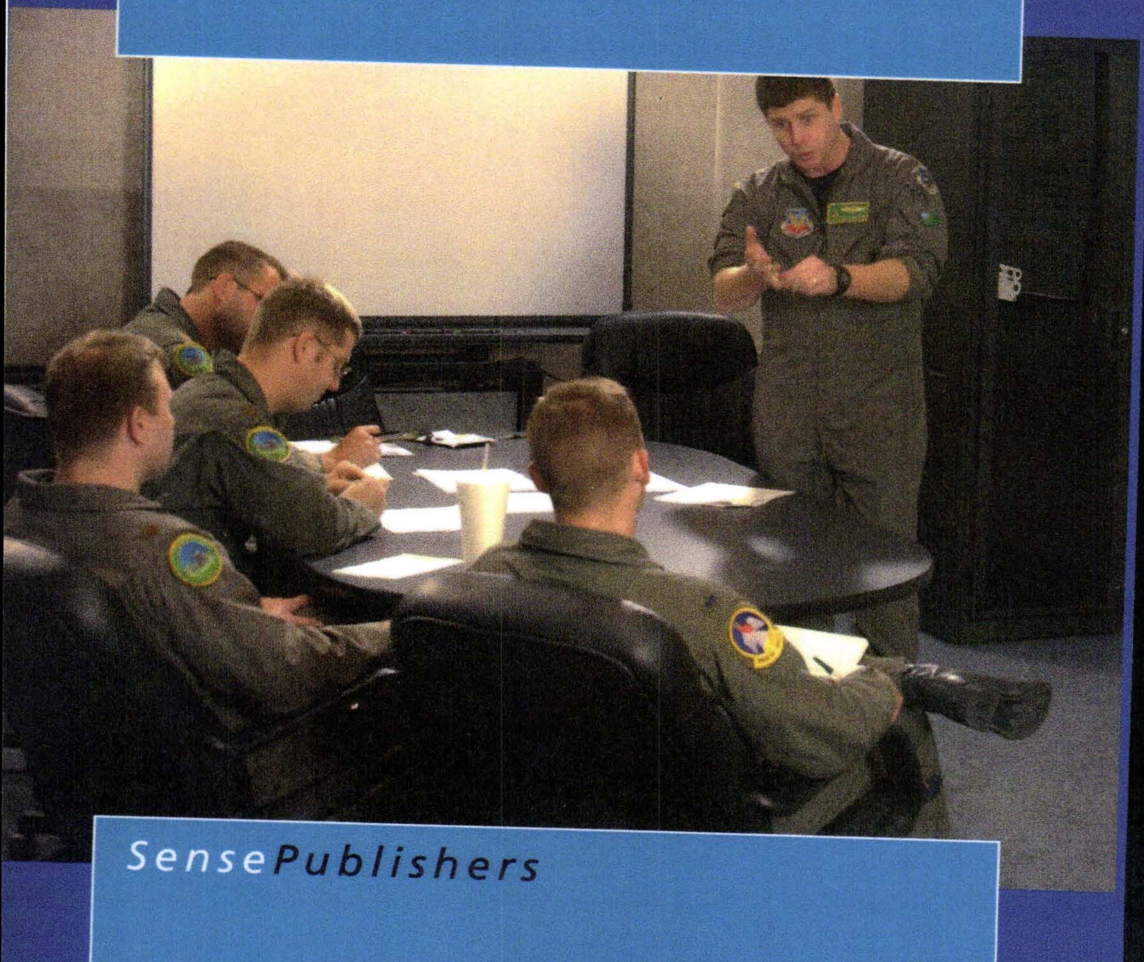
MODELING AND SIMULATIONS FOR LEARNING AND INSTRUCTION

Storytelling as an Instructional Method

Research Perspectives

Dee H. Andrews, Thomas D. Hull and Karen DeMeester (Eds.)



SensePublishers

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2010	**Book**	**08-11-2006 to 31-12-2009**

4. TITLE AND SUBTITLE
Storytelling as an Instructional Method Research Perspectives

5a. CONTRACT NUMBER
FA8650-05-D-6502

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER
62205F

6. AUTHOR(S)
Dee Andrews; Thomas Hull; Karen DeMeester

5d. PROJECT NUMBER
1123

5e. TASK NUMBER
AC

5f. WORK UNIT NUMBER
01

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Research Laboratory/RHA,Warfighter Readiness Research Division,6030 South Kent Street,Mesa,AZ,85212-6061

8. PERFORMING ORGANIZATION REPORT NUMBER
AFRL; AFRL/RHA; 711 HPW

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Research Laboratory/RHA, Warfighter Readiness Research Division, 6030 South Kent Street, Mesa, AZ, 85212-6061

10. SPONSOR/MONITOR’S ACRONYM(S)
AFRL; AFRL/RHA; 711HPW

11. SPONSOR/MONITOR’S REPORT NUMBER(S)
AFRL-RH-AZ-BK-2010-0001

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Published by Sense Publishers

14. ABSTRACT
This book stems from a workshop organized by the US Air Force Research Laboratory. The military is interested in better instructional storytelling because military instructors have historically relied heavily on that technique. One of the workshops major goals was to explore different ways to produce more instructionally effective stories. This book is organized around four story types: Case-based instruction; narrative-based instruction, scenario-based instruction, and problem-based instruction.

15. SUBJECT TERMS
Storytelling; Case-based instruction; Narrative-based instruction; Scenario-based instruction; Problem-based instruction; Military stories; Instructional methods; Instructional storytelling

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Public Release**	**33**	

A C.I.P. record for this book is available from the Library of Congress.

ISBN: 978-94-6091-132-3 (paperback)
ISBN: 978-94-6091-133-0 (hardback)
ISBN: 978-94-6091-134-7 (e-book)

Published by: Sense Publishers,
P.O. Box 21858,
3001 AW Rotterdam,
The Netherlands
http://www.sensepublishers.com

Printed on acid-free paper

Cover photo: "Air Force Research Laboratory, Mesa Research Site" by Bruce Liddil

DEE H. ANDREWS[1]

1. STORY TYPES AND THE HERO STORY

For thousands of years societies have taught key principles through storytelling (Brady, 1997; MacDonald, 1998). In some cultures without a written language storytelling was the only way to convey a society's culture, values, and history. Instructional tools have been used by great teachers and leaders in the forms of parables, legends, myths, fables, and real-life examples to convey important instruction (Benedict, 1934; Brown & Duguid, 1998; Davenport & Prusak, 1998; Leonard-Barton, 1995). Fictional and non-fictional examples have always been powerful teaching tools. Storytelling as instruction is still heavily used today. The military, aviation, medical, law, and business communities are just a few groups which rely heavily on storytelling as methods for teaching key principles of their discipline and to help build analytical prowess in students and trainees.

While many definitions of "story" can be found in the literature, this author is partial to two of them. Labov (1972) defines a story or a narrative "as one method of recapitulating past experiences by matching a verbal sequence of clauses to the sequence of events" (p. 359–60) and at a minimum a "sequence of two clauses which are temporally ordered" (p. 360). Denning (2009) states that, "A narrative or story in its broadest sense is anything told or recounted; more narrowly, and more usually, something told or recounted in the form of a causally-linked set of events; account; tale,:[sic] the telling of a happening or connected series of happenings, whether true or fictitious."

There are many publications that give guidance about how best to formulate and use stories for use in instruction. Many of these offer prescriptive guidelines to those who teach using storytelling. Examples include: Gershon and Page (2001), Harries, C. (2003), Hill, Gordon, and Kim (2004), Merrill, (2002), Preczewski, Hughes-Caplow, and Donaldson, (1996). However, there is not a large theoretical foundation or empirical evidence about the storytelling technique. As have teachers and instructors for thousands of years, we know that storytelling is a very effective instructional method. However, the key questions are, "Why do stories work so well in instruction? What are the features and characteristics of stories that make them work? How can stories be improved for instruction?"

This book stems from a workshop organized by the U.S. Air Force Research Laboratory[2]. The military is interested in better instructional storytelling because military instructors have historically relied heavily on that technique. Whether the instruction is done from the platform, through texts, via computer-based instruction, in simulators, or in the field, stories are told. In fact, storytelling does not stop in the classroom or in a formal training setting. Much of the culture and tradition of the military is passed along in stories as military personnel stand watch,

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socialize after hours, and interact while traveling to and from missions and exercises. In most cases these instructional stories stem from actual experience in combat operations or in training exercises.

