Overview and Evolution of the ADDIE Training System

W. Clayton Allen

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The problem and the solution. The workforce of the 21st century is in a continual state of flux. This has created a need by human resource development scholars and practitioners to continue to review best practices in developing a workforce with the latest technology, knowledge, and expertise. Revisiting traditional training models and processes is important as a means of moving forward. Although there are many system models, almost all are based on the generic analysis, design, develop, implement, and evaluate (ADDIE) model that evolved from instructional systems research following World War II. The purposes of this article are to (a) reacquaint the profession with the background and basic concepts of the traditional ADDIE model and (b) compare the original and revised ADDIE models. Subsequent articles in this volume deal with issues and advancements surrounding ADDIE and the ADDIE phases.

Keywords: *systematic training; instructional systems design; ADDIE; training*

The most widely used methodology for developing new systematic training programs is often called instructional systems design (ISD). ISD evolved from post–World War II research in the U.S. military to find a more effective and manageable way to create training programs (Swanson & Holton, 2001). In the beginning, the primary focal point was on creating technical training programs for new recruits that were to function in a variety of standardized military work roles. These efforts led to early ISD models that were developed and implemented in the late 1960s. "Since the 1970s, there has been a proliferation of models of instructional design (ID)" (Molenda, Pershing, & Reigeluth, 1996, p. 268). There are more than 100 different variations of the model; however, almost all of them reflect the generic "ADDIE" process—analysis, design, develop, implement, and evaluate. The ADDIE approach provides a systematic

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process for the determination of training needs, the design and development of training programs and materials, implementation of the program, and the evaluation of the effectiveness of the training (Gagne, Wager, Gola, & Keller, 2005). This article describes the ADDIE models, principles, and processes for developing education and training programs as detailed in the U.S. Air Force manual AFMAN 36-2234 (Department of the Air Force, 2001). It discusses the background of ADDIE and describes the phases, and touches on the theory and philosophy undergirding this training system. This article is organized around three sections: Background and Evolution of ADDIE, Phases of ADDIE, and a Conclusion.

Background and Evolution of ADDIE

The ADDIE process is an adaptation of the systems engineering process to problems of workplace training and instruction. The process assumes that alternative solutions to instructional problems will be more or less cost-efficient depending on the instructional need and environmental constraints, and that using a systems approach intelligently to choose among alternative solutions will produce the most effective results.

According to Tennyson and Michaels (1991), ADDIE has been an evolving process. Tennyson categorized this process into four generations of instructional development. The main focus of the first-generation model was the implementation of the behavioral patterns of learning. The system had four components: objectives, pretest, instruction, and posttest. The system was complete with an evaluation loop for purposes of revision. Advances in instructional technology led to increasing the variables and conditions of the ADDIE model. The second generation adopted systems theory to control and manage the increasingly complex instructional development process. The behavioral learning patterns remained but were of secondary importance to the focus of the system—developing instruction (Kruse, 2002).

In practice beyond the military context, the ADDIE process was found to be too rigid and did not account for the different situations and applications for which it had to be used. To account for the situational differences, the external control of the system (i.e., the boxes and arrows) gave way to phases of ADDIE that could be manipulated in any order by the training professional. This third-generation model assumed that ADDIE was an interactive process that could be entered at any point depending on the current situation. Although behavioral learning theory was still dominant, cognitive theory was beginning to have an impact, such as in the use of simulations for acquisition of cognitive expertise in decision making (Driscoll, 2005).

Advancements in understanding how humans learn and educational technology (e.g., management, delivery systems, cost-effectiveness, content analysis, objectives, measurement, and instructional strategies) provided major changes in many of the system variables, making the ADDIE model even more complex. Employing technological developments from the field of artificial intelligence, the fourth-generation models handled the complexity of the ADDIE system with

a continuous evaluation and troubleshooting process (Gagne et al., 2005). Concepts used in creating and revising the ADDIE process have been drawn from the disciplines of system engineering, behavioral and cognitive psychology, instructional technology, and performance improvement.

