

Training as Old as the Firm Itself

Training has been an integral part of Arthur Andersen & Co. since the earliest years of the firm. When he founded the firm in Chicago in 1913, Arthur Andersen was on the faculty at Northwestern University, a role he continued until 1922. Arthur Andersen & Co. preceded other accounting firms in professional education by many years and today retains the number one position in training among accounting firms.

The firm's commitment to training encompasses not only its own people, Arthur Andersen & Co. offers educational services to many others outside the firm. Certain characteristics of the firm's professional education program have contributed to its success. Line personnel from the field traditionally have served as instructors. The program relates specifically to an individual's choice of career specialization. Centralized training schools in Chicago have maintained training uniformity over the years, although training also is conducted in practice offices and sessions arranged in central locations worldwide.
Firm Growth Accelerates
Training Problems

As the Arthur Andersen & Co. organization grew, adequate training accommodations became a critical problem. Sessions were held in dimly lit office buildings, hotels, the attic of the Chicago office building and, for years, at the Chicago campus of Northwestern University. The growing number of trainees, limited and inappropriate space, the need for translating courses for international use, and demands for additional courses to meet professional needs made the advantages of acquiring a centralized training facility apparent.

Saint Dominic's College in suburban St. Charles, Illinois, became available, and in October 1970, the college became the Arthur Andersen & Co. Center for Professional Education. The move into our own facilities overcame one of the biggest shortcomings in our training program. We could remodel the facilities to fit our training requirements.

The acquisition of the college marked the firm's largest single investment for developing and conducting training to date. However, it was just another step in Arthur Andersen & Co.'s plan to maintain its leadership in professional education for business and industry. The challenge began as the firm made this facility come to terms with its purpose, its organization and its potential.

Dynamics Behind Increased Training at Arthur Andersen

Certain dynamics of the 1960s and 1970s—in our profession, in the economy and government, in technology—affected the firm toward greater commitment to its professional education program. Specifically, these dynamics pressured Arthur Andersen & Co. to speed up training development and make it more efficient and effective. In retrospect, these dynamics became catalysts for the introduction of instructional design in PED.

For years there had been no radical change in the methodology used by the firm to perform its professional services. Then almost simultaneously during the late-1970s, the audit and consulting divisions revised their methodology. The new firm methodologies changed how work was done in the field and, ultimately, affected every Arthur Andersen & Co. professional in these practice areas.

This meant that every audit and consulting training course had to be revised. Furthermore, changes in the firm's basic precepts meant an outstanding training backlog. Older members of the firm, who were familiar with the previous methodology, and every new hire needed training. To maintain the best client service, pressures existed in the firm to discard the present curricula, redo all courses in the audit and consulting curricula, and do it immediately.

At the same time, Arthur Andersen & Co., like other business and industry of the 1960s and 1970s, was experiencing the significant information, regulation and technological explosions of this period. Tax laws, auditing procedures, financial reporting and presentation standards changed continually. Computer technology and applications advanced dramatically. The consensus was that training was the way to meet these significant changes affecting the firm's professional practices.

Speedy results were now crucial to the firm. No longer was a leisurely "Socratic" transmission of new information feasible or economical. As soon as we identified training as the instrument of change, an exceptional burden was placed upon our training personnel. The necessity of speed was, and still is, one of the biggest frustrations of our Professional Education Division. But speed without results is wasted effort, so we learned to concentrate on effectiveness as our main objective.

Efficiency became another factor impacting training development within the firm. Like everyone else, we had to get more for our money. During the first twenty-five years of our training program, it was relatively inexpensive to hold a three-week school at Northwestern University. By 1970, the changing economy encouraged us to reduce training time that took professionals away from client service.

As a result of this pressure for maximum effectiveness and efficiency, the roots of PED's synergistic course development process took hold. The idea that professionals outside the firm should be brought in as specialists in course design, development and production began to make sense to PED and the firm.

Reviewing Our Program to Meet New Demands

Partners and managers in PED had varying educational and firm backgrounds. They were well-versed in the content that was to be taught, although they sometimes depended on subject matter experts from the field to write a particular content. Common denominators among this PED group were Arthur Andersen & Co. background, knowledge of the content, and experience in the classroom. In actuality, this group was carrying on an earlier firm concept of "teaching by the expert."

We knew what worked and what did not work for the unique population of Arthur Andersen & Co. trainees, and we built course after course based on this prior experience. Our system was

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were more limited than those methods instructional designers later introduced, they worked. But we did not know why our design methods worked. What we lacked were the fundamentals of instructional design or the psychological tenets on which adult professional education rests.

Occasionally, there were complaints from our practice offices. One complaint criticized the inclusion of unnecessary material in some courses. Today, the Evaluation Services Unit, an outgrowth of instructional design that has existed at PED since 1979, diagnoses training needs of any audience and guarantees content that hits the mark for the targeted audience.

Students complained that certain courses, especially those heavily dependent on lectures, were dull. This was due partly to an admitted deficiency in design and media techniques, time constraints that forced us to make use of what we knew worked, and previously unsuccessful experience in trying to introduce new instructional methods. Arthur pull professionals from the field. Although instructional designers are quick to assimilate a particular subject matter, they cannot read a book about accounting principles and then write a course on basic accounting. This aspect of our synergistic process and the designer role was not yet recognized by PED and the firm. Though instructional design in PED eventually increased training quality and enhanced our course development process, it did not save time.

Introducing Instructional Design to PED

The people who first interviewed for instructional design positions at PED were in an unusual position. They had to sell their expertise to a group that essentially believed its products already were perfected. In addition, the expertise they were selling was a mystery to the buyers. Designers had to prove they could contribute to a well-established training program and enhance highly technical and professional content for better course development but failed to acknowledge the usual constraints of a large enterprise that is introducing new ideas, methods or technological approaches. With one hand, we supported pointed out specific improvements for new designers to make; with the other hand, we emphasized restrictions, rules and regulations and wagged our finger at their proposals.

Potential instructional designers had a glorious, ideal environment presented to them. Some of the overflow elaborated upon the great potential in PED—development of training for firm personnel and clients around the world, the most progressive media support and training facilities available and, finally, utmost respect from PED as specialists in the field of training.

Miscommunication and People Problems

During 1979 and 1980, we added another twelve instructional designers to PED, bringing the total to 27 in late 1980. There was a large influx of other people during this time, including managers and staff from the field as well as administrative and support personnel. Few had any experience with instructional design.

The things I remember most during this rapid expansion in PED involved poor communication and interpersonal problems. The "old guard" in PED was not always receptive to change; several members were downright antagonistic toward the "savior syndrome" of instructional designers. New training personnel, who transferred into PED, had to learn about training development in general—basically how to get their information and experience into a practical training form. They had little patience with the instructional design group since they were concerned about pinning down "the right way" to develop training. These were Arthur Andersen & Co. people who had grown up in a firm that extolled "the right way" to perform an audit or do a systems installation. Unfortunately, the new designers were not immediately successful in convincing them that instructional design is not like an audit or a systems installation. In instructional design, there are often different avenues for reaching a destination; there is no "right way."

Many users were "turned off" by academic, pedantic attitudes of some instructional designers. Users could not

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understand the instructional design jargon. Most designers were recent graduates (within 0-5 years) of well-known universities. The remainder had advanced degrees in the instructional design field. Few had worked in a business environment, let alone the highly structured world of accounting.

We had many conflicts stemming from the "theoretical versus the pragmatic." There was the confident "It's good design because I say it's good design" of the instructional designer offset by an obvious deficiency in business acumen.

Another conflict centered on the primary reason for introducing instructional designers to PED. The division depended on firm professionals to formulate the content of any course by serving as subject matter experts. Unfortunately, these subject matter experts created a major obstacle for designers who were hired to expand and revamp our methods of instruction.

Subject matter experts from the field did not understand the instructional design theory and language and did not immediately see the importance of dealing with the intricacies of instructional design. Most subject matter experts were on short-term "loan" to PED and anxious to return to their offices rather than student evaluations began to prove the validity of new instructional approaches.

Defining the Designer's Role

Confusion and confrontations over responsibilities, authority and territory were numerous. One division of the firm began a five-year development program of its basic curriculum for its firmwide professionals in 1978. The long-range plan projected approximately 800 hours of training to be produced on a strict timetable based on the prerequisite, interlocking nature of its curriculum. However, developers at PED barely could obtain enough content people from the field. Developers were desperate for knowledgeable firm experts for the development stage of the program. Since instructional designers often performed their own "quick-studies" of the content, PED developers felt instructional designers might substitute for content people and eliminate the need to pull important experts from field assignments. As mentioned previously, this misconception about the role of the designer originated early in the introduction of instructional design and was difficult to reverse.

Other users saw designers as editors.

They often had peripheral information about printing, slides, or graphic design, but they lacked practical production experience for using color properly and economically, knowing how much text is appropriate for good readability on a slide, or what level of detail makes a graphic too busy and ineffective.

Suddenly, these designers were working for an organization that had modern audio-visual equipment, a television studio, graphic designers, print specialists, audio-video bookups in classrooms, a warehouse, and personnel to inventory and maintain training materials. The designers wanted to go all out because they had minimal experience in project control or budgeting. Review checkpoints were necessary for their good but idealistic media choices.

Too Much Too Soon

The general scenario in PED following its sudden expansion between 1978 and 1980 was typical of any enterprise experiencing rapid growth. There were too many challenges and not enough experienced people (in terms of organizational experience) to handle them. PED initiated several special programs that also distracted the division and inhibited its getting organized more quickly. These included instructor training courses, executive development programs for managers temporarily transferred to PED, expanded client training and even orientation programs for new designers and subject matter experts.

It was a period of poor upfront planning and scheduling, largely a result of: (1) increased demands for course production to train professionals in the new firm methodologies, (2) a surge in new personnel who had no benefit of a "learning curve," and (3) ineffective and insufficient resources and support despite PED's tremendous expansion.

Basically, these were growing pains of a newly expanded, potentially sophisticated operation that needed time to pin down methodology, terminology, role definitions, scheduling, cost guidelines and consistent procedures.

Instructional Design Progress and Acceptance

Indications that PED and the firm were accepting instructional design slowly began to appear. Progress was gradual but increasingly evident; certain factors contributed to the progress.

First, a major reorganization in PED fostered a new sense of belonging for the designers. Until August 1980 when the

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learn about instructional design. Instructional designers often interpreted this miscommunication as a put-down and seldom as a basic misunderstanding between two alien parties.

Although everyone, including instructional designers, brought his/her "educational baggage" to PED, subject matter experts were particularly biased. Not only were these professionals conditioned to the instructional methods of their school days (i.e., the lecture, chalkboard, textbook approach), they also believed that they should build courses similar to ones they had experienced during their careers at Arthur Andersen & Co. They were reluctant to add variety to content or presentation modes. Instructional designers fought many battles until testing results and production supervisors, even instructors; however, most failed to see designers in the first two phases of course development, feasibility and design, and the last phase, evaluation. To say the least, this created an identity crisis for the designers. They realized that recognition as training specialists was not "a given"; they would have to earn this recognition and work hard to define their roles.

As a group, instructional designers did lack certain information and, more important, certain viable experience, such as working in a team environment instead of the individualized environment of academia. Out of 27 designers, there was a variety of degrees and areas of specialization. Many designers lacked print, video and other media experience.
reorganization occurred, a "pool" of instructional designers existed. Designers were assigned as required to different course development projects in different PED training groups. A designer might work three months on designing an audit training course, move to the development phase of a consulting course for four months and, at the same time, be finalizing another course for a different division.

The PED reorganization officially terminated this rotation system and created permanent assignments for all PED personnel within units responsible for firm educational programs (i.e., accounting and audit, tax, consulting).

Permanent assignments to a specific division or group created continuity for the designer, especially regarding course development procedures and methodology, content, terminology and coworkers.

Permanent assignments helped to diminish the disturbing feeling of "being in limbo" which many designers felt. In a survey authorized by PED management in early 1981, all instructional designers agreed that their effective use increased following the reorganization in August 1980.

Second, PED users began accumulating proof that designer recommendations were valid. Student responses in development and pilot tests verified previous designer suggestions. Users gradually realized that designers were the students' advocates in the presentation of training and made important contributions during feasibility, design and development phases. Members of the course development teams, the "old guard" as well as new personnel, were acknowledging and appreciating designer input.

Third, a subtle but important change in designer attitudes aided instructional designer acceptance. Instructional designers realized that winning the war "skirmish by skirmish" was the only strategy possible. A "D-Day" was not going to happen. They accepted the fact that proving their credibility was going to take time and required patience. Designers learned that winning their war would be accomplished by course by course, manager by manager and by demonstration, not talk.

A fourth factor influencing instructional designer acceptance was the establishment of a synergistic course development process in PED. The cooperative and practicable process is the key to Arthur Andersen & Co.'s improved training programs. Important aspects of this synergistic process include the necessary team approach to course development, where each team member contributes his/her special skills to the final product; the ability of team members to compromise for the good of the final product; and a clear and logical definition of the roles and responsibilities of team members.

Establishing this synergistic course development process ironically dispelled the notion of "the one true design model" and "the one true role of the instructional designer." Evolution of this process did not interfere with the different requirements of firm divisions. Instead, the process demonstrated that, since different divisions stress different things, design models and designer roles will vary among divisions. Minimum design standards must continually be maintained and redefined to provide overall uniformity; however, design checkpoints and standards can be flexible enough to accommodate variations in divisions and still create consistent instructional design at PED.