They may be "there I was, in danger" stories where individual instructors tell stories from their personal experience, or they may be scenarios for simulators or field exercises that come from third person accounts of battle, but stories have proven for thousands of years to have a positive instructional effect. Hence the military interest in better instructional storytelling. One of the workshop's major goals was to explore different ways to produce more instructionally effective stories.

Over the course of two days at the workshop, a variety of presentations were given exploring four techniques using stories in instruction; case-based, problem-based, scenario-based, and narrative-based methods of instruction. The group examined and/or developed instructionally relevant definitions for the different types of storytelling approaches. Another goal of the workshop was for attendees to develop and discuss key research questions related to the theme of the workshop.

The first section of the chapter describes the four types of stories considered by workshop participants. What are their definitions and how are they used in instruction? The chapter then examines some of the research questions that emerged from the workshop. A major goal was to develop a set of questions that might lead to the development of a more empirical foundation for instructional storytelling than currently exists. Theories help explain and predict phenomena. As the workshop did not identify a strong theoretical base for instructional storytelling, the chapter is concluded by briefly examining the ideas of scholar, Joseph Campbell, who spent his professional career theorizing about the place of stories (myths) in cultures. He believed that mythical stories are much more than just entertainment, but are actually a deeply engrained part of our psyches that are often used as learning tools. It is but one example of what might provide a theory foundation for storytelling as a method of instruction.

FOUR STORY TYPES

While all four main storytelling instructional methods (case-based instruction, problem-based instruction, scenario-based instruction, and narrative-based instruction) share a common element – stories – the four do have differences in definition, purpose, use of the story, and outcomes. Each method presents learners with a temporally ordered sequence of information and employs an attention-focusing mechanism. Uniting these methods through a common characteristic enables researchers to draw on one another's work for insights into the learning process. Andrews, Hull, and Donahue (2009) describe these story types in greater detail and provide concrete examples. This book is organized around these four story types.

Case-Based Instruction

Cases are stories that have occurred in the past. They are widely used in contexts such as medical, law, and business schools. Case-based instruction fixes the problem and solution, but the learner is placed outside the story context (Barnes, Christensen, & Hansen, 1994). The learner must discover the key facts and events as they occurred; hence case studies have a historical nature. Because they are historical, cases do not allow a learner to alter their outcome or processes. Rather, the student must apply critical thinking and theories to the existing facts to be able to form hypotheses about why the facts of the case occurred as they did. A major advantage of cases when compared to the other three types of stories is that they are imbued with authority which comes from the actual facts of the stories (Abbot, 1992).

Narrative-Based Instruction

Narrative-based instruction fixes the problem, the solution, and the learner all within the context that the story frames (Cobley, 2001). The storyteller or narrator controls all of the information received by the learner. Narratives can be either fictional or non-fictional. They seek to emotionally immerse the learner in the narrative's situation; probably more deeply than any of the other three story types. For this reason, narratives often are told for entertainment's sake, often without pursuing an instructional objective. A narrative seeks to express a series of events; however it does not necessarily have to tell the events in a chronological sequence.

Scenario-Based Instruction

Scenarios state fixed solution criteria, but not necessarily fixed solutions. The learner is positioned in a place that allows them to interact with the scenario and produce different outcomes depending on their decisions and actions. They can be fictional or non-fictional. However, for purposes of instruction they often come from history (Salas, Wilson, Priest, & Guthrie, 2006). Scenarios are heavily used in operational training such as the nuclear power industry and the military because they require active interaction by the learner and can be given operational characteristics. While many scenarios are drawn from actual cases, they can be altered (sometimes significantly) to suit the purpose of instruction and evaluation measurement. This ability to accurately measure learner responses in a scenario-driven simulation, simulator, or instructional game makes scenarios effective places to try out new theories, approaches, and procedures for solving operational problems. Learners can gain valuable lessons from the experience. The main goal of scenario-driven instruction is to improve performance.

Problem-Based Instruction

The final story type is especially suited for teaching learners about how to best solve ill structured problems that do not have optimal solution criteria or parameters (Hmelo-Silver, 2004; Savery, 2006). Problem-based instruction requires, or at least allows, the learner to take charge of their own learning process and activities. This uses the problem (fictional or non-fictional) as a mechanism for conveying knowledge to the learner. The learning is usually done in a team setting, where each team member must provide collaborative help in finding a solution (Boud & Feletti, 1997). A key is that while a teacher might help the learning, each learner and the learning team must take responsibility for defining a path to solving the problem and then applying facts and skills to reach a solution (Savery, 1998).

KEY INSTRUCTIONAL STORY RESEARCH QUESTIONS

Regardless of the type of story, there are many research questions about instructional storytelling whose answers might help in developing more instructionally effective stories. Following are a few examples of research questions that resulted from the Air Force Research Laboratory workshop:

- How much impact does the individual storyteller have on the instructional effectiveness of the story, and more importantly, what about the storyteller makes him or her effective? Can instructors be taught how to be better storytellers, or are some people just born storytellers and others are not?
- How long are lessons learned from stories retained by the learner versus learning via other methods? All of us can likely remember instructional stories from our early childhood, but are there characteristics of some stories that lead to longer retention than stories lacking those characteristics?
- Do different types of stories have different effects on different learning styles? Stated differently, do certain learning styles respond more effectively to different story types?
- Are there material differences in the genesis, form, and effectiveness of case-based vs. scenario-based vs. problem-based vs. narrative-based instruction? That is, are these just different names for the same method or are they really different in some important ways? If so, does it matter to the learner? Continuing along that same line of questioning, do different storytelling techniques have differential effects on different learners?
- Why do stories work from a cognitive standpoint? It seems they certainly have associative properties that can make the learning relevant to the user, but can that association be empirically analyzed and modeled so that more effective stories can be developed?
- Is it better to (a) first present examples via storytelling and then extract a general principle from examples, or (b) first learn a general principle and then listen to examples via storytelling? What does theory and evidence tells us about this question that could be applied to improving storytelling as instruction?

CAMPBELL AND THE HERO STORY

The Air Force Research Laboratory workshop examined the questions, "Is there a theory of storytelling as instruction? If not, should there be, and can there be?" Those questions were addressed but not really answered in the workshop, largely because of the brief time the participants had to discuss the issue. One direction to turn for a possible theory might be to the ideas of a thinker who believed that stories have a special place and purpose in every culture around the world, including for pedagogical purposes. The mythologist Joseph Campbell spent his career exploring myths from many cultures (Campbell, 2008; Campbell & Moyers, 1991). He concluded that virtually all myths have similar structures that revolve around a hero. A writer, Christopher Vogler, (2009) provides a brief overview of Campbell's findings about the hero myth.

> *The hero is introduced in his ordinary world, where he receives the call to adventure. He is reluctant at first but is encouraged by the wise old man or woman to cross the first threshold, where he encounters tests and helpers. He reaches the innermost cave, where he endures the supreme ordeal. He seizes the sword or the treasure and is pursued on the road back to his world. He is resurrected and transformed by his experiences. He returns to his ordinary world with a treasure, boon, or elixir to benefit his world.*

Campbell posits the existence of a *Monomyth* (Joyce, 1995), which is a clearly defined pattern that seems to fit every well known myth from every culture. He believed that humans resonate with the themes and the imagery of myths because the stories are a metaphor for life. That is why they have such a powerful educational value. Campbell believed that myths are psychologically "true". Even when the myths portray fantastic events and creatures, we still respond to them because they map to our psyches.

Campbell drew inspiration from the ideas of noted psychiatrist and critical thinker, Carl Jung. Jung developed the concept of the "Archetypes" (Jung, 1981). He believed that there are characters which repeatedly populate the dreams and myths of all mankind across cultures. He postulated that the mind is reflected in these Archetypes. He believed that myths and stories map to the archetypes of our minds and that is why they have such power in every culture. They tap into a collective unconsciousness and map on to our psyches.

Campbell's generalized hero myth concept is not without its critics. Some scholars who study myths believe his twelve stages are too formulaic, and their use squeezes from myths the true nature of what makes cultures different.

Campbell (1990) believed that mythology had four major functions; mystical, cosmological, sociological, and pedagogical and that myths and stories have significant contributions to learning in all cultures. It is because of his interest in the pedagogical nature of myths that we find interest in the possible use of his ideas for laying a theoretical foundation for research of instructional storytelling.

