

## **Training Technology System: A Method for Identifying and Solving Training Problems in Industry and Business**

Richard A. Swanson  
University of Minnesota

The Training Technology System (TTS) provides an orderly means of separating training from non-training problems and a means of systematically solving training problems in industry and business. The TTS was first developed in 1978 (Swanson, 1980; Swanson & Sisson, 1980) in response to a private sector need for a comprehensive training system for all levels in the firm and for all training content. For example, the levels encompass corporate, regional, or site training and the potential training content spans management, motivational, or technical work behaviors.

More and more, training and development are becoming crucial elements for industry and business as firms begin to realize that employees are resources who must be maintained and developed; this investment in human resources is just as important as the investment in physical resources; but, like all *good* business decisions, it should be cost-effective (Mosier, 1986).

Norman Willard (1973) encouraged management to accept training as a regular part of doing business while Springborn (1977) explained that it does little good to invest in computers, numerically controlled machines, tools, or other sophisticated devices if a skilled work force is not available to operate and maintain them.

One of the most often quoted perceptions about the need for training in the 1980s comes from Odiorne (1979). He predicted the following demands for trainers: (a) induction (orientation/socialization) training for 26 million *new* employees who will replace those leaving the workplace, (b) skills training for six million new workers and retraining for an undefined number of current workers who need to learn new skills, and (c) upgrading for three to four million managers, both those entering the managerial ranks for the first time and those making upward or lateral moves that require new skills.

---

Swanson is Professor of Industrial Education and Director of the Training and Development Research Center, University of Minnesota, St. Paul, Minnesota.

If these views are not enough to underline the need for inventive, creative, cost-effective ways of training and development, the American Society for Training and Development recently estimated that U.S. firms are spending between \$30 billion and \$50 billion annually to train their employees ("Industry spending," 1985). In view of these facts, resourceful managers should settle for no less than useful tools.

### System Overview

The TTS is one of several education-for-work training systems reported in the literature. Most systems begin with a curriculum theory base. The military's Instructional System Development (ISD) system is the most widely known (Campbell, 1984).

The TTS is firmly rooted in the fields of economics and psychology and the more applied fields of management and education. Underlying the economic/management foundation is an assumption that training can increase profits. The record of the impact of systematic training in industry and business substantiates such a claim (Swanson, 1982c). Underlying the psychological/educational foundation is an assumption that learning can be efficiently and effectively managed. In practice, this may not be true for every program, but it is a reasonable expectation when expertise from learning theory and learning technology is systematically applied to training problems.

Most training and learning systems are grounded first, and sometimes only, in psychology. The TTS is unique because it is grounded in economics and psychology. Furthermore, the economic foundation is considered as important, if not more important, to the TTS as the psychological foundation. Another way of explaining this is that, from the TTS perspective, trainers are business persons first and trainers second (Swanson, 1985); their decisions must first make economic sense before they make psychological sense.

The TTS program of research and development has been funded by several firms, including Control Data Corporation, Hutchinson Technology, Inc., Kellogg Company, Manville Corporation, Minnesota Mining and Manufacturing (3M), Medtronic Corporation, Northern States Power Company, and Onan Corporation. The TTS has been proven successful because these firms also have used it on a day-to-day basis.

Integration of the practical realities of industry and business operations and the university's demand for rigorous inquiry have become the hallmarks of this system. While the general form of the TTS has not changed since 1978, the specific methods for implementing it have been under continuous refinement. Most recently, a program to develop and validate a method for forecasting the financial benefits of training has been pursued and integrated into the TTS (Geroy & Swanson, 1984; Prifrel, Swanson, & Geroy, 1985; Sleezer, Swanson, & Geroy, 1985; Swanson & Geroy, 1984). This forecasting

research is a follow-up to earlier cost-benefit analysis studies (Cullen, Sisson, Sawzin, & Swanson, 1976, 1978).

**System Phases**

To identify and solve training problems in industry and business, the TTS embraces five phases: (a) analyze, (b) design, (c) develop, (d) implement, and (e) control (Figure 1).