The end result is a professional development catalog that is available to firm professionals and presently lists 275 different courses in accounting, auditing, tax planning and compliance, management information consulting, and specialized areas of industry, manufacturing and management development.

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Instructional Design at PED Today

Although instructional design at the Professional Education Division is continually evolving, there is no doubt that today instructional designers are an integral part of course design teams. Few training organizations in the world have 50 instructional design professionals and can claim a systematic design methodology as sophisticated as ours. Few organizations have quality assurance and evaluation groups that gather and analyze data to determine training quality, assess needs and evaluate impact.

Evidence of the firm's respect for instructional design is becoming increasingly apparent. There are more and more requests for offices of the firm for designer assistance on client training engagements. Additional evidence is included in the April 1981 report submitted to PED leadership on "The Use of Instructional Designers at Arthur Andersen & Co." Specific duties of PED designers essentially required the same competencies established by the Association for Educational Communications & Technology (AECT). Also, this report cited the most frequently listed contributions of instructional designers as objectivity, orderliness in the development process and quality.

The PED course development process and all team members, including designers, gained special recognition outside the firm in April 1982. Arthur Andersen & Co. received the 1982 Outstanding Instructional Product Award from the National Society for Performance and Instruction for a self-study training unit, "System Controls."

The unit is part of the Business Systems Skills Course in the mainline curriculum of the management information consulting practice. The training unit includes printed manuals, audiotapes and videotapes. The management information consulting practice, the
If I must point out one shortcoming in our design group, it is a general deficiency in business administration skills and overall business/industry background.

Areas Needing Constant Attention

We do not expect instructional design at PED to become static or immutable. There are instructional design concerns that require constant attention. One concern involves educating subject matter experts about instructional design. Since content people from the field are assigned temporarily to PED for course development, continual education of new users is a necessity. Instructional designers have an advantage in their permanent assignments; they have the opportunity to build an understanding of their respective subject matter. Content people go back to local offices about the time they begin to understand and appreciate instructional design terminology, strategies, and so forth.

We have experimented with providing some basic training in the design process to subject matter experts at the beginning of a PED assignment. Results are impressive. A course in instructional design for users is presently proposed in a self-instructional format for use by content people in the field.

We are educating new instructional designers about the division to which they are assigned, so they can contribute to course development efforts more quickly. We are providing continuing professional education for instructional designers to keep them current in their content areas.

Another concern of PED designers has been their early involvement in the design process. The April 1981 report cited examples of the need for early designer involvement. The report explained that professionals in the field who identify the potential audience for training are often incorrect in their recommendations. Their experience does not necessarily qualify them to make these early and vital decisions in planning courses. Our Evaluation Services Unit, which presently includes ten professionals specializing in course and program evaluation, survey research, statistics, and tests and measurements, has improved training needs analysis. However, we acknowledge the need for greater designer involvement in front-end analysis. Our designers generally have the necessary skills, and we are actively trying to use their knowledge and skills in the earliest phases of curriculum planning.

Evaluating Our Experience With Instructional Design

My training involvement at Arthur Andersen & Co. began in 1962. I have experienced the introduction of many concepts, methods and specialists during my twenty years in professional education. The past four years at PED have been challenging, sometimes exasperating, but always exciting. The Professional Education Division has reached an impressive level of training. Instructional design definitely has contributed to our achievement, but it is important to acknowledge the unique, 40-year history of professional education at Arthur Andersen & Co.

Since 1975, we have learned about instructional design and how valuable it is to quality training. We also learned a great deal about our training environment and ourselves. We experienced the natural growing pains of any enterprise undergoing rapid growth and change—defining responsibilities and authority, establishing procedures and systems, and experimenting with new media and technology. I hope our experience at Arthur Andersen & Co. contributes to the instructional design profession and others in the field.

If I must point out one shortcoming in our design group, it is a general deficiency in business administration skills and overall business/industry background. We professionals build our business insight slowly, but I think fundamentals of management and business administration should be part of any instructional design education.

In PED we have two professionals managing a project: 1) an education manager who handles project budgeting, scheduling, human resources, and other management functions, and 2) a design manager, who is concerned with all educational aspects of the project. These two positions often overlap in PED, and this supports my feeling that one person can do both jobs—once an instructional design degree includes general business management skills.

I believe our experience and present position in the field of professional education suggests one final insight for training development. Equality among development team members should be recognized and respected. No one area of a systematic course development process can be neglected or deleted without suffering the consequences—deficient training.

Reaching the most efficient and effective training development process takes time and experimentation. Maintaining and refining that process is a never-ending, but extremely rewarding activity.

Arthur Andersen & Co. is an international public accounting and professional services firm with 137 offices in more than 40 countries. Professional Education Division (PED) personnel develop and conduct training in Arthur Andersen & Co. offices worldwide, although PED primarily is based at the firm’s Center for Professional Education in St. Charles, Illinois.

Housing and classroom facilities at the Center for Professional Education accommodate 800 students and faculty per day. Nearly 300 employees at the center create and deliver training for firm, client and other business/industry professionals.

Geordie D. Miles, a member of the firm partnership since 1968, has served Arthur Andersen & Co. in its firmwide training program for 20 years. Presently, he is Managing Director—Educational Programs for the Professional Education Division at the Center for Professional Education. Professional memberships of Mr. Miles include the American Institute of CPAs, Illinois CPA Society, American Accounting Association, American Society for Training and Development, and the Association for Educational Communications and Technology.
Distributed Training

Meeting Challenges of the '80s

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Acquiring and maintaining the skills and knowledge required to remain technically current and competitive in an international marketplace is a major business concern of the 1980s. Recent educational policies and strategies prepared individuals with intellectual backgrounds that made them versatile problem solvers in a wide range of situations. In the past, however, businesses did not deal with the information explosion now being experienced as a result of new technology and international competition. With so much more skill and knowledge needed today, businesses find it necessary to narrow the focus of their training activities.

When young people are ready to enter the job market after high school or college, they face a greater number of work options and a more uncertain future than did their parents. In addition, each option entails specialization of skills and knowledge that cannot be obtained through an academic curriculum but only through specific task related training. Thus, the challenge of training goes beyond basic skills; it is a charge to prepare people to work in highly complex and diverse fields of rapidly changing technology.

This challenge of diversity and complexity places heavy demands on businesses to provide effective, continuous education and training for employees. Occupations involving complex technology require more training both in content and proficiency levels; diversity of tasks demands broader, more flexible curricula; and rising training costs require many students to interleave work and education in their lives. This paper examines centralized and distributed approaches to the training challenge of the 1980s. Advantages and disadvantages of the two training approaches are discussed with some suggestions as to how the two might be merged to produce an effective solution to problems of delivering effective training and education.

The Centralized Approach to Training

A commonly cited rationale for centralized training is that conducting all training in one location achieves economy of shared resources. The assumptions behind this rationale are that all training is conducted either in one building or in buildings within walking distance of one another; all teachers and learning resources are accessible to all students; and all associated physical facilities are co-located in a single, easily managed unit.

The primary raison d'être for centralized training is delivery of instruction. Consequently, the organization, management, and operation of the training center revolves around teachers and teaching. The training, therefore, tends to be "instruction-centered" rather than "learning-centered." An example of instruction-centered training is indicated by scheduled instructional periods. If a student can attend a session at the scheduled time, that is good; if not, that student must either choose another subject or another time the subject is scheduled. In addition, the content of a centralized training curriculum is based in part on staff talents. A subject is not taught if there is not enough demand to warrant hiring an instructor qualified to teach that subject. Consequently, curriculum content can rarely change to meet the needs or desires of individual students. If a subject is not included in the curriculum, students who need or desire it must either find a school whose curriculum includes it or abandon the subject altogether.

In most cases, centralized training locations have a fixed amount of instructional time for any given subject. Student achievement is then measured in terms of the amount learned from the instruction within that fixed time. The value of the amount learned (e.g., the grade) is usually a function of a student's position on a "normalized" distribution of achievement scores from past or present students in the curriculum. The "cut off" score between passing and failing may also be adjusted periodically, depending on such factors as the academic aptitudes of the current student population.

Student responsibility in centralized training is usually minimized in terms of what and how to study. Students are in the program to be taught by teachers rather than to learn by themselves. If a student does not respond to this "treatment," he or she is counseled, tutored, remediated, and finally, if all fails, released to pursue some other activity.

Advantages and Disadvantages of Centralized Training

These characteristics of centralized training illustrate a number of advantages, the first of which is that training is easy to manage. All facilities, faculty, and learning resources are nearby and can be easily measured, counted, evaluated, scheduled, and controlled. Students can be observed as they learn, and the training program can be easily adjusted to accommodate change in training direction or policy. The cost of developing materials that form the foundation of instruction is invested primarily in the training staff. Consequently, the costs of developing and delivering instruction are relatively small compared with the cost of operating and maintaining the physical facilities. Finally, centralized training has a strong and revered tradition; almost everyone has experienced it and is comfortable with it as an effective way to train.

In spite of these advantages, there are also some significant disadvantages to centralized instruction. One disadvantage is the tendency of a central location
The objective of distributed training is to place training in the context of an individual's worklife.

to become isolated from demands of the work place. The jobs people perform and the skills and knowledge they need are often not closely related to the subjects and information presented in a "closed" training system. Frequently, instructors are deeply concerned with how they teach and how to improve their delivery skills. Because they are teachers, however, they have difficulty measuring the need for or relevance of what they are teaching.

Another disadvantage of centralized training is that once a program is completed, students find it difficult to continue training on an "as needed" basis. Graduates find jobs well away from the training location and tend to live in homes more convenient to work than to the training site. Commuting, parking, and time away from the job all interfere with incentives to continue training. The result of this situation is a conflict of interest between going to work and going to school, one if not both of which usually suffer.

Operating a centralized training facility also presents some difficulties. The cost of keeping the facilities in good repair, heated or cooled, and keeping the staff current and adequately paid, amounts to a substantial and continuous outlay of funds. Furthermore, the movement of students through the system must be reasonably constant and predictable. A sudden increase or decrease in numbers of students can cause considerable disruption to orderly training schedules. Enroll too many students, and the facilities, resources, and staff are inadequate to provide quality training. Enroll too few students, and limited funds must be spent on under-used teachers, training facilities, or other resources.

What are the alternatives to training organizations which must operate within these restrictions? One alternative is to distribute the training to various locations where students can access structured education at times and places convenient to their lives rather than to that of the centralized training facility.

The Distributed Approach To Learning

The objective of distributed training is to place training in the context of an individual's worklife. This facilitates student access to learning opportunities and reduces the "overhead" of training costs associated with centralized training. Distributed training can be conducted in several ways. The simplest form is the travelling seminar in which an instructor teaches a course in various places, spending a few days to several weeks conducting intensive lecture/workshop sessions designed to impart specific skills and knowledge. On a more complex level, training can be distributed through large-scale, computer-based training networks that deliver individualized instruction to sites which have a computer terminal. Between these extremes are various self-study correspondence courses, and packaged, paper-based or multi-media individualized training programs using a "programmed" instructional approach.

Characteristically, distributed training focuses strongly on the learner since the approach tends to increase the distance, both physically and intellectually, between instruction developers and instruction consumers. Distributed training developers are therefore required to put much more thought into who the students are, what skills and knowledge they bring to training, and what skills and knowledge they should take away from the experience. Obviously, this situation is far different than that of teachers who see students personally every day.

Effects of distance between an instructor and students are particularly salient when the distributed training is media-based and individualized. In these cases, a student's only contact with the instruction is what an instructional developer has written as prose, drawn as diagrams, or interrogated as questions. If the instructional developer fails to anticipate and prepare for student misunderstandings or incorrect interpretations, some students can be prevented from mastering the required skills and knowledge. Individualized training materials must, therefore, be much more carefully developed for group training settings where error can be corrected on the spot by the instructor.

Using individualized instruction to distribute training also puts more responsibility on students to complete training programs than does centralized training. Since training is not scheduled in structured periods, students must take it upon themselves to set aside time to study. Usually, if students fall behind schedule, there is no one to counsel, tutor, or otherwise motivate them to catch up. When individualized training is used, the completion rate for students tends to be higher than in traditionally delivered group programs. Reasons for the increased completion rate can lie in training errors that prevent completion, in the lack of extrinsic motivation to finish the training, or both.

Distributed training is concerned primarily with students' abilities to know well-defined facts and principles, develop specific skills, and combine these abilities to perform specific behaviors. The goal of most distributed training, then, is to facilitate learning to a pre-specified level of performance, regardless of how long it takes to reach that level. As a result, achievement is measured in terms of discrete mastery of objectives rather than in the amount of skills and knowledge gained relative to a norm group continuum. Thus, while centralized training tends to keep time constant and allows learning to vary, distributed, individualized training attempts to keep learning constant and allows time to vary.

Finally, distributed training is designed for delivery at almost any location, preferably one close to the student's primary work site. The object of variable delivery is to make training as convenient as possible in order to reduce competition from other activities that make demands on a student's time. The less effort students must make to incorporate training into their everyday worklives, the more likely it is that they will start and finish available training programs.
Advantages of Distributed Training

When these features are examined more carefully, a number of advantages of distributed training are seen. The first advantage is that students are given much more freedom over what and when they study. Since distributed training is less limited by geographic boundaries, the student population pool can be very large. This large size makes it feasible to prepare a wide variety of different subjects and still have enough demand for each subject to make the development effort worthwhile.