Campbell believed that the hero myth helps us cope with, if not answer, the key universal questions humans have about the universe and their existence. Questions such as, "Where have we come from?", "Why are we here?", and "Where are we going?" The myths can be real or fictional and still have the same powerful teaching influence. He believed that these stories are ways for entire cultures to express their identity and answer questions about their beliefs. As long as the pattern of the hero myth is adhered to these myths and stories can teach for many generations.

Campbell identified twelve stages of the hero myth:

1. Hero introduced to his ordinary world
2. Call to adventure
3. Reluctant hero

4. Hero encouraged by wise old man
5. Hero passes first threshold
6. Hero encounters tests and helpers
7. Hero reaches perilous place
8. Hero undergoes serious test
9. Hero takes control of the prize
10. Hero makes final escape
11. Hero is transformed by the quest
12. Hero uses prize to benefit mankind

Many military training instructional stories follow Campbell's twelve step model. The instructor recounts a tale, either first or third hand, about a military member or team (hero) that has a mission to complete (quest or prize). Along the way, many obstacles are encountered. These obstacles may be the enemy, the weather or failing equipment. The hero overcomes the obstacles, accomplishes the mission, and benefits the larger military mission, which will benefit a particular group (the hero's military forces in the field or nation, and eventually the entire world).

Perhaps the educational influence of myths and stories will have a stronger emotional influence if they use the steps as a pattern. Campbell's ideas could provide theoretical underpinning for developing better instructional stories. If his theoretical twelve-step model is correct, then perhaps we should start with that model to construct many of our instructional stories. Research in this area could offer evidence about the efficacy of Campbell's model as it applies to instructional stories. While his ideas are but one explanation for the power of instructional stories, his views have received considerable attention from both the scholarly world and the popular press. Campbell's concepts can help researchers as they explore the storytelling questions described in the previous section.

We ask the reader to consider other possible foundational theories for instructional storytelling as they read this book. It is vital that instructional storytelling be founded on well developed theories so that it can take its rightful place alongside other proven instructional methods that have strong theoretical bases.

CONCLUSION

Stories used for instruction have a history as long as the spoken word. They will continue regardless of whether theory bases for instructional storytelling are constructed or not. In like manner, the use of instructional stories will remain a part of instruction regardless of whether empirical research is focused on the domain. What theory building and empirical research should contribute is a better understanding of how to best construct and use such stories.

The four story types are not mutually exclusive. Their construction and use overlap. However, their differences are important enough to treat separately. Empirical research might help build a prescriptive guide for when and how each type can be optimally used in education. Perhaps Campbell's ideas are correct and all humans have an innate understanding of the power of stories. Research might also help us understand when and how to use the different story types in combination. If so, research can help the instructional process by proposing underlying story theories that help explain and predict their optimal use for instruction.

NOTES

[1] The opinions expressed in this chapter are those of the author and do not necessarily represent the official views or policies of the U.S Department of Defense.

[2] *Storytelling as an Instructional Method Workshop: In search of Theoretical and Empirical Foundations*, November 7 - 8, 2006, Mesa, AZ. United States Air Force Research Laboratory, 711[th] Human Performance Wing, Human Effectiveness Directorate, Warfighter Readiness Research Division.

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ROBERT PATTERSON

3. STORYTELLING, ARCHETYPES AND SYSTEM DYNAMIC MODELING

As discussed by Andrews, Hull and Donahue (2009), storytelling has been used for thousands of years as a means for teaching members of various societies about their culture, values, and history. Indeed, it would be difficult to overstate the importance of storytelling as a universal method of teaching. Moreover, in many cases, storytelling is effective by its use of archetypes. An archetype represents an original pattern, a prototype, or ideal example; archetypes represent universal symbols. For example, one archetype would be that of a 'hero'. The archetype of a hero would evoke a number of images and expectations on the part of the listener or reader, such as bold and fearless, which would aid in understanding the meaning of the interactions of that individual with others in the story. In this way, listeners or readers of a story can easily relate to, and understand, the meaning conveyed by the evolving pattern of actors and events by understanding the meaning of the archetypes.

ANALOGICAL REASONING AND STORYTELLING

The use of archetypes in storytelling is an effective means by which to communicate essential information because archetypes involve reasoning by analogy. As discussed by Holyoak, Gentner and Kokinov (2001) and Juthe (2005), analogical reasoning involves making inferences from the *similarity of relationships* of elements across two or more domains. These authors note that by dealing with the *shared relational patterns* among potentially diverse objects, analogical reasoning involves dynamic, context-sensitive mental representations. Analogy can involve specific cases or highly abstract concepts or schemas. Reasoning by analogy may also be referred to as case-based reasoning, wherein the structures and relations of situations stored in memory are applied to novel problems.

Analogical reasoning involves creating a mental structural-alignment process, or mapping, of relationships from one domain to another in order to *transfer inferences* between domains (see Holyoak, Gentner & Kokinov, 2001). Hofstadter (2001) makes a strong case that analogical processing is at the very core of cognition. He notes that the development of concepts, which are employed in many mental functions such as reasoning and thinking, requires individuals to mentally chunk together the core relational properties of objects and situations, using analogical abilities, into a concept. Indeed, humans typically perform very well using analogies for reasoning, especially when the connection between the analogue and target is made explicit (Gick & Holyoak, 1980, 1983). Analogical reasoning appears to be one of the more fundamental thinking skills humans possess.

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Juthe distinguishes between same-domain analogies wherein the elements of the analogue and target are drawn from the same domain, and different-domain analogies wherein the elements of the analogue and target are drawn from different domains (the latter case involves metaphors or parables). Same-domain analogies are likely to yield more specific courses of action than different-domain analogies (Markman & Moreau, 2001).

Although analogical reasoning can be classified as a different form of reasoning from deductive and inductive reasoning (Juthe, 2005), Holland, Holyoak, Nisbett and Thagard (1986) suggest that analogical reasoning is a form of inductive reasoning because analogy may entail the integration of information from a number of diverse sources or analogues. These authors discuss how analogical reasoning entails creating a mental model of the target problem by 'modeling' the model (i.e., relations) contained in the analogue problem, which creates a new model that can be applied to the target problem—therefore analogical reasoning involves a second-order morphism.

Moreover, Hofstadter (2001) and Chalmers, French and Hofstadter (1992) argue that analogical reasoning is intimately involved in high-level perception. According to this view, raw sensory information is taken in by sensory systems which, at the highest level, evoke perceptual processes relating to mental categories and concepts. Here, the meaning of the sensory information is interpreted via an application of structural alignment and mapping from stored representations in memory. Thus, the elicitation of stored mental categories and concepts by sensory input is analogical processing, a form of high-level pattern perception.

Thus, storytelling, and its use of archetypes, is an effective method for teaching and conveying information because analogical reasoning, in the context of storytelling, would involve the creation of dynamic, context-sensitive mental schemas of relational patterns conveyed in a story. An individual could then transfer these schemas to their real-life circumstances which would assist the individual in the interpretation of previous, present, or future real-world events. This, in turn, could facilitate problem solving.

It is interesting to note that storytelling is a form of mental *simulation*, entailing a high degree of imagery. Moreover, analogical reasoning would also be involved in virtually all other forms of simulation as well. In these cases, a mapping of relational schemas and transfer of meaning and inferences would occur from the simulation context to the real-world. To state it another way, the importance of simulation in training and other endeavors is to be found in the analogical reasoning, and pattern recognition, that is brought into play by the simulation context.

Storytelling is a relatively informal method for conveying information by simulation. On the other end of the continuum are formal methods (e.g., mathematical) for conveying information via simulation. In the following section, we discuss one such method, namely system dynamics modeling.

SYSTEM DYNAMICS MODELING

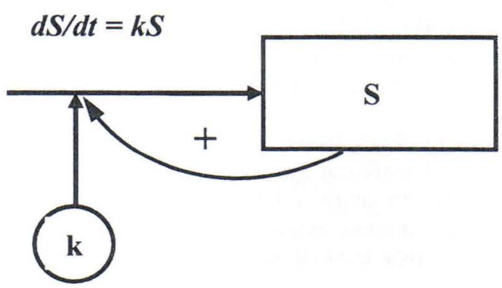
System dynamics modeling (Forrester, 1961, 1968; Sterman, 2000) is a systematic framework for analyzing complex systems by simulating them as interconnected multiple positive and negative feedback loops. Such complex systems are set up as systems of differential equations that are solved step-wise using numerical integration techniques. In this context, the behavior of a system is given by the interconnectiveness of the system elements—not by the elements themselves. The advantage of this approach is that it permits a precise specification of the variables, and their interrelationships, in the problem space. Because this approach entails the creation of dynamic models of relational patterns whose simulation can generate inferences that can be transferred to real-life circumstances, system dynamics represents an approach that is analogous to storytelling in its implicit use of analogical reasoning as a means for learning and teaching. Some of the computational structures created in system dynamics modeling can be taken to be a form of an archetype. The only difference is that system dynamics is a more formal approach for framing the analytical reasoning.