When the ADDIE process was originally defined, it represented the then state-of-the-art specification for the design and development of systematic training within a military context of learning highly specified job tasks by a continuous cadre of homogeneous learners. At that time, behavioral learning theory held that efficient job instruction could teach the behaviors without dwelling on the cognitive understanding of the theoretical foundations of the activity being performed. Clearly, behavioral learning theory has provided a successful approach for teaching procedural tasks. Procedural tasks once accounted for the vast majority of jobs, the remainder required concepts beyond behavioral learning theory. Concepts from cognitive psychology and systems engineering were called on for approaching nonprocedural tasks (Gagne et al., 2005). It is interesting to note that although the military embraced ISD for technical training, ISD was not used for creating their management training.

The original goal of ADDIE was to increase the effectiveness and efficiency of education and training by fitting instruction to jobs—eliminating peripheral knowledge from courses while ensuring that students acquired the necessary knowledge and expertise to do the job. Instruction was to be provided in the areas most critical to job performance and was not to be wasted in areas having a low probability of meeting immediate or critical long-term needs. The ADDIE process prescribed a series of procedures that addressed decisions about exactly what, where, how, and when to teach the skills, knowledge, and attitudes needed to perform every task selected for instruction. Application of the ADDIE process has consistently improved the quality of instruction (Dick, Carey, & Carey, 2005). Use of the process increases the effectiveness of the instruction, improves delivery-time efficiency, and under the right conditions produces the best instruction for the lowest possible cost.

Original ADDIE Model

Throughout the years, the ADDIE process has been described through a wide variety of graphic models that call out the procedures in a number of phases and steps. Most models encompass the functions of analyzing instructional needs, and designing, developing, implementing, evaluating and improving instruction. The use of a systematic problem-solving approach is the common thread that runs through all models. At its best, the processes and products of the phases are continuously assessed for quality with emphasis on how well they meet the users' needs. Life-cycle evaluation ensures continuous improvement of the instruction. The original ADDIE model was a five-phase process referred to as the Air Force Model shown in Figure 1.

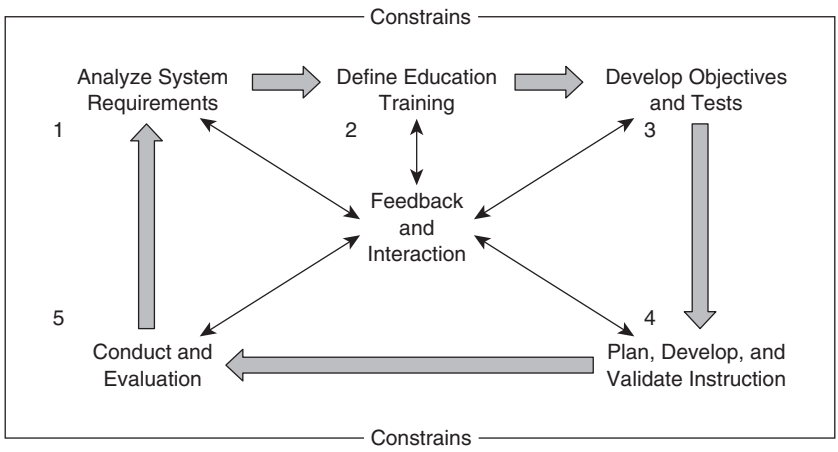

FIGURE 1: Original Air Force ADDIE Model
Source: University of Maintenance (1990, p. iii)
Note: ADDIE = analyze, design, develop, implement, and evaluate.

The five-phase process of the ADDIE model includes analysis of immediate work-system requirements; definition of educational and training requirements; development of objectives and tests; plan, develop, and validate instruction; and finally conduct and evaluate instruction. The analysis of job requirements is done through occupational, job, and task analyses that result in statements of behavior, conditions, and standards for task performances. Defining education and training requirements includes a needs analysis to determine if training is needed, assessment of target population characteristics, and selection of tasks for instruction through consideration of such factors as criticality, learning difficulty, and frequency of task performance.