Careful consideration of the skills and knowledge to be taught using distributed training can lead to performance objectives that are directly related to job tasks. This direct job-training connection allows measures of training effectiveness to be obtained that "close the loop" between job performance requirements and training program objectives. If students or their supervisors report dissatisfaction or simply stop using the course, it is obvious that the training is either inadequate or incorrect and needs revision. Consulting with end users helps pinpoint precisely where training is weak and needs improvement. The precision afforded by distributed training gives it a quality of measurability that is important to business managers. Knowing more accurately what skills and knowledge a training program will provide allows managers to make better decisions because they know in advance what they are buying with their training budgets.

Another benefit of distributed training is its responsiveness to fluctuations in demand without much disruption to the program in general. If demand for a course declines temporarily, materials are merely held in stock until demand resumes. Increase in demand can also be accommodated without difficulty as long as required materials are available. Even in the least desirable circumstances, producing more copies of a course is not nearly as expensive as hiring more instructors or building more classrooms. In short, incremental costs per student in distributed training tend to be linear while, with centralized training, incremental costs per student tend to follow a "step" function.

It should also be noted that the continuing costs of distributed training are much lower than those of centralized training. In distributed systems, overhead costs of facilities and instructors are minimized. Since students study on individual schedules, a small learning space can serve a relatively large number of students. Further, the cost per copy of materials produced in large quantities is quite small compared with the cost of retaining an instructor.

Disadvantages of Distributed Training

There are, however, disadvantages to distributed training. Among these disadvantages is the fact that managing training resources can become quite complex, particularly if special equipment, like a computer terminal, is involved. Other complicating factors include keeping track of what courses students have started, how far current students have progressed in their courses of study, and which students have completed specific programs.

When training is distributed, it is usually not possible to exert control over student study behavior. Unless the training organization has access to a fairly sophisticated, computer-managed instruction system, students are at liberty to study a course using any strategy they desire. Because most students grew up experiencing centralized instruction based in schools, they have had little or no opportunity to learn from learner-centered, individualized instruction. Thus, strategies they employ when faced with an individualized course may or may not be appropriate to the task. If the strategy they choose is inappropriate, they may spend more time than necessary working to master the objectives. Lack of access to an instructor means that students may not be able to talk to anyone about how to study a subject. This situation could lead to frustrating obstacles for the student and ultimately might cause him or her to discontinue training.

One of the major disadvantages of distributed training is the complexity and high initial cost of preparing even quality, "user-friendly," individualized instruction. Developing self-instructional materials is a special skill that is acquired only with specialized training and considerable experience. As the distance between the developer and student becomes greater, writing, graphic presentation, and interrogation/feedback skills become more critical. If course materials are not well prepared, maintenance and revision of the materials can become a significant burden on the operation of any training organization.

Regardless of how well a course is prepared, however, content and objectives can change, requiring modification of the course itself. Depending on the delivery mechanism used, such changes can vary greatly in terms of expense. If a video tape must be changed, for example, the cost could be very high. A computer lesson, on the other hand, might involve only some relatively minor adjustments to the software. In any case, maintenance and updating of course materials is a constant problem that is considerably more complex to solve in an individualized, distributed environment than in a centralized, group environment.

Although the disadvantages of distributed training are not trivial, too much can be gained from decentralization to discourage adopting this approach. The next section examines the future of distributed training in overcoming disadvantages, and provides alternatives to increasing effectiveness and efficiency of distributed training.

The Future Of Distributed Training

Overcoming the major disadvantages of distributed training should be the primary near-term goal of companies interested in decentralizing training. Loss of student control can be surmounted largely by utilizing a fast, efficient, computer-assisted management system. Record keeping, management of learning resource utilization, and automation of test administration and scoring are all areas that improve control of student learning.

Centralized training has a strong and revered tradition; almost everyone has experienced it and is comfortable with it as an effective way to train.
progress through a training program. Such training management capabilities can play a key role in assuring the success of distributed training where students and training facilities are separated by significant geographic or organizational distances.

Reducing costs of developing individualized materials can be overcome by carefully recruiting developers or vendors who have demonstrated a capability for producing high-quality course materials. Careful planning, thorough job analyses, and clear training objectives can do much to minimize costs incurred by rework and revision. A good set of standards and conventions which reduce the number of development decisions that must be made also contribute to reduced course production costs.

Problems of keeping materials current can be reduced by attempting to design instruction in such a way that it can accommodate changes in content or objectives. Normally, presenting course material in a modular manner, where modules can be changed without disturbing other modules, can significantly reduce maintenance costs. Another approach to the problem of keeping materials current is to choose media such as computer-assisted instruction or printed text for unstable (i.e., subject to change) content, and only use expensive media (i.e., AV) for content that is stable and less likely to become obsolete. Finally, maintenance can be simplified if changes can be forecast during course design so materials can be prepared ahead of time for updating rather than trying to retrofit changes after development.

Engaging in efficient strategies for learning from individualized, distributed training is a skill that can be taught. By considering that students need to be taught how to learn from individualized materials, and by utilizing materials designed to teach methods for learning from individualized materials, it is possible to overcome problems of student difficulty with self-instruction. Establishing a support staff that answers questions and responds to student needs by telephone can also serve to close the distance between students and those who are responsible for delivering training.

Overcoming the disadvantages of distributed training, then, is not impossible. A creative problem solving approach will eventually lead to an effective, functional distributed training system. The kind of system eventually implemented can depend in part on the general approach taken to training distribution. To a great extent, the advent of computer-assisted instruction and management has made distributed training practical and cost effective for businesses. There is such a high information load in any training program that, unless the information can be processed at a high speed, the program will not run well. In centralized training, most of the information is close at hand. With distributed training, information can be scattered over a wide area where, without computer assistance, access would be prohibitively slow.

The first caution about adopting a distributed training approach is that serious attempts at implementing large-scale distributed training should not be attempted without the aid of some type of computer system. A question often asked in this regard is, "Should the computer hardware employed be a collection of stand-alone microcomputers with a central system to handle the management, or a network of terminals connected to a host mainframe that does the entire job?" Each alternative has both advantages and disadvantages.

A system of several stand-alone terminals for distributing training has the most attractive benefits: low hardware costs and absence of continuing communications costs. The disadvantage of stand-alone terminals is that the processing power of microcomputers is quite limited, making them just one step above an electric book. Clerical tasks of ordering and distributing disks containing instructional programs complicate training management. Information on student performance and rate of learning is also more difficult to obtain. Use of the mail for returning disks containing student information is a possible solution, but it takes time to extract the data, and disks can be damaged in transit. Attempting to provide for the possibility of damaged disks means having a backup system that adds still another level of complexity to the management system.

A serious attempt at implementing large-scale distributed training should not be attempted without the aid of some type of computer system.

Most of these problems can be overcome with implementation of a computer terminal network connected to a central mainframe. Computer-based lesson material, student data, automated management functions, and all other information is stored in a single, easily reached and maintained central location that can be accessed by any distributed site. Furthermore, input/output speed, CPU power, and memory capacity of a networked mainframe provide a far more versatile training medium than can be achieved within the limitations of stand-alone microcomputers.

The disadvantage of the network solution, however, is the high cost of equipment. Nevertheless, it is not hardware alone that makes an effective distributed training program. One crucial component of successful training is the software programs that support delivery and management of the entire program. The software is merely a tool whose processing capabilities of which place boundaries on what services can and cannot be automated. It may well be that to achieve an effective, working distributed training program, a networked mainframe is the only solution. Companies investigating computer uses in a distributed training environment should be careful to evaluate the importance of well controlled, tightly managed training.

Training investments are becoming increasingly expensive and the cost of poor training is a poor return on the training investment. For companies which require high employee productivity, efficient training, and management control, it is critical, first, to look at the training services needed, and second, to find the training system that will provide those services most effectively.

Stand-alone systems are appropriate for small-scale operations where distribution is limited and close supervision is not required or difficult. When distribution becomes widespread and
A third alternative to reducing the disadvantages of both centralized and distributed training is to combine the two approaches.

close supervision is not practical, the importance of control available through networking becomes increasingly significant.

A third alternative to reducing the disadvantages of both centralized and distributed training is to combine the two approaches. It is well known that some skills are very difficult, if not impossible, to teach in an individualized, media-based approach. Psychomotor skills and affective responses are examples of areas where human instruction and interaction are particularly appropriate.

By combining centralized and distributed training, it is possible to deliver introductory and prerequisite skills and knowledge to the distributed sites. Once the distributed training has been completed, students can be brought to a central site for the intensive training that is best accomplished in a centralized location with an instructor delivering training that cannot be individualized and distributed. In this case, the centralized training instructor serves as a point of contact for students in the individualized portion of training, using the telephone to answer questions and provide explanations or additional details as needed by individuals.

Striking a Balance

Making the decision to centralize or distribute training can be difficult. Usually one mode must be primary with the other serving as an adjunct. To date, centralized training has enjoyed the greatest popularity. But, with information processing becoming more powerful, more accessible, and less expensive, distributed training is gaining momentum.

Distributed training should be seriously considered in situations when students must travel substantial distances to reach a training facility; when classes are intended primarily for the dissemination of information; or when need for training is unpredictable, required for limited numbers of students at widely spaced times, or required at several different places at the same time.

Centralized training is most advantageous when person-to-person interaction between instructor and student is absolutely necessary to teach the needed skills; when training is a one time need for a fixed number of students in a one-time situation; or when the course content changes so fast that the lesson will be obsolete before the cost of development for individualized media can be recovered.

Combining centralized and distributed training is recommended when neither centralizing or distributing training alone can meet the training needs of an organization. In this case, however, it is crucial that a coherent system of centralized and distributed training be orchestrated to maximize the advantages and minimize the disadvantages of each approach. Too often, the individuals responsible for centralized training compete with individuals responsible for distributed training. The result of this needless competition is wasted resources and lost opportunities for a highly effective mix of group and individualized instruction.

In conclusion, the role of distributed training is just beginning to emerge in the training industry. It is a new frontier and, as such, has its share of hidden problems waiting to be discovered by those who first explore it. But evidence is mounting that traditional, centralized training cannot meet the challenge of productivity now being experienced. Those who will benefit first from distributed training are those who are not presently shackled to large investments in central training facilities with full-time instructors, classrooms, and training equipment. Others to benefit from distributed training are those able to divert themselves of commitments to existing facilities and invest in developing training that can be implemented where the students rather than the instructors are located.

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The Future of Computers In Industrial Training

Can the Potential Become Reality?

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Abstract. Recent surveys indicate a considerable increase in the number of industries and businesses employing computers to support their training. Examination of a number of factors, especially the advance in computer technology, the national acceptance of technology, appearance of the “Office of the Future” and others, indicate a strong potential for business use of Computer Based Training (CBT) to grow. However, the training managers must demonstrate that they have learned from CBT’s past failures. They must employ skillfully the total art of instructional technology, plan project implementation systematically, create an effective management organization, and begin with a detailed cost affordable justification.

For several decades technologists predicted commanding roles for the computer in the management and operation of business and industry. They asserted not only that the basic operation of many businesses would change drastically as a result of the impact of computer technology, but that the technology would generate new industries. Trainers and educators have followed these developments closely to see if the rewards of technology were meant for them. While the record is still unclear, and results uneven, an assessment of the situation indicates that industry and business are positioned to expand greatly their use of these technologies for training.

It is probably useful to pause and summarize the uses and benefits of the computer to support training. The computer can deliver training, test performance, manage the delivery of training and manage the resources and administrative details of the training system. A variety of terms have emerged as short hand titles for each of these functions but they have served more to divide the community than to unite it. This article will use the ‘general term computer based training (CBT) to refer to the use of computers in support of training, computer assisted instruction (CAI) to refer to the use of computers to deliver the training, and computer management instruction (CMI) to refer to the computer in its management role. The reference in note one provides detailed descriptions of the benefits of CBT. This work, as well as others, assert that CBT in one or more of its forms can: reduce the length of training, make training more interactive, make training more interesting, take training closer to the job site, standardize the delivery of training, replace expensive end items, deliver training twenty four a day and on demand, and provide real time information on individual and group performance. Since evidence exists to support each of these assertions, the primary issue concerns the amount of gain, the ability of an organization to achieve the gain and the cost paid.

The Use of Computers in Industrial Training

A 1981 survey by the Alexandria, Virginia, based Human Resources Research Organization (HumRRO) provides an excellent snapshot of industrial and business use of computers in training. HumRRO contacted 160 “Fortune 500” companies, of whom 56 responded (Kearsley et al., 1981). Half the respondents indicated that they used computers for their training responsibilities. Of the half using computers, twenty reported that they used microcomputers. Microcomputer use for training was often in addition to the use of mainframe computers for similar purposes.

Figure 1 displays the survey results. Two conclusions are especially interesting. First, most CBT use supported technical training. This observation is substantiated by the figures indicating that a large number of companies use simulations (an approach that many training organizations find useful to make technical training effective and efficient). Second, the sample companies use CBT across the total range of training requirements, employ a broad range of approaches, and use many different hardware systems. This diversity indicates both a willingness to experiment and the presence of imperatives for the companies to try CBT.