In system dynamics modeling, complex systems are analyzed by using a small set of elements which are interconnected to create a system. These elements include an object called a 'stock', which is a rectangular structure representing the mathematical process of integration; a "flow", which is a thick arrow representing rates of change or derivatives; a connector, which is a thin arrow representing a feedback connection as well as other types of connections; and a 'converter', which is a circle representing an expression, symbol, or conditional logic. These elements are used to create and model positive feedback loops and negative feedback loops, which are archetypes.

Positive feedback refers to a deviation-amplifying process wherein a given entity grows in a fixed proportion to its size over time, creating exponential growth. This type of feedback is considered destabilizing. An example of positive feedback is the initial growth of cells in a Petri dish. In this case, a small amount of cells at the beginning of the process grows over time to become very large as more and more cells create more cells. Or consider the example of the adoption of a technological innovation by a hypothetical society. Here, a small amount of innovation adoption at the beginning of the process grows over time to become very large as more and more individuals spread the innovation by word of mouth. In system dynamics terms, the rate of change in system state is directly proportional to the state of the system at any point in time (called first-order positive feedback):

$$dS/dt = kS \qquad (1)$$

where S = the entity or state of the system, k = the proportionality or fractional growth rate, and dS/dt is the rate of change over time. In a system dynamics block diagram, positive feedback can look like the following:

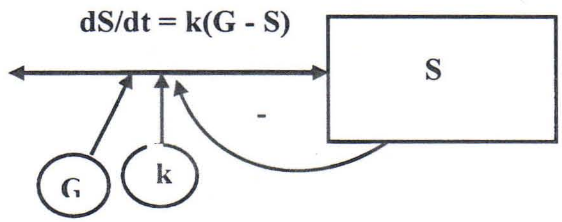


Repetitively over time, the amount of the system state is fed back to provide input so that a portion of it is added to the accumulation, which creates exponential growth over time. This is one kind of archetype in system dynamics modeling.

Negative feedback, on the other hand, refers to a goal-seeking process wherein a given entity or state of the system is adjusted over time to match a given goal (there are two versions of this concept; only one is discussed below). This type of feedback loop involves the adjustment of a system in the context of intentions; it is considered stabilizing. An example of negative feedback is the thermostat in a room which controls the temperature. In this case, the room is cooled if the temperature is higher than the setting (goal), and the room is heated if the temperature is lower than the setting. Or consider the cruise control on an automobile whose adjustments attempt to keep the speed of travel equal to the setting on the control. These types of systems are termed controllers or regulators. In system dynamics terms, the rate of change in system state is directly proportional to the difference between the goal and the state of the system at any point in time (called first-order negative feedback):

$$dS/dt = k(G - S) \tag{2}$$

where G = goal, S = entity or state of the system, k = the proportionality or fractional change rate, and dS/dt is the rate of change over time. In a system dynamics block diagram, negative feedback looks like the following:

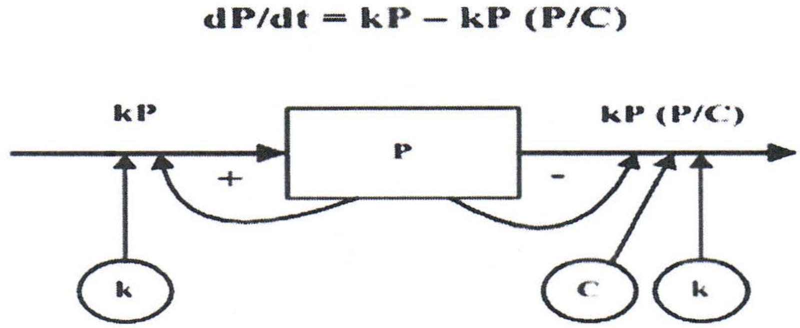


Note that when the magnitude of S, the state of the system, is less than that of the goal (G), the expression k(G-S) is positive and the action taken is to add a fractional amount to S; and when the magnitude of S is greater than that of the goal (G), the expression k(G-S) is negative and the action taken is to subtract a fractional amount from S. These actions create exponential growth or decay, respectively, toward the goal state over time. This is another kind of archetype in system dynamics modeling.

These two types of feedback loops, positive and negative, can be combined in different ways to model different systems. For example, positive and negative feedback can be coupled to create a logistic function, which looks like an "S"-shaped curve and is a common expression for capacitated growth, such as the growth of cells in a Petri dish beyond the initial growth stage. The initial growth is approximately exponential, but as more cells grow, the available population shrinks as accumulation approaches capacity, and growth asymptotes. The differential equation for this process is:

$$dP/dt = (kP) - (kP)(P/C) \tag{3}$$

where P = a hypothetical population, k = fractional growth or decay factor, and C = capacity. In a system dynamics block diagram, this expression looks like the following:



This expression is modeled as a pair of coupled positive and negative feedback loops, with kP defining the positive loop, and -(kP)(P/C) defining the negative loop. In the latter expression, the effect of the negative loop -kP (exponential decay) is weighted by the factor P/C, so that when it is early in the simulation and P is small, then P/C is small, and the positive growth loop dominates the process, which gives a high rate of overall growth. Later in the simulation P becomes large and near capacity, P/C is near 1.0, and the negative loop begins to balance out the positive loop, and growth asymptotes–the system reaches dynamic equilibrium. The figure below depicts the output of this model, which is a logistic function:

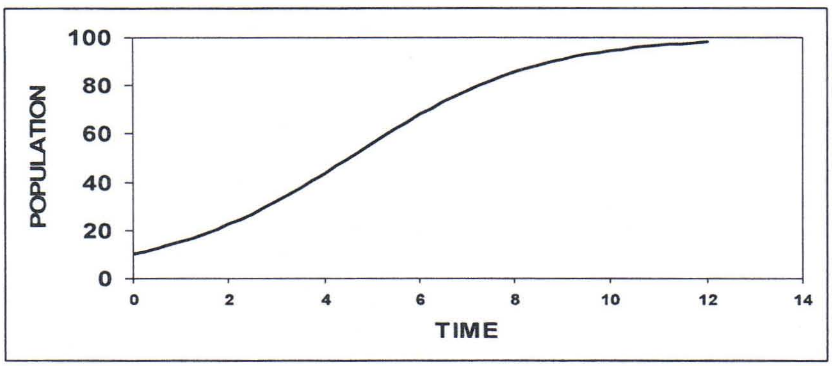


Figure 1. Interaction between two archetypes.

Thus, this logistic function, which is a function of capacitated growth, is the result of the interaction between two archetypes, a positive feedback loop and a negative feedback loop.

The two archetypes of positive and negative feedback can be combined in other ways to model other types of systems as well, such as systems involving epidemics of infectious diseases (Sterman, 2000). Thus, the two archetypes can have different interactions between them and therefore tell different stories.

In summary, certain configurations of elements in system dynamics modeling can be seen as representing different archetypes that can have different types of interactions among them. In so doing, the archetypes can tell a wide variety of stories–as in traditional storytelling–which can serve to help the reader transfer meaning and inferences from the simulation (mental simulation in storytelling; mathematical simulation in system dynamics) to situations in everyday life. Both storytelling and system dynamics modeling involve the processes of simulation, analogical reasoning, and pattern recognition which involve the use of archetypes.

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4. USING SCENARIOS TO ARCHIVE EXPERIENCE AND ORGANIZE TRAINING

INTRODUCTION

Scenarios are widely recognized as an effective way to engage trainees directly in their training; this interactivity is consistent with newer educational approaches that promote active learning, such as the Adult Learning Model (Dean, 1994; Prevou & Colorado, 2003) and constructivist theories of instruction (Bruner, 1966, 1996). Coincident with these instructional methodologies are major advances in simulation technology, giving rise to scenario-based training (SBT), where the development and delivery of compelling scenarios via high or moderate fidelity simulators are the focal points of the instructional process (Salas, Wilson, Priest, & Guthrie, 2006). This can be partially contrasted with scenario-driven training, in which scenarios play a supporting role but are not the foundational instructional unit (Alexander, 2000).