During the development of objectives and tests the developer writes the three-part objectives that define what the students should be able to do after instruction, the conditions under which they may perform, and the acceptable standard of performance (Dick et al., 2005; Molenda et al., 1996). The developer then writes test items to measure student performance on each objective.

To plan, develop, and validate instruction the developer creates and produces course materials. The developer tries these materials out on students using the criterion test items to ensure that the students can achieve course objectives. During the final step in this process the developer conducts and evaluates instruction. Here the course is field tested. Evaluation of instructional effectiveness continues for the life of the course through the identification of needs that may develop for improving or updating the instruction (Gagne et al., 2005).

This original model also shows (a) how the ADDIE process uses feedback and interaction among the functional blocks of activities to allow for continuous

improvements to the products and (b) how environmental constraints limit the designers' choices to what is possible. The process allowed instructional developers to enter or reenter the steps of the ADDIE process as necessary to develop, update, or revise the instructional system. This model worked well for the military and was considered appropriate in many business and industry settings (Molenda et al., 1996). It supported an instructional system that was focused primarily on classroom education and technical training delivered by an instructor using the lecture and/or demonstration method.

Revised ADDIE Model

The ADDIE goal, which has not changed, is field-effective and efficient instruction that help prepare individuals to meet their work-performance requirements. Constant changes in the instructional environment, increasingly complex job requirements, new instructional technologies, emerging automated instructional development tools, and other changes, stretched the capabilities of the ADDIE process (Smith & Ragan, 2005). This led to a belief that the almost linear approach to ADDIE was not adaptable to today's conditions. The process needed to be revised.

Today's concerns include not only classroom instruction but also instruction that is exported to the job site using new delivery methods and technologies. New automated instructional development tools can make the instructional development more efficient. Building quality in instructional systems is a key concern. Other concerns are the concept of totally integrated training systems and how the ADDIE process works in different applications such as systems acquisition, education, management development, and technical training programs.

Principles of ADDIE have evolved during the past three decades. ADDIE is more than a tool for applying behaviorally oriented learning principles to classroom instruction. This advancement has been through step-by-step procedures designed to enable anyone to develop instruction on sophisticated models concerned with complex technological and cognitive and attitudinal issues that require experienced instructional design experts to sort out (Gagne et al., 2005; Reigeluth, 1983).

Today, instructional development, updating, and revision require expertise not only in instructional design but also in media (e.g., computer hardware and software, video, interactive systems), cognitive learning theory, and vastly complex content areas. The scope of required expertise has gone beyond the capabilities of the single instructional design expert. It now often requires a team of experts from several disciplines.

Attempts are being made to use expert system techniques to help the experienced and novice instructional developers cope with advancements and demands. If successful, these techniques will affect systematic training in fundamental ways, such as providing ADDIE expert system tools. It is clear that

any new model of the ADDIE process should reflect the movement away from rigidity and emphasize adaptability to changing environments (Robinson & Robinson, 1996).

One of the greatest challenges continues to be the low level of training expertise being required of those functioning as trainers in organizations. It is not enough to enhance the methodology of an ADDIE system and its principles. Professionals must be prepared to understand and apply the system.

The following is a revised ADDIE model created to represent simplicity and flexibility so that instructional system developers with varying levels of expertise can understand the model and use it to develop effective, efficient instructional systems (Dick et al., 2005). This revised instructional systems model depicts the flexibility that developers need to have to enter or reenter the various stages of the process as necessary. The nature and scope of the development, update, or revision activity determines entry or reentry into a particular stage of the process (Gagne et al., 2005). This extension of the systems approach places the ADDIE process within an organizational function context (top-level functions for training efforts—management, support, administration, delivery, and evaluation). The ADDIE phases are embedded within the system functions. Evaluation is shown as the central feedback "network" for the total system illustrated in Figure 2.

The management function includes the directing or controlling of instructional system development and operations. The support function maintains all parts of the system. The administration function involves the day-to-day processing and record keeping (Smith & Ragan, 2005). The delivery function brings instruction to students. And last, the evaluation function gathers feedback data through formative, summative, and operational evaluations to assess system and student performance.