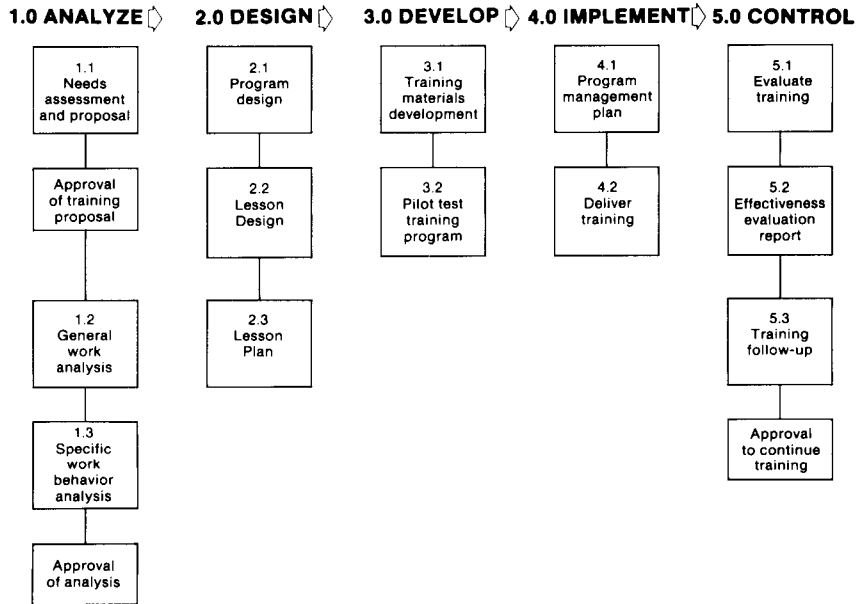


Figure 1. Training Technology System

*Analyze*

The analyze phase focuses on (a) separating training from nontraining problems in an organization and (b) defining precisely what people need to know and be able to do to perform at work. These two discrete steps are called needs assessment and analysis of work behavior. During a needs assessment, needs are identified, causes are determined, solutions are studied, and plans are proposed. The TTS model (Figure 2) for organizational needs assessment considers (a) types of needs assessment, (b) causes of performance, and (c) data collection methods (Swanson, 1982b).

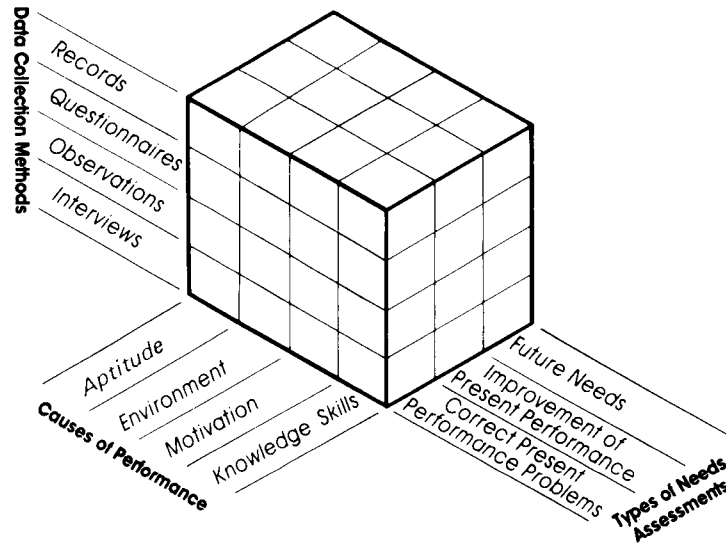


Figure 2. Training and Development Needs Assessment Model

The model is implemented through an eight-stage process that results in a specific proposal for management consideration and approval. One predisposition of the TTS is that the majority of problems in an organization cannot be solved by training alone. Therefore, management approval of training typically is coupled with a commitment for support that goes beyond the training program.

Analysis of work behavior begins after the approval of a training proposal. General work behavior analysis (Figure 1) includes job description and task inventory analysis work and can be completed in relatively short time periods if there is ready access to the workplace and the subject experts. Specific work behavior analysis (Figure 1) determines precisely the knowledge and skill required to perform the tasks that make up the job. This analysis work is detailed, time-consuming, and at times very difficult. Three specific methods available to the analyst are (a) procedure analysis, (b) process and troubleshooting, and (c) subject matter analysis. Procedure analysis works best for analyzing "people-thing" work behavior such as machine operation, tool usage, and materials handling (Swanson & Murphy, 1981; Swanson & Gradous, 1986). Process and troubleshooting analysis works when focusing on "people-system" work behavior including information and hardware

systems (Swanson & Sisson, 1983). Subject matter analysis is for non-observable work knowledge including “people-people/people-idea” work behavior (Swanson, 1981; 1982a).

