RUNNING HEAD: Developing Adaptability

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A Theory for the Design of Integrated-Embedded Training Systems

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The nature of work and organizations is changing. Over three decades ago, Terreberry (1968) observed that future organizational environments would evolve to become increasingly turbulent and unpredictable. As we prepare to enter the next millennium, that future is upon us. The dynamics and uncertainty associated with the constellation of external forces that impact organizations create pressures for innovation, flexibility, and adaptability. Adaptability as an individual, team, and organizational capability is increasingly critical to effectiveness.

The increasing rate of technological innovation, and the penetration of technology into all aspects of organizational operations, is changing the nature of work (Howell & Cooke, 1989). Work is increasingly complex, placing a high emphasis on cognitive skills and specialized expertise. It is increasingly mediated by computerized systems that link distributed experts together. From air travel, to medical diagnostics, emergency response, engineering design, and command and control, among many others, organizational functions that range from the mundane to esoteric are all dependent on teams of distributed experts operating via complex systems. Although teams are often co-located in time and space, the increasing connectivity of technology systems facilitates the creation of far-flung virtual teams that interact dynamically, but never actually meet face to face (Bell & Kozlowski, 1998).

There are economic pressures for improved efficiency, cost-control, and effectiveness. Traditional training is typically conducted off-site. A substantial portion of training costs -- upwards of 80% -- is devoted to simply getting trainees to the site, maintaining them while there, and absorbing their lost productivity. Because off-site training is often decontextualized -- that is, abstracted from the work setting -- it also incurs potential problems of skill transfer that impede effectiveness.

This convergence of forces -- environmental, technological, and economic -- is driving a reconceptualization of the nature of training systems. Training is shifting from an inefficient, time consuming, and expensive enterprise to one that can be delivered efficiently, as needed, and just-in-time. It is shifting from an off-site single episode to a systematic series of learning experiences that are *integrated* in the workplace and *embedded* in work technology. It is shifting from a primary emphasis on retention and reproduction to a broader emphasis that also includes the development of *adaptive* knowledge and skills (Kozlowski, 1998). Training will not be a separate activity, but a continuous activity that is an integral part of the workplace and its systems. This reconceptualization of training systems is highlighted by three key terms in our title which constitute the theoretical and application focus of this chapter:

- *Integrate* -- to form, coordinate, or blend into a functioning or unified whole;
- *Embed* -- to enclose closely; to make something an integral part of;
- *Adapt* -- to make fit; implies a modification according to changing circumstances;
  (Webster's Ninth New Collegiate Dictionary, 1987).

Skill Demands in Complex Task Environments

Dynamic tasks necessitate adaptive skills. Many critical activities are accomplished by teams of distributed decision makers interacting through complex, technology-mediated systems. These task environments, which are characterized as dynamic decision making (DDM) situations, place high demands on the skills and capabilities of teams and their leaders. DDM tasks are shifting, ambiguous, and emergent, necessitating rapid assessment of the situation as it unfolds, diagnosis and prioritization of possible actions, and implementation of appropriate task strategies (Orasanu & Connolly, 1993). Modern systems present the decision maker with a wealth of raw information that must be distilled to its essentials, comprehended, and addressed under significant time pressure.

Complex task situations such as these place heavy demands on individual and team decision making (TDM), necessitating high levels of expertise to enable the strategic action and adaptability required for effective performance (Kozlowski, 1998). Although a substantial portion of the information processing required to assess the situation and take appropriate action can be augmented or automated, situation assessment and strategic action are largely the

domain of the human decision maker. Effective utilization of these complex technology systems rests on the high level training, skills, and expertise of system operators.

Advanced technology necessitates high level skills. Technological advances will further augment decision making systems. We can anticipate that the technology will accomplish more of the mundane vigilance and information processing tasks, and will also augment human decision making (e.g., decision aids, intelligent agents, coaches). Fewer people will be required to operate a system. However, the consequences of fewer operators include broader roles, greater responsibility, and increased criticality for each individual. This directly affects the configuration of abilities, knowledge, skills, and attitudes demanded of decision makers. Each team member in the system must now learn higher level skills, accomplish more tasks, and is more critical to the effectiveness of the team. Yet, the human decision maker will still be confronted by a dynamic, knowledge-rich task environment that demands rapid situation assessment and coordinated action. In effect, technological advances will make the skills of the human element *more*, rather than less, important. Thus, training requirements for adaptive, high-level skills and coordinated teamwork can be expected to *increase*, not decrease, as the sophistication and capabilities of technology improve.

Challenges for Training Design

The need for integrated-embedded training systems. Recent theory and research addressing DDM, TDM, and complex skill acquisition are clear that the cognitive and behavioral capabilities needed for effectiveness in these task environments are contextually based. Although these high level skills rest on more basic knowledge and skills that can be acquired in conventional training environments (i.e., the classroom), adaptive skills and team coordination fully develop and refine in the actual performance environment or in very close approximations to it. This means that training systems must either (a) push training toward long-term exposure of intact teams to a wide variety of task situations in high fidelity, full mission simulations (i.e., extended off-site training), or (b) shift more training to the performance context, where tools, techniques, and methods to enhance acquisition of these key skills can be integrated with appropriate instructional support systems (i.e., contexualize training in the workplace, and embed it in work technology).

The development of promising new media and technologies for training, when combined with pressures to reduce costs associated with off-the-job training, reduce training time, and increase efficiency make option (b) the logical choice. By specifying the principles needed to operationalize integrated-embedded training systems, it will be possible to capitalize on an opportunity to enhance the flexibility and effectiveness of training in for the next generation of advanced systems.

Application criteria. Developing integrated-embedded training systems that can reliably deliver the high-level adaptive skills presents several challenges. Such training systems must be able to enhance the acquisition of the high-level skills that underlie strategic action and adaptability. The training systems, and their associated instructional supports, must be developmental in order to shift the focus of skill acquisition as learning and performance improve. They must also be flexible enough to allow leaders to customize and adapt the training to deliver skills that are needed for current or anticipated situations (Kozlowski, Gully, Salas, & Cannon-Bowers, 1996). And, training systems must offer ease of implementation, ease of use, and compatibility with advanced systems.

Theory and research objective. Although new training techniques and technologies offer the potential for flexibility, efficiency, and integration into the workplace, there is little theoretically based guidance in the training and instructional design literatures that directly informs application. This is particularly relevant with respect to the challenges noted above. Without the foundation of a theoretically based and empirically grounded model, it is impossible to determine how to specify and utilize the potential capabilities of advanced technologies to provide integrated and embedded training. *The purpose of this research is to develop and evaluate theoretically based principles to guide the design of integrated-embedded training systems.*

This chapter is organized into three sections to address our theoretical and research objective. We first provide an overview of our theoretical model, and explicate the logic underlying the application of the model to training design. In the second section, we provide a literature review of those research domains of substantive relevance to the theoretical model. The review provides the basis for the derivation of training design principles that are consistent with the theoretical model. The third section of the chapter identifies key leverage points in the model, and associated principles, that we believe hold the most research and application promise. Research propositions are

posed and explicated. Finally, we close with a discussion of the contribution of our theory, and the research challenges that will have to be surmounted in order to effectively integrate training in the workplace, embed instructional tools in work systems, and enhance adaptability.

THEORETICAL MODEL

Background Assumptions

It is impossible to predict with certainty the specific training capabilities that can be embedded in the next generation of advanced systems. However, two training capabilities are likely to be prominent in whatever form the technology assumes: (1) the capability to selectively generate a variety of practice experiences (simulated and real), and (2) the capability to monitor trainee performance in real-time and to generate extensive, detailed, and specific information about the trainee's performance. *Thus, it is assumed that precise control of practice and feedback will be key attributes of advanced systems. The theoretical and research challenge is to determine the best ways to leverage the instructional potential of these training capabilities.*

Theoretical Model

Adaptive learning system. Recent research on learning, cognition, training design, and complex skill acquisition provides the theoretical underpinnings for our approach. We have developed a theoretically-based, application-oriented model formulated around the Adaptive Learning System (ALS), that is particularly well-suited to meet the challenges of integrated-embedded training. The ALS approach is designed to enhance the development of complex knowledge, learning strategies, and adaptive capabilities that are grounded in the performance context. ALS is based on a self-regulatory model of learning, motivation, and performance (Ames & Archer, 1988; Bandura, 1991; Karoly, 1993; Latham & Locke, 1991; Smith, Ford, & Kozlowski, 1997).

Self-regulatory models have been shown to be particularly effective at enhancing learning for difficult and complex tasks (Bandura & Wood, 1989; Gist, Stevens, & Bavetta, 1991; Karl, O'Leary-Kelly, & Martocchio, 1993; Kozlowski, Gully, Smith, Nason, & Brown, 1995; Kozlowski, Gully, Smith, Brown, Mullins, & Williams, 1996; Martocchio, 1994; Martocchio & Dulebohn, 1994; Martocchio & Webster, 1992; Thomas & Mathieu, 1994). At its most elemental level, self-regulation involves monitoring the differences between goals and current states. Negative discrepancies induce self-evaluation and, depending on affective reactions and causal attributions, reallocation of attention and effort to move closer toward goal accomplishment.

The ALS is designed to selectively influence the self-regulatory process to influence learning and performance. It forms the core of our conceptual model shown in Figure 1, and is comprised of three subsystems: (1) *Training Components* that encompass Training Design, Information Provision, and Trainee Orientation; (2) *Training Strategy*, which entails the construction of a training intervention from a combination of specific Training Components; and (3) the *Self-Regulation System* which entails the interconnections among Practice (Behavior), Self-Monitoring (Cognition), and Self-Evaluation / Reactions (Affect). Individual differences, such as cognitive abilities and dispositions, can interact with the ALS. The combination of individual differences and the ALS subsystems affect proximal training outcomes of learning and performance, which in turn influence distal outcomes of retention and adaptation.

Insert Figure 1 about here

Training Components consist of Training Design, Information Provision, and Trainee Orientation. *Training Design* refers to the nature of the information and practice (e.g., experiential exercises, simulation scenarios) to be used for training, including such features as their complexity, difficulty, degree of learner control, sequencing, and variability. *Information Provision* refers to the feedback provided to the trainee that influences their interpretation of past progress, and to the guidance provided that influences their preparation for future learning efforts. *Trainee Orientation* refers to motivational (e.g., training goals) and attributional frames that affect the way the trainee perceives the training experience. Thus, each Training Component represents a set of related instructional manipulations.

Training Strategy is the assemblage of specific training components that form a *Training Intervention*. That is, interventions are constructed from a combination of manipulations drawn from one or more of the Training Components. For example, the Training Intervention, *Sequenced Mastery Goals*, is a combination of sequenced complexity from Training Design, mastery goals fromTrainee Orientation, and process feedback from Information Provision. Training Interventions are constructed to influence one or more of the foci of the Self-Regulation System.

The *Self-Regulation System* (SRS) is comprised of three foci. *Practice* entails the behaviors trainees exhibit as they interact with the training simulation or exercise, and is primarily influenced by Training Design features embedded in the intervention. *Self-Monitoring* represents the cognitive focus of the SRS that concerns trainee attention and reflection on their progress. It is primarily influenced by Information Provision. *Self-Evaluation / Reactions* represents the affective focus of the SRS. It reflects the emotional reactions trainees have to their learning and performance, and is primarily influenced by the Trainee Orientation. All three foci of the SRS are interlinked. The SRS is iterative and developmental over time, with impacts on learning, motivation, and performance.

Application logic of the ALS. *The ALS leverages the SRS by impacting its underlying cognitive, behavior, and affective foci*. The nature of this energization is determined by the combination of Training Components that comprise the Training Intervention. In operation, the model is predicated on trainees working toward training goals. Goals are either set by the training system as part of the intervention, or are determined by trainees themselves as the by-product of an intervention. Trainees monitor their progress toward goals during the training episode. Trainees determine progress by observing their behavior during practice and by interpreting specific feedback provided by the simulated task, exercise, or instructor. When learning complex tasks, trainees frequently fail to meet goals or self-set objectives. Negative discrepancies between goals and current performance prompt evaluation. Moderate negative discrepancies motivate additional attention and effort toward learning and performance. Large negative discrepancies will generally yield withdrawal.

Discrepancies also implicate affective reactions as trainees attempt to account for their progress, or lack thereof. Small negative discrepancies, indicating progress toward goals, will prompt the development of self-efficacy and attributions that enhance the self. Large negative discrepancies, indicating a lack of progress, will undermine the development of self-efficacy and prompt attributions that devalue the self. These affective reactions influence trainee motivation in the current and subsequent training episodes. Positive affect enhances motivation, learning, and performance, and provides resilience to the failures that are inherent in complex skill acquisition. Negative affect degrades motivation, and makes trainees prone to task withdrawal. Implications for training are self-evident.

Research focus. *The instructional logic of the ALS is predicated on selectively combining training components into an integrated intervention that allows the trainee to experience moderate negative discrepancies, and a sustained trajectory toward the accomplishment of training goals as they learn the critical knowledge and skills necessary for task effectiveness. The central research question for application of the ALS model concerns identifying combinations of training components that yield synergistic positive effects on the SRS, thus enhancing complex skill acquisition and adaptability.*

Feedback is a critical characteristic of instructional design, a central process in the SRS, and a key capability of the next generation of advanced systems. Thus, there is convergence from theory, research, and practice perspectives that the Information Provision Training Component must be a central feature of integrated-embedded training strategies. What form of feedback information, and how it is to be employed are key research issues.

Conventional research examining feedback effects on training and learning have tended to focus on its informational properties; that is, on the descriptive characteristics of feedback, including its amount, specificity, accuracy, frequency, consistency, and process / outcome orientation. Our literature review suggests that this descriptive focus is incomplete. Although it catalogs important informational properties of feedback, it neglects interpretive properties that may be more central to learning. *It is the interpretation of feedback that is most relevant to self-regulation, and hence a critical leverage point in the design of training interventions.*

We have developed a typology of feedback shown in Figure 2 that addresses this limitation. The foundation of the typology is provided by *Information Properties*, which includes Description as its primary property. Beyond that foundation, the typology includes three *Interpretation Properties*: (1) Evaluation, (2) Attribution, and (3) Guidance.