Using these essential functions to design the overall instructional system architecture and then allocating them to the respective instructional system components, or people responsible, ensures that these functions are operational when the total training system is fielded. ADDIE products are integrated into the total instructional system, and aspects of the instructional system functions are active throughout all phases of the process—analysis, design, development, and implementation, with the evaluation activities integrated into each phase of the process.

The instructional development process, which the model summarizes, calls for instructional developers to

- analyze and determine what instruction is needed.
- design instruction to meet the need.
- develop instructional materials to support system requirements.
- implement the instructional system.

Evaluation is a central function that takes place at every phase.

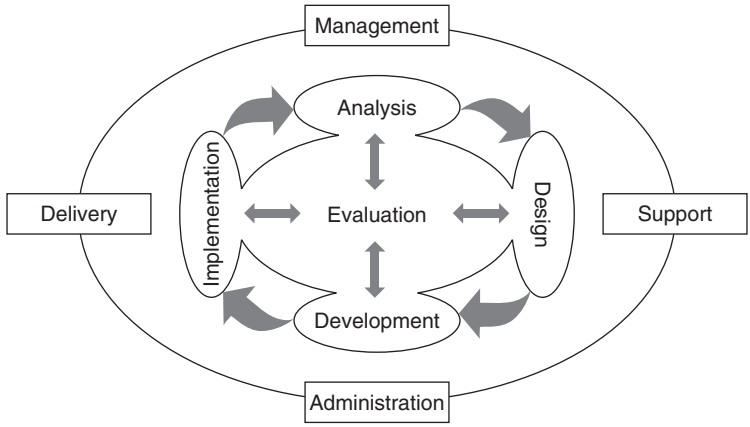

FIGURE 2: Organizational System Functions Supporting the ADDIE Phases
Source: Department of the Air Force (2001, p. 15).
Note: ADDIE = analyze, design, develop, implement, and evaluate.

Phases of ADDIE

Symbolically, Figure 2 shows that all phases of the model depend on each of the other phases. The ADDIE process allows the instructional developer or design team to enter or reenter the various phases of the process as determined by the nature and scope of the development or revision activity. The phases of the updated model are described below (Gagne et al., 2005).

Analysis phase. In courses that tie the content directly to preparing a student to do a job, the instructional developer analyzes the job performance requirements and develops a task list. The developer then analyzes the job tasks and compares them with the skills, knowledge, and abilities of the incoming students. The difference between what they already know and can do and what the job requires them to know and be able to do determines what instruction is necessary. The activities of formative evaluation begin.

Design phase. In the design phase, the instructional developer develops a detailed plan of instruction that includes selecting the instructional methods and media and determining the instructional strategies. Existing instructional materials are reviewed during this phase to determine their applicability to the specific instruction under development. In this phase, the developers also develop the instructional objectives and test and design the instruction. The implementation plan for the instructional system is developed in this phase and

a training information management system is designed, if required. Formative evaluation activities continue in this phase.

Development phase. In the development phase, the student and instructor lesson materials are developed. If the media selected in the design phase included items such as videotapes, sound and/or slides, interactive courseware (ICW), and training devices, these are developed. If a training information management system was developed for the instructional system, it is installed in this phase. As a final step in this phase, the implementation plan is revised. During this phase, instructional developers also validate each unit and/or module of instruction and its associated instructional materials as they are developed. They correct any deficiencies that may be identified. Validation includes:

- internal review of the instruction and materials for accuracy
- individual and small-group tryouts
- operational tryouts of the "whole" system
- revision of units and/or modules occurs as they are validated, based on feedback from formative and summative evaluation activities. The final step in this phase is to finalize all training materials.

Implementation phase. With the instructional system designed and developed, the actual system is ready to become operational in the implementation phase. In this phase, the instructional system is fielded under operational conditions. The activities of operational evaluation provide feedback from the field on the participant's performance.