Significant questions for this article are whether the 1981 survey represents an increase in the use of CBT and, if so, what factors drive the change. Data concerning business and industry use of CBT is fragmentary at best, forcing us into inferences.

A 1980 study surveyed 113 companies and found 21% of them using computers for training. A study of 400 companies in 1978 found about 10% of them using computers for training (Kearsley et al., 1981). While the available evidence seems to indicate that the use of computers for training in business and industry is on the increase, we can only put it in perspective by looking backward and examining expectations concerning computer based training over the past decade or so, along with the reasons why reality differed from these expectations.

Although technologists and futurists of the sixties and seventies predicted widespread use of computers to support training and education requirements, those predictions missed the mark. Dramatic changes failed to occur. A variety of causes explain this failure. Hardware was extremely costly;

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Clearly, the first change is the advance in computer technology. We face a situation in which computers the size of a typewriter provide the power that required a computer the size of a room a decade earlier. A series of curves depicting drastic reductions in cost and size and equally dramatic increases in capacity could illustrate dramatically the increase in computer technology. The singular benchmark of this shift is the microcomputer, a self-contained instrument rivaling the power provided by the mainframes of a decade or so ago.

The computer can deliver training, test performance, manage the delivery of training, and manage the resources and administrative details of the training system.

from 4-7 years to become operational, reduced CAI to less than 10% of the delivered program, and provided supplementary rather than substitutional CAI (Seidel and Wagner, 1981).

Despite the presence of two large CAI systems, one developed and supported by IBM and the other by Control Data Corporation, business and industry funding for computer-based education represented only about 10% of the funds spent within the U.S. on CBT and CAI during the seventies. Support of education in the colleges and schools of the United States was the major driver (Office of Technology Assessment, 1979). Even Control Data's program focused more on education than training. The business managers of the seventies apparently did not see CBT as an attractive option.

Despite the problems of the last decade, the evidence available today indicates a considerable increase in the use of computers to support business and industry training over the past 2-3 years. This result should not be surprising when one examines the recent advances within technology and other changes in the business environment. A host of factors, once seen as constraints on the use of such technology for training, now appear to propel some companies boldly into computer-based training.

The National Science Foundation estimates that the power that cost $20 million fifteen years ago will be available for a few hundred dollars by the mid-eighties. The small computer now being advertised nationwide for under a hundred dollars is only the forerunner of this shift. Within a period of thirty years, capacity has increased 10,000 fold while price has dropped 100,000 fold.

Another important factor in technological advance is the increasing graphics capability available on all computers, and the ease of access to it. Sophisticated graphics are not only available in such systems as PLATO or TICCIT but are found in typical microcomputers such as the Apple II. Graphics capabilities enable the computer to support simulations and displays critical to effective training in such areas as equipment operation and maintenance. Anyone who has seen "Three Mile Island," a nuclear plant simulation, or the "Aviation Flight Simulation," two microcomputer simulations, cannot help but be impressed by the power of the microcomputer graphics and simulations and their potential to support effective training.

Keyboards still frighten many people or are cited by managers as a reason they are deterred by computers. The advent of more user-friendly interfaces is another important step toward making CBT more attractive. Touch panels and light pens have been particularly successful interfaces for operator and maintenance programs. They are attractive not only because they circumvent the keyboard but because the student action in touching a portion of the display may have greater psychological fidelity to the real world task than does making a keyboard entry. Voice input is becoming more practical and is already appearing in some hardware configurations. It represents an even more attractive option for many types of human-computer interaction.

Until recently the training manager had several stark alternatives when choosing a CAI delivery system. A multi-site, multi-terminal mainframe system such as the IBM IIS or ITS or Control Data's PLATO could represent a considerable investment. It was cost effective only for certain circumstances involving a specific number and geographic distribution of students. A single site, multi-terminal system such as Hazeltine's TICCIT could be cost effective for other circumstances but required a critical mass of students. Stand alone microcomputers also had their uses. None of these options was a perfect solution. Each had its own advantages and disadvantages. Advanced technology has created a variety of network operations. The ability to have micros operate...
as stand alone delivery systems but to network for management and information purposes offers an attractive option for a number of industrial and business training situations. The importance of this advance is apparent in the speed with which Hazeltine and Control Data have adopted this option for their systems.

Another new training technique that is particularly interesting is embedded training. Embedded training consists of using the computer within a piece of equipment to deliver the training program and testing program for its operators and/or maintainers. Xerox is employing this approach for customer operator training on the Xerox 8010 professional workstation, the STAR. The Army has also employed this approach in several of its command and control systems.

Although authoring effective instructional courseware is still a major undertaking, it is difficult to deny the emergence of authoring languages and systems that tend to make the development of computer assisted instruction easier for non-programmers. Admittedly, each authoring language or system internalizes an instructional approach, which has been described by some as a straight jacket. But for many uses they represent an effective compromise between program flexibility and development cost. Authoring languages such as Pilot, the TICCIT Authoring Language, and PASS are examples of the headway made in developing user friendly languages for the use of instructional developers. Moreover, authoring difficulties are being addressed by automated authoring approaches and by authoring job aids, many of which show promise.

The nation is in the midst of a major environmental shift which may have as much an impact as any factor on the probable success of computer based training. That shift is the invasion and acceptance of technology in everyday life. The exploding popularity of personal computers, the extraordinary success of video games, and the proliferation of video arcades are all manifestations of this phenomenon. One has only to count the number of articles in popular magazines such as Time and Newsweek during 1982 to grasp the pervasiveness of technology. Industry sources estimate that over 750,000 people in business are being supported by microcomputers and that these smaller computers are selling at the rate of 30,000 a month. The 30,000 figure is probably conservative by a factor of two.

The presence of the "Office of the Future" and the maturing of the Office Information Systems (OIS) concept create an environment, provide tools, and generate a demand for computer based training. OIS is an electronics revolution which provides a highly automated office environment. This automation performs clerical tasks electronically and brings new electronic tools to bear on professional and managerial jobs. These tools will redefine and reconfigure some professional positions. The nature of the electronic environment should produce an acceptance of CBT seldom found in present industrial or business settings. More importantly, the managerial and professional workstations can themselves become the new training delivery system. Finally, the presence of such sophisticated electronic equipment will generate a demand for CBT programs to train their users. Traditional training would be anachronistic in such a setting.

As transient as the present economic situation may seem, its importance cannot be neglected. Informal conversations with representatives of a number of companies indicate the movement of more training to decentralized locations because of the cost of transporting and housing students. This does not spell doom for centralized facilities. It may mean instead, the development of a set of objective criteria to determine whether training for a given requirement should be provided in a centralized or decentralized setting. Neither setting is the answer for all requirements. (Editor's note: see Sarenpa this issue.) However the cost of transportation, and the related issues of skill decay and poor likelihood of early use of some of the skills provided, places a great deal of training in a local setting. The major shortcoming of decentralized or distributed training systems is the lack of standardization of training delivery and the uneven quality of field or job site trainers. Computer based training can address this effectively. Hence, the increase in decentralized training ought to increase the demand for CBT among those organizations concerned with effectiveness. A companion impact is the current economic situation's impact on the willingness of a company to invest in expensive training technologies. Some companies are making this investment during the hard times of 1982.

**Instructional Design and CBT**

Another factor which supports industry acceptance of CBT is the increasing systemization of industrial and business training, and the simultaneous, but unrelated, greater involvement of instructional technology professionals in the development of computer based training. Both phenomena are difficult to quantify, much less prove. The greater acceptance of instructional systems development and criterion-referenced instructional approaches in business and industry training leads one to assert the increasing systemization of training. This result places any training requirement in a better position to be supported by computer technology. In those cases where the manager is able to specify a job in terms of a list of tasks and specify those tasks as objectives, he/she has provided the pre-conditions for an effective training program, regardless of the delivery medium. Similarly, the increased involvement of instructional technologists in CBT program development bodes well for the development of effective programs. The HumRRO survey described earlier noted that a number of companies which had not implemented CBT programs had taken the preparatory step of converting their programs to criterion-referenced form with appropriate behavioral objectives.

It can be also argued that more companies will conclude that the use of computer based training, to support either their own training requirements or to train their customers to use and maintain their products, represents a competitive
The videodisc offers exceptional possibilities in its immense storage capacity, random access, excellent video quality and capability of being controlled by a computer.

edge that must be accessed. As an example, market analysts are beginning to assert the need for effective training programs to support the expanding microcomputer market. The analysts usually cite the few CAI tutorials available as examples of the training required. The first microcomputer manufacturer that can support its hardware and application programs with effective CAI tutorials, as well as better documentation, may gain a significant competitive edge. This need can be projected to any other sophisticated electronic item requiring training to operate it.

Other Technologies in Training

In addition to the technologies already described, other approaches, supportive of the larger area of training, are becoming both available and affordable. An increasing number of companies are developing programs delivered by microcomputer driven videodisc players. The videodisc offers exceptional possibilities in its immense storage capacity, random access, excellent video quality and capability of being controlled by a computer. A videodisc can store 54,000 separate pictures or frames of information. At the August 24-26, 1982 Society for Applied Learning Technology workshop on microcomputer driven videodiscs, over eighteen videodisc programs were demonstrated or described. They supported fields as diverse as leadership training, equipment maintenance, and data base management. At present, videodiscs are not a panacea; they are more expensive than the video tape to produce, cost effective only if produced in quantity, and impossible to revise once mastered and duplicated. More near term use may be made of computer-driven, interactive video tape. Although lacking videodisc’s random access speed, video tape is more cost effective where the number of copies is small. It enables trainers to access the same video results that videodisc provides. Computer driven, interactive-type video tape production at this stage should be viewed as complementary rather than competitive with videodisc development since most of the advances it will make will have a direct impact on the development of better videodisc programs.

The use of artificial intelligence (AI) processors to support training appears to be moving from the experimental to the operational. The work on SOPHIE by John Seely Brown and Richard Burton of Xerox’s Palo Alto Research Center illustrates the sophisticated interactive instructional medium that the AI processor can support. The migration of the Navy Personnel and Research Development Center’s (NPRDC) STEAMER project to an artificial intelligence processor is another example of the potential of the AI machines. The strength of an artificial intelligence supported approach is its ability to help students learn strategies, rather than to teach lessons. Students try out their own strategies under the eye of the expert tutor (the AI processor’s program) rather than being forced through someone else’s programmed approach.

The Case of Xerox

One corporate example of the impact of these factors on training program can be seen by examining computer based training at Xerox. Until 1981, the primary operational CBT program within Xerox was a multi-site, multi-terminal, time-sharing system used to provide training to office, administrative, and data processing personnel. Although the program remained cost effective for several years in the areas it addresses, the technology never gained a foothold in the company’s premier training areas—sales, equipment servicing, and management. Training managers in those areas perceived the program as automated program instruction and felt that the absence of graphics and simulations made it inappropriate for their areas. This reaction to shared, multi-site CBT systems surfaced in many other larger companies.

However, during the last eighteen months, Xerox developed or initiated development of computer based training programs across a wide spectrum of topics. Each of these programs took advantage of a new technological capability. When Xerox announced the Xerox 8010 professional workstation, and STAR in 1981, one of the competitive capabilities demonstrated was an embedded training system. STAR, the embedded training program, required operators to hit any key to enter a program which guided them through STAR’s principal features and taught the system’s capabilities, including operation of the “mouse,” the device to move the cursor. The program is interactive and provides precise feedback derived from the operator actions. The STAR also contains two other embedded programs: fourteen training modules to provide greater skill in STAR’s capabilities, and a HELP function which is really an electronic embedded job aid.

Other Xerox programs were developed in 1981 and 1982 to take advantage of the presence of microcomputers throughout the company. These programs included knowledge and troubleshooting programs for factory technicians, and a pre-school knowledge program for new sales representatives. An experimental microcomputer data base game on sales representative knowledge requirements was developed to take advantage of NPRDC’s work in this area.

The largest microcomputer based training program was developed to support Xerox’s 9700 electronic printing system. The Xerox 9700 Electronic Printing System was selected as the focus of a CBT demonstration project. It is a sophisticated system which reflects the latest technology in printing. The material to be printed is provided to the 9700 either by keypunching into the terminal atop it or via computer tape. Most purchasers use the printer to print forms as one of its outputs. Reducing a form to a series of coded commands is an art taught in a short course to customer operators. When the operator keys the coded commands for a form into the terminal, all that is seen on the display are the commands keyed, not the resulting form. The operator must print one copy to see if the desired result is obtained.

The operator course is a two day program taught to Xerox personnel at one location and to customer operators at six locations around the country. The company’s goals in developing a computer
In this CBT application, the Xerox 820-II simulates the operation of a Xerox 9700 printer in the creation of forms. The student hardware consists of a Xerox 820-II with a second monitor.

Based training course were: to reduce the training time required; to shift the training to all Xerox branch sites or to customer locations; and to increase operator effectiveness over the present course.

The solution to this training requirement was the creation of a computer assisted instruction training program on the Xerox 820-II microcomputer. The Xerox 820-II is an upgrade of the Xerox 820. It offers business graphics, runs faster and has more disk storage than the 820. This training program is built around a simulation in which the Xerox 820-II simulates the operation of a Xerox 9700 printer in the creation of forms. The student hardware consists of a Xerox 820-II with the monitor of a second Xerox 820-II driven by it. When students key the commands into the computer, they will see on the first monitor the commands keyed, which is all that would be seen on the terminal atop the printer. The second monitor displays the resulting form.