The use of this systematic program for analyzing work behavior is a major element of the TTS (Swanson & Sisson, 1985; Swanson & Gradous, 1986). This analysis provides the basis for confirming the original program proposed in the needs assessment and is the behavioral anchor for the design, development, and evaluation of a sound training program. The TTS analysis tools go far beyond traditional job and task analysis because they are capable of specifying knowledge work and systems work. In doing so, these methods never lose touch with the actual performances required by successful workers.

### *Design*

The design phase includes both program design (Figure 3) and lesson design (Figure 4). Program design is focused on matching the training program to organizational needs and constraints. The decision-making process emphasizes the economic/management foundations of training. While program design includes a breakdown of individual lessons that make up the program, lesson design is more directly linked to the psychology/education foundations of the training profession. Eight variables are used to focus on the lesson design process (Swanson, Sisson, & Summers, 1985). They are

1. Trainee Readiness
2. Objectives
3. Content Structure
4. Instructional Sequence
5. Rate of Delivery
6. Repetition and Practice
7. Reinforcement and Rewards
8. Knowledge of Results

The lesson takes its initial form as a lesson outline based on the work behavior analysis and the eight design variables. The lesson outline is further developed into a lesson plan which orchestrates the instruction in terms of content and method. It is a document that is shared and used by a number of trainers. In contrast, the lesson outline is an intermediate document that is cryptic in nature.

### *Development*

Training practices in industry and business require initial program design to occur at the program proposal stage and then to be confirmed and /or revised following the work behavior analysis. Similarly, training lesson design revisions are made as development takes place. Lesson designs result in lesson plans for instructor-based training or story boards for media-based materials.

**ANALYSIS WORK THAT SHOULD BE THE BASIS OF THE TRAINING**

GENERAL WORK ANALYSIS   
  PROCEDURE ANALYSIS   
  PROCESS AND TROUBLESHOOTING ANALYSIS   
  SUBJECT MATTER ANALYSIS

Job Description     Observation     System Flow     Behavior  
 Task Inventory     Analysis     Parts and Purposes     Literature  
 Illustration and Nomenclature     Process Analysis     Synthesis  
 Troubleshooting Analysis     Subject Matter Description

**DESIGN CONSTRAINTS**

TRAINEE CHARACTERISTICS

Total Number of Trainees \_\_\_\_\_  
 Number per Group \_\_\_\_\_  
 Education Level \_\_\_\_\_  
 Work Experience: amount & type \_\_\_\_\_  
 Other: \_\_\_\_\_

DEVELOPMENT CONSTRAINTS

Time Available to Develop \_\_\_\_\_  
 Staff or Staff Competencies Available \_\_\_\_\_  
 Media Available \_\_\_\_\_  
 Budget Available \_\_\_\_\_  
 Other: \_\_\_\_\_

IMPLEMENTATION CONSTRAINTS

Where training can take place \_\_\_\_\_  
 Who can deliver training \_\_\_\_\_  
 When training can be delivered \_\_\_\_\_  
 Other: \_\_\_\_\_

**DESIGN SUMMARY**

**TRAINING SEQUENCE**

	Whole or Part	Lesson Titles	Notes (goals, methods, and reminders)	Est. Time
1				
2				
3				
4				
5				
6				
7				
8				

Figure 3. Program Design

In addition, peer review and pilot testing of training materials usually result in revisions of the materials, lesson design, and/or program design. It is typical for industry and business to use the first group of trainees as the pilot test group. It is important that they be treated as such and that follow-up evaluation and revisions take place.

*Implementation*

The implementation phase of the TTS contains the training program management plan and the delivery of training. In the training management plan, course schedule, promotion, and management are systematically considered. Included in the TTS are specific methods for organizing all tasks required to implement a training program, such as when the task must be completed, who completes the task, and what specifications are for the task.

Lesson _____		Effective Date _____
Program _____		Cancels Sheet Dated _____
Estimated Time of Lesson _____		Approved _____
Prepared by _____		

<b>Design Variables</b>	
<b>1. Objectives</b>	A. What are they (terminal and enabling)? B. When will they be shared with trainees? How?
<b>2. Trainee Readiness</b>	A. What is the starting point of instruction? B. If uneven, what will be done?
<b>3. Content Structure</b>	A. How abstract is the content to the trainees? B. Will a logical or conceptual model help?
<b>4. Instructional Sequence</b>	A. What is the best instructional sequence?
<b>5. Rate of Delivery</b>	A. What is the expected rate of learning? B. How big should each instructional "piece" be?
<b>6. Repetition and Practice</b>	A. What will the practice consist of? B. How much required? C. How remediated?
<b>7. Knowledge of Results</b>	A. What will be used to assess trainee performance? B. How will this information reach the trainee?
<b>8. Reinforcement and Rewards</b>	A. What will it be? B. When will it be applied?