Evaluation is past oriented, and concerns any manipulation that affects whether trainees perceive their performance as positive or negative. Normative feedback makes reference to the performance of others as a comparison standard. Velocity feedback is self-referenced against internal expectations for progress. Labeled feedback is simply a positive or negative sign provided by an external agent (i.e., the system, instructor, or leader) that is not referenced to an explicit standard. Evaluation affects the trainee's interpretation of what happened.

Attribution is also past oriented, and concerns any manipulation that affects the attributed cause of performance. Locus references internal (e.g. ability, effort) or external (e.g., luck, task difficulty) causes. Stability references whether causes are malleable or fixed. Controllability references whether the causes of performance can be influenced by the trainee. Attribution affects the trainee's interpretation of why it happened.

Guidance is future oriented, and concerns any manipulation that directs future cognition, behavior, and / or affect. Behavioral guidance directs the trainee about what actions to do next. Cognitive guidance directs the trainee about what to think, such as using metacognitive strategies or to focus on particular practice strategies. Affective guidance directs the trainee to exercise emotional control with respect to his or her reactions to practice feedback. Guidance provides an interpretation of what next.

LITERATURE REVIEW: DESIGN PRINCIPLES FOR INTEGRATED-EMBEDDED TRAINING

The theoretical model was constructed to be a comprehensive conceptual framework for deriving principles for integrated-embedded training. The following review provides a description of the literature supporting our theoretical rationale, and a conceptual foundation for several research avenues represented by the principles derived from the model. The review is organized to follow the major segments of the model shown in Figure 1: Individual Differences, Training Components, the Self-Regulatory System, and Training Outcomes.

Individual Differences

Cognitive Individual Differences

Different levels of cognitive and metacognitive abilities and skills are brought to the training setting by each trainee. These individual difference variables can have important effects on training and transfer outcomes, although they are often ignored in research on training design. Therefore, training research has and should continue to explore ways to design training interventions so as to make the best use of trainees' cognitive abilities and skills. These individual differences should be considered when making decisions concerning the design of training.

Cognitive ability. The general cognitive ability of trainees can have an important effect on both learning and performance outcomes of training. First, and well-documented, is that general cognitive abilities have demonstrated predictive validity for training performance (Ree & Earles, 1992; Schmidt, Hunter, Outerbridge, & Goff, 1988). Based on this evidence, researchers have advocated that different kinds of training should be developed and targeted at trainees of different ability levels (Kanfer, 1996; Kanfer & Ackerman, 1989). This notion of tailoring training to abilities is particularly relevant to integrated-embedded training, because such systems have the potential to be adaptive to the different ability levels of the trainees. The adaptability could be in the form of the type of training given (Kanfer, 1996; Kanfer & Ackerman, 1989), the type of feedback provided (Podsakoff & Fahr, 1989), or the type of guidance provided (Bell, 1999). Training can also be designed to reduce the demand for cognitive ability (Goska & Ackerman, 1996).

Learning outcomes are also hypothesized to be affected by a trainee's cognitive ability. All things being equal, trainees with high cognitive ability would be expected to learn more and in a shorter period of time than trainees with low cognitive ability. This is because attentional resources -- which are largely determined by cognitive ability -- are central to the skill acquisition process (Ackerman, 1992; Kanfer & Ackerman, 1989; Norman & Bobrow, 1975). Different attentional resources are necessary at different stages of skill acquisition (Ackerman, 1992; Kanfer & Ackerman, 1989; Norman & Bobrow, 1975). Flexibility for different stages of skill acquisition is also feasible with integrated-embedded training. For example, incorporating specific error-prone events to prompt learning (e.g., scenario-based training; Cannon-Bowers, Burns, Salas, & Pruitt, 1998) requires more cognitive resources at certain stages of training (Ivancic & Hesketh, 1995), and should therefore be used only at those stages of training for which they would be useful to trainees.

Some authors suggest that trainees should be made aware of their cognitive abilities (Garcia & Pintrich, 1994), and should be taught self-regulation strategies that correspond to their level of understanding and ability (Carver & Scheier, 1982). For example, a trainee who is having trouble with mastering basic aspects of a complex task should be encouraged to self-regulate at the level of the task, rather than focusing on more comprehensive goals or

normative information that draws attention to the self level. This notion is particularly relevant to considerations of the role of the self-regulation system in learning.

Metacognitive skills. Metacognition is often conceptualized as "thinking about thinking. This ability to think about -- choose, monitor, and adapt -- cognitive strategies can also affect training outcomes. For example, a person working on a task may not only be thinking about performing the task, which is a cognitive skill, but may also be thinking about how her performance is progressing toward a goal, what strategies are being used or need to be used to improve performance, and how she feels about her performance, which are metacognitive skills. Although metacognitive skills may be conceptualized as a trainable component of the self-regulatory process, many researchers have examined metacognitive skills as primarily an individual difference variable. Some individuals bring to training high metacognitive awareness, or strong skills, and others have low metacognitive awareness, or weak skills (Ridley, Schutz, Glanz, & Weinstein, 1992; Schraw & Dennison, 1994; Swanson, 1990). Schraw & Dennison (1994) and Swanson (1990) demonstrate that metacognitive skills are distinct from general cognitive ability and task knowledge. Swanson also suggests that metacognitive skill is more predictive of training performance than is general cognitive ability. Such metacognitive skills may include trainees' use of mnemonics, mental repetition, mental models, summarizing, synthesizing, and familiarizers (associating new information with information you already know) to aid them in monitoring their learning process.

Several studies indicate that the use of metacognitive skill can be fostered by other variables. First, metacognitive skill is related to learning orientation; a strong mastery orientation entails the use of metacognitive skills (Ames & Archer, 1988; Ford, Smith, Weissbein, Gully, & Salas, 1998; Schraw, Horn, Thorndike-Christ, & Bruning, 1995). Second, metacognitive skill is related to goal setting; self-set goals are more effective for trainees with high metacognitive skills (Ridley et al., 1992). Third, motivation and encouragement should help trainees use their current level of metacognitive skill (Brief & Hollenbeck, 1985; Garner, 1990). Although metacognitive skills may vary across trainees, it may also be possible to train, influence, or leverage the use of metacognitive skills by increasing motivation (e.g., Garner, 1990) or influencing the SRS. The effectiveness of training metacognitive skills can be evaluated by our model, because the effects of individual differences on metacognitive skill can be distinguished and controlled. This will be discussed in more detail when we address the self-regulation system.

Integrated-embedded training will allow training to be adapted to many different combinations of variables. For example, self-regulation that is encouraged can be varied according to the level of understanding or ability of trainees (Carver & Scheier, 1982), either on an individual basis or with respect to their point of progress through the training program. This could be accomplished by providing different types of feedback which would focus trainees to self-regulate at different levels. Other metacognitive skills that facilitate adaptability may also be accommodated within integrated-embedded training systems. Examples of derived ALS principles relevant to trainee cognitive abilities are listed in Table 1.

Insert Table 1 about here

Motives and Dispositions

Goal orientation. Goal orientation is the extent to which individuals prefer mastery or performance goals. Individuals with a learning orientation are more likely to adopt mastery goals focused on improving skills and increasing competence (Elliot & Dweck, 1988; Boyle & Klimoski, 1996; Duda & Nicholls, 1992). Learning-oriented individuals believe that their abilities are malleable and are characterized by positive affect, increased motivation, constructive self-instruction, and active self-monitoring (Dweck, 1986, 1989; Dweck & Leggett, 1988).

Performance-oriented individuals possess a different set of concerns. Rather than developing competence, they are concerned with demonstrating competence to themselves or others. Motives of performance-oriented individuals include wanting others to think they are smart or to simply do better than others around them (Meece, 1994). Performance-oriented individuals believe that their abilities are fixed. They seek situations in which they can demonstrate their competence, and tend to avoid novel situations where their competence is unknown or in question (Dweck, 1986, 1989). It has been suggested that an orientation toward performance tends to suppress the metacognitive and cognitive processes that are stimulated by the adoption of a learning orientation (Schraw et al., 1995).

Goal orientation has several motivational implications that are relevant to deriving instructional principles. First, initial motivation is dependent in large part on the goal orientation trainees bring with them to the training environment; learning-oriented trainees are more motivated to learn than performance-oriented individuals (Archer, 1994). Learning-oriented individuals tend to maintain motivation during training, provided successful performance is construed by trainees as a skill that can be improved (Bandura, 1991). Finally, learning-orientation can interact with the training technique to increase intrinsic motivation (Nordstrom, Wendland, & Williams, 1995). For example, trainees with a learning orientation who are given Error Management Training (in which trainees are taught to use errors constructively) will likely gain more from the training than will performance-oriented trainees.

The theoretical underpinnings of goal orientation as an individual difference focus on the individual's implicit theory of intelligence. Individuals either believe that intelligence is malleable, and can be improved through effort, or they believe that it is a fixed quantity and people must simply deal with what they possess (Dweck, 1986). Belief in the malleability of intelligence maps to a learning orientation. On the other hand, a view of intelligence as immutable is more closely related to a performance orientation. Care must be taken in the design of training, since individuals who believe intelligence to be immutable are less efficacious (e.g., Martocchio, 1994), and may be more likely to withdraw (either physically or psychologically) from the training when faced with failure (Ivancic & Hesketh, 1995). Indeed, much of the research on goal orientation and learning has treated it as a situational state by manipulating trainee beliefs about the malleability of their ability, but has done so without controlling for the goal orientation traits (e.g., Martocchio, 1994).

Trait self-efficacy. Self-efficacy is usually conceptualized as a domain-specific belief in one's competence (Bandura, 1991). High self-efficacy has been found to be associated with increased performance, with the relationship moderated by the complexity of the task (Bandura & Cervone, 1983, 1986). An alternative perspective is one that treats efficacy as a more global construct, where individuals have a general belief in their capability to handle any situation that might arise (Scherer, Maddux, Mercadante, Prentice-Dunn, Jacobs, & Rogers, 1982; Eden & Zuk, 1995). It might be argued that people enter any situation, even a novel one, with varying degrees of confidence in their abilities to handle whatever problems may confront them (Mathieu, Tannenbaum, & Salas, 1992). It is reasonable to expect that those individuals who feel more confident in their ability to respond to such situations will show the same type of effects, at a general level, that have presented themselves in the self-efficacy literature. However, the meaningfulness of a trait conceptualization of self-efficacy is questionable, particularly when we consider how to distinguish such a notion from more general self-image. Because of this ambiguity, our use of the term "self-efficacy" will throughout this paper refer to the domain-specific conceptualization that is more theoretically appropriate. Discussions of task-specific self-efficacy as a training outcome are addressed in subsequent sections of this chapter.

Locus of control. As with the theory of intelligence discussed above, individuals vary in the extent to which they attribute control of occurrences to themselves (internal locus of control) or to their environments (external locus of control). Individuals with an internal locus of control, who perceive themselves to have some control over the training environment, will maintain their motivation better than will those with an external locus of control (Noe & Schmitt, 1986).

Obviously, trainee motives and dispositions are critical to skill acquisition. Not only do they provide direct influences on outcomes (Dweck & Leggett, 1988), they may also interact with the training program to influence outcomes of interest (Ivancic & Hesketh, 1995; Martocchio, 1994). Some examples of derived ALS principles relevant to trainee dispositions are compiled in Table 2.

Insert Table 2 about here

Training Components

Information Provision

Information Provision is that component of training typically referred to as feedback. It is composed of information the training system provides to the trainee for use in the self-regulation process. The information provided may have many different properties, which can be generally categorized along two lines: properties which are purely informative (providing descriptive information), and properties which are interpretive (providing additional characterization of the information, which may have motivational or metacognitive consequences). These

characteristics are illustrated in Figure 2. This section describes these information and interpretive properties and literature relevant to deriving principles to guide the provision of information during training.

Information properties. Information properties of feedback provide trainees with knowledge of learning or performance results. Thus, this aspect of feedback is often termed "knowledge of results." All feedback has at least some of this descriptive property, and is characteristic of the traditional notion of feedback. The descriptive feedback simply relates to the trainee what behaviors they did or did not exhibit, what concepts or facts they did or did not learn, and what results they did or did not achieve. Description is a behavior-oriented property. Most conceptualizations of feedback end here, providing a categorization of types of descriptive feedback including its specificity, amount, frequency, accuracy, consistency, and process / outcome orientation. These different types of descriptive feedback are briefly described and illustrated below.

Feedback presented to trainees can differ with respect to the specificity, or detail, of the information. For example, in a complex decision-making task, "You made many decisions," would represent a more general feedback statement, whereas, "You made 28 decisions in 8.5 minutes of practice," would be a much more specific feedback statement. In general, researchers seem to agree that specific feedback is preferable to general feedback (Earley, Northcraft, Lee, & Lituchy, 1990; Lindsley, Brass, & Thomas, 1995; Wofford & Goodwin, 1990), particularly when goals are specific and when task strategies are being learned (Earley et al., 1990).

Feedback can also differ with respect to the amount or quantity of information presented to trainees. If trainees are performing five different behaviors, feedback could be presented for only the most important behavior or all five behaviors. Amount of feedback may also be related to the specificity of the feedback, in that more specific feedback necessarily entails a greater amount of feedback be given than does very general feedback.