Evaluation phase. Evaluation is a continuous process beginning during the analysis phase and continuing throughout the life cycle of the instructional system. Evaluation consists of:

- formative evaluation, consisting of process and product evaluations conducted during the analysis and design phases, and validation that are conducted during the development phase. Included are individual and small group tryouts.
- summative evaluation, consisting of operational tryouts conducted as the last step of validation in the development phase
- operational evaluation, consisting of periodic internal and external evaluation of the operational system during the implementation phase. Each form of evaluation should be used during development, update, and revision of instruction, if possible, and if the form of evaluation is applicable (Gagne et al., 2005).

Figure 3 depicts a further revised ADDIE model. The figure shows the system functions and ADDIE phases embedded within the quality improvement (QI) process.

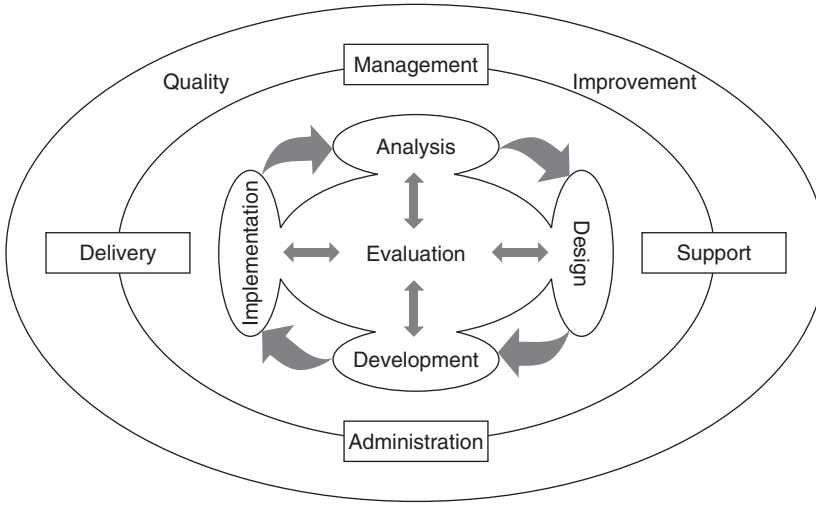

FIGURE 3: ADDIE Model: Phases, System Functions, and Quality Improvement
Source: Department of the Air Force (2001, p. 18).
Note: ADDIE = analyze, design, develop, implement, and evaluate.

The revised model graphically illustrates that (a) evaluation is the "centerpiece" of the ADDIE process; (b) ADDIE is a continuous process with the flexibility to enter and reenter the various phases, as necessary, to develop, update, or revise instruction; (c) all ADDIE activities take place within and are dependent on the system functions; (d) teamwork is required between personnel performing system functions and those designing, developing, and implementing instructional systems; (e) all ADDIE activities and system functions focus on continuous quality improvements of the overall system (vs. the formative evaluation of the steps within the phases).

The entire ADDIE process takes place within the sphere of quality improvement. QI is the continuous, organized creation of beneficial change to the system. The objective of QI is to foster continuous improvement in the products and processes. The process relationships between QI and ADDIE are highlighted in the following paragraphs.

ADDIE depends on mission and job analysis for the necessary data to design, develop, and implement instruction. All instruction should be based directly on mission or job requirements. The quality checks in the analysis process help eliminate instruction that is unrelated to the job. Job analysis uses data from many sources, including mission statements found in regulations or locally developed statements. Analysts or curriculum developers also make use of management engineering reports, occupational survey data, and direct observation to determine the actual job requirements.

As part of the job analysis process, a Training Needs Assessment (TNA) is conducted to determine what the actual performance problem(s) is (are) (Rossett, 1999). In some cases, a problem is not due to a lack of instruction, but to deficiencies within the job structure or environment (Clark, 1999). The ADDIE process helps ensure that instruction is not developed for noninstructional problems. Instruction may also be developed as a "preventive" measure—that is, to prevent problems and to meet the informational and educational needs of personnel.