<b>Lesson Outline</b>				
	Whole or Part	Topic	Notes (goals, methods, and reminders)	Time
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

Figure 4. Lesson Design

For managing the actual instruction, a method for incorporating media, notebook materials, and handouts into the formal lesson plan and into a training materials storage system is advocated. When these management considerations are overlooked, a training program can be undermined.

Individually, each managerial task of the implementation stage is easy to complete, but just as easy to put off. The benefits derived from these tasks

are long-lasting returns in the form of time savings whenever a training program is repeated.

Delivery of training in the TTS is addressed at two levels. On the surface, all instructional content and method, including the management of minute-by-minute trainee and trainer activities, are specified, and the trainer is expected to execute the lesson plans. On a long-term basis the evaluation step of the control phase determines discrepancies between what was intended, what happened, and what needs to be done to improve the program. During the instruction, a traditional four-step job-instruction training method is used to guide trainer-trainee interactions:

1. Trainer prepares the learner
2. Trainer presents the material
3. Trainee practices the materials
4. Trainee is tested for understanding

Beyond these general steps, the TTS identifies 31 specific training methods. Each method requires instructor skills that can best be described as an artistic smorgasbord of human interaction skills.

### *Control*

The control phase of the TTS includes (a) evaluating and reporting the effectiveness of training, (b) revising training, and (c) maintaining trainee behavior once trainees are back on the job. Evaluation, the major step in the control phase, consists of an effectiveness evaluation plan, tools for measuring training effectiveness, and the evaluation report.

In effectiveness evaluation, planning decisions are made about which tools will be used to assess whether the training program produced the desired results. Four questions represent levels of training effectiveness and are asked of every training program:

1. Was the training delivered professionally?
2. Were the training objectives met?
3. Was the original training need met?
4. Was the training valuable?

Three categories of evaluation tools are considered for gathering the information needed to answer the evaluation questions. These tools measure (a) satisfaction, (b) learning, and (c) performance that result from the training. The satisfaction score is an indicator of how pleased trainees and their supervisors are with the training, the learning score is an indicator of the amount of knowledge acquired by the trainees during the training course, and the performance score is an indicator of the organizational or economic accomplishment resulting from the training program. The economic evaluation compares financial costs and benefits of training.

Effectiveness evaluation includes reporting the results of the training program to management. The report contains summative information that



managers need to make good decisions. It provides a decision maker with the necessary information for understanding the impact of a training program in satisfaction, learning, and performance.

One major purpose of evaluation information is to provide a sound basis for training program revisions. Program revisions need to be made in an orderly and timely manner and should be based on reliable and valid evaluation data.

Maintenance of trainee work behavior back on the job can range from a follow-up memo highlighting training content to a formal follow-up assessment of trainee/worker work behavior to determine if additional or refresher training is needed. This latter case can take the form of a new needs assessment and proposal for follow-up training. Reporting back to management for continued approval of training programs causes top management to reassess continually and recommit to training; it also causes the trainer to reassess and commit to a viable set of priorities.

#### *A Critique of the System*

The TTS creates one-of-a-kind products with each training program being built to individual specifications. The TTS assures that the correct tasks are performed in the appropriate order. Process control techniques are used to insure that all training programs are constructed to predetermined standards. Work is reviewed during construction so that errors can be identified and corrected before they adversely affect the next step of the program. Using process control at the TTS phase and step levels increases the odds that the training program will be effective.

The TTS is broader than most training systems because it covers areas ranging from organizational needs assessment and the economic impact of the training. Many rival systems begin with the assumption that training is needed and will solve a problem; the TTS does not. Others start further down the line by assuming that not only is training needed, but the person organizing the training program is a subject expert; the TTS does not. Other systems eliminate needs assessment and analysis of work behavior which are vital to the TTS. Evaluation in many systems is restricted to measuring learning objectives; evaluation in the TTS is not. The TTS assesses both learning objectives and ways the training program supports the organization's business and financial goals.