The frequency with which trainees are presented the information is another way in which feedback can vary. Feedback can be presented at one time only (i.e., at the end of training), after every performance episode, or after every minute of the performance episodes. To maximize retention and transfer, feedback should not be given excessively (Schmidt & Bjork, 1992); however, to maximize self-efficacy, feedback should be given frequently (Gist & Mitchell, 1992). These conflicting recommendations may be resolved by evaluating which goals are more important to the training -- raising efficacy or improving retention and transfer. Mikulincer (1989) suggests that less feedback be provided during early stages of skill acquisition, particularly when trainees are prone to interfering thoughts following negative feedback. Some authors stress the importance of the timeliness of the feedback (Lindsley et al., 1995) particularly when developing a strong procedural knowledge base (Anderson, 1987). This simply means that feedback information should be presented contiguous to the performance episode rather than at a later time, further removed from the performance episode.

The accuracy of feedback information presented to trainees can vary as well. For example, feedback can represent the trainee's actual learning and performance, or the trainee might receive fabricated feedback. This is usually provided to achieve some expected motivational gain. Researchers indicate that, in the interest of long term gains, feedback should be accurate so that trainees will know what task behaviors need improvement (Hunter-Blanks, Ghatala, Pressley, & Levin, 1988; Lindsley et al., 1995). Podsakoff & Farh (1989) suggest that feedback should be credible; credibility can be established by demonstrating some evidence for the authenticity of the feedback. Feedback which is perceived as credible will have greater effect on trainee behavior. However, positive feedback does have benefits of increasing self-efficacy, which increases resilience. Therefore, a trainer might choose to provide a trainee with positive evaluative feedback that is technically not accurate (e.g., "you are doing very well"), particularly when the trainee is learning a complex task that results in substantial negative feedback (e.g., many mistakes, low scores) during the initial stages of skill acquisition.

Feedback presented to trainees can differ with respect to how consistent the information is with the trainee's goals. Just as a trainee can have either mastery or performance goals, the feedback can be tailored so that it provides information on the trainee's progress toward either mastery or performance improvement. For example, feedback consistent with mastery goals would inform the trainee as to what concepts and/or facts have or have not been learned; feedback consistent with performance goals would inform the trainee as to what level of performance, relative to the goal, has been achieved. Feedback consistency is important with respect to any goals; it is not limited to mastery and performance goals. So if a goal were for a trainee to perform faster, speed information should be given.

Finally, feedback presented to trainees may differ with respect to whether the information is process oriented or outcome oriented. Generally, process feedback concerns how a trainee is using information or how behaviors are performed; outcome feedback describes how well that information is used or those behaviors are performed. If there are three behaviors associated in combination with an outcome, process feedback would provide information concerning how well the three behaviors were exhibited, whereas outcome feedback would only provide information related to achievement of the outcome. It is recommended that process feedback be provided when task strategies are being learned (Earley et al., 1990), so that trainees can learn to modify and improve the strategies. Process feedback regarding errors should be provided when building a procedural knowledge base, but withheld when trainees are learning how to handle errors (Anderson, 1987).

One of the challenges of using descriptive feedback in training is determining the optimal combination of feedback types at different points in the learning process. Alternatively, training can be designed to influence the interpretation trainees apply to the information, as discussed in the following section.

Interpretation properties. Descriptive feedback provides raw information; interpretation is a psychological process that extracts meaning from the information. This psychological interpretation of the meaning of feedback is central to self-regulatory processes, but is typically uncontrolled in training. However, it is possible to augment feedback to provide an interpretive direction or prompt. Thus, from a theoretical perspective, it is a key leverage point in our model. The three primary ways of manipulating the interpretive properties of feedback include: *evaluation* -- providing a point of reference with which to compare the feedback information; *attribution* -- prompting potential causal explanations for the feedback information; and *guidance* -- providing direction for future actions, thoughts, and / or feelings. Another way to frame these three interpretive properties is that they explain (respectively) *what happened, why it happened, and what should happen next*.

Evaluation is the interpretation property that involves a comparison of descriptive feedback to a reference point. Such comparative information may have substantial impacts on the subsequent training and performance behavior of the trainee. For example, trainees performing poorly should be given negative evaluative feedback when performing simple tasks, but not when performing complex tasks. For simple tasks, negative evaluative feedback will lead to increased effort and performance; for complex tasks it may lead to reduced effort and performance (Karoly, 1993). The literature suggests three categories of evaluative feedback -- normative feedback, velocity feedback, and labeled feedback -- which differ with respect to how the feedback sign is established.

Normative feedback compares a trainee's performance to a social standard, in that it provides information about the trainee's relative standing with respect to a reference group. Those with whom the trainee's performance is compared may include other trainees, others who have performed the task before, etc. It has been suggested that social comparison information will best allow trainees to develop accurate perceptions of their own ability levels (Fahr & Dobbins, 1989). However, there are some reasons to exercise caution when using normative feedback. Kluger & DeNisi (1996) report that such normative feedback encourages trainees to pay attention to themselves and draws attention away from the task, which may result in performance decreases. Field (1996) determined that normative feedback provided during early skill acquisition was beneficial for high ability trainees in improving performance, but for low ability trainees undermined self-efficacy and produced negative self-reactions.

Velocity feedback is self-referenced, in that the trainee's performance is compared only with her or his own prior performance on the task. The trainee is then able to gauge the rate of progress at which a performance goal is being reached. This feedback is termed "velocity" because it is analogous to the physical concept of change in distance over time (Carver & Scheier, 1990; Hsee & Abelson, 1991; Kluge & Demisi, 1996). Such self-referenced feedback has not been frequently examined in research.

Labelled feedback is not referenced to self-performance or the performance of others, but is referenced to an unspecified standard and carries either a positive or a negative label. If a trainee's performance exceeds the standard, it carries a positive label. If a trainee's performance falls below the standard, it carries a negative label. Labelled feedback may be provided by a trainer, leader, test, or other delivery agent. This "labelled" property of evaluative feedback has been investigated in numerous studies and is associated with a variety of findings. Such findings may also apply to feedback which is not expressly labelled as positive or negative when presented to the trainee, but the trainee interprets the normative or velocity feedback to be positive or negative. The most basic of these findings is that positive feedback may help increase learning (Martocchio & Webster, 1992). However, such a broad statement

should be viewed with some caution; other research indicates conditions under which this assertion may or may not hold true (Kluge & Demisi, 1996).

Some authors indicate that trainees learning tasks with differing levels of complexity will respond differently to the positive or negative label of the feedback. Negative feedback will be motivating to trainees learning simple tasks, whereas positive feedback may lead to complacency or overconfidence. For trainees learning complex tasks, negative feedback will likely be demotivating, whereas positive feedback will benefit trainees (Karoly, 1993; Waldersee & Luthans, 1994). Thus, under difficult or complex task conditions, initially poor performance may be labelled as moderately negative. Trainees given such an interpretation will be more likely to maintain effort and less likely to abandon the goal than trainees given large negative discrepancies as feedback (Bandura & Cervone, 1983).

Self-efficacy may also have a moderating effect on how trainees respond to the feedback label. Following negative feedback, trainees with low self-efficacy may suffer further decreases in self-efficacy, and subsequently reduce effort and performance. Low self-efficacy trainees will maximize self-efficacy and task performance when provided with positive feedback (Karl et al., 1993; Kluge & Demisi, 1996). When a goal of training is to enhance self-efficacy, positive feedback should be provided (Karl et al., 1993; Latham & Locke, 1991; Martocchio & Webster, 1992).

When trainees are using behaviors, routines, and / or strategies that are ineffective, specific negative feedback will allow trainees to learn how to correct their performance (Garner, 1990; Wofford & Goodwin, 1990). However, trainees who are in a long term training program should not be given continual negative feedback, or they will be likely to decrease motivation and performance, and may abandon the goal (Waldersee & Luthans, 1994).

Attribution. This interpretation property involves the cause to which a trainee attributes descriptive feedback. Such attributional information may have substantial impacts on the subsequent training and performance of the trainee. The three dimensions of attributional causality presented here -- locus, stability, and controllability -- are consistent with the constructs proposed by Weiner (1985).

A trainee may view feedback resulting from an internally influenced cause, such as ability and / or effort, or an externally influenced cause, such as luck and / or task difficulty. A trainee may additionally view feedback as resulting from a stable cause, such as ability and / or task difficulty, or an unstable cause, such as effort and / or luck. It should be noted that these examples were somewhat arbitrarily chosen; some trainees may perceive ability to be a stable trait, while others perceive it as not stable, but malleable (see the Individual Differences section). Similarly, perceptions of task difficulty may or may not necessarily be stable; as one becomes proficient on a novel task it is perceived to be less difficult. Thus, providing trainees with negative feedback that suggests performance resulted either from external or unstable causes may help to preserve trainee self-efficacy and effort toward future performance attempts (Silver, Mitchell, & Gist, 1995).

Finally, a trainee may view feedback as resulting from a controllable cause, such as effort, or a cause which is beyond her or his personal control, such as luck. Feedback which encourages trainees to attribute performance to controllable factors may lead to an increase in trainees' self-efficacy and effort (Martocchio & Dulebohn, 1994).

Guidance. Guidance is an interpretation property that involves giving a trainee direction regarding future actions that should be taken for improvement. Guidance can be thought of as a kind of proactive "feedforward" mechanism, as opposed to "feedback." Such guiding information may have substantial impacts on the subsequent training and performance of the trainee. For example, providing trainees with information about their current level of achievement and advisement about what they need to do to attain the goal will allow them to learn more efficiently and will help prevent premature goal termination (Tennyson, 1980, 1981).

The form of guidance can be behavioral, cognitive, or affective. Guidance can describe what behaviors a trainee should next engage in and what strategies might be employed in order to best achieve the learning or performance goal (e.g., Earley et al., 1990). Guidance can also describe what a trainee should think about and how to think about it in order to best achieve the goal. This type of guidance particularly makes use of metacognition to help trainees improve learning strategy and / or performance. One example is the work on judgments of learning and feelings of knowing by Nelson, Dunlosky, Graf, and Narens (1994). Another example is the work by Bell on adaptive guidance (Bell, 1999; Bell & Kozlowski, 1999). Finally, what emotions the trainees might next encounter and how to best handle that affect may also be provided by interpretive information (Bell, 1999). Emotional control skill training (e.g., Kanfer, 1996) which builds such skills can be useful.

While there is considerable coverage in the literature on topics that concern the informational properties of feedback provision, much less has been examined with respect to the interpretive nature of feedback. We propose that it is these interpretive properties which provide the best means of manipulating feedback during training in order to affect the self-regulation process. Interpretive feedback can convey information to trainees that evaluates how they are doing, suggests attributable causes, and guides their future actions. Selected ALS principles relevant to information provision are shown in Table 3.

Insert Table 3 about here

Training Design

Training is generally conducted off-site, in a classroom, decontextualized from the performance environment. New technologies and increased connectivity enhance the potential for distance learning, web-based training, and simulation systems to integrate training in the work context and to embed instructional capabilities into work technology (Schreiber, 1998). Although the future holds great promise for the development of training that can be delivered -- literally -- "just-in-time" by an intelligent tutor or agent, much current emphasis for pushing training into the workplace is focused on the use of simulation. Simulations can often be run on the same systems in which trainees perform, or in low physical fidelity systems that nonetheless capture the essential psychological fidelity of the task (Kozlowski, 1998).

One of the major advantages in using simulations is that the characteristics of the simulation (i.e., task) can be tailored to the needs of the trainer and trainees. Although the task is often taken as given in training research, aspects of the task or information in the training materials have been found to have important psychological consequences for learning. Task characteristics such as sequencing, complexity, variability, workload, and built-in errors, used appropriately, can impact the depth or speed of knowledge acquisition. Many of these task, simulation, or instructional characteristics can be determined by the trainer and thus become an important part of the design to the intervention. Often the implications of relevant task characteristics are not considered, and they may interfere with the success of training interventions. However, when task characteristics are taken into consideration during the design of training, these characteristics can be a leverage point for maximizing the efficiency and effectiveness of integrated-embedded training. Research findings on task characteristics are reviewed below.

Sequencing. Sequencing refers to the order in which training material is presented. Research has indicated that sequence and pacing of training is critical to building long term retention of skills, and the improvement of stable knowledge structures (Kozlowski et al., 1995, 1996; Schmidt & Bjork, 1992). For example, Reigeluth, Merrill, Wilson, and Spiller (1980) suggest that to build stable knowledge structures, training material should be elaborated from simple to complex starting with a familiarizer or analogy, and the most important topic should be presented first. Furthermore, not only does the difficulty of the material affect the optimal sequencing, but in some cases the subject matter being trained should influence the sequence of training. For example, to train learning skills, primary learning strategies should be presented prior to supporting strategies (Dansereau, Brooks, Holley, & Collins, 1983). Likewise, research suggests that strategy training should be reserved for later portions of training programs, since in early skill acquisition cognitive capacity is reserved for task accomplishment (Etelapelto, 1993). Thus, the difficulty and type of material being presented can have implications for determining the best sequencing of material.

Complexity. Like sequence, the complexity of material has implications for learning. Task complexity has been defined as the number, interrelationship, or dynamics of task components (Wood, 1986). Complex tasks can be difficult to learn, which may demotivate the trainee causing them to become distracted, lose self-efficacy, and even withdraw from the task. Fortunately, several authors have suggested ways to prevent such problems. Research suggests that trainees learning complex tasks should be encouraged to monitor their rate of progress rather than performance itself (Carver & Scheier, 1990). Monitoring progress reduces the potential to experience large discrepancies between one's current performance and the goal level. Monitoring progress focuses the trainee on improvement, thereby maintaining self-efficacy. As learning and performance progresses to a point where the trainee has some initial success and understanding of the task, goal setting can be used to maintain appropriate amounts of goal-performance discrepancy (Carver & Scheier,1990; Kanfer & Ackerman, 1989).