This chapter addresses two questions concerning the use of scenarios for design and delivery of SBT. First, how can we optimize scenario construction to embody important operational experiences that, in turn, instill the essential cognitive and behavioral skills, knowledge, and attitudes (KSAs) the trainee is to acquire? Second, how can we use scenarios to structure, guide, and organize training? As a backdrop to these two issues, we first discuss the distinguishing features of scenarios, their advantages and disadvantages, and how scenarios have evolved to their present form. Following the two questions, we conclude by discussing several trends we see on the horizon concerning scenario design, development, and implementation.

In discussing the chapter's titular questions, we will interleave relevant findings from evaluations of some half-dozen SBT projects we have conducted over the past few years (Spiker, 2006a). Where appropriate, we invoke best practices, borrowed from instructional system design (ISD) (Spiker, 2006b). Sadly, development and delivery of SBT is at best only lightly-principled (Baker, Kuang, Feinberg, & Radtke, 2004), though we are optimistic that this state of affairs is improving (Ross, Phillips, Klein, & Cohn, 2005).

SCENARIOS AS A STORYTELLING METHOD

As one member of the class of verbally-rich storytelling methods that comprise this book – the others are narratives, problems, and cases – scenarios do indeed tell a *story* to trainees. Yet it is a particular type of story, with features that make

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scenarios particularly well-suited for training. Among these are their purposive nature that constrains the otherwise free play that tends to occur in simulators (Salas et al., 2006), along with associative properties that make them personally relevant to the trainee (Baldwin & Madjuka, 1997). Scenarios share a number of features with the other storytelling instructional methods. These include an emphasis on grabbing and holding the student's attention, promoting active learning, instilling a learner-centered orientation, and a desire to have the student internalize the experience to support subsequent transfer to the post-training environment (Fowlkes, Dwyer, Oser, & Salas, 1998).

In common language (Dictionary.com), scenario has multiple meanings, such as a setting of story, a postulated sequence of possible events, or an outline of the plot or action, among others. As applied to training, scenario usage is more focused, where it encapsulates a blueprint of what will happen that defines the roles of trainees and supporting non-trainee personnel; thus it comes to dictate the content of what is to be trained. As espoused by Salas and his colleagues, scenarios in a SBT or event-based learning environment *are* the curriculum (Oser, Gualtieri, Canon-Bowers, & Salas, 1999; Salas & Cannon-Bowers, 2001).

ADVANTAGES AND POSSIBLE PITFALLS OF SCENARIOS

Scenarios enjoy a number of advantages as a framework for training content. Besides helping to establish cognitive realism and trainee buy-in, scenarios: provide a contextual basis for trainees to more readily adopt their role in the action; define the roles for non-trainees; lay out the sequence of action that will unfold; dictate the specific events that will occur; provide a timeline for those events; and facilitate communication among members of the training team (Spiker, 2006a; Van Berlo, 1998). In these ways, scenarios help prevent chaos in the training environment; provide an antidote to unscripted free play in the simulator; make training more interesting, believable (i.e., more face validity), personable, and customizable; and make training reflect the motivational goals advocated in models of adult learning (Wlodkowski, 1993).

But despite these advantages, scenarios do not guarantee success, as there are pitfalls to avoid. For example, while scenarios are the essence of the SBT curriculum, they are not a substitute for training objectives. Within ISD, a training objective specifies the skill to be acquired, the performance standards to be achieved, and the conditions under which the skill is to be executed (Department of Defense, 2001). Unless these attributes are built into the foundation of the scenario, the trainer cannot be sure that a given scenario will accomplish these aims. Using a scenario to guide training also does not ensure that criterion levels of proficiency have been achieved unless explicit goals for performance were set. That is, completing a scenario does not guarantee that one has been *trained* unless explicit criteria for successful training are provided (US Air Force, 2002). Finally, employment of scenarios within an SBT context does not ensure that a trainee's acquired skills will transfer positively to the criterion or operational environment; some type of test for the presence of positive transfer must be performed to establish that the scenario training environment is effective (Schmidt & Bork, 1992).

DISTINGUISHING FEATURES OF SCENARIO

Though its learning goals are clearly in line with the other story-based methods of instruction, scenarios have several important distinguishing features. One of these is the highly structured nature of scenarios, where well-designed scenarios will include both a specification of the stimulus events to be delivered and an enumeration of the trainee responses that can be expected (Hooper & Hannafin, 1991). The latter is especially important since anticipating trainee responses gives the instructor some advance idea where the scenario might be going, a template for assessing performance, and items for use in the debrief (Dismukes, Jobe, & McDonnell, 1997). Structure is indeed quite important, and in fact, Bills (1997) reported that having a structured learning environment was even more important than interactivity for successful performance with Internet-based instruction.

Another hallmark of scenarios is that they must be authored by someone, as opposed to being largely or wholly borrowed from other sources the way that narratives, cases, and – to a lesser extent – problems, can be. Our experience has been that scenario authoring is difficult and while subject matter experts (SMEs) have the technical expertise to populate a scenario with challenging events, they still need guidance in laying out the elements of a scenario in a way that promotes effective learning (Spiker, Walls, & Karp, 2006).

Another distinguishing feature of scenarios is their inherent dynamic character, where there is an implicit or explicit timeline dictating the pace and sequence of events (Van Berlo, 1998). The temporal placement of events is a major facet of scenarios, stemming from the emphasis of SBT on KSA practice and the concomitant goal of efficiently compressing skill acquisition. The need for learning efficiency arises because high fidelity training simulators are a scarce training resource, and there is an urgent requirement to maximize the trainees' learning rate to free up the device for the next trainee (Salas et al., 2006).

Scenarios are often designed around a series of decision points, where a trainee's particular response to some event will determine the branches or sequels he/she receives next (Prince, Oser, Salas, & Woodruff, 1993). Rich scenarios can contain many decision points and multiple paths, but some means must be invoked to keep the number of choices at each decision point to an acceptable number, else trainee and analyst will be overwhelmed. One strategy is to break a lengthy scenario into smaller vignettes or frames, where each frame contains a single decision point (Pomerol, 2001). At the end of the frame, the instructor has the option of resetting the scenario to some earlier condition, thereby avoiding a combinatorial explosion of possible branches. Decomposing mission scenarios into smaller frames makes scenario authoring more manageable and, importantly, supports modularization of SBT (Gillan, 2003).

Another feature of scenarios is the need for associated performance measurement, either through automated recording or live observers, and feedback. Regarding the latter, if real-time (i.e., during the training session) feedback is not possible, then delayed feedback, in the form of after action reviews and debriefs, must be provided and incorporated into the scenario (Dismukes et al., 1997). The scenario is, thus, a very dynamic context that does not require that trainees receive an extended history before beginning skill practice.

Perhaps most importantly, scenarios are authored to train particular KSAs, so events are scripted to ensure that the targeted KSAs are required (Dormann & Frese, 1994). These KSA triggers are thus an essential part of the scenario. Figure 1 illustrates how this might be implemented. This example is taken from software developed for authoring training scenarios for use in Navy and commercial airline flight training (Walls, Spiker, & Hunt, 2006). These triggers can either occur (a) automatically, based on time into the mission, phase of flight, or the trainee's response; or (b) manually, when inserted by the instructor. The event, *Fuel low level caution light*, might be triggered automatically, when the aircraft reaches a certain altitude (5500'), or the instructor might use his/her discretion to generate the event based on some condition designed to challenge the trainee. Because operational conditions can give rise to any number of triggers for a given scenario event, an authoring shell is useful for capturing important triggers and archiving them for later use. Besides the challenge factor, if the events and their triggers are carefully designed, sequenced, and integrated into the scenario, there will be minimal unproductive time for the trainee. This is particularly important in full-mission simulations, where considerable time is needed to set up the event (e.g., doing extended, unchallenging flying in the visual database in order to reach a threat area), and for team training simulation, where multiple team members must be managed (Salas, Bowers, & Rhodenizer, 1998).

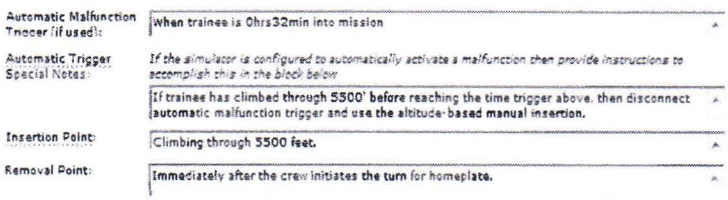

Figure 1. Automatic and manual insertion of triggering events in a scenario.