The key to the program is the use of the Xerox 820-II as a simulator. It simulates the running of the 9700 in the creation of forms. When the student creates forms, the 820-II microcomputer reacts like a 9700 printer. It will display the result the student would actually achieve on the printer.

The training program is in three parts. In the first part, the student is introduced to the eleven most frequently used commands for creating a form, and to the actual form created from those commands. Students change the nature of a form by changing each of the parameters in the command set. As a result they are able to relate a command change to a form change. In the second part of the course students are provided a form and told to create the necessary commands on the microcomputer. The system provides feedback on the actions and displays the resulting form. After successfully coding several forms, students are allowed to move to the printer, where they are given a form and required to verify their proficiency by coding it and printing the desired outcome within three trials.

Instructional developers will appreciate the strengths of this program. It is an interactive program demanding the total involvement of the student. The student is continually coding and changing forms and receiving feedback after each action. The course is built around considerable practice at performing the terminal job task — creating forms.

Several important benefits are expected. Developmental testing to date indicates that the course should be reduced from its current two days to one day or less (probably 6-8 hours). This reduction will enable one full day of work to be captured by each Xerox worker and each customer operator who takes the course. It also appears that the CAI course will reduce the average number of tries a student requires to code a form successfully. The course will be shifted to Xerox branches and be available whenever a prospective student requires the training.

Thus the range of CBT Courses across Xerox is considerable. While a mainframe based system probably will continue to be cost effective to support distributed administrative and data processing training requirements, the other programs are more apt to be supported by microcomputers. Embedded programs have just arrived and will increase in number. The whole equipment servicing training area will receive considerable attention as simulations of increasing fidelity become available.

The factors which I have mentioned thus far represent a considerable change in the situation and hence bode well for the growth of computer based training. The eighties could well see the flowering of this technology.

However, I have purposefully used the conditional term because of the obstacles and pitfalls that confront training managers and developers. CBT is still an expensive technology. Lead times will remain long, managers will become impatient, and the temptation to take shortcuts may be overwhelming. There are several key issues which training managers and instructional developers must address more effectively in the future if they expect the new training technologies to succeed.

**Key Issues for the Future**

First, project planning must begin with a complete cost benefit assessment to quantify the alternatives and to ensure that the project will be beneficial. An effective cost benefit assessment will examine a number of alternatives, especially the location of the training, hardware configurations, and the means of acquiring the courseware. This is a difficult step for an organization that may not have completed a computer based training program previously. But it is more important for such an organization, because it raises critical variables and consciously forces assumptions in areas in which the organization may be ignorant. Further, it surfaces a number of hidden costs, especially those associated with the maintenance of the hardware and ongoing software maintenance which otherwise would be surprises. Computer based training is not inexpensive and is not the answer to every training requirement. It must be addressed like every other business issue in an objective and professional manner, so that managers understand their costs, risks, and returns.

A second major issue is establishing appropriate forms of project management with due attention paid to several critical management concerns. An organization is faced with choices among functional management, project management, and matrix management. Cases can be made for each in certain situations according to the application of different decision criteria. However, our concern, for the most part, is not with the upgrade of existing CBT systems or development of single experimental prototype. These are both simple projects that probably can be handled by functional management. The larger problem is those companies which make a conscious decision to establish a computer based training system and begin the development of courseware. The expenses involved, the complicated nature of the technology, the time length of the project, and the probable size are all factors that many combine to defeat a functional organization. "Business as usual."
will destroy an emerging CBT program. The project manager must take steps to develop a carefully balanced staff that includes all of the disciplines required. Planning, development, implementation, and evaluation of a CBT program is a truly interdisciplinary effort. Another aspect of management is the requirement to ensure that the expectations of the different parties agree. Most military CBT efforts of the 1970s failed because the research and development expectations of the developers differed substantially from the operational expectations of the users upon whom the products were going to be imposed. Early phases of any large CBT effort will by their nature include more developmental and evaluation aspects than may be included later in the project. The potential users must not only understand this; they must share in the development and evaluation. Finally, the project management must ensure a serial development of critical components. Hardware and software environments must be stabilized before courseware is developed. Unfortunately, parallel development is often used because of time restraints. It leads to situations in which hardware and software shortcomings create courseware errors and ultimately slow and make more expensive the courseware development. This occurred in the Army's Computerized Training Project and in the Computer Education Research Laboratory's test of PLATO for the Air Force. Skeptical project managers or their management seem to feel that a CBT "law of gravity" does not pertain to them (Seidel, 1981).

Third, the necessity of performing effective needs assessment, front-end analysis, and instructional development is as critical as in any other training development effort. The best skills of the art of instructional technology must be skillfully brought to bear. Put simply, bad instruction supported by computers becomes "computer-based bad instruction." The need for a systematic approach to instruction is required at the start of the project when the performance technician seeks to determine the performance problem and then, if a training solution is required, selects tasks for training. CBT is an expensive distraction if the performance problem requires a solution other than training. Further, if poor analysis causes inappropriate tasks to be selected for training, this will increase the program cost considerably. Although the costs of CBT may be difficult to cite in the abstract, it is reasonable to assert that each lesson delivered via the computer probably costs 5 to 10 times more to develop than a conventional form of instruction. The CBT lesson can only amortize its development costs in the savings made during the delivery of the training. Effective front-end analysis is critical to ensure that CBT lessons do not suffer the fate of much traditional material that is developed following a hasty front-end analysis and then sits on the shelf as the trainers and managers find that training in certain tasks is not critical to job performance. CBT demands an even more rigorous application of a systematic approach to instruction since the shortcomings become apparent more quickly than in the development of materials for a conventional course.

Organization for curriculum development is a highly significant but separate issue that relates to project management and systematic use of instructional technology. If a company or business intends to employ computer-based training in other than the most experimental way, it must take a serious approach to the creation of a computer-based training development capability. One of the problems of the CBT efforts of the past is that each business or military CBT effort was a prototype venture in which the participants committed all of the obvious errors. As long as each CBT effort is an ad hoc affair, this track record will continue. However, if a company recognizes the long term investment required, acquires the diverse skills necessary, supports them with the necessary equipment, and then develops the programs sequentially in order to draw systematically the appropriate lessons from each project, an effective development group can be created. Such a group is akin to a successful team in any professional sport. It requires individual skills at each position, as well as a skilled and experienced management and group cohesion, to obtain the synergism that is possible. Creation of such groups is one of the best ways to reduce the present high ratio of hours of development time to hours of course time found in most CBT efforts.

Finally, considerable thought and planning must be applied to the plan for implementing the CBT program. This is a technology transfer issue. Our principal concern must be with the transfer of CBT technology from a group of developers, steeped in the technology and accepting of its characteristics, to a group of users who wonder what strange apparition is about to be imposed upon them and upset the order and stability of their world. Instructors and trainers must be won over. They must be continuously involved so that they feel they "own" the program. The implementation list is endless and does not bear detailing. It is important to remember that some of the of CBT programs developed in the past eventually reposed permanently on shelves (or on the computer equivalent thereof) due to poor implementation plans. The issue is a complicated one to address because it involves all levels of the users. It is insufficient to obtain only the agreement or support of the user management. Individual trainers and instructors can sabotage the effort if they are not involved. Coordination meetings are not enough. Examples abound of CBT efforts wherein numerous meetings were held but did not address the substantive project issues in a shared way. Finally, the entire user apparatus must be sub-

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An Economic Model of Training in an Industrial Setting

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Within the economics of education literature there are several examples of attempts to model the behavior of students and instructors in a microeconomic framework. These attempts have focused, however, on the student's behavior toward learning in a general educational setting—a setting in which the student is assumed to desire learning for the satisfaction it brings and the future income that may be obtained upon completion of the given course of study (Becker, 1982). Similarly, the development and implementation strategies treated in literature are typically those of an academic setting (Becker, 1979). The economics of training within the industrial setting has received little attention. Yet well over $40,000,000,000 is spent annually by private, U.S. corporations on the direct training of their employees (Carnevale, 1982).

This industrial training, unlike general education, tends to be job specific and particular to a given firm or industry. Benefits of training accrue primarily to the firm and only indirectly to the individual being trained. Thus, economic models developed for general education cannot be directly transferred to industrial training situation.

This article presents a microeconomic model of training and its development for a profit maximizing firm. In this model we are particularly concerned with the impact of training on the production process—the fundamental activity of the firm. We argue that since training is not part of the direct production process itself (training functions may be performed by staff positions and not line positions), its contribution to the production process must be to augment or enhance the physical and human capital that is used in the production process. In short, trainers seek to make workers more productive, but are not part of the production process themselves.

When an organization undertakes a program of instructional development and training, such efforts constitute a drain on the firm's resources. The cost of instructional development and program implementation in the training period is the production loss by diverting resources from direct production. The benefit of instructional development and training program implementation is the expected gain in productivity following the training period. At the time of initiating the instructional effort this gain is a probabilistic gain, the magnitude of which cannot be known with certainty. It is management's job to assess the degree to which the resources diverted from current production actually do bring about greater future production. It is our purpose to illuminate some of the underlying economic principles which impact this decision.

Microeconomic Theory of Resource Employment

Our first step is to develop an overview of the economic theory of resource employment (Henderson and Quandt, 1980). Our model is mathematical, as most economic models are, and may be new ground for some readers. We have tried to highlight the key points and relate them closely to training.

In the classic microeconomic view, a firm is seen as a profit maximizer. As it is looked at in many economic models, the firm seeks to maximize profits in a competitive product and factor market. All wages, rents and prices are specified in markets; the firm attempts to select the optimum mix of labor and capital to maximize its total revenue minus its total cost. Algebraically, the firm attempts to maximize this function:

$$\text{Profit Objective Function} \quad \pi(L, K) = wL - rK$$

where $$L$$ (Labor) is the quantity of labor time employed, and $$K$$ (Capital) is the quantity of capital employed in the firm's production process of value $$v$$. A unit of labor costs the firm $$w$$ and a unit of capital costs $$r$$.

Figure 1 shows graphically the typical production process. As the firm begins to employ labor, total revenue ($g$) rises rapidly. But with a fixed capital stock, a point is soon reached at which total revenue begins to rise less rapidly as more and more labor is added. In the short run, where capital is fixed and the firm is restricted to a given technology in its production process, the firm attempts to select the quantity of labor that maximizes profits. As long as the additional revenue from hiring one more unit of labor (the marginal revenue of labor), which is given by the partial derivative of $$g$$ with respect to $$L$$ and is denoted by $$g_L$$, is greater than the added cost of that labor (the marginal cost of labor, $$\delta L$$, exceeds the wage rate, $$w$$) the firm will increase its profits by hiring more people. The marginal revenue and the marginal cost of labor will be equal at some labor employment level $$L$$, where the slope of the total revenue curve is equal to the wage rate ($$w$$) equals its marginal cost, i.e., $$g_L = w$$.

A comparison of Figures 1 and 2 shows that a rise in the marginal cost of labor results in a decrease in the profit maximizing level of labor to be employed. A rise in $$w$$ (as occurs in moving from Figure 1 to Figure 2) implies that the firm will raise the marginal revenue attributed to labor by cutting back on the amount of labor employed, i.e., $$L_2 < L_1$$.

Total revenue and profits will be lower at $$L_2$$ than at $$L_1$$, but given the higher wage rate, the reduced labor employment level represented by $$L_2$$ is
the best the firm can achieve with a fixed capital stock and given technology. The practical point is this: For any given firm with fixed capital and fixed technology, there is some level of employment at which the profitability of the firm is greatest. The firm has neither too many nor too few employees.

(2) First Order Conditions for Labor and Capital

\[ s_L - w = 0 \] and \[ s_K - r = 0 \]

These functions show that the higher \( w \) (wages) and the lower \( r \) (rents, or cost of capital), the less labor and more capital the firm will employ. The effect resulting from a rise in \( w \) yields:

(4) Slope of the Factor Demand Curves

\[ \frac{d L}{d w} = \frac{s_L}{s_L - s_K} \] for labor, and

\[ \frac{d K}{d w} = \frac{s_K}{s_L - s_K} \] for capital

The first observation which can be drawn from these equations (4) is the same as the one demonstrated in Figure 1. At the higher end of the production process function (e) where total revenue is largest, the rate of increase in marginal revenue decreases (total revenue rises at a decreasing rate as \( L \) is increased, i.e., \( s_L < 0 \)). This is one example of what is commonly called the law of diminishing marginal returns. In addition, the mathematics of profit maximization require that the determinant of the Hessian matrix in the second order conditions (3) be positive. The Hessian matrix is the leftmost box of equation (3); the requirement about determinants means that the value of the denominator on the right-hand side of equation (4), \( s_L s_K - s_{LK} s_{KL} \), must be positive. But in order for that to be true, both \( s_{LK} \) and \( s_{KL} \) must be negative.

The key profit in all of this is not a mathematical one, but a very practical one indeed. The slope of the Labor demand curve, the first equation in (4), shows that an increase in wages implies reductions in labor employed to optimize total revenue, even when capital is variable. Unfortunately, the capital effect of an increase in wages cannot be determined without an additional assumption because the crosspartial \( s_{KL} \) and \( s_{LK} \) are signwise unknown.