The complexity of the task also has implications for the use of feedback. Trainees should not be given negative feedback when performing poorly on complex tasks, as this may reduce effort and performance (Karoly,

1993). Instead, trainee self-efficacy should be fostered when learning complex tasks to increase motivation. Trainees should be encouraged to take a satisfaction perspective, meaning they should focus on their improvement or progress toward their goal to avoid low self-efficacy. Although maintaining efficacy is vital for complex tasks, on simple tasks self-efficacy alone cannot be relied upon as a motivator. Boredom or too much self-satisfaction can lead trainees to decrease effort on simple tasks. Therefore, trainees on simple tasks should be encouraged to take a dissatisfaction perspective, setting more challenging goals to provide a discrepancy between their performance and their goal which will maintain interest. Likewise, for simple tasks negative or corrective feedback can be used for those performing poorly to increase performance, whereas positive feedback can actually inhibit performance (Bandura & Cervone, 1986; Karoly, 1993; Salomon, 1984; Waldersee & Luthans, 1994).

In addition to the motivational implications, task complexity may impact the type of intervention that will be optimal for learning, particularly where goals are concerned. Difficult, specific goals may cause learning difficulty for trainees on tasks with many different strategies. Guidance in strategy selection should accompany goals in such tasks (Earley, Connolly, & Ekegren, 1989). Presenting goals early in training may be useful for encouraging performance on low complexity tasks. For complex tasks, goals should be delayed until skill strategies have developed or proceduralization has begun (Earley, Lee, & Hanson, 1989; Kanfer & Ackerman, 1989). Proximal subgoals which break the task into smaller parts should be used on cognitively complex tasks to increase initial self-efficacy and persistence (Kozlowski et al., 1995, 1996; Stock & Cervone, 1990). Error training, which is discussed later in this section, may be increasingly beneficial as tasks become increasingly difficult (Frese, Brodbeck, Heinbokel, Mooser, Schleiffenbaum, & Thiemann, 1991; Ivanicic & Hesketh, 1995).

Variability. Variability is the third type of task characteristic shown to have implications for learning. Variability is the degree to which the training task provides some variety in relevant characteristics of the training stimulus. Baldwin (1992) has demonstrated that providing variability in the training scenarios and model competency improved the generalizability of behaviors learned in training. Ohllson (1996) suggests that variability of the training situation is important because training should provide sufficient practice for trainees to learn the links between the goal, the situation, and the appropriate action. Finally, Schmidt and Bjork (1992) present evidence that stimulus variability may decrease short term performance, but is critical for long term retention and transfer.

Workload. Several authors have found the degree of cognitive workload related to learning and performance. Workload is the degree of attention or activity required to perform a task and may be related to learning. Workload is primarily a function of other decisions made about the task, such as the sequencing and complexity of the task. Early in skill acquisition complex, consistent tasks are resource limited, meaning increased attention and effort should yield increased performance. Later in skill acquisition, consistent tasks become data limited and increased devotion of attentional resources will not yield better performance (Norman & Bobrow, 1975; Kanfer & Ackerman, 1989). Therefore, maintaining a trainee's full attention and effort early on will be critical for learning, but later the trainee may be unable to increase performance simply by devoting more effort.

Trainees should be able to make at least some consistent progress during training. Extremely high workload, difficult or unsolvable problems can result in anxiety that undermines effort and attention (Mikulincer, 1989). Errors should only be encouraged if the learner has the attentional capacity to reflect on and learn from them (Ivancic & Hesketh, 1995).

Errors. Errors, while typically thought of as problematic in learning, can serve important functions for learners. Although we often think of errors as something to eliminate during training, research indicates that including errors in certain circumstances may aid in learning and retention. Many authors have examined when it is appropriate to include errors in training design (Frese & Altman, 1989; Frese et al., 1991; Ivancic & Hesketh, 1995; Lord & Levy, 1994; Nordstrom et al., 1995). If errors occur frequently in the transfer domain, trainees should be encouraged to make errors in training in order to learn error management strategies and develop their knowledge or mental model of the task system. This is particularly true for trainees with a tendency to make errors (Frese & Altman, 1989; Frese et al., 1991; Lord & Levy, 1994; Nordstrom et al., 1995). Some researchers suggest that trainees should not be restricted from making mistakes. Tasks that do not allow trainees to commit errors limit their ability to learn by exploring (Frese et al., 1991).

The type of skill being trained may determine whether explicitly "building in" errors is appropriate. Errors are especially important if the goal of training is to develop problem-solving, hypothesis testing, or other cognitive skills (Ivancic & Hesketh, 1995). When training procedural skills, training should not include errors in some

instances (Ivancic & Hesketh, 1995), although some suggest that trial and error training may be appropriate (Prather, 1971).

Using errors to improve learning is not simply a matter of including them or not including them; how the training system uses the errors and incorporates them into instruction is critical to making them useful. Simple heuristics should be provided to the learner to counter the common notion that errors are a sign of weakness or stupidity, and trainees should be taught that errors can serve a positive role in learning (Frese & Altman, 1989; Frese et al., 1991). Encouraging errors is best done in the middle of training so as not to overwhelm trainees. In addition, easily interpretable feedback should be provided by the instructor or task if errors are used as part of training (Frese & Altman, 1989). Informative task environments are needed for error management training to allow the trainee to correctly diagnose the problem and make the error attribution necessary for learning (Ohllson, 1996). When using error training, feedback should be immediate and directed at specific behaviors (Anderson, 1987; Wofford & Goodwin, 1990). If the goal of training is to enable trainees to handle errors in transfer, then feedback regarding errors may be withheld to allow learners to identify errors, although this may sacrifice some speed of procedural knowledge development (Anderson, 1987).

Clearly, incorporating errors into training can have motivational consequences that can affect learning. Nordstrom et al. (1995) suggest that error management training and goals can be used to increase motivation and lower frustration associated with errors in the transfer environment. Individual differences in capability to handle negative feedback or learning orientation should be considered before employing error training, particularly early in training (Ivancic & Hesketh, 1995; Kuhl & Koch, 1984). Trainees may be encouraged to attribute errors to variable causes that can be overcome to maintain self-efficacy in the face of goal-performance discrepancies (Thomas & Mathieu, 1994).

Recent research has also suggested that not only can errors be added into training, but in some cases it is useful to give the trainee control over their own training processes to varying degrees (Tennyson, 1980; 1981). This has been referred to as providing learner control over training. However, Tennyson's work has indicated that the learner, given control, needs information to avoid over-estimating how well they have learned and to inform them about actions to take to maximize learning. Learners with control over time-on-task or sequence of instruction should be provided with information about their learning and predicted needs to avoid premature termination of the training. Given proper information, learners can decide when they have learned material and eliminate unnecessary learning trials. Thus, learners should be given control plus some advisement or feedback in order to make training efficient (Tennyson, 1980; 1981).

Rather than advisement, some research suggests that learners on a new task should either start with some prior knowledge of the training domain or begin with initially structured training before being given control. Learners with some prior conceptual knowledge about the task are in a better position to make decisions about their learning and may learn more efficiently given some control over the medium, pace, sequence, or practice in training. Learners lacking conceptual knowledge about the task should have their initial learning structured more than those with some prior learning (Gay, 1986). This reinforces the importance of training sequence, particularly when control is to be given to the trainee.

In summary, there are a variety of characteristics to be considered in training design when the focus is on leveraging learning effectiveness. It is an unfortunate fact, however, that training design, particularly simulation design, is more often directed by a desire to achieve realism, rather than a desire to enhance learning. Selected ALS principles relevant to training and simulation design are listed Table 4.

Insert Table 4 about here

Trainee Orientation

Trainee orientation reflects the motivational goals that trainees adopt with regard to the training task, simulation, or practice. Research in both organizational and educational psychology has emphasized the distinction between mastery or *learning goals*, where trainees seek to improve their knowledge and skills, and *performance goals*, where trainees are concerned with demonstrating their competence (Ames & Archer, 1993; Archer, 1994; Farr, Hofmann, & Ringenbach, 1993). Although conceptualized as an individual difference (Dweck, 1986), research has frequently treated this as a manipulable situational variable. Current evidence suggests that situational and

dispositional influences are independent and additive (Archer, 1994; Kozlowski et al., 1995, 1996). Individual differences in goal orientation were discussed earlier in this section of the chapter.

While learning and performance goals are not mutually exclusive (i.e., a trainee can be oriented to both mastery and performance; Button, Mathieu, & Zajac, 1995), there are a number of training components that affect whether trainees focus on one goal more than the other. These situational factors can be divided into two categories: Instructional goals and general training frames. Instructional goals are the explicit directions provided to trainees. General training frames are cues or prompts given to trainees regarding the training, the task, or their ability that can be conveyed purposivefully (i.e., by explaining the task is extremely difficult) or unintentionally (i.e., by implying that trainees do not have the ability to perform successfully).

Instructional goals. Goal orientation can be influenced by explicit instructions presented to trainees. Instructions suggest the behaviors and actions trainees should engage in during training, and in this sense identify the goals trainees should strive to achieve. Generally speaking, goals can either emphasize performance or learning.

Performance goals have been studied extensively over the last 20 years. Locke & Latham (1990) review years of research and literally hundreds of studies demonstrating the benefits of difficult and specific performance goals. Trainees given performance goals outperform trainees given no goals, "do your best" goals, or general goals. Research suggests this effect is strongest when trainees are committed to a goal that they have the ability to accomplish, and when the task is simple and provides clear feedback (Latham & Locke, 1991).

In the training context, two of these moderators present ubiquitous problems. First, training is often for complex, rather than simple tasks. Second, trainees generally do not begin training with the ability to accomplish performance goals or objectives on these complex tasks -- that is, after all, the purpose of training. Research clearly indicates that the benefits of performance goals are attenuated on complex tasks, and that performance goals can even result in performance decrements (Cervone, Jiwani, & Wood, 1991; DeShon & Alexander, 1996; Earley, Connolly, & Ekegren, 1989; Earley, Connolly, & Lee, 1989; Huber, 1985; Wood, Bandura, & Bailey, 1990). Further, performance decrements are even worse for individuals with low ability (Kanfer & Ackerman, 1989).

Some authors have used this research to conclude that goals should not be used early in skill acquisition (Kanfer & Ackerman, 1989; Kanfer, Ackerman, Murtha, & Dugdale, 1994). Other authors have suggested modifications to performance goals that may improve their usefulness in training contexts. For example, Earley and colleagues have demonstrated that supplementing performance goals with strategy guidance can offset the difficulties created by goals on complex tasks (Earley, Connolly, & Ekegren, 1989).

While strategy training is one potential solution to the problems created by performance goals in training, the educational literature suggests learning problems will continue as long as trainees are oriented toward performance. Archer (1994) and Dweck (1986, 1989) suggest that performance goals, as compared to learning goals, lead to maladaptive learning patterns. In their research, students following performance goals tended to avoid challenging tasks, exhibit negative feelings following performance, and use surface strategies during task engagement (for a review see Dweck, 1986). Thus, students who follow performance goals learn less and exhibit greater dissatisfaction than trainees who pursue learning goals. This finding is supported by recent organizational research that suggests it is not goals per se that result in decreases in complex task performance, but the way in which performance goals frame the task (DeShon & Alexander, 1996; DeShon, Brown, & Greenis, 1996). As a result, training research should consider alternative goals, such as learning goals, that can be employed in training complex tasks. For simple or well-learned tasks, however, research clearly indicates the usefulness of performance goals to increase motivation and subsequent performance.

Research suggests that trainees will learn more when given *learning goals* than when given performance goals. This effect occurs through a number of mechanisms. First, trainees pursuing learning goals make better use of learning strategies (Ames & Archer, 1993; Archer, 1994; Garner & Alexander, 1989; Nolen & Haladyna, 1990; Pintrich & DeGroot, 1990; Schraw et al., 1995). Second, attributions that encourage sustained effort following failure are stimulated (Ames & Archer, 1993; Archer, 1994; Elliot & Dweck, 1988). When negative feedback is received, effort is maintained by leading trainees to interpret their failures as caused by external but controllable factors, or to internal strategies that are controllable (e.g., Curtis, 1992). Either of these attributions help trainees maintain self-efficacy in spite of negative feedback. Supporting these research findings, Kozlowski and colleagues (1995, 1996) demonstrate that learning goals enhance self-efficacy and metacognitive coherence during training, and

improved retention and adaptability during transfer. The third benefit of learning goals is that positive attitudes toward learning are facilitated (Archer, 1994). These attitudes can facilitate later learning efforts as well as a positive attitude toward the task being trained. Finally, Duda & Nicholls (1992) add that learning goals can increase cooperation among trainees.

As noted earlier, performance goals and learning goals are not mutually exclusive, and consequently the effects of performance goals are not the opposite of the effects for learning goals. Rather, the difference between these goals is best captured by the outcome that they encourage trainees to pursue. Learning goals encourage the *development* of knowledge and skill, while performance goals encourage the *demonstration* of current levels of knowledge and skill. These differences affect the self-efficacy and attributions of trainees, which in turn influence the practice behaviors and self-monitoring activity employed by trainees.

The negative effects of performance goals seem to apply most during the earliest stages of skill acquisition, when trainees have not developed the knowledge and skill necessary to perform effectively. Ultimately, both goals are critical to success in organizations, but at different times. Early in skill acquisition, learning goals are critical for building skill and self-efficacy. When individuals have the requisite skill and self-efficacy, performance goals can be applied to maintain interest and motivation on task (Kanfer, 1996).

Research by Winters and Latham (1996) provides some support for this assertion. These authors demonstrated that on simple tasks performance goals were beneficial; but on complex tasks, learning goals resulted in better final performance. It is reasonable to suggest that, after the complex task was well learned, performance goals would maintain performance levels more than learning goals. A similar position is asserted in the educational literature where Wentzel (1991) suggests effective school performance requires individuals to pursue both types of goals. With regard to team development, leaders and trainers are advised to provide learning goals during early stages of skill acquisition, and move toward performance goals as skills become better learned (Kozlowski, Gully, McHugh, Salas, & Cannon-Bowers, 1996).