EVOLUTION OF SCENARIOS IN SBT

Viewing simulator training as an enterprise, the role of scenarios and the *story* they tell have evolved through three distinct phases, depicted in Figure 2. When SBT was first introduced to military and industry, scenarios were presented in the context of large, geo-specific databases having a high physical fidelity with the criterion environment. The scenarios were created by SMEs, where there was little capability to measure any aspect of trainee performance (Salas et al., 2006), particularly cognitive. Early instructor operator stations (IOSs) were inflexible and hard to use, so trainees had to adapt to the scenario as originally designed since instructors were unable to modify scenario elements to tailor simulator events to the trainees' level of expertise (Spiker, Nullmeyer, & Tourville, 1998).

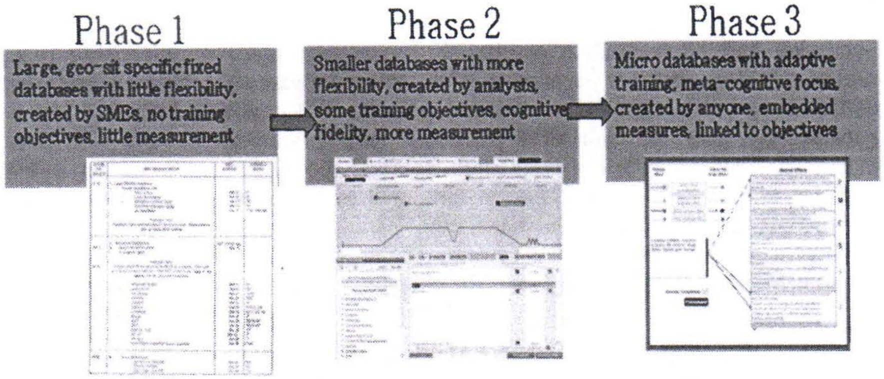

Figure 2. Three phases of scenario evolution within scenario-based training.

Though highly detailed, these mission scripts contained little information about how to instruct, what to measure, or what training objectives should be accomplished. Because these scenarios were costly to create – teams of SMEs might labor for a week or more to develop one – and even harder to change, the same scenario might be used repeatedly. In extreme cases, the same training scenario (i.e., same threats, emergency events, weather, etc.) would be used for years, so that trainees receiving refresher training might see the same scenario multiple times, clearly degrading its training effectiveness (Nullmeyer & Spiker, 2000). As might be expected, trainee response to these repeated scenarios was not high either, and declined further with each successive repetition of the same scenario.

During the second phase, which we have been in for some time, scenarios became smaller and more regional in scope, more cognitive in orientation, more likely to be created by a project team, and could include stopping points for measuring performance. With improvements in IOS technology, it has become easier to change the contextual features of the scenario database – threats, weather, visibility conditions, time of day – so the difficulty level of the session could be altered to match the trainees' level of expertise. The story has also become more interesting, where specific events could be inserted to tax particular cognitive skills, such as decision making, situation awareness, and problem solving (Salas et al., 2006). Importantly, there ensued greater ability to practice the *science of training*, through repeated practice opportunities, richer feedback, and more focused debriefs (Salas & Cannon-Bowers, 2001).

In the third phase, whose onset is imminent, scenarios will become even smaller in scale and scope, emphasizing meta-cognitive as opposed to purely cognitive or psychomotor KSAs. Scenarios will be used to structure training in which events will be presented in an adaptive fashion, with difficulty levels manipulated in real-time to match the trainees' present level of skill and knowledge. Performance measurement capabilities will be embedded into the scenario, and with the advent of scenario authoring tools, virtually anyone will be able to create or tailor scenarios, as less subject matter expertise and training analytic skill will be required. Scenarios will be created to emphasize a particular meta-cognitive skill (e.g., critical thinking, adaptive decision-making, cultural awareness), where high levels of transfer of training will be expected (Gillan, 2003). With widespread use of generic databases not tied to a particular locale, scenario authors will have expanded freedom to tell a story with broader appeal and even greater utility (Lussier & Shadrick, 2004). This, in turn, will open up the possibilities of new technologies, pedagogical constructs, and paradigms, such as serious games, intelligent agents, and adaptive systems (Salas et al., 2006). These issues are discussed further at the conclusion of the chapter.

INCORPORATING USER EXPERIENCES INTO SCENARIOS

Unlike cases and problems, the story told by a scenario does not have to be factual, though most often it will have been based on the operational experiences of instructors or training analysts. The scenario might also be based on a recorded event, such as a mishap or near miss, but more often the inspiration comes from *war stories* that were experienced or reported, with embellishments to target specific KSAs for training. An efficient way to collect many such experiences at one time is to hold critical incident (CI) workshops, where experts convene individually or as a group to relate one or more encounters they had on the topics of interest (Hanson, Hedge, Logan, Bruskiewicz, Borman, & Siem, 1995). In the past few years, the CI technique has been transformed by Klein and his associates into the Cognitive Decision Making (CDM) method, in which a series of ever-deepening probe questions are asked on a given incident (Seamster, Redding, & Kaempf, 2000). The CDM yields a richer tapestry of cognitive detail, shedding particular light on decisions, potential sources of errors, response alternatives, and overall subjective impressions of the participating SMEs.

Stimulating SME recall through workshops or CDM protocols is just the beginning step in constructing a face-valid scenario. In addition, a structured method is needed to categorize that information in a format that can be picked up by scenario designers who may not be an SME. We have found that using a framework like that shown in Figure 3 is a good way to standardize scenario development and ensure that all requisite story information is in place for the designer (Spiker et al., 2006a). As shown in the figure, we can decompose a scenario into five main elements: a (1) synopsis or storyline that summarizes the main actions that occur; (2) the non-trainee entities or players who must be represented to make the story realistic and contextually meaningful; (3) the individual training events that are specified, selected, and inserted as the basic unit of action; (4) supporting materials, physical artifacts, and other content that must be supplied by the SBT system; and (5) a timeline that serves as a scaffold on which to place events (Spiker, Holder, Walls, Campsey, & Bruce, 2007). In this illustration, we have represented the training scenario for a simulated commercial airline flight by specifying the (1) takeoff and departure airports, (2) need for three role-playing entities, including air traffic control; (3) five different events that will

Storyline/Synopsis	Players	Events	Content	Timeline
Basic daytime flight from Dulles to Nashville. During start, several interrupted start problems are encountered and discussed. Normal SID using autopilot. Practice area entry for steep turns and stalls. In practice area, low hydraulic pressure (1) light comes on. After isolation and correction, descent is initiated back to Dulles, using autopilot. Full stop landing is completed.	ATC ATIS Dispatch	Interrupted Start IFR Standard Departure HYD 1 Low Pressure Steep Turns Stalls	SID Chart CFM (company flight manual) Checklists	**Start & Taxi** – Interrupted Start **Departure**– IFR **Enroute**– Turns Stalls HYD **Approach**– ILS

Figure 3. Example of a five-part scenario framework.

be introduced, such as requirement for steep turns; (4) different pilotage charts that must be available during the flight; and (5) points in the flight profile where the various events are to occur.

Over the course of developing SBT systems in several domains, we have learned that formal methods are needed; not only to stimulate the recall of operational experience, but to capture these insights in order to populate our training regime with interesting and compelling scenarios. This can be done in a variety of ways, including worksheets, checklists, and formal scripts. Each format has its advantages, such as ease of use, graphical convenience, and completeness, among others. Importantly, our evaluation results have shown that trainees and trainers alike react positively to having consistently designed scenarios in the training curriculum, where acceptance has been high for commercial airline pilots (Spiker et al., 2006a), Air Force mission planners (Spiker, Walls, & Holder, 2006), Navy pilots (Walls et al., 2006), and Army staff officers (Fischer, Spiker, Harris, & McPeters, 2006; Spiker et al., 2007).

Interpreting the results of field evaluations of SBT is notoriously difficult since the no-scenario control condition is typically absent, making simultaneous comparisons impossible. Instead, we rely on a combination of measures taken from archival records (e.g., grade sheets), instructor interviews, and trainee survey responses, where baseline data are compared with corresponding measures collected after SBT has been implemented. In this way, we infer the benefits that might have resulted from SBT in general, and structured methods of archiving experience to support scenarios, in particular. The difficulties associated with forming definitive conclusions under quasi-experimental conditions have been well-documented (Salas, Burke, Bowers, & Wilson, 2004). Nevertheless, positive reports, even if based on non-experimental, qualitative accounts, can at least give us a sign that we are on the right track.