Some other important observations can be drawn from this elementary model of the firm. If capital and labor are complements in production, then an increase in labor increases the marginal revenue product of capital, i.e., \( s_{KL} = s_{LK} > 0 \). Labor is required; labor knows how to work with current capital. Suppose, for example, that every person working on an assembly line were given an air wrench to replace a ratchet wrench. The marginal product of labor would increase purely in response to an increase in capital. In this case a rise in labor cost \( (w) \) would still result in a fall in total labor required \( (L) \), but the marginal product of capital also falls as labor is reduced \( (s_{KL} > 0) \). In response to this decrease, the firm cuts back on capital employed as well as labor to get capital’s marginal revenue product back up to equal the marginal cost of capital \( (r) \), i.e., \( d K/dw < 0 \). So
the whole firm retrenches to make the most money.

But if capital and labor are substitutes in production, i.e., $8_{kl} = 0$, something very different occurs. Suppose, for example, that welding robots were introduced on the assembly line. The marginal product of labor would decrease in response to this increase in capital. Now, a rise in labor cost \( w \) results in a fall in labor employed \( L \), but the marginal revenue product of capital rises. The firm increases its use of capital to get its marginal product back down to the marginal cost of capital \( r \) thus \( \frac{dk}{dw} > 0 \).

Regardless of whether capital and labor are complements or substitutes in production, any rise in the marginal cost of either labor or capital will make the firm worse off given its current technology if it is represented by the production function \( g(L, K) \). As long as the production process \( g \) is fixed, the firm will cut back production when its marginal costs rise. The only way the firm can return to its old profit level or increase it is to change the production process itself by improving the technology it uses.

The Role of Training: A Microeconomic Theory

It is precisely for the implementation of new technologies that the need for firm-specific training arises. If the firm is willing to gamble that better technology can be brought on line, then it may be necessary for the firm to divert some of its resources to the training of its labor force so that it can function under a new technology. Unlike what occurs in capital deepening, where the firm just adds more robots or more wrenches to the current production process, a change in technology associated with a change in production process requires that labor be trained in the new approach. For example, the acquisition of word processing equipment cannot be described as either a substitute or complement for labor in a particular office. The mere acquisition of the equipment in no way implies that the marginal product of labor for the existing labor force is increased or decreased. Changes in the production process accomplished not only through the additional capital but through training of the work force, underlie increases in the firm's productivity. Because of its direct tie to productivity, training must be considered in any economic view of the production process. But not only does training play a central role in the technological change of the firm's production process. Training implies opportunity costs of two kinds, since training costs money and takes time.

Unfortunately, the simple model introduced above is not sophisticated enough to capture the changes in the production function we are now interested in considering. Nor does it permit us to examine how training indirectly enters the production process. We will now proceed to develop a model which does deal with these considerations.

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The Two-Period Model

The in-house training of labor cannot be viewed as entering the production function of a firm directly, since training does not enhance productivity immediately. Management hopes, rather, that after training is completed, the productivity of labor will increase. But during the period in which the training occurs, the firm faces additional costs with no immediate return. The firm must take part of its labor force out of productive activity to attend training; it must hire trainers and training developers; it must divert capital from production to training. Besides, since the effects of education and training are imprecise, the impact of training on productivity cannot be assured. With the best of intentions, the firm may invest substantial funds on training, get high participant reviews, but obtain little if anything in increased productivity—its real objective.

So training represents a complex economic environment. If we are to move beyond the textbook idea of capital deepening we will need a model in which the production function itself changes. In economic terms, we will show that training involves large costs which can yield maximum benefit to the profit maximizing firm only if the production process itself changes as labor learns to work with new capital.

The model. Assume, first that there are two periods described in the model: in the first period training takes place; in the second period there is no training. In our model all training is specific to the firm. We do not address the problem of trained employees leaving the firm in search of higher wages. We assume that instructional developers and program implementers are employed only in the first period. We assume, furthermore, that all decisions in the firm are risk neutral; that is, individuals concern themselves with expected gains and not with the variability of those gains.

Activity in the model. While developing a training program, the decision maker recognizes that some labor and capital may have to be diverted from the current production process. Let \( k \) be the amount of capital that is diverted to training from the firm's capital stock of \( K \); thus, \( (K-k) \) is the amount of capital available for current production. Similarly, let \( t \) be the amount of labor time diverted from current production, where \( L \) is the total amount of labor time hired in the first period. Thus, \( (L-t) \) is the amount of labor time employed in current production. The first period production function, or total revenue function, is now given:

\[
g(l-t, K-k)
\]

Let the unit cost or wage of labor be represented by \( w \). The unit cost of capital will be \( r \)—just as in the earlier
model. Trainers are hired for an employment time e. Their unit cost is valued at a wage rate of \( w_e \). The firm's first period profit function is now:

\[
g(l-t, K-k) - w_l - w_e - rK
\]

(6) Profit Function During Training

The cost of development and training is given by the lost production resulting from the fact that \( t \) hours are spent by labor in training, at a cost of \( w_t \); \( k \) amount of capital is used in that training, at a cost of \( rK \), and development and training expertise costs \( w_e \).

In the second period, subsequent to training, the firm expects to achieve the fruits of its expenditures on training. In particular, it hopes to operate under a new technology that is better (i.e., more profitable) than the old. This technology is represented by the new production process:

(7) New Production Process

\[
g' \; (L, K)
\]

where \( L \) represents the augmented Labor hours used in the second time period in a production process described by \( g' \). (Note 2).

But in reality, \( g' \) may not be realized. There is a chance that the firm can never do better than the old production process described by \( g \). Let \( P \) represent the probability that the firm does actually realize the production process \( g' \) in the second period, and represent the probability that it continues with the existing output of the old production process by \( (1 - P) \). The probability of realizing the new technology is a function of the amount of expert time devoted to development, \( e \), the amount of time spent in training, \( t \), and the amount of capital used in development and training, \( k \). In addition, let the wage rate in the second period be \( W_L \), which may not be equal to the wage rate in the first period. The expected profit in the second period is now given by:

(8) Expected Profit After Training

\[
P(t,e,k) \cdot G(L,K) + g(L,K) - W_LL - rK
\]

\[
(1 + r)
\]

\( G \) in this equation, is the change in the production process from the old one \( g \) to the new one \( g' \). (i.e., \( G(L,K) = g'(L,K) - g(L,K) \). Given a two period horizon, we can assume that the firm attempts to maximize its profits described in equations (6) and (8) with respect to the parameters of the model: \( l, L, K, t, e, \) and \( k \) (Note 3). The first order conditions for such maximization are given by:

First Order Condition for Profit Maximization with Respect to:

Labor

\[
(9) \quad g_L - w_l = 0
\]

Capital

\[
(10) \quad g_P + PC_L - W_L = 0
\]

Training

\[
(11) \quad g_e r + (g_K + PG_K r) / (1 + r) = 0
\]

where \( g_1 = \delta g / \delta (1 - t) \), and \( g_2 = \delta g / \delta (K - k) \) and where all other partial derivatives are designated by letter subscripts.

Observations from the Model

Conceptually, equations (9) and (10) define the optimum employment of labor time in direct production in the first period, \( 1 - t \), and the second period, \( L \). Labor will be employed in direct production in the first period up to the point where its marginal product equals its wage rate, just as in the first model. But to the extent that labor time is diverted to training, more labor time will be employed than would be the case if training were not undertaken.

In the training period, the training actively creates jobs, even though training costs the firm additional money to hire that added labor. But what is particularly noteworthy is that training creates jobs in the second period (subsequent to training) as well. This finding runs directly contrary to the popular notion that you train in order to reduce employment.

One trains to increase profits. In this model, increased profits are achieved not by cutting back on employment, but by increasing it to operate a more efficient production process. This improvement in the production process itself is the source of the increased labor utilization observed in the second period. Unlike simple capital deepening, where the production process \( g \) does not change, true innovation results in an increase in labor under profit maximization conditions. Thus, as a measurement of the effectiveness of training, one cannot use changes in the labor force. For example, a manager who feels that the introduction of word processing in an office will reduce staff may be confusing his or her goals. The purpose of changing the production process and providing training is to maximize profits. Profits may be maximized by increasing labor employment as production rises. Reducing labor employment may not be associated with profit maximization.

We can demonstrate our point most easily in the economic context of the model by noting the absence of a training effect with no likelihood of improving productivity \( (P = 0) \). Without training, the firm would employ labor in the second period to the point that \( B_L - W_L = 0 \). But to the extent that training actually does produce an expected positive productivity effect (i.e., \( P > 0 \)), then the profit maximizing firm should employ labor in the second period to the point that \( PG_L - B_L - W_L = 0 \). The added product brought in by \( PG_L \) means that the marginal revenue product of labor must be lowered to the point that it equals the wage rate. This is accomplished by employing more labor, not less. Recall from the assumption of the model that \( W_L \) may be larger than \( W_e \), so that more labor is required with training even if wages increase. Recall too, however, that training is firm specific. Thus, there need be no market pressure to pay higher wages in the second period.

Equation (11) yields the optimum levels of capital that will be employed in the first and second period. Unlike that situation described for labor, where different amounts of labor are employed in the first and second period of the model, capital employed \( (K) \) is assumed to be the same in both periods. But like the case of labor, equation (11) demonstrates that to the extent that instructional development and training can be expected to produce a positive effect in the second period, (again, \( P = 0 \)), more capital will be employed by the firm in both periods than would be the case if this gain were not expected. The manager's focus must be on profit—not just cost or resource employment.
Equations (12) through (14) describe the profit maximizing conditions regarding the amount of training that the firm can be expected to attempt. In particular, (12) and (14) state that training effects are optimized when the firm diverts labor and capital from direct production to training in the following way: The loss of revenue product from one additional unit taken out of first period production equals the present value of the expected gain in revenue production in the second period. It is important here to clearly point out what these conditions do not state. One does not invest in training to the point that total cost equals the total expected revenue gain. That level of training is always too high because gains must be discounted since they occur in the future, and because profit maximization is based on marginality.

To make these conditions more meaningful, let us consider the behavior of the manager. Intuitively, a profit maximizing manager will adjust the amount of training given subordinates so that his or her estimate of the present value of the expected marginal benefit of training equals the marginal cost of providing that unit of training now. Poor management decisions will be revealed not by changes in the labor force or capital stock. Nor will the amount of training provided serve as an index of effectiveness. Failure to train adequately will be signalled by unrealized profit.

Conditions for optimizing development. Equation (33) states that the training development expert’s time should be employed to the point that the present value of the expected gain in second period production from the last hour of the expert’s time equals the instructional expert’s wage rate. In short, you keep developing until the present value of the expected benefit from doing more development equals the wage rate of the developer.

The amount of time the instructional development expert is employed in the first period is totally dependent on his or her wage rate and on the present value of the expected production increase that his or her efforts will produce in the second period. Unlike labor that is employed in the direct production of the firm’s product, for a given capital stock, the employment of the instructional expert will be sensitive to the rate of discount (interest rate) applied to the capital. The higher this rate, the less time an instructional developer will be demanded by the firm, for a given

cofactor of an element off the diagonal, is not known. The effect on I, L, K, t, e, and k of a change in w₁, w₂, w₃, and r can now be analyzed by solving (15).

Effects of Changes in the Wage Rate of Labor

The effect on the demand for labor of an increase in the wage rate of labor in the first or second period is given by:

slope of the Demand Curve for Labor

\[ \frac{dL}{dw_{w_1}} = H_{11}/|H| \]

\[ \frac{dL}{dw_{w_2}} = H_{22}/|H| \]

Since \( H_{11} < 0, H_{22} < 0, \) and \(|H| > 0,\) then \( dL/dw_{w_1} < 0 \) and \( dL/dw_{w_2} < 0.\) An increase in the first or second period wage rate of labor will cause the demand for labor in the respective period to fall. Correspondingly, a decrease in wage will cause demand to rise. The effect on the demand for the other variables of production is not known, however, since \( H_{31} \) is signwise not determined by the second order conditions. For instance, the change in demand for an instructional development expert’s time is given by:

\[ \frac{dL}{dw_{w_1}} = \frac{H_{13}}{|H|} \]

Since the sign of \( H_{13} \) is unknown, the sign of \( dL/dw_{w_1} \) is not known. As a result of a rise in the wage rate of labor, the demand for instructional development

\[ \begin{bmatrix}
  \frac{d1}{dt} \\
  \frac{dL}{dt} \\
  \frac{dK}{dt} \\
  \frac{de}{dt} \\
  \frac{dk}{dt}
\end{bmatrix}
\]

\[ y = \begin{bmatrix}
  \frac{d1}{dt} \\
  \frac{dL}{dt} \\
  \frac{dK}{dt} \\
  \frac{de}{dt} \\
  \frac{dk}{dt}
\end{bmatrix}
\]

Figure 3. Values for \( H, v, \) and \( y \) in equation (15).
could rise, fall or remain unchanged. It is not necessarily the case, as one might easily assume, that a rise in the cost of labor will lead to an increase in capital usage and an increase in the need for additional training of labor to work with that capital. The only thing we know for sure is that an increase in the unit cost of labor will result in a decrease in the demand for that labor.

Effects of Changes in the Unit Cost of Instructional Development

Similar to the above results for labor in general an increase in the unit cost of instructional development will result in a decrease in the demand for the development and vice-versa, i.e.,

\[ \frac{d/\partial}{d w_c} = \frac{H_{gs}}{|H|} < 0 \]

It is important to note here that instructional development is subject to forces of demand in a labor market. In short, developers can price themselves out of the market.