General training frame. Learning and performance orientations can be induced by training instructions that do not focus explicitly on goals or objectives to be accomplished. Research indicates that general statements made by trainers can influence the orientation that trainees take toward the training task. For purposes of improving training outcomes, researchers have focused on eliciting learning orientations. A few of the dominant methods that have been used to create learning orientations can be organized into three categories: (1) framing training in terms of long-term outcomes and success, (2) encouraging trainees to be satisfied with training successes, and (3) persuading trainees that they have the ability to succeed.

First, framing training in terms of long-term outcomes and success can induce a learning orientation. Curtis (1992) suggests that training which emphasizes long-term benefits of training will increase motivation to learn the material and, ultimately, learning. Similarly, Meece (1994) suggests that training which emphasizes self-improvement and the usefulness of information provided in training will encourage the adoption of a learning orientation.

Second, a learning orientation can be induced by encouraging trainees to be satisfied with effective performance, discounting poor performance as due to strategy or task difficulty rather than ability. For example, Bandura (1991) reviews research that suggests self-satisfaction for performance success in complex tasks can serve to increase self-efficacy and increase future on-task effort.

Third, persuading trainees that they have the ability to perform effectively can induce a learning orientation. Meece (1994) emphasizes that trainers can push trainees to adopt learning orientations by instilling the belief that they can accomplish the goals of training. Miller, Behrens, Greene, and Newman (1993) suggest that persistence, positive affect, and self-regulation can be encouraged by increasing trainee self-efficacy. Similarly, Martocchio (1994) demonstrated that training which emphasizes the malleability of ability can increase self-efficacy. In this experiment, increased self-efficacy led to greater learning.

In summary, the way trainees are oriented toward training can influence their self-regulatory processing. Sometimes by design, and often inadvertently, training systems and trainers create a press toward performance rather than an orientation toward learning. The literature indicates, however, that a mastery or learning orientation is more

effective for enhancing skill acquisition for complex tasks. Selected ALS principles relevant to trainee orientation are shown in Table 5.

Insert Table 5 about here

Self-Regulatory System

Overview

From a training perspective, the self-regulatory system can be conceptualized as possessing three components. These components -- practice behaviors, self-monitoring, and self-evaluation / reactions -- map onto those behavioral, cognitive, and affective aspects of performance that trainees regulate throughout the learning process. This conceptualization allows us to attend to all those domains in which trainee self-regulation might reasonably be expected to impact training outcomes.

While a trichotomization of self-regulation is useful, it must be kept in mind that the dimensions are not completely separable. "Doing," "thinking," and "feeling" all affect each other and we are not asserting that any one has primacy. All three are engaged concurrently, such that whenever a trainee has an experience which stimulates her to practice more, she will simultaneously become more cognizant of and reflective about her practice behaviors, and will likely experience some change in her efficacy as the result of task experience.

In its broadest sense, the self-regulatory system is likely greater than the sum of its parts. However, we must study the parts in order to make meaningful assertions about the learning-related consequences of self-regulatory activities, and ultimately how we can leverage different aspects of this activity to attain particular outcomes. With that in mind, we turn our attention to the three components of the self-regulatory system.

Although self-regulation has been recognized as crucial in the educational and instructional design literatures for years (e.g., Flavell, 1979), it is only recently that its applicability to the organizational training literature has been noted (e.g., Gist & Mitchell, 1992; Kanfer & Ackerman, 1989). For the purposes of training, self-regulation can be divided into three general domains: *practice*, the behaviors individuals engage in during training to improve their skills; *self-monitoring*, the focus of cognitive attention and effort, and the reflection on one's progress toward desired objectives as part of the skill-building process; and *self-evaluation / reactions*, which includes the affective, emotional, and motivational consequences self-regulation. The literature on each of these will be reviewed to clarify their relevance to instructional design, and the effects of each on critical training outcomes as well as the overlap of each with the other two components will be discussed.

Practice

Within the training context, one of the most obvious tools available to trainers is practice. Practice is central in simulation-based training, since having trainees practice the skills that are the target of training serves the purpose of making the skills more "real" to the trainees, rather than leaving them in the abstract, lecture-based domain. Practice also gives trainees the opportunity to learn the links among the goal, the situation, and the appropriate action, provided the task environment is informative (Ohllson, 1996). The benefits of practice are numerous, and a few findings from the literature bear particular note. Practice increases transfer performance (Goska & Ackerman, 1996) and allows the trainee to develop automaticity on consistent aspects of the task, which thereby frees up attentional resources (Lord & Levy, 1994). As a result, trainees can do more things and handle more difficult situations than they might have otherwise. Finally, depending on the type of practice encouraged, it can increase the retention of information from training (Hastie, 1984), can increase persistence (Forsterling, 1985), and can increase the positive affect of trainees (Carver & Scheier, 1990).

It should be clear that practice is important. The question then becomes, what specific recommendations with respect to practice and self-regulation can be identified from the literature? One area in which the literature makes recommendations with respect to trainees' practice behaviors is that involving hypothesis-testing and error-making. Frese and Altmann (1989), for example, put forth the notion that trainees should be encouraged to actively develop their own hypotheses and explore different problem solutions during training. Engaging in this type of hypothesis-testing activity during practice presumably engages the trainees more fully in the task domain, thereby making the lessons more salient.

Moreover, an orientation toward experimentation on the part of trainees is evident in the literature recommending the use of errors as practice tools. Errors are discussed at great length in other sections of this report, but some findings are of particular relevant to our discussion of practice. For instance, Lord & Levy (1994) put forth the counterintuitive notion that trainees should be encouraged to make errors during training, as these stimulate and enhance learning. Frese and Altmann (1989) echo this recommendation, and further specify that errors may be most effective as learning tools if they occur near the middle of the training process. In that way, the trainees are not overwhelmed with information, but still have a chance to practice error management strategies.

Ivancic and Hesketh (1995) add an important caveat to the literature on errors. Building errors into training, they claim, is only beneficial if the goal of training is the development of problem-solving or hypothesis-testing skill, in which case the errors facilitate transfer. In cases where procedural skills are being trained, the use of errors is less advisable as it can lead to learning of incorrect behaviors.

It may be surprising that most of the design principles relevant to practice behaviors relate to their impact on the self-monitoring / evaluation aspects of self-regulation. The importance of self-monitoring becomes clear when we realize the following: When trainees are encouraged to consider the activities they engage in during practice, and to use their time in practice to actively improve their skills, they undergo a process of active improvement during which their focus on the task is greatest (Smith et al., 1997). We will therefore discuss those principles relevant to self-monitoring first.

The work of Carver and Scheier (1982, 1990) points out the importance of the trainees' focus during practice sessions. If trainees focus on their own behavior while practicing and use their assessments of that behavior as guideposts to help them evaluate whether developmental goals are being met, they will become more generally efficient at self-regulation (Carver & Scheier, 1982; Karoly, 1993). Practice can be further enhanced by asking the trainee to make judgments of learning, which can help trainees determine which practice behaviors might be most beneficial (Nelson, Dunlosky, Graf, & Narnes, 1994). Monitoring activity can be taken a step further during practice; trainees can be instructed, as part of their practice regimen, to visualize possible courses of action that represent positive behavior scenarios. This can lead to positive expectancies with respect to the task as well as increase positive affect (Carver & Scheier, 1990).

Turning our attention to the impacts of practice on the self-reactions domain (self-efficacy and attributions), Martocchio and Webster (1992) discuss an interesting issue in their work on cognitive playfulness among trainees. Trainees who approach their tasks with a cognitively "playful" attitude, under which they are willing to experiment with the task situation and "play" with it, tend to perform better on the training task than those who lack such an attitude. Practice behaviors can also be driven by the attributions trainees make during training. Hastie (1984) tells us that the processing and retention of critical information are increased if trainees make attributions about their own behavior while practicing. Along the same lines, Forsterling (1985) suggests that teaching proper attributional techniques, with respect to the causes of failure and success, can increase performance on and persistence with the trained task.

Finally, practice allows the trainee time to become familiar with the task domain, which can help them avoid potentially maladaptive efficacy-performance spirals. In such a situation, due to a lack of familiarity with the task, the trainee performs badly, his self-efficacy goes down and he becomes demotivated, and he subsequently performs even worse reifying the downward spiral (Lindsley et al., 1995). Selected ALS principles relevant to practice are illustrated in Table 6.

Insert Table 6 about here

Practice is the behavioral element of the self-regulation system, yet as we have seen, it is difficult to separate operationally from affective self-regulation (practicing making appropriate attributions) and cognitive self-regulation (monitoring behavior and evaluating progress). When we tell individuals to practice doing either of these, we are asking them to engage in a behavior, so that the primary impact of such a manipulation will be behavioral. This serves to highlight the warning we gave earlier: Whenever a manipulation targets the self-regulation system, we must be certain that the primary impact will occur in the appropriate domain. It is very easy to imagine a training program designed to increase self-monitoring which simply increases the amount of practice and doesn't provide any new skills

with respect to monitoring the self. How can we best train self-monitoring? This is an issue we take up in the next section.

Self-Monitoring

Self-monitoring is the cognitive component of the self-regulation system. It involves the allocation of attentional resources to a task (in this instance, to the training task) and to tracking discrepancies between current performance and goals, as well as the capacity to continually determine whether one's learning strategy is appropriate and, if not, how to change it. The literature on self-monitoring has burgeoned in recent years as the self-regulation system has come to be viewed as increasingly central to understanding learning, motivation, and performance. Self-monitoring is viewed as the central element of self-regulation (Karoly, 1993). Not surprisingly, the literature supports this position based on the finding that self-monitoring does, in fact, increase self-regulatory behaviors (Carver & Scheier, 1982). How can self-monitoring be leveraged to enhance learning and adaptability for complex tasks? We first examine the direct impacts of self-monitoring on training outcomes, and then consider its relationship with other self-regulation components, particularly self-evaluation.

Flavell (1979) asserted the notion that instruction in cognitive monitoring skills would help individuals not only to learn better -- because of the increased attention they pay to their own cognition -- but also to perform better in complex task environments. This basic idea has been expanded by more recent research. For example, Carver and Scheier (1990) note the importance of monitoring not only the behaviors individuals perform, but the progress they make toward their goals. It makes little sense, after all, to believe that individuals will learn better if they observe only static elements of their behavior, instead of paying attention to their own development and using that development to guide their future activities.

Such monitoring requires attentional resources, as many researchers have pointed out. Ivancic and Hesketh (1995) note that some forms of monitoring are only appropriate once individuals have sufficient attentional capacity to reflect on and learn from their experiences. This reiterates Kuhl and Koch's (1984) finding that self-monitoring activities should be discouraged early in training if learning and performance are to be maximized. Kanfer and Stevenson (1985) went a step further, pointing out that the extent to which self-monitoring interfered with future learning and performance might be dependent on the complexity of the task, with more complex tasks producing greater interference. Kanfer and Ackerman (1989) provide some evidence to support this notion, noting that early in training much of the critical development is in the form of building a declarative knowledge base; self-monitoring activities seem much more relevant and less intrusive after declarative knowledge has been developed.

All of these variables together -- the timing of self-monitoring, the sequencing of the training, and the complexity of the material to be learned -- determine the effectiveness of self-monitoring. Therefore, the process of teaching trainees to self-monitor should not be taken lightly. When trainees are instructed to do so, it is critical that the monitoring not only be appropriate for their stage of cognitive development with respect to training, but also that their self-monitoring activities be evaluated to ensure that they are monitoring the proper aspects of their behavior and reaching the proper conclusions (Goska & Ackerman, 1996). One area in which such concerns are especially salient centers around the goals of training.

In considering goals, several factors have potential influence on the occurrence and utility of self-monitoring. For instance, the adoption of a learning goal has been found to increase self-monitoring behaviors (Ames & Archer, 1988). This should come as no surprise, since the essence of the learning goal encourages the continual monitoring of the trainee's progress toward mastering the material.

Bandura (1991) provides some interesting material with respect to goals and self-monitoring. For instance, he points out that encouraging self-monitoring can lead trainees to set progressive goals for performance improvement. He also notes that goals which are set too high can lead to dysfunction in the self-regulation system. This is thought to occur because of the dissonance brought about by the act of setting goals that are based on monitoring of one's performance and then not successfully reaching those goals. This interaction between goals and self-monitoring keeps the impact of goals from being as clear-cut as might otherwise be the case, but the recommendations from the literature still make it possible to design training that uses both goals and self-monitoring to their fullest effect.

Other variables must be taken into account as well when considering the interaction of goals and monitoring. The ability of trainees to self-set goals may allow their attention to be more easily maintained (Lord & Levy, 1994), thereby increasing their capacity to self-monitor. Characteristics of the task may also influence the effectiveness and utility of self-monitoring. For maximally beneficial monitoring, proximal, difficult goals should be used (Schunk, 1990), with easy goals offered early in training and more challenging goals offered later in training (Bandura & Wood, 1989). As with issues of attentional resources, the use of goals and their impacts on the self-monitoring portion of the self-regulatory process are complex. The selected principles for self-monitoring included in Table 6 represent one way to approach these complex issues.

The development and use of strategies within the training context may represent the pinnacle of self-monitoring behaviors. Individuals who are capable of understanding the task to such a degree that they can develop task strategies, implement those strategies, evaluate their strategies, and finally alter their strategies to better fit the requirements of the task are undoubtedly those who will be able to best adapt the skills gained in training to the transfer environment. Not only does strategy use allow for more efficient implementation of procedural skills, it has also been shown to be a critical factor in maximizing on-task learning (Pintrich & DeGroot, 1990).

Not surprisingly, strategy development and use is intricately tied to training goals. The work of Earley and colleagues has made this relationship very clear. Earley, Wojnaroki, and Prest (1987) found that providing specific goals increases the amount of planning activity (strategizing) that goes into the task, in order to improve performance. Expanding on this notion, Earley, Northcraft, Lee, and Lituchy (1990) found that the provision of challenging, specific goals promoted higher quality strategy use and performance when combined with specific feedback. Their most specific finding was that if the development and use of strategies are one of the goals of training, then specific goals and specific feedback provide the most direct and powerful way to improve strategies. However, Earley, Lee, and Hanson (1990) found that if a task has highly complex components, it may be beneficial to withhold goals from trainees until after effective strategies have been developed. For integrated-embedded training, then, it may be most useful to allow individuals a chance to practice with novel task scenarios and develop some strategies prior to giving them the specific goals and specific feedback that will allow them to tailor their strategies to their most effective level.