For example, one can use less experienced training analysts to create scenarios when there is a structured framework as discussed above (Spiker et al., 2006a), since they can rely less on their personal experience and more on the archival accounts. An archiving framework also allows the scenario to be parceled out to multiple designers. The framework can be further enhanced by adding a sixth column, in which the training events are categorized by type of problem. Categorization becomes particularly important when a number of training events have been identified in the domain, where the optimal categorization scheme will depend on the job domain. In the area of flight training, a particularly useful scheme has been to classify events as falling into one of four problem areas: operational, environmental, equipment, and human factors (Spiker, 2006a).

Classifying events by problem type permits a logical ordering based on severity, frequency, and types of problems the student is expected to overcome. Using this scheme, analysts can design a scenario whose content difficulty is optimal for the student's current level of proficiency. Besides yielding an optimal level of difficulty, drawing content events from a categorization scheme can help create scenarios of comparable difficulty, though populated with different training events. This keeps the scenario regime fresh and unpredictable (Dubois & Gillan, 2000). Using the four-problem area scheme mentioned in the paragraph above, one could produce a scenario in which the trainees must takeoff with an aircraft whose gross weight exceeds recommended limits (operational problem). They might then experience, in succession, inadvertent instrument meteorological conditions (environmental problem), loss of radar altimeter (equipment problem), and an incapacitated crew member (human factors problem).

Ease of scenario construction can be a double-edged sword, however. While archiving frameworks can help populate a scenario with more detail, this can overwhelm trainees if left unchecked (Fischer et al., 2006). This problem can occur in several ways. On the one hand, ease of scenario development encourages the designer to inject more story lead-ins and backdrops for a given set of training events. In conducting formative evaluations of our training program for critical thinking, we discovered that users thought that the scenario vignettes varied too often with problem sets. Users instead preferred having a common back story structure (e.g., a single operational order that they would then review) as the basis for subsequent exercises (Fischer et al., 2006).

The other pitfall with easier development is that a greater amount of scenario material itself can be generated. This is particularly true when training cognitive KSAs, where the most frequent criticism of scenario background information is that they entail too much reading (Spiker et al., 2007). The multi-media literature has consistently shown that instructional materials need to minimize reading as much as possible (Mayer, 2001), so the experience-archiving system that one adopts should reflect this need. For example, one can use scenario templates where storylines are word-limited and supporting graphics are always required. Interestingly, all of the SBT evaluations we have conducted in recent years have found that a highly valued aspect of training is the ability to convene as a group, such as for roundtable discussions. While this activity may be *off script* for our individual training scenarios, it is well-received by participants and serves important team training functions. One should also consider having such stopping points in a scenario, where possible, to allow for face to face discussions, thus producing a blended training experience (Spiker et al., 2007).

One of the most important reasons for having structured archiving tools for scenario development is the assurance it provides for technical accuracy and operational relevance of the scenario. These features have consistently been found to dictate user acceptance, even more so than ease of use and other interface features (Fischer et al., 2006). To achieve this realism, we have found that it is important to work with SMEs of all types, where it is essential that we have tools that capture their expertise. The framework, checklist, worksheet, and event specification frames depicted in Figures 3–4 help ensure that this expertise is properly archived.

Since trainees and instructors do not want to be beta-testers, internal review of scenario quality is important as well. Figure 4 depicts examples of screen displays that inform scenario designers when they have violated pre-established rules concerning missing parameters (e.g., leaving out aircraft fuel amount), initial conditions, and logical conflicts (Walls et al., 2006). Prior to generating the completed scenario as output, these quality control indices are invoked and give designers clues on how to improve their scenario. Employment of automatic quality checking both increases scenario design efficiency and reduces the amount of in-simulator fixes that have to be employed once the scenario has been installed.

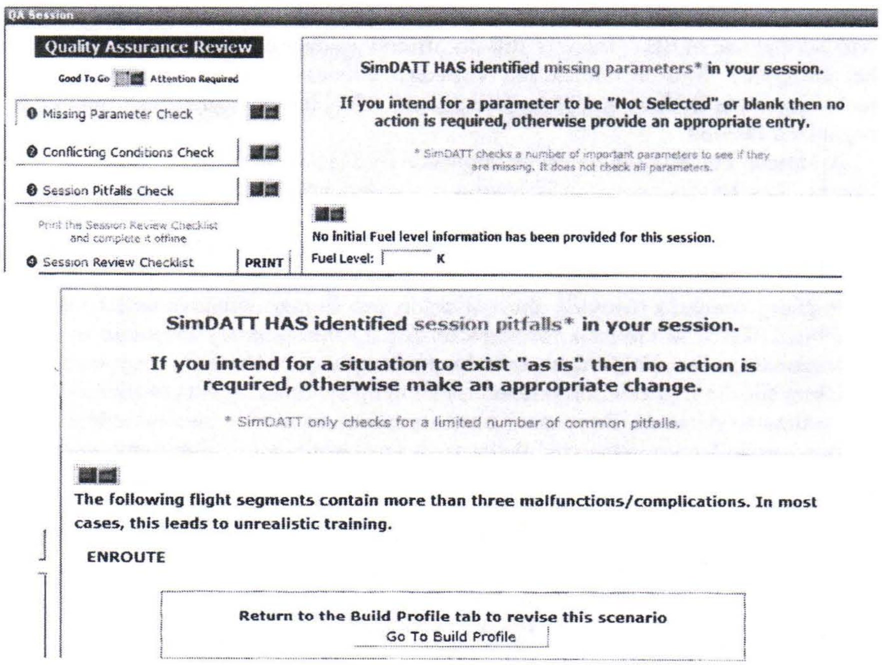

Figure 4. Example of a scenario quality control (QC) checking function.

Finally, our evaluations of SBT have indicated that, through interviews and formal surveys, instructors have little time to develop and refine scenarios (Walls et al., 2006). In fact, in many cases development of new training scenarios amounts to an added duty. Given the benefits to a training program that accrue from creating rich scenarios, it is imperative that structured archiving tools be available to help instructors and staff SMEs record their experiences as efficiently as possible. The multiple job demands on front-line instructors require that this expertise be extracted quickly, so other, less technically-versed individuals can interact with the material to package it into a more complete scenario format. In other words, having scenario archiving and design tools that separate the KSA-content from pedagogical aspects of instruction is an important ingredient to a successful SBT program (Spiker et al., 2006a).

USING SCENARIOS TO ORGANIZE TRAINING

Scenarios not only offer a useful means for recording and classifying training events, they also provide an effective way to organize the delivery of training. Since scenarios are the primary curriculum element in SBT, they must be represented in ways that they can be accessed quickly and inserted into the training flow at the appropriate time. Because ISD was developed prior to widespread use of SBT, there is still no official guidance for how scenarios are to be integrated into a curriculum (Spiker, 2006a). Below, we discuss five techniques we believe support delivery of SBT lessons and exercises in an organized fashion.

A simple but effective way to organize SBT is to house the scenarios in a library. Key to this approach is having a viewing area that contains a thumbnail sketch of each scenario, so users may rapidly search the library for scenarios of immediate interest. This concept is illustrated in Figure 5, where the upper part lists the scenarios by name while the lower part shows a thumbnail sketch for the highlighted scenario. Moving the cursor in the library window will cause the thumbnail sketch in the lower window to display the summary information of the corresponding scenario. In this example, our summary contains the major defining variables for the flight training domain, including synopsis, events, difficulty level, and estimated duration. Depending on the application, it may be desirable to have other scenario features depicted there, such as objectives or KSAs, among others. Importantly, a library organization helps time-pressured training analysts quickly find scenarios appropriate for upcoming SBT sessions. Exposing the training staff to the distinguishing features of scenarios in the summary window increases their core knowledge, which in turn, will help them modify scenarios to meet their immediate training needs (Prince et al., 1993). In this regard, our evaluations have shown that SBT-users are more likely to create and contribute new scenarios when they have ready access to a central scenario from which modular offshoots can be produced (Walls et al., 2006).