The effect of a change in the cost of instructional development on all the other variables of production is once again undefined since the signs of the cross partials contained in the respective \( H_{gs} \) co-factors are unknown.

Perhaps most surprising is the fact that a change in the unit cost of capital, \( r \), yields no determinant effects. In the case of the demand for capital itself the results of a change in its cost is given by:

\[ \frac{d K/\partial r}{|H|} = \frac{g + \beta}{\partial} + g + \beta \]

Since the signs of the \( H_{gs} \) co-factors are undefined, the sign of \( d K/\partial r \) is known. A decrease in the cost of capital need not result in an increase in the demand for capital and an increase in the demand for instructional experts to train labor and training, however, the demand for capital need not rise as that capital becomes less expensive. But this observation may be an artifact of the model, as we assumed at the start that the rate of discounting is equal to the rental rate of capital (\( r \)).

Conclusions

In this paper we have developed a microeconomic model of training development that is based on the argument that training, unlike labor and capital, is an indirect factor in production. Training development, to the extent that it is successful, enhances or augments labor and capital in the direct production process following the actual training of labor. Training is fundamentally different from capital acquisition, even though the goal of both activities is the same—the increase of profit.

During the training period, training requires that capital and labor resources which could be used in direct production be diverted to the instructional program. This diversion of resources represents "opportunity cost" of training. The benefit to the firm is realized only after the labor completes training. Thus, at the time when the decision to invest in training is made, the decision to incur the opportunity cost must be based on a probabilistic benefit that may or may not materialize in the future. The firm takes a risk when it trains.

In the profit maximizing setting, the firm makes a trade-off between the opportunity cost of training and the present value of the expected gain in production from the training. The worth of that tradeoff (the amount of the benefit) determines the amount of training to be undertaken. In particular, instructional development should be undertaken to the point that the present value of the expected marginal benefit from training equals the marginal cost of that development. The greater the present value of the expected marginal benefit, the more training that should be undertaken. The model, in fact, suggests that training projects should be closely scaled to the expected marginal benefit if the firm's profit is to be maximized.

The implications of marginality and profit maximizing for training clearly suggest that some training might be undertaken with less than perfect competency expected, and yet with a major impact on profitability. At the same time, however, training with very high performance outcome standards might negatively effect profits. There is no fixed rule to apply in answering the question, "How much time and money for training is enough?" Good training is profitable training, no matter how much time and effort gets spent.

In planning, justifying and documenting training, changes in profitability need emphasis. It appears to make little sense to justify training on the basis of expected reductions in the labor force. In fact, if training is successful, labor increases are likely to prove profitable. Industry wants training because training increases profits by making people more productive; if people are more productive, the firm will want more of them.

It is comforting to be able to base these generalizations on a microeconomic model, rather than simply on the basis of management conjecture and heresey. The inferences drawn from the model—many, of them counter intuitive—suggest that the formal modeling process is worthwhile.

Future directions. In general education, training is justified and evaluated in myriad ways. In industry, however, there is ultimately only one criterion—profitability. The effects of training on profits, employment levels and technological change itself, cannot be handled adequately through ad hoc theorizing or managerial rules of thumb. Through formal microeconomic models of the firm, however, we can analyze the interactions of the factors which operate here, and assess the contribution each makes.

We have provided the theoretical basis for a formal economic model of training in the profit maximizing firm. We hope that others are encouraged to develop models on a similar basis to seek out generalizable rules and frameworks for describing training in the industrial setting.

Reference Notes

1. The authors are indebted to Douglas Davis for the constructive criticism he provided in reviewing their model and its applications.
2. It is assumed that all labor time in the second period is homogeneous. Thus, the time of training in the first period must be divided evenly across the firm's labor force.
3. The expected value in the second period of the production process is \( P' \) (the likelihood of achieving the new process and of working with the old one). After rearranging terms:

\[ P' + (1 - P') = P' + g \cdot P = g + P' \cdot g = (g + P') \cdot g = \text{(and substituting G for g + P)} \]

References

Algorithmic Processes for Increasing Design Efficiency

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Efforts to increase the efficiency of instructional design throughout the education and training community often attempt to: (a) increase the effectiveness of instructional materials, (b) increase the amount of instructional improvement activity impact by the individual designer, and (c) reduce the costs of instructional design. Examples of these attempts are the dozens of instructional design models which have been expounded to improve the design process (Andrews & Goodson, 1980; Branson, 1981; Gustafson, 1981). Other efforts include attempts to reduce costs and multiply the impact of individual designers by using graduate students or interns as deputies, and training instructors to perform as designers with minimal consultant assistance.

It is not the purpose of this paper to argue the relative merits of specific efforts to increase the efficiency of instructional design. Rather, the intent is to offer for consideration as an addition or supplement to other efforts, the use of algorithmic processes as a means to increase design efficiency. Algorithmic processes and types of applications in instructional design are described in this paper. In addition, a range of algorithmic processes which form the progression in the development of a project for the increase of design efficiency are described.

Algorithmic Processes

Three algorithmic processes for problem solution are: (1) algorithms, (2) quasi-algorithms, and (3) heuristics. An algorithm is a precise, generally comprehensible prescription for carrying out a defined sequence of elementary operations in order to solve problems belonging to a certain class (Landa, 1974, p.11). A theorem in mathematics is a good example of an algorithm. Given a set of data and accurate computation of the theorem, the results will always be correct. Error occurs through inappropriate application of a theorem to a situation. In this case a correct calculation of the theorem results in an incorrect solution to the problem.

A quasi-algorithm has characteristics similar to an algorithm but may not yield the same results every time (Good, 1973). An instructional design model is a good example of a quasi-algorithm. The design model is similar to an algorithm in the sense that there are defined steps regarding what must be done (and often well defined procedures about how to do it). However, highly proceduralized models are usually designed for a specific problem in a specific situation. The vast number of variables involved make it very unlikely that any given set of procedures could be generalized to the universe of instructional design problems. Instructional design models are useful guides to the solution of instructional problems, but there is no guarantee of achieving similar results. Two individuals applying the same model might end up with quite different results. The results in each case might be equally good or one might be superior to the other. Among the variables determining the quality of results are the abilities of the designers, the extent of client cooperation, and the adequacy of resources and support.

The heuristic is a method which considerably narrows the scope of searching for a solution without prescribing a solution. Heuristic methods assume a support of accumulated experience in problem solving and the use of this experience for specifying the direction of the search toward the greatest probability of solution (Landa, 1974, p.117). Heuristics are a set of rules-of-thumb accumulated from personal experience, observation of the experience of others, reviews of research literature and case studies, and other sources. Often one individual rule-of-thumb will contradict another; the experienced problem-solver selects from the repertoire of heuristics those relevant to the particular problem at hand. Heuristics are only intended to short-cut problem solution; there is no guarantee of results. Probably the best known works on heuristics in the area of instructional development were published by Durzo (1978) and Haney, Lange, and Barson (1981).

The instructional designer employs algorithmic processes for three types of applications: (1) content, (2) strategy, and (3) production. Landa (1974, 1976) described content applications as teaching students to solve problems by using algorithms. This approach results not only in the solution of the immediate problem, but also trains students to approach other problems in an algorithmic fashion. Content applications of algorithmic processes relate to instructional design efficiency in the sense that an increase in instructional effectiveness of the content would indicate an increase in the efficiency of the design.

Landa (1976) and Mitchell (1980) describe instructional strategy applications as algorithms which aid the student in learning. Instructional strategy applications are procedures for teaching specific kinds of learning tasks. Instructional strategies may be developed at the heuristic, quasi-algorithm, and algorithm levels. Typically, generally defined and less specific tasks are approached using heuristics. As learning tasks are more clearly defined and specific it becomes possible to use quasi-algorithms. Only the most clearly defined and highly specific learning tasks are suitable for applying algorithms.

Instructional materials production applications of algorithmic processes increase design efficiency by relieving in-
A list of tasks commonly found in training programs.
Guides for learning to perform tasks selected from the list of tasks.
A flowchart of the kinds of steps required to implement the guides for learning to perform each of the selected tasks.
A procedure for the selection of cost-effective media for the implementation of each of the learning algorithm flowcharts as training aids.
Guides for preparing the selected training aids to teach each of the selected tasks and which implement the learning algorithms.
Computer program to implement the format models with automated preparation of training aids.

Figure 1. Progression of the TAEG development effort.

Instructional designers of much of the tedious and repetitive drudgery involved in the actual design and production of materials. Unskilled labor, using algorithms generated by the instructional designer, can perform such tasks as test item construction, test administration, and data coding. Computer data bases can be established for task analyses, behavioral objectives, and test items. Computer aided authoring, editing, and publishing programs such as word processing, readability analysis, graphics production, exercise and test generation, and layout of the printed page are other examples of how production algorithms release the instructional designer for more creative efforts and increase designer efficiency.

The Training Analysis and Evaluation Group (TAEG), working for the Chief of Naval Education and Training, is heavily involved in the effort to increase instructional design efficiency. Figure 1 shows the progression of the TAEG effort beginning with sets of heuristics in the form of learning guidelines which were developed for training sailors to perform eleven discrete types of learning tasks. Quasi-algorithms were then developed for each set of the learning guidelines. A set of heuristics was established for selecting media to implement each of the learning algorithms. Format models were developed as quasi-algorithms for the preparation of training aids for each of the learning algorithms. Computer based production algorithms were developed to guide authors in producing training aids for the most common types of tasks. Other computer based production algorithms were also developed for text and illustration processing, and for calculating readability of text and providing a guide for editing.

Background
The Naval Training Command is responsible for teaching over four thousand courses. In contrast to general education, graduates of Navy courses are expected to perform specific tasks in their duty assignments as a result of training. The welfare and safety of their shipmates and ultimately the national security are dependent in large measure on the quality of the training program. The rapid pace of technological change creates a tremendous demand for course revision. Equipment, strategy, or tactical innovations within our own or a potential adversary’s forces will usually require major revisions in all courses related to the area of change. For example, the Navy will soon adopt a hover-craft for amphibious troop landings. This innovation will require the development of operation and maintenance procedures, technical manuals, and training courses. Also, there will be a lengthy period of constant revision as maneuvering techniques and related equipment modifications develop.

Instructional Program Development (IPD) centers are charged with the basic responsibility for course development and revision within the Naval Training Command. The IPD center personnel, utilizing Instructional Systems Development (ISD) [NAVEDTRA 110] procedures, are responsible for a major portion of the Navy instructional design activity, however, the demand for course development and revision is so great that the IPD centers can handle only high priority requests. A significant portion of the course development and revision activities must be performed within the schools by the subject matter experts (SME) who have little or no training in ISD. TAEG’s development of instructional design algorithms is an effort to support the IPD center activity with more efficient procedures and to provide guidance for SMEs in the development of certain kinds of instructional materials.

The development and validation of algorithms is a lengthy and costly process. The TAEG effort is limited to five kinds of learning tasks: recall of bodies of knowledge, symbol learning, rule learning, procedure learning, and classifying. These five learning tasks were selected because they occur most frequently in Navy training courses and were considered to have a reasonably high potential for successful adaptation as algorithms. Finally, the TAEG effort is limited to the development of print and CAI media algorithms for each of the five types of learning tasks. Print was selected because of its current frequency of use in Navy training. CAI was selected because major commitments within the Naval Training Command indicate CAI will be adapted as a major medium in future course development activities.
Algorithms In Instructional Design

The instructional designer’s role is divided among professional and routine tasks. Professional tasks place great demands on their creative insight, theoretical knowledge (e.g., evaluation systems, learning theory, diffusion/dissemination theory, etc.), and interpersonal skills. Instructional designers who are weak in some skills may compensate with strengths in others. Instructional designers have usually not been formally trained in the design process. Rather, they acquire a repertoire of heuristics from such activities as formal course work, personal experience, and review of professional literature. The quality of instructional designers is determined by the depth of their repertoire and intuitive ability to apply heuristics in a variety of instructional problem situations. However, the instructional designer may be trained to perform the routine tasks that make up the craft of instructional design. The routine tasks include specific techniques for instructional design activities (e.g., task analysis, needs assessment, specification of objectives, test writing, etc.). The instructional designer utilizes professional skills in the process of selecting a set of routine tasks appropriate to the instructional problem. The implementation of the routine task activity might be expedited by relying on an algorithm for actual performance. Or, the instructional designer might devise an algorithm so that the task could be performed by an untrained assistant.

This assignment to lower level staff occurs after the designer has defined the input and the outcome and has limited the scope of the algorithm to the specific class of problem. The assistant (human or machine) performs only the execution of the algorithm. The instructional designer, relieved of the routine drudgery, which is often a major time consumer, is freed to perform at the professional level on other instructional problems. In this way the instructional designer is able to use differentiated staffing to increase efficiency while at the same time maximizing control through specification of algorithms.

TAEG Algorithm Development Effort

The first step (see Figure 1) in the progression of TAEG’s effort to increase instructional design efficiency was identifying the learning tasks which occurred most frequently in Navy training.