The main issues with respect to self-monitoring seem to be (1) trainees' limited attentional resources, (2) characteristics of the goals and the goal situation the trainees are faced with, and (3) the extent to which trainees develop and use strategies. These are primarily cognitive issues, and as we already noted the relationship between cognitive and behavioral components of the self-regulatory system, we must now note the relationship between the cognitive and affective subsystems.

The relationship between self-monitoring and self-evaluation -- the affective, emotional, motivational aspects of the self-regulatory system -- is complex. Bandura (1991) found that self-monitoring activities were most effective when trainees had high self-efficacy for the task. Harris (1990), on the other hand, found that self-monitoring could be used to improve self-efficacy, and Miller et al. (1993) found that levels of self-monitoring can be raised by encouraging high self-efficacy among trainees. The fact that these subsystems interact in such a complicated manner has been noted as potentially problematic in the literature (e.g., Mitchell, Hopper, Daniels, George-Falvy, & James, 1994). The tie between the cognitive and affective domains is further strengthened by Russell and McAuley (1986), whose work on attributions demonstrates a link between the way trainees think about their training experiences and the affective or evaluative reactions they have to them. More consideration of attributions, as well as other evaluative domains, is made in the next section of this paper.

Self-Evaluation / Reaction

As was mentioned at the outset of this section, there should be no implied primacy among the three components of the self-regulation system. Self-efficacy and causal attributions -- the two primary aspects of what we define as self-evaluation and self-reaction -- are just as important to effective self-regulation during training as are self-monitoring and practice, though each will be important at different points in the training process and may be targeted by different types of training interventions. In fact, Mitchell et al. (1994) point out that the importance of self-efficacy itself will vary across times within training, being most important at the early stages of training and less so as training progresses.

The literature makes it clear that self-efficacy and attributions are important to self-regulatory processes. We first review the evidence for the importance of self-efficacy and attributions to the self-regulation system, then discuss

how to raise self-efficacy, and conclude with a discussion of how to encourage attributions that sustain efficacy and persistence in the training environment. Selected principles relevant to self-evaluation are shown in Table 6.

The case for the importance of self-efficacy is made most succinctly by Kanfer and Ackerman (1989), who note that the presence of task-relevant self-efficacy is absolutely essential if self-regulatory activities are to be engaged or maintained. Miller et al. (1993) echo this finding, reporting that self-regulation can be increased by encouraging high self-efficacy among trainees. While the Miller and colleagues study focuses primarily on post-training self-regulation, it is reasonable to expect manipulations designed to increase self-efficacy during training would have the same impact on self-regulation during training that the authors reported post-training. In fact (and as was mentioned earlier), Bandura (1991) offers a replication of the finding that increasing self-efficacy increases self-regulation.

The importance of attributions to self-regulation is similarly established. Martocchio and Dulebohn (1994) report that attributions about past experiences can have an impact on trainee expectations for success and failures, which could reasonably be expected to impact the quality and quantity of self-regulation they engage in relevant to training. As such, the authors suggest that attributional retraining may be needed, presumably to prevent inappropriate self-regulations from taking place. Hastie (1984) also points out that the likelihood trainees will process and retain information from training will depend in part on the attributions they make relevant to their training experiences.

Raising self-efficacy. With the importance of efficacy and attributions to the self-regulation system thus established, we now turn our attention to the question of how to raise trainee self-efficacy. Bandura and Wood (1989) offer two methods by which self-efficacy may be raised. The first, providing trainees with easy goals, has the benefit of not requiring a great deal of attentional resources, thereby allowing trainees to spend their time developing effective strategies. More useful, perhaps, is teaching trainees that they have control over their performance in training, since success in an environment where they perceive themselves in control will obviously increase their sense of self-efficacy.

Schunk (1990) recommends using different aspects of the training environment to influence self-efficacy. Goals should be proximal in order for self-efficacy to be built with respect to the task, as distal goals make it too difficult for the trainee to see the relationship between his or her behavior and the ultimate outcome. Stock and Cervone (1990) agree that goals should be proximal, but recommend breaking goals down into proximal subgoals to better enable their completion.

In addition, Schunk (1990) argues that goals should be specific, to allow the trainees to have a solid referent when they make later efficacy judgments. The question "Did I do what I was supposed to?" is much easier to answer if the goal is specific than when the goal is nebulous. Winters and Latham (1996) support this finding, noting that specific goals increase the use of task strategies in addition to raising self-efficacy. Finally, as was discussed earlier in the section on Information Provision, Schunk (1990) puts forth the notion that feedback should be provided if self-efficacy is to be built, since without some feedback about performance it is impossible for the trainee to make judgments regarding his or her capability to perform the trained task. Karoly (1993) notes that feedback has the added benefit for participants already high in self-efficacy of increasing the effort they are willing to expend on the training task.

Gist and Mitchell (1992) note several ways to enhance self-efficacy that differ from the somewhat micro-level concerns voiced above. First, they argue that trainees need as much information as they can get about the task to ensure maximum efficacy. The more information that is available to trainees, the better they will be able to gauge their progress on the task. Second, Gist and Mitchell argue that if self-efficacy for the task is a critical outcome of training, the training should be designed with care to tap all the requisite knowledge, skills, and abilities for the task; if any are left out, trainees will note the deficiencies and blame themselves when such blame may not be wholly appropriate. A final concern Gist and Mitchell voice is that trainees who are supposed to build self-efficacy on the task be given information in training that improves their understanding of the behavioral, analytical, or psychological performance strategies for the task. Here again, we see the link among the components of the self-regulation system.

A final set of recommendations for raising self-efficacy deals directly with the affective experience of training for the trainees. Carver and Scheier (1990) recommend that trainees be taught to engage in "positive visualizations" about the task, in order to increase their self-efficacy. Efficacy is built in this manner by setting up

positive expectancies and general positive affect with respect to the task. Quiñones (1995) makes a similar recommendation, noting that it is possible to boost trainee self-efficacy by framing training as "advanced" -- that is, training designed to further existing skills. It should be clear that trainees who leave training believing they have gained "advanced" skills will report higher self-efficacy than will those who believe they have gained only basic competencies with the task.

Encouraging attributions. Encouraging appropriate attributions is also important with respect to the affective aspects of the self-regulatory system, since the attributions trainees make about the causes of their performance can impact what they attend to, what they practice, and how motivated they are for future training and transfer sessions. The principles relevant to attributions are fairly simple, but their importance cannot be overemphasized.

Forsterling (1985) recommends that in order to maintain motivation, trainees should be taught to attribute causes of failure to unstable, external, or controllable causes. A fine line must be drawn here, as too many external attributions may lead the trainee to a condition of learned helplessness in which he or she does not believe anything can be done to prevent failure. One way to deal with this issue is broached by Ivancic and Hesketh (1995), who recommend attributing the causes of failure to unstable situational influences. Because situational influences vary significantly, learned helplessness is an unlikely response unless the same failure conditions are found across a variety of situations. The reader will note that these issues are important in light of the literature on error-based training which was reviewed earlier.

A final way to deal with failure attributions is put forth by Thomas and Mathieu (1994), who note that the external causes of failure should not only be treated as variable, but also as things that the trainee can overcome. In this way, changes in self-efficacy as a result of failure will be minimized, as the trainee is being told, "You didn't succeed because of something out of your control -- but with further training, you can handle situations like this just fine."

Leveraging Self-Regulation Through Training

Our model conceptualizes a Training Strategy as an intervention that is created through the combination of training components (Training Design, Information Provision, and Trainee Orientation; see Figure 1). By combining different aspects of these components, the training system and trainer can influence different aspects of the self-regulatory system.

Initially, several linkages should be obvious. Training and simulation design characteristics, for example, should most strongly affect practice behaviors, since the design of the task will directly influence what behaviors are required by the task. Similarly, the information provided to trainees should have its most direct impact on the self-monitoring (cognitive) portion of the self-regulatory system, and the trainee orientation (motivation) variables should be most directly relevant to efficacy and attributions, the evaluative and affective portion of the self-regulatory system.

What is less apparent is what we have tried to make explicit throughout this section. Impacts of a training component on any given part of the self-regulatory system will never be solely on a single aspect of self-regulation. Training design elements (such as the sequencing of the material presented) will direct what behaviors the trainee practices, but will also affect what cognitive processes he or she monitors (by directing attention) and should also be expected to affect self-efficacy (by providing direction in skill building which the trainee can use to gauge his progress). However, the self-regulatory activities that are not directly in line with the training component are going to be less focal to the trainee, and will not constitute a substantial portion of his or her self-regulatory activities. We can therefore use the training components as levers to engage the self-regulatory process, in that they have the potential to guide which type of self-regulatory activity becomes the trainees' primary focus. Combinations of training components, then, can be designed such that multiple aspects of the self-regulatory system are called into play, which has the potential to create more active, aware, and reflective learners.

A caveat must be noted, however, with respect to combinations of training components. The complementarity of the components must be ensured, or problems in the self-regulatory system may result. By complementarity, we simply mean that the training components must be consistent with one another, and not lead to conflicting or contradictory types of self-regulatory processes within the three domains of self-regulation.

Training Outcomes

Traditional methods of designing training systems use a behaviorist approach that emphasizes correct performance. In fact, training programs often place too much emphasis on achieving performance-related goals (Farr et al., 1993). This focus on producing observable improvements in behavior has led to a narrow conceptualization of learning and training outcomes (Ford & Kraiger, 1995). We take an explicitly multi-dimensional perspective (Kraiger, Ford, & Salas, 1993), identifying differences between learning and performance-oriented training outcomes which are proximal to completing training, and between these proximal outcomes and more distal transfer outcomes such as retention and adaptation.

Proximal outcomes. Proximal training outcomes are learning outcomes that arise directly from training and are exhibited immediately at its completion. These outcomes can be broadly divided into two categories: (1) Learning, and (2) Performance. The differences between these two reflect a basic distinction between more abstract cognitive indicators of learning and behavioral manifestations of that learning.

Learning outcomes include the cognitive outcomes of declarative knowledge, procedural knowledge, strategic knowledge, and knowledge structure suggested by Ford & Kraiger (1995) and Kraiger et al. (1993). Ford and Kraiger (1995) learning outcomes as beginning with basic factual or declarative knowledge (what), which is then organized and compiled into procedural knowledge (how), and then with greater experience becomes strategic knowledge (which, when, and why). *Declarative knowledge* represents comprehension of basic task features and concepts, and is a prerequisite for skilled performance. *Procedural knowledge* is the knowledge of how to perform critical tasks. While procedural knowledge is often considered to be directly reflected in successful performance outcomes, there are abstracted measures available which assess whether key portions of a skill have been successfully learned (e.g., Royer, Carlo, Dufresne, & Mestre, 1996). These abstract manifestations of skill should be distinguished from actual performance, which is measured and defined by the nature of the task rather than by the component skills to be learned. *Strategic knowledge* represents the knowledge necessary for situational assessment, prioritization, and trade-offs. Finally, *knowledge structure* reflects trainees' awareness of the links among important task features and outcomes. Knowledge structure has been associated with expert-novice differences, with experts possessing more stable and coherent structures (e.g., Schvaneveldt, 1990). Knowledge structure has been treated as a form of mental model representation.

Performance is the ability to successfully complete the behavioral requirements outlined by training objectives. We have found it useful to distinguish between basic performance and strategic performance. *Basic performance* captures the information processing and decision making aspects of the task domain. These aspects of performance are essential foundation elements of successful performance, but they are also superficial and routine aspects of the task domain. *Strategic performance* involves the more complex behavioral routines that underlie adaptability to the dynamics of DDM task environments. Thus, strategic performance is a broader construct that encompasses situational awareness, prioritization of actions, and the implementation of task strategies.

Distal outcomes. Each of the outcomes explained above is expected to affect a trainee's ability to use trained skills on tasks that occur following training. Transfer from training settings back to work settings is characterized by the dimensions of maintenance and generalization (Baldwin & Ford, 1988). *Retention* refers to the maintenance of learning outcomes over time, and is a prerequisite to transfer. For the purposes of integrated-embedded training that occurs in settings that are similar if not identical to the performance settings, generalizability refers to the *adaptability* of skills to new configurations of environmental stimuli rather than to new settings (Kozlowski, 1998; Kozlowski, Gully, Nason, & Smith, 1999). *We conceptualize adaptability as the generalization of trained knowledge and skills to new, more difficult, and more complex task situations.*

RESEARCH IMPLICATIONS AND DIRECTIONS

Our conceptual model provides multiple avenues for training research that has the goal of developing adaptive capabilities. Based on our literature review and on our research on complex skill acquisition, we can identify Training Design and Trainee Orientation components that we believe exhibit high promise and should be included in the construction of interventions. For Training Design, theory and research are clear that the complexity of knowledge and skills to which trainees are exposed should be sequenced, and that training experiences should vary in complexity. Thus, sequencing and variability of complexity (Wood, 1986) are key Training Design components in our research. For Trainee Orientation, performance and mastery training frames, in combination with training goals, have been

shown to have differential effects on the practice, self-monitoring, and self-evaluation / reactions aspects of the SRS. Thus, training goals are examined as an integral aspect of our training strategy. Our research indicates that interventions representing the combination of these Training Components enhances the quality of practice, self-monitoring, and self-evaluation / reaction (Bell, Mullins, Toney, & Kozlowski, 1999; Brown & Kozlowski, 1997; Brown, Mullins, Weissbein, Toney, & Kozlowski, 1997; Kozlowski et al., 1995; 1996; Mullins, Brown, Toney, Weissbein, & Kozlowski, 1998; Mullins, Kozlowski, Toney, Brown, Weissbein, & Bell, 1999).