The information gained in the mission and/or job analysis process gives the instructional design team information that defines the customer's expectations. ADDIE emphasizes criterion-based instruction. The criteria are directly linked to performance requirements in the field. Field representatives identify education and training requirements that instructional providers or other training consultants are under "contract" to satisfy. All evaluations are focused on the graduate's actual job performance.

The goals and standards for an instructional development effort come in many variations. First, the job requirements and the impact of the performance deficiency determine the timing required for the development process and the conduct of the instructional program. Second, the content of the instruction is determined by the person's need to do the job. The design team must directly translate the cues, conditions, and performance standards of the job directly into the instructional program.

As mentioned earlier, the gaining unit or work center needs determine instructional requirements. By continuing to trace the relationship between the job requirements and the person's need to do the job, a continual focus on the actual field requirement is maintained. In addition, the ADDIE process requires that the capabilities, aptitudes, and attitudes of the target audience be considered.

Each phase of the ADDIE process requires constant evaluation against the job requirements identified earlier in the process. In addition, a myriad of tools has been developed to ensure that design and development decisions are made with supporting data. For example, a number of media selection tools are being used that provide managers information that matches training media with the instructional requirements. These matches are based on learning theories and development cost factors (money and time). ADDIE is designed to guide the design team to awareness of factors affecting their decisions.

To develop effective instruction, the design team must be in constant touch with the work center and evaluation offices. This ensures that the instruction matches the performance requirements of the job. ADDIE is a problem-solving, decision-making model. Because the system is flexible and because there is any number of ways to solve a given instructional problem, a design team can be allowed freedom and given authority to design, develop, and implement instruction that meets job performance requirements.

Evaluation is continuous quality checking. This is true during each phase of the ADDIE process, from analysis to evaluation. Built-in checks in each phase ensure the quality of the ADDIE process and instructional products with emphasis on the graduate's performance.

The ADDIE process is a cyclical, ongoing process of continuous improvement. As curriculum developers progress through the different phases of ADDIE, the process and products of each phase are constantly evaluated against the instructional requirements and principles of learning. The results of the evaluations determine which phase of the model to enter next. Constant evaluation identifies changes in instructional requirements due to updates in equipment and personnel, which results in new ADDIE efforts to provide the best possible instruction to personnel (Gagne et al., 2005).

Conclusion

The conceptual phases of systematic training—analyze, design, develop, implement, and evaluate—have stood the test of time. Part of the reason for their resilience is that they have allowed adaptation and revision. The original ADDIE phases and steps that were created for the U.S. military training establishments have blossomed into many variations—some represent advances and some represent losses.

The fundamental flaws in the original ADDIE model have been twofold: (a) the complexity of the original ADDIE system and (b) the lack of a systemic connection to the needs of the host organization. Given that the original model served the military's large and homogenous training function, the detailed ADDIE steps exceeded the needs and resources of most other organizations. As a result, many versions of ADDIE have evolved during the years to be responsive to other settings.

The issue of ensuring the systemic connection of ADDIE to the organization it serves was ignored in the original model as those strategic decisions and connections were made outside the ADDIE training process. Torraco and Swanson (1995) cited three ways for human resource development (HRD) to be strategic. The simplest of the three was for HRD interventions to be performance based. This is no small promise. Most training sponsored by organizations, 50 years after the advent of ADDIE, still have difficulty verifying participant expertise at the conclusion of training. When properly implemented, ADDIE has a proven record of creating training that results in learners acquiring specified expertise, a foundation of performance. The question remains as to whether or not the expertise is in fact the expertise required of an organization to achieve important performance goals. Making these connections is the focal point of many of the advances in ADDIE.

The following articles review the advancements within each of the ADDIE phases as well as review alternative training models and alternatives to training itself. The final article looks at the future of ADDIE.

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W. Clayton Allen is professor and chair, Department of Human Resource Development and Technology, College of Business and Technology, The University of Texas at Tyler (UTT). He led the development team for the establishment of a new PhD in human resource development at UTT and is serving on the HRD Theory Committee of the Academy of Human Resource Development.

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