Eleven types of learning tasks were originally identified (Aagard & Braby, 1976) and the descriptive characteristics for each task was clearly defined. Next, a set of learning guidelines was developed for each learning task. The learning guidelines were actually a list of heuristics drawn from a review of the literature on learning theory which seemed to apply to each learning task. While the task definitions and heuristics of the learning guidelines were valuable resources for the professional designer, they would make a minimal contribution to increasing efficiency. Aagard and Braby (1976) went on to develop learning algorithms (actually quasi-algorithms) for each of the eleven learning guidelines. Figure 2 is a simplified version of the flow diagram of the quasi-algorithm for procedure learning. Though more precise and structured than the heuristics, the prescriptive directions were still not always specific enough to provide desired results. The learning algorithms, by themselves, were not sufficient to make a significant contribution toward increasing the efficiency of instructional design.

Media Selection

Effort to increase instructional design efficiency through application of algorithms was extended with the Training Effectiveness, Cost Effectiveness Prediction (TECEP) technique (Braby, Henry, Parish, & Swope, 1978). TECEP is a set of quasi-algorithms for selecting appropriate media and media mixes called delivery systems. Also included is a cost model which estimates the cost of alternate instructional delivery systems capable of producing the desired instructional events. TECEP is unique in that a separate instructional delivery system chart has been devised for each of the learning algorithms. This enables designers to tailor TECEP to the specific requirements of each learning algorithm. It seems reasonable to assume that the selection of appropriate and cost-effective instructional delivery systems would make a major contribution to increasing the efficiency of instructional design. However, print continues as the dominant instructional medium in Navy training. The impact of TECEP is minimized when the major instructional materials production requirement is for printed materials such as training aids, job aids, operational manuals, maintenance manuals, technical manuals, and text books. The effectiveness of an individual instructional program might
be enhanced by TCEP, but the overall efficiency of instructional design would be most affected by reducing the cost and speeding the production of print materials.

Recent activities within the Naval Training Command indicate commitment to widespread use of computer assisted instruction (CAI). The potential demand for the design and production of CAI programs suggests that increased efficiency would have a major impact. It was also determined that five of the eleven learning tasks (recalling bodies of knowledge, symbol learning, rule learning, procedure learning, and classifying) were used frequently and that, an increase in their production efficiency would have a major impact on overall instructional design efficiency. Thus, recently, TAEG's efforts toward increasing instructional design efficiency have concentrated first on the print medium and then CAI for the five most frequently encountered learning tasks.

Format Models

Quasi-algorithms for production were developed as guides for page layouts of printed training aids which would require students to perform the learning algorithms. Figures 3, 4, 5, and 6 illustrate the sequence of page layout formats for Procedure Training Aids. These figures are taken from the Format Models for Technical Training Materials (Braby, Brown, & Smode, 1982) which was prepared as a guide for authors of job training materials. The format models are also published in Procedures for Instructional Systems Design (NAVEDTRA 110A) which is the Navy manual for authors of instructional materials.

Figure 5 illustrates the Information Page which contains all information to be taught in the Procedure Training Aid. As stipulated by the learning algorithm, the format model relies heavily on visual illustration with limited text to transmit information. Figure 4 illustrates the Paraphrase Page, which is a check to aid the reader to determine whether he/she remembers the information. Figure 6 illustrates the Finger Tracing Page which is a heavily prompted exercise in the sequence of steps in a procedure. The reader is expected to recall actions and responses for each step without prompts. Figure 6 illustrates the Paper Mock-Up which requires the reader to trace the sequence of steps in a procedure and recall the actions and responses at each step without prompts.

TAEG has developed training aids for validation of the format models for each of the five types of learning algorithms. Evaluation of the training aids is directed toward determining whether the learning algorithms improve students learning and whether the format models provide sufficient guidance to assure efficient and effective production of the training aids.

Evaluation Of Training Aids

Symbol Learning—Morse Code. A Morse code training aid (Braby & Ainsworth, 1979) was produced using a set of computer automated page formats based on the learning algorithm for symbol learning. The training aid was tested on 160 Navy and Coast Guard enlisted men enrolled in Signalman School, Service School Command, Naval Training Center (NTC), Orlando, FL. Morse Code Sending Scores for average and above average aptitude students were higher for those using the Signal Learning Training Aid (SLTA) than for those using the traditional Morse Code Training Materials. Morse Code Receiving Scores for average and above average aptitude students were higher for those using SLTA than those using the traditional materials.

Procedure Learning—Oscilloscope. A Probe Calibration Procedure Training Aid for the Tektronix 545B Oscilloscope was developed using the page formats based on the learning algorithm for Procedure Learning. The Procedure Training Aid was tested against a Traditional Narrative Handbook and a Job Performance Aid. The Procedure Training Aid relied heavily on visual illustrations with limited verbal text for clarification and specific directions. It also implemented the learning algorithms for Procedure Learning by providing practice exercises and self-tests. The traditional narrative handbook relied heavily on verbal text with limited visual illustration. The Job Performance Aid relied heavily on visual illustration and verbal text similar to that of the Procedure Training Aid; however, it did not include the practice exercises and self-tests.

Higher and lower aptitude students using the Procedure Training Aid had fewer performance errors on the operation of the oscilloscope than students using the other training methods. Since the primary difference between the Procedure Training Aid and the Job Performance Aid is the practice exercises and self-tests, some support must be noted for the value of the learning algorithm for Procedure Learning. Students using the Traditional Narrative Handbook tend to score higher on Job Knowledge Tests than students in the other training methods. The Job Knowledge Test results and Performance Test results indicate that the Traditional Narrative Handbook tends to be more successful at teaching verbal information about operation of the oscilloscope and the Job Performance Aid and the Procedure Training Aid tend to be more successful at teaching operation of the oscilloscope. The relative merits of the respective treatments would depend upon whether the expected outcome of training were knowledge about, or the ability to perform, a procedure.

Procedure Learning—Helicopter Training. A Normal Start Checklist Procedure Training Aid for the SH-3D/H Helicopter was developed using the page formats based on the learning algorithm for Procedure Learning. The Procedure Training Aid was tested on thirty-five students in pilot training at Fleet Replacement Helicopter Squadron One (HS-1), Naval Air Station, Jacksonville, FL. The Normal Start Checklist is a 200 step, 31 item checklist that students found difficult to master using the traditional instructional materials. The traditional instructional materials include the Naval Air Training and Operations Procedures Standardization (NATOOPS) manual and a student workbook. The Procedure Training Aid for the Normal Start Checklist (Figure 7) included practice exercises and self-tests prescribed by the Procedure Learning algorithm.

Over 50% of the students using the Procedure Training Aid attained proficiency on the first trial and all of the remaining students achieved proficiency by the fifth trial. Twelve percent of the students using the traditional materials attained proficiency on the first trial and it took ten trials for all the remaining students to attain proficiency.

Rules of the Road—Lights. The instructional module Rules of the Road: Lights (Thomas, Terrell, & Braby, 1982) has been developed and is presently being tested with students enrolled in Quartermaster School, NTC, Orlando. Section One of the module is based on the page formats for the learning algorithm for Recalling Bodies of Knowledge (Nomencature). Students learn the names and relevant facts about ship's lights. Section Two of the module is based on the page formats for Rule Learning. Students learn the rules
PROCEDURE FORMAT MODEL

A general format for use in designing training materials which present steps of a procedure to be performed from memory.

Procedure Format - Page 1

Use this page format to present each step in a procedure.

The purpose of this page format is to present:
- the word description of the step—emphasize human action,
- the visual display of the step—emphasize human action,
- the purpose of the step,
- the location of actions on equipment,
- the system response to actions taken,
- notes—additional needed information.

Break procedure into logical steps.
(Each step should start on a new page.)

Keep purpose short and simple.

Use line drawings or photographs.

If possible, each step should have no more than 3 or 4 actions.

State Action, and Response if there is one, and any Note.
Number the boxes in the order you want them read.

Use notes to present additional information that must be recalled and used on the job.

Underline key words.

Keep pages simple, with no more than 3 or 4 boxes per page. Use additional pages if necessary.

Figure 3: Procedure format information page.

Use this page format immediately following each use of the page 1 format.

The purpose of this page format is to:
- provide students exercise in the recall of key words in the procedure,
- direct the students to practice the step on the paper mock-up.

Copy the previous page. Then drop out key words that were underlined on the previous page.

EXERCISE

Step 23: Insert probe tip into CAL OUT connector.

Purpose: To observe the signal generated at the CAL OUT connector can be displayed on the CRT.

1. ACTION: Unscrew end of connector and insert probe tip.
   Tighten and lock probe to secure.

2. RESPONSE: Waveform appears on CRT, and should...

3. NOTE: The displayed waveform is called...

Add directions requiring students to go to the paper mock-up to practice the step.

Figure 4: Procedure format paraphrase page.
Training Aid the same procedure is performed in less than one minute. Though apparently successful in producing an effective training aid, the novice designer reported that the page layout process required by the Guide was tedious and time consuming. The format model for procedure learning resulted in more efficient instructional design in the sense that an SME, untrained in instructional design, could produce an effective procedure training aid. However, the labor involved in the design and actual production of the page layouts would discourage preparation of Procedure Training Aids by anyone except the most dedicated instructional designers.

A computer automated page layout system for Procedure Training Aids (Terrell, 1982) was developed to minimize the labor involved in the preparation of Procedure Training Aids. Machine production includes the actual page layout, printing of boxes, and printing of text. An advantage in using computer automation is the greater compliance of the outcome to the procedure learning format because the computer requires precise adherence to the algorithm. Figure 8 illustrates the comparison between manual and computer automated preparation of a page layout. The computer automated Page Layout (PLA) program is currently being tested for effectiveness in field situations and for acceptance by SMEs and instructional designers preparing procedure training aids.

Studies have already been conducted which have established the effectiveness of the symbol learning format model and a computer automated authoring system for symbol learning (Braby & Ainsworth, 1979). Studies are currently underway to test the effectiveness of the format models for recall of bodies of knowledge, rule learning, and classifying (Thomas, Terrell, & Braby, 1982; Braby & Brown, 1982).

### Authoring Aids

TAEG has also developed the Computer Readability Editing System (CRES) and the Text and Illustration Processing System (TIPS) as part of the effort to increase the efficiency of instructional design. CRES (Kincaid, Aagard, & O'Hara, 1980) is a set of machine-performed algorithms which analyze the reading level and suggest editing changes as a method of improving the readability of instructional materials. The CRES contributions to increasing the efficiency of instructional design are more comprehensive editing, reduction of time, and elimination of drudgery by replacing the human search for text problems with a machine search. The human role is reserved for intuitive application of the creative editing skills required to improve text readability.

The Text and Illustration Processing System (v.1, Brown & Cox, 1982; v.2, Cox & Braby, 1982) is part of the TAEG effort to increase the efficiency of instructional design. The intent is that text and graphic data bases will be built and drawn upon for the production of a variety of instructional materials including training aids based on the learning algorithms.

Graphics represent a particularly high cost and time consuming element in the production of heavily illustrated printed instructional materials. In many cases, local production of highly illustrated materials as training aids by SMEs is nearly impossible because graphic art support is not available. The TIPS graphic processing system is still under development though some elements are currently operational. If proven successful, the computer generation, storage, and reproduction of line art and half-tone graphics will make a significant contribution toward increasing the efficiency of instructional design.

### Summary

The effort to increase the efficiency of instructional design included strategies to provide maximum use of the professional skills of designers, reduce the time required for design, reduce the cost of design products, and maximize the effectiveness of design products.

### References


Use this page after presenting each set of 3 to 7 steps in a procedure.

The purpose of this page format is to provide a finger-tracing exercise to aid students in recalling a sequence of steps.

For each cluster of 3 to 7 steps, present a Road Map showing how the steps are chained together.

With your finger, trace the steps
Recall (1) how to perform, (2) systems response
Look up answers if you need help
Keep practicing until you can describe the steps without error or hesitation.

Go To Paper Mockup
- Step through all items
- Touch where each action and response takes place
- Recall exact action for each item

If the procedure is to be performed on the job with a checklist, present the checklist items here.

Figure 5. Procedure format finger tracing page.

Use this type of page at the end of the learning module.

The purpose of this page format is to provide students with a way to practice one step, a set of steps, or all the steps in a procedure without the use of guides and prompts.

PAPER MOCK-UP

If the procedure is to be performed on the job with a checklist, present the entire checklist here, or on the opposite page where it can be easily seen while viewing this page.

Figure 6. Procedure format paper mock-up.
NORMAL START CHECKLIST ITEM NO. 28. No. 1 Overspeed System .... CHECK.

Purpose: To simulate an overspeed condition for checking the electrical overspeed system.

1. Action
   Pilot place OVSP GOV TEST switch to ON (FWD). Hold in this position.

2. Result
   1. NF will drop to between 95 and 100%

3. IF Engines are RFI (Radio Frequency Interference) shielded,
   THEN
   NF will drop to between 85 and 99%

4. Action
   Pilot place OVSP GOV ORD switch to ON (FWD)

Figure 7. Normal start checklist procedure training aid.
**Manual Page Layout**

**Step 21:** Adjust FOCUS and ASTIGMATISM controls

**Purpose:** To sharpen the display.

Action: Turn knobs at the same time until waveform is sharpest.

Response: Waveform thins and sharpens.

NOTE: The displayed waveform is called a square wave. A square wave is flat on the top and bottom, and all its angles are 90°.

GO TO PAPER MOCKUP: Touch where each action and response takes place.