As noted at the onset, we believe that the interpretation properties of feedback provide the most promising new direction for training research. Indeed, improving our scientific knowledge of how to best employ the information provision aspects of advanced technology systems is critical to integrated-embedded training design. Thus, this Training Component comprises the primary focus of new research. A brief overview of the directions for new research is provided below.

Sequenced descriptive feedback and goal-feedback consistency. Principles of training design generally assume that descriptive feedback should be specific, accurate, frequent, consistent, and process oriented. The next generation of advanced systems will be able to deliver descriptive feedback with these properties in prodigious amounts. The questions are: what information, how much of it, and in what sequence? For example, too much descriptive feedback may limit attentional resources needed for learning, diverting it to less important aspects of performance (Schmidt & Bjork, 1992), and may overwhelm the trainee with a mass of raw information. In contrast, more limited descriptive feedback that is sequenced to match current levels of skill development may better focus trainee attention on more proximal and attainable learning goals, thereby enhancing self-regulation that leads to skill acquisition (Stock & Cervone, 1992). Which is the better way to manage the provision of descriptive feedback? Furthermore, feedback is likely to be most useful when coupled with appropriate instructional objectives. Thus, this effect is likely to be enhanced when sequenced feedback is consistent with mastery versus performance instructional goals; that is, goals that emphasize learning objectives versus goals that emphasize achieving specific performance levels.

> ***Proposition 1a:*** **Sequenced mastery feedback will enhance learning, performance, and adaptability when coupled with mastery goals. The effects of coupling mastery feedback with performance goals are unclear. Sequenced mastery feedback may shift attention away from performance goals toward mastery goals, enhancing learning, or they may interfere with learning, thereby adversely affecting training performance and transfer.**

> ***Proposition 1b:*** **Sequenced performance feedback will boost training performance when coupled with performance goals. Such feedback is generally expected to be less effective for trainees given mastery goals, although prior research indicates that mastery goals coupled with performance feedback is an effective training strategy.**

Evaluative feedback. Positive evaluative feedback tends to build self-efficacy (Karl et al., 1993), which leads to the setting of higher goals and increased trainee self-regulation (Bandura, 1991), as well as to motivation toward performance improvement (Bandura & Cervone, 1983). Negative evaluative feedback, tends to undermine self-efficacy (Karl et al., 1993), thereby leading to reduced effort and performance (Karoly, 1993). These effects have prompted some to suggest that training should always provide positive evaluative feedback to prevent negative outcomes. However, the effects may be more complex. Too much positive feedback can raise self-efficacy so much that it may actually hinder learning. That is, when self-efficacy is "artificially boosted" by positive feedback trainees may conclude that they have mastered the material and may reduce attention and effort before they have actually done so. Thus, feedback that is consistently positive may cause trainees to miscalibrate their mastery of the task domain and reduce their self-regulation prematurely.

Our model suggests that moderate negative discrepancies are most effective for prompting self-regulation and motivation once trainees have acquired basic task knowledge. Thus, we propose that positive feedback will be most useful very early in skill acquisition when trainees have yet to master basic task information. By providing positive feedback early when the trainee makes many simple errors, efficacy is boosted and motivation is maintained. As trainees master basic aspects of the task domain, the greater effort needed to learn more complex aspects of the task can be enhanced by moderately negative feedback. At this point, their self-efficacy will provide resilience to the potentially detrimental effects of negative feedback, while the discrepancy between the training goal and current

proficiency will prompt attention and effort. This suggests that evaluative feedback should be sequenced from moderately positive to moderately negative across the skill acquisition process (Toney & Kozlowski, 1999).

> ***Proposition 2:*** **Positive evaluative feedback during early skill acquisition that transitions to moderately negative feedback in later acquisition will promote better self-regulation, learning, and performance than feedback that is consistently positive or negative.**

Attribution. Research indicates that trainee attributions of causality can have impacts on their affective states, future expectations, and the behaviors they engage in during training (Forsterling, 1985; Curtis, 1992). In general, when good performance is attributed to oneself, motivation, learning, and performance improve over time. When bad performance is attributed to oneself, the effects are negative. Indeed, in order to protect the self, bad performance is more often attributed to external, stable, and uncontrollable factors, justifying withdrawal from the task. Attributional interpretations occur naturally. Because complex tasks engender many trainee errors, particularly early in skill acquisition, uncontrolled attributional processes have the potential to undermine self-regulation, learning, and performance.

From a ALS training perspective, trainees whose causal attributions that are internal, malleable, and controllable, will exhibit better learning and performance than trainees whose causal attributions are external, stable, and uncontrollable. Moreover, attributions interact with evaluative feedback. Internal attributions accompanied by positive feedback will result in better learning and performance than internal attributions associated with negative feedback. Finally, trainees will tend to make many more errors early in training, and relatively fewer after they have acquired basic skills. Thus, external attributions (e.g., task difficulty) early in training when feedback is mostly negative can protect the self, whereas internal attributions later in training (e.g., ability, effort, task strategies) can enhance the motivation to improve performance.

> ***Proposition 3:*** **Early in skill acquisition, attributional feedback should be external, stable, and uncontrollable (e.g., task difficulty). As basic skills are acquired, attributional feedback should shift to internal, malleable, and controllable in order to promote learning and performance.**

Guidance. Feedback is informative about past behavior, but is not diagnostic about what the trainee should do, think, or feel next. Indeed, it is a major challenge for trainees is to figure out what sort of practice behavior, metacognition, and emotional control is most appropriate for improvement. Intelligent tutors and other adaptive algorithms that attempt to monitor trainee development and guide the next steps in the learning process have demonstrated potential to enhance learning for *static* knowledge domains. For example, when left on their own to interpret how much more practice was needed to memorize information, trainees tended to terminate practice prematurely (Tennyson, 1980; Tennyson, 1981). On the other hand, the literature also suggests that many "adaptive algorithms" are relatively simplistic. The programs merely exhort the trainee to practice more, relative to trainees who have control over their practice time. The trainees who practice more, do learn more, but do so inefficiently (Tennyson, 1980; Tennyson, 1981). Moreover, there is little theoretical or practical gain from the finding that more practice yields better learning.

Embedded adaptive guidance orients the trainee toward what to *think* about next (self-monitoring of attention during study and practice), and what to *do* next (behavioral practice). This intervention combines the cognitive and behavioral aspects of guidance, as it is virtually impossible to influence one without also influencing the other. As the trainee masters basic knowledge and skills, the guidance adapts to their level of acquisition and instructs them to focus attention and effort on increasingly advanced knowledge and skills in the task domain. Embedded adaptive guidance is intended to influence the focus of trainee attention and relevance of practice behavior. Thus, this form of guidance is not intended to get the trainee to practice *more*, rather it is intended to get the trainee to practice *better*.

Our model also suggests that affective guidance may complement the instructional effects of cognitive/behavioral guidance. One of the primary challenges of training design for complex tasks is that trainees often perform poorly during the initial stages of skill acquisition. Performance that fails to meet the trainee's -- often unrealistic -- expectations undermines self-evaluations, and can ultimately lead to significant reductions in motivation to learn (Bandura, 1991; Kanfer & Ackerman, 1989). Affective guidance is expected to help trainees to maintain emotional control and to bolster self-evaluations in the face of early task difficulties. It is not an instructional intervention per se, but rather a support that is intended to work in concert with cognitive/behavioral guidance.

Proposition 4: **Behavioral/cognitive guidance will lead to a more relevant sequencing of individuals' effort and attention (practice and self-monitoring), improve the acquisition of strategic knowledge and performance, and enhance adaptability. Affective guidance will lead to more overall effort and a less withdrawal.**

DISCUSSION

Pushing Training Systems into the Workplace

We began this chapter by noting the convergence of forces -- environmental, technological, and economic -- that are creating both pressures and opportunities to rethink the logic of training system design. Training needs to be able to accomplish more learning, more quickly, more often, more flexibly, and more effectively. The nature of training is changing from a single episode, off-site, inflexible, decontexualized, time and resource intense activity to a multi-episode, flexible, contextualized, time and resource efficient system. It is changing from a focus on learning basic skills and reproducing skills in the workplace to a focus on learning basic, strategic, and adaptive skills that generalize beyond training (Kozlowski, 1998). The key to this shift in the nature of training is the enhanced capability to build training into the workplace; to *integrate* it into the work context and *embed* it in work technology. This capability is predicated on advanced computer technologies and connectivity.

Our purpose is to promote this revolution in training through the development of a theoretically based and practically relevant model that can guide the application of these technologically based training capabilities. The simple fact of the matter is that we have many potentially useful instructional tools available, and relatively few well-developed instructional models to guide their combination and application in this training revolution. The purpose of our model is to fill that gap.

Theoretical Contributions

There are two primary theoretical contributions of our approach: (1) The provision of a common theoretical mechanism to integrate the effects of a wide range of instructions tools and techniques; and (2) The provision of a comprehensive conceptual framework to guide the design of training research, application, and evaluation.

Theoretical mechanism. We use a single theoretical mechanism to integrate the effects of a broad range of potential instructional tools and techniques. By providing a common theoretical mechanism for their effects, our model can address the likely effects that accrue from the combination of several constructs or tools. This is particularly important from an applied perspective as well, because training interventions are rarely singular constructs. Training interventions are molar combinations of multiple constructs or tools. Our model provides a conceptual foundation to guide that combination.

The training design literature has traditionally been technique oriented. Many observers have noted this tendency toward faddism; training design has often focused excessive attention on the tools and media that deliver training (e.g., Campbell, 1971; Goldstein, 1980). The remarkable capabilities and features inherent in advanced systems have the potential to fall into the faddism trap. Features like intelligent tutors that can step in to assist the novice in basic comprehension, or intelligent agents that can guide more experienced decision makers to consider all options, or web-based training systems that can be accessed anytime, anyplace, and for anything, are fabulous *tools* -- but they are merely tools with instructional potential. The key is to know how those tools can be systematically combined and applied to accomplish instructional objectives.

The creation of these tools and techniques is linked to the capabilities of technology. The tools in and of themselves do not have common theoretical underpinnings that can guide their application. That is where the model we have developed makes its contribution. It provides a classification for different kinds of training tools and techniques, which can then be located as training design, information provision, or trainee orientation components. More importantly, the model provides a *common theoretical process* for understanding the likely impact of the techniques. Variants of the self-regulation model have proven remarkably useful for guiding research on the basic processes of learning, motivation, and performance. By linking the component categories to critical aspects of the SRS -- practice behavior, self-monitoring, and self-evaluation / reaction -- we provide a common theoretical mechanism for understanding the likely effects of specific instructional constructs or tools, and the expected effects of combining the

tools or constructs into more molar interventions. This is a substantial conceptual advance over the single tool approach that typifies research on training design.

Guiding research, application, and evaluation. The model provides a comprehensive conceptual framework for capturing factors relevant to integrated-embedded training design at the individual level of analysis. That is, the model encompasses the domains of individual differences, training components and strategy, self-regulation, proximal outcomes of learning and performance, and distal outcomes of retention and transfer. Thus, it provides a foundation for understanding the interaction of individual differences with training strategies. This can help guide the development of training strategies that adapt to the abilities and dispositions of the trainee. It provides a foundation for constructing multidimensional training outcomes that are relevant to enhancing the important outcomes of long-term retention and adaptive capabilities. It can guide research, application, and evaluation.

Although our model is intended to be comprehensive, it is focused primarily at the individual level of analysis; self-regulation and the means to influence it are formulated around individual level psychological processes. Additional issues will need to be incorporated into our theoretical framework as we shift attention to the team level, and the unique challenges that accrue when we consider emergent and collective phenomena (Kozlowski & Klein, in press). For example, teams create a context for individual learning and performance, and must be explicitly considered in the design of training systems (Kozlowski & Salas, 1997). Moreover, teams are not necessarily uniform and additive collectives that can be treated as simple aggregates of individuals. Indeed, some theorists assert that teams progress through a developmental process that proceeds across levels -- from individuals, to dyads, to the team network -- as well as time (Kozlowski et al., 1999). Although we have not explicitly incorporated team level considerations in the current model, other theoretical work provides a basis for extending key aspects of our conceptualization to the team level (Kozlowski, Gully, McHugh, Salas, & Cannon-Bowers, 1996; Kozlowski, Gully, Salas, & Cannon-Bowers, 1996; Kozlowski et al., 1999). Moreover, theory and research to extend key aspects of the model to the team level is currently underway (DeShon, Milner, Kozlowski, Toney, Schmidt, Wiechmann, & Davis, 1999; Kozlowski & DeShon, 1997).

Summary and Conclusion

The ALS is a theoretically driven approach to the design of integrated-embedded training systems that is highly flexible and offers ease of implementation. It operates by exerting leverage on foci of the self-regulation system, which recent research has demonstrated to be central to learning and performance for difficult, complex, and dynamic tasks. The training strategy incorporated in the ALS constructs instructional interventions by combining specific training components that affect different aspects of the SRS. By designing synergistic combinations, instructional interventions can be tailored to the developmental progress of trainees and can enhance learning, performance, and adaptability.

Our research will target those training components that offer the greatest practical and theoretical potential for improving complex skill acquisition, and the enhancement of adaptive capabilities. By building on existing principles of training design (e.g., mastery goals, sequencing), and examining promising new ideas (e.g., information, interpretation) that are likely to be key capabilities of the next generation of advanced technology systems, the research is expected to yield new principles of training design uniquely suited for the design of integrated-embedded training systems.