Many of the curriculum theory models are fixed on evaluation "proxies," such as learning objectives rather than organizational performance or work behaviors. Additionally, some systems dissect learning behaviors into domains (e.g., cognitive, psychomotor, and affective) in a manner that does not parallel the wholistic work performance actually required on the job.

Beyond the noted differences, the greatest strength of the TTS is also the greatest strength of several other training systems available to industry and

business. That is the systematic approach they take to the complex work of identifying and solving training problems. Without such a system, employee training is likely to be inefficient and ineffective.

### References

- Campbell, C. P. (1984). Procedures for developing and evaluating vocational training programs. *Journal of Industrial Teacher Education*, 21(4), 31–42.
- Cullen, G., Sisson, G., Sawzin, S., & Swanson, R. A. (1976). Training, what's it worth. *Training and Development Journal*, 30(8), 12–20.
- Cullen, G., Sisson, G., Sawzin, S., & Swanson, R. A. (1978). Cost effectiveness: A model for assessing the training investment. *Training and Development Journal*, 32(1), 24–29.
- Geroy, G. D., & Swanson, R. A. (1984). Forecasting training costs and benefits in industry. *Journal of Epsilon Pi Tau*, 10(2), 15–19.
- Industry spending billions to reeducate labor force (1985, March 25). *Minneapolis Star and Tribune*, pp. 7B, 14B.
- Mosier, N. R. (1986). *Financial analysis: A review of the training methods and their application to employee training*. St. Paul, MN: University of Minnesota, Training and Development Research Center.
- Odiorne, S. (1979). The need for an economic approach to training. *Training and Development Journal*, 33(6), 32–40.
- Prifrel, R. J., Swanson, R. A., & Geroy, G. D. (1985). *Forecasting the financial benefits of quality-based electronics manufacturing training*. St. Paul, MN: University of Minnesota, Training and Development Research Center.
- Sleezer, C., Swanson, R. A., & Geroy, G. D. (1985, December). *Forecasting the financial benefits of an articulated management training and organization development program*. St. Paul, MN: University of Minnesota, Training and Development Research Center.
- Springborn, R. (1977). Technical and skill training: We need to do much more. *Training*, 14(10), 20–22.
- Swanson, R. A. (1980). Training technology: The system and the course. *Journal of Epsilon Pi Tau*, 6(2), 49–52.
- Swanson, R. A. (1981). Analyzing non-observable work behavior. *Journal of Industrial Teacher Education*, 18(4), 11–23.
- Swanson, R. A. (1982a). Content analysis: Beyond job and task analysis. In C. Bradley & J. Friedenberg (Eds.), *Vocational-Technical Education for the Eighties* (pp. 53–87). Miami, FL: International Dynamics.

- Swanson, R. A. (1982b). High technology, training and crystal balls. *The Criterion*, 1-2.
- Swanson, R. A. (1982c). Industrial training. In H. E. Mitzel (Ed.), *5th Encyclopedia of Educational Research*. New York: MacMillan.
- Swanson, R. A. (1985). A business person first. *Performance & Instruction Journal*, 24(7), 10-11.
- Swanson, R. A., & Geroy, G. D. (1984). *Forecasting the economic benefits of training*. St. Paul, MN: University of Minnesota, Training and Development Research Center.
- Swanson, R. A., & Geroy, G. D. (1985). *Validation of the training-benefit forecasting method: Recreational vehicle service training*. St. Paul, MN: University of Minnesota, Training and Development Research Center.
- Swanson, R. A., & Gradous, D. (1986). *Performance at work: A systematic program for evaluating work behavior*. New York: John Wiley & Sons.
- Swanson, R. A., & Murphy, B. P. (1981). The growing trend of industry and business training. In K. Greenwood (Ed.), *1981 American Vocational Education Yearbook* (pp. 105-112). Washington, D.C.: American Vocational Association.
- Swanson, R. A., & Sisson, G. R. (1980). Training technology: A hands-on course for trainers. *Training and Development Journal*, 34(1), 66-68.
- Swanson, R. A., & Sisson, G. R. (1983). Analyzing process and troubleshooting work behavior. *Performance & Instruction Journal*, 22(2), 19-22.
- Swanson, R. A., & Sisson, G. R. (1985). *Training technology system—abridged edition*. Littleton, CO: Paradigm Corporation.
- Swanson, R. A., Sisson, G. R., & Summers, K. (1985). Instructional design: The basics. *Training*, 22(8), 73, 75-76.
- Willard, N. (1973, April). Hard nose training. *Training in Business and Industry*, 56-59.