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Table 1. ALS Design Principles: Cognitive Abilities and Skills

Citation	Principle
	Cognitive Ability
Bandura (1991) Dweck (1986)	Trainees should be encouraged to believe cognitive ability is a skill that can be developed to better maintain motivation and more likely adopt mastery goals.
Ivancic & Hesketh (1995)	High ability trainees should be encouraged to make errors during training, as they have the attentional capacity to reflect on and learn from them.
Kanfer (1996)	High ability trainees should be provided with motivation control skill training later in training to maintain high performance levels when the task becomes less challenging.
	Low ability trainees should be provided with emotional control skill training early in training to prevent interference of on-task effort from negative thoughts.
Kanfer & Ackerman (1989)	High ability trainees should be encouraged to engage in self-regulatory activities to improve performance, because they have more attentional resources to devote to both task performance and self-regulation.
	Low ability trainees should be encouraged to engage in goal-setting activities later in training to improve performance.
Podsakoff & Farh (1989)	Trainees of both high ability and high self-efficacy should be provided with negative feedback to improve performance.
Ree & Earles (1992)	Trainees should be chosen on the basis of their cognitive ability, because general cognitive ability is a better predictor of training performance than specific abilities such as metacognitve ability.
	Metacognitive Skills
Garcia & Pintrich (1994)	Trainees should be encouraged to become aware of their own knowledge and strategies in both motivational and cognitive domains to improve performance and transfer.
Swanson (1990)	Trainees should be encouraged to develop metacognitive skills, because metacognitive skills are a better predictor of training performance than general cognitive ability.
Ford et al. (1998)	Trainees should be encouraged to develop metacognitive skills, because their use during training will enhance learning, performance, and self-efficacy.

Table 2. Training Design Principles: Trainee Motives and Dispositions

Citation	Principle
	Mastery/Performance Orientation
Archer (1994)	Trainees with high mastery orientations rather than high performance orientations should be chosen for training if trainees need to be highly motivated prior to beginning the training.
Boyle & Klimoski (1996)	Trainees with high performance orientations should be pushed to adopt mastery goals during training, to acquire more declarative knowledge.
Duda & Nicholls (1992)	Trainees with high mastery orientations should be chosen for training if one of the goals of training is to increase collaboration among trainees.
Ivancic & Hesketh (1995)	Trainees with high performance orientations (or entity views of intelligence) should not be provided with error-filled training because they are less capable at handling negative feedback.
	Trait Self-Efficacy
Karoly (1993)	Trainees with high self-efficacy should be given feedback, particularly when performing poorly, as they will be likely to increase their effort.
Mathieu et al. (1993)	Trainees with high self-efficacy at the outset of training are likely to maintain high levels of efficacy throughout the training.
	Locus of Control
Noe & Schmitt (1986)	Trainees with an internal locus of control are likely to maintain motivation throughout training.

Table 3. ALS Design Principles: Information Provision (Feedback)

Citation	Principle
	Information Properties
Anderson (1987)	Feedback about errors should be provided immediately if the goal is to develop rapidly a strong procedural knowledge base; Feedback about errors should be withheld if the goal is to prompt learning of how to identify and handle errors.
Earley et al. (1990) Wofford & Goodwin (1990)	Feedback about strategies and practice behaviors should be specific, particularly when feedback is negative, to facilitate the acquisition, practice, and improvement of appropriate strategies and behaviors. Specificity will avoid ineffective strategy or behavioral changes.
Gist & Mitchell (1992)	Feedback should be provided frequently to facilitate the development of self-efficacy during training for a complex task.
Lindsley et al. (1995) Podsakoff & Farh (1989)	Feedback about training performance should be accurate and credible, regardless of the positive or negative sign of that feedback, to facilitate long-term development of self-efficacy and competency.
	Interpretation Properties
	Evaluation
Bandura & Cervone (1983)	Trainees should be encouraged to believe (whenever possible) that substantial negative performance discrepancies are moderate discrepancies, to maintain effort and avoid goal abandonment.
Field (1996)	Normative feedback should not be provided to low ability trainees during early stages of skill acquisition, to avoid decreasing self-efficacy and increasing negative self-reactions.
Karl et al. (1993)	Positive performance feedback should be provided to increase self-efficacy of trainees.
Karoly (1993) Waldersee & Luthans (1994)	Negative evaluation (or corrective) feedback should not be provided to trainees learning a complex task, to avoid reductions in effort and performance; Positive evaluation feedback should not be provided to trainees learning a simple task, to avoid decreases in effort and performance.
	Attribution
Martocchio & Dulebohn (1994)	Feedback should encourage trainees to attribute performance to controllable factors, to maintain self-efficacy and effort.

Table 3 continued

	Guidance
Tennyson (1981) Tennyson, Tennyson, & Rothen (1980)	Guidance should be provided to trainees in learner control environments to prevent premature termination of effort directed toward learning.
Tennyson (1980) Tennyson & Buttrey (1980) Santiago & Okey	Guidance should be provided to trainees in learner control environments to appropriately sequence their effort and attention, and to facilitate the acquisition of critical knowledge and skills.

Table 4. ALS Design Principles: Training and Simulation Design

Citation	Principle
	Sequencing
Etelapelto (1993)	Trainees should not be provided strategy instruction until later in training, to facilitate basic skill development during early stages of training.
Reigeluth et al. (1980)	Training material should be elaborated so that instruction proceeds from general to detailed, and from simple to complex.
	Complexity
Carver & Scheier (1990)	Trainees learning a complex task should be encouraged to monitor their rate of progress (rather than just their performance), to reduce dissatisfaction, as complex tasks may produce large performance discrepancies.
Earley et al. (1990)	Trainees learning complex tasks should not be given goals until later in training, when the individual develops effective strategies; Trainees learning simple tasks should be provided with goals early in training.
Stock & Cervone (1990)	Trainees learning complex tasks should be provided with proximal subgoals that break the task into smaller parts, to increase self-efficacy and persistence.
	Workload & Variability
Mikulincer (1989)	Trainees presented with extremely difficult problems that appear unsolvable should be assisted in making some consistent progress during training to avoid anxiety and abandonment of effort.
Schmidt & Bjork (1992) Ellis (1965)	Variability in practice trials should be provided during training to maximize retention and transfer.
	Errors
Frese & Altmann (1989) Nordstrom et al. (April, 1995) Prather (1971)	For domains where errors are a frequent part of the transfer environment, trainees should be encouraged to make errors in training so they can learn to develop tolerance for errors, how to handle errors, and to experience lower frustration. Errorless training may lead to effective training performance but decrements in transfer performance.
Frese et al. (1991)	For difficult tasks, trainees should be encouraged to make errors in training to increase transfer.
Ivancic & Hesketh (1995)	Trainees should be encouraged to make errors in training in order to develop problem-solving or hypothesis-testing skills.

Table 5. ALS Design Principles: Trainee Orientation

Citation	Principle
	Instructional Goals
Ames & Archer (1993)	Mastery or learning goals should be presented to increase metacognitive behavior such as self-monitoring and self-instruction.
Boyle & Klimoski (1996)	Mastery orientations should be fostered by creating successful early training experiences or by presenting mastery goals, in order to facilitate persistence, task interest, and task satisfaction.
Dweck & Leggett (1988)	Mastery orientations should be fostered during training to discourage internal attributions about failure and negative affect, to encourage greater focus of attentional resources, and to increase performance.
Nolen & Haladyna (1990)	Mastery orientations should be fostered by emphasizing learning and independent thinking and presenting mastery goals early in training.
Schunk (1994)	Performance goals should be presented under conditions of task engagement, on short-term or easy tasks, or for rapid task completion.
	General Training Frame
Bandura (1991)	Trainees should be encouraged to be self-satisfied with the attainment of subgoals as well as end-goals, to foster a mastery orientation and retain motivation throughout skill acquisition.
Curtis (1992)	Trainees should be encouraged to focus on long-term outcomes and success, to avoid task withdrawal due to initial difficulty and failure.
Meece (1994)	Trainees should be encouraged to believe they can accomplish a goal by emphasizing self-improvement, discovery of new information, and the usefulness of learning material, in order to facilitate the adoption of a mastery orientation.

Table 6. Design Principles: Self-Regulation System

Citation	Principle
	Practice (Behavior)
Goska & Ackerman (1996)	Trainees should be given the opportunity to practice critical skills in order to increase transfer performance.
Ivancic & Hesketh (1995)	Trainees should not be encouraged to make errors when learning procedural skills, as it may impede the acquisition of correct behaviors.
Lindsley et al. (1995)	Trainees should be given time to become familiar with the task to avoid maladaptive downward efficacy-performance spirals in transfer.
Lord & Levy (1994)	Trainees should be provided as much practice as possible during training to develop automatic control processes and reduce attentional demands.
Nelson et al. (1994)	Trainees' idiosyncratic "judgments of learning" should be used to reallocate study and practice time to the most difficult trials or items, in order to make learning most efficient.
Ohllson (1996)	Trainees should be provided enough practice to learn the links between the goal, the situation, and the appropriate action.
	Self-Monitoring (Cognition)
Bandura (1991)	Trainees should be encouraged to closely self-monitor progress, to increase the likelihood of setting progressive goals for performance improvement.
Carver & Scheier (1982) Karoly (1993)	Trainees should be encouraged to monitor their own behavior and performance during training, to enhance the self-regulation process and increase progress toward the goal.
Flavell (1979)	Trainees should be provided instruction in cognitive monitoring skills, to learn and perform better in complex task environments.
Harris (1990)	Trainees should be encouraged to self-monitor their use of strategies during training, rather than be provided with strategies, to increase performance.
Kanfer & Ackerman (1989)	Trainees should not be encouraged to self-regulate during early skill-acquisition stages that involve the development of declarative knowledge, to avoid the diversion of attentional resources that would lead to decreases in performance.
Lord & Levy (1994)	Trainees should be encouraged to establish reference values for their tasks, to more easily maintain attention.
Schunk (1990)	Trainees should be encouraged to engage in self-observation during training, to better monitor their progress and increase motivation.

Table 6. continued

	Self-Evaluation / Reactions (Affect)
	Self-Efficacy
Bandura (1991) Kanfer & Ackerman (1989)	Trainees should be provided self-efficacy enhancing training experiences to encourage their setting higher goals and maintaining more effective self-regulatory activities.
Carver & Scheier (1990)	Trainees should be encouraged to visualize possible courses of action as positive behavior scenarios, to enhance positive expectancies and affect.
Gist & Mitchell (1992)	Trainees should be provided with information that allows a complete understanding of the task's attributes, complexity, environment, and how all of these can be controlled, in order to enhance trainees' self-efficacy.
Schunk (1990)	Trainees should be provided with proximal goals during training, to enhance self-regulation and self-efficacy.
	Attributions
Bandura & Wood (1989) Bandura (1991) Martocchio & Dulebohn (1994)	Trainees should be encouraged to believe their environment and performance are controllable, to maintain effort and motivation, and to increase self-efficacy and performance.
Forsterling (1985) Thomas & Mathieu (1994)	Trainees should be encouraged to attribute causes of failure to unstable, external, and/or controllable causes to avoid reduction of self-esteem, self-efficacy, and/or motivation.
Quinones (1995)	Trainees should be discouraged from attributing negative feedback to ability factors, to enhance self-efficacy.
Schunk (1990)	Trainees should be encouraged to make internal attributions for training successes to enhance self-efficacy.

Figure 1. Theoretical Model for Integrated-Embedded Training Systems.

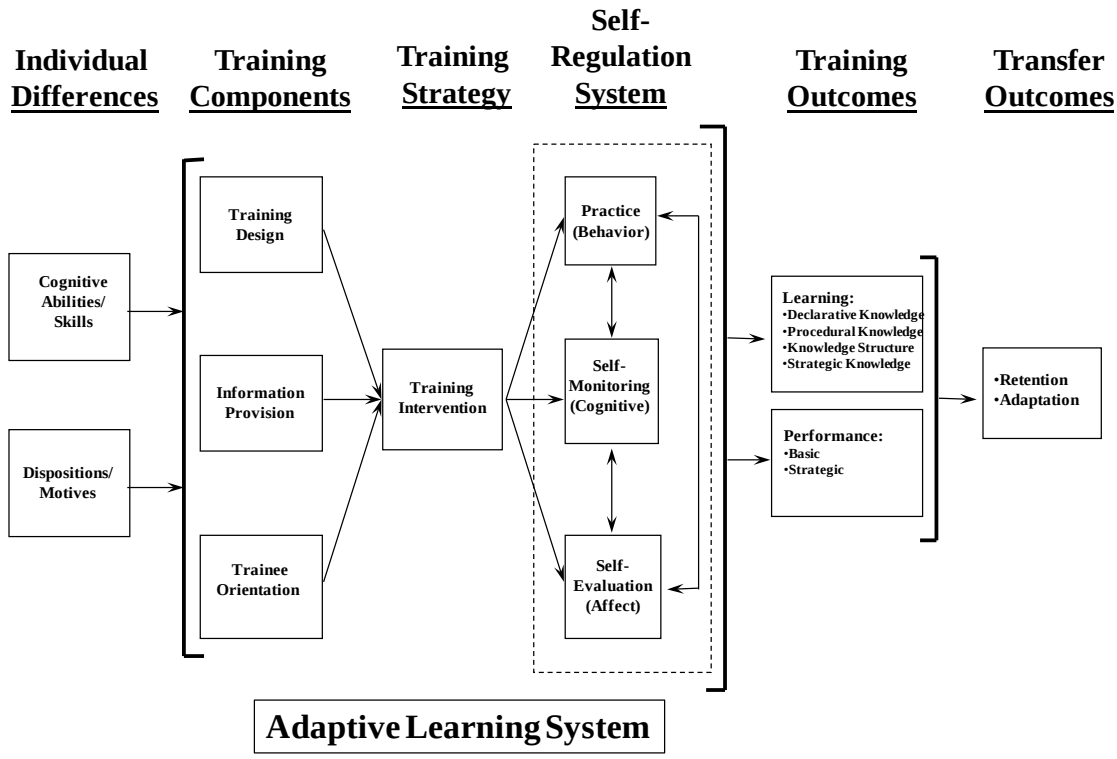

Figure 2. Typology for ALS Information Provision.