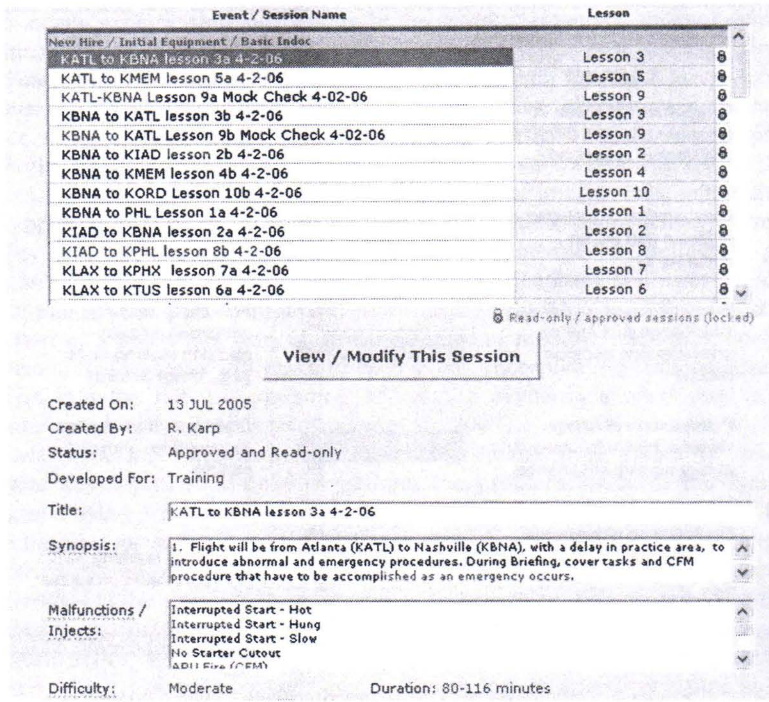

Figure 5. Example of a scenario library and viewing portal.

An effective long-term strategy for organizing SBT is to link each scenario to a set of underlying training objectives, allowing the objectives themselves to be the organizing theme. Unfortunately, SBT has a history of having open-ended simulator sessions without any underlying objectives (Salas et al., 2006). With that deficit in mind, we created a scenario development system, SimDATT, to help Navy training analysts develop cognitively-challenging flight profile scenarios for fixed wing aircraft (Walls et al., 2006). Each scenario was created to satisfy one or more explicit training objectives.

In a formative evaluation of the system, feedback from our test subjects revealed that it was not enough to specify training objectives, as these can seem somewhat ponderous and obtuse to students who are in the midst of the curriculum (Van Berlo, 2005). As well, the objectives should be linked to the student's specific learning goals. This linkage is illustrated in Figure 6, where each training objective (on the left) is translated into concrete learning experiences the trainee is expected to leave with. Thus, specifying the student learning goals, in addition to training objectives, becomes a more powerful way to organize training since it allows instructors to describe the upcoming scenario to the student in terms that are directly relevant to them.

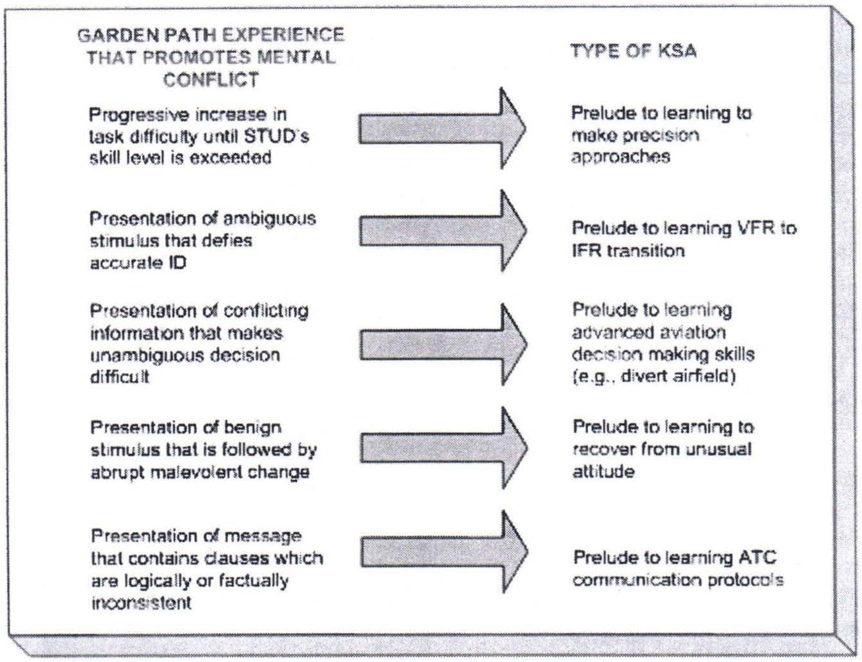

Figure 6. Linking scenario objectives to trainee learning goals.

A third organizational technique is to use a staged progression of scenarios, where scenarios are ordered according to basic principles of ISD (Swezey & Llaneras, 1997). Among these are the complexity and difficulty of the KSAs to be trained, where it is advisable to present the simpler and easier scenarios first, followed by scenarios whose events are progressively more complex and difficult. Difficulty can be manipulated by having setup conditions that approximate the real world (e.g., weather, visibility, winds, air traffic, aircraft configuration), and with training events that overlap in time and occur in higher densities (Greitzer, Pond, & Jannotta, 2004). Besides organizing scenarios by complexity and difficulty, it is important to have the presentation sequence ensure that trainees experience marked variability in the conditions, as this is a proven way to increase transfer of training to the criterion environment (Schmidt & Bjork, 1992). Likely reasons for such improved transfer include keeping trainee workloads to a manageable level, avoiding intense frustration periods that can demoralize students, adhering to a building block approach (crawl – walk – run), as well as allowing for a more natural, incremental acquisition of complex skilled behavior (Spiker, 2006a).

A fourth method for organizing SBT delivery is to give the instructor flexibility over how events are injected into the scenario. This will usually require that the IOS be programmed to support both automatic and manual delivery of events. The former will be pre-determined based on certain trigger events in the environment, such as at a specific time or location in the session. However, manual delivery of events can be useful since the trainee's responses to prior events cannot always be predicted; hence, the scenario might proceed down a path for which pre-programmed events are no longer appropriate. In these instances, allowing the instructor to inject response-contingent events is effective for maintaining an appropriate difficulty level. In implementing this dual method of control, the list of possible events contains a mix of scripted (planned) and unscripted events, where the latter lets the instructor tweak the scenario to fit the trainee's proficiency level. This duality also makes scenario control adhere to principles of deliberate practice (Ericsson, Krampe, & Tesche-Romer, 1993), where feedback and repetitive practice are explicitly designed to improve performance on a targeted KSA. Recall that a key part of a scenario's story is its anticipation of possible responses, correct and incorrect, that trainees will make to each event. Incorporating response-contingent control into the IOS programming of training events is a good way to handle unanticipated trainee responses (Spiker et al., 2007).

Finally, a key organizational capability entails progressive or telescopic content development. With this method, the problem space of the scenario is designed using progressive increase in detail. In the use of our SimDATT tool for pilot training, the authoring sequence is: (1) desired overall KSA behaviors/concepts, (2) instructional objectives to be achieved, (3) the basic training flight profile to be flown, (4) the training scenario events to be accomplished, and (5) a detailed script for instructors and any role-playing entities (Spiker, 2006a). For example, in constructing a lesson plan scenario for a CRJ 200 flight training device, we started with an overall concept of inserting a low hydraulic pressure indication into the flight profile. The instructional designer then took this notion and progressively increased its detail and placed it into the scenario. This culminated in Step 5, as a script for the instructor, to be spoken right after the event, role-playing air traffic control to distract the trainee and increase scenario difficulty (Spiker, et al., 2006a).

Telescoping helps the instructor keep the big picture in mind before drilling down to the specific details that will actually be programmed in the simulator. Not only is the general-to-specific technique a proven design method, it is an effective approach for any planning activity (Van Berlo, 1998). In our SBT evaluations, telescoping content down to the kernel KSAs was viewed as an essential capability of any scenario authoring system (Spiker et al., 2006a).

CONCLUSIONS AND FUTURE DIRECTIONS

Like its storytelling cousins, scenarios provide an effective way to engage trainees in the instructional process by stressing interactive learning and critical thinking. Scenarios have additional features that make for a good training framework. Among these are an implicit or explicit timeline of action, an event-based focus that elicits behaviors underlying the to-be-acquired KSAs, training objectives, and individual trainee goals. When scenario design includes a specification of potential trainee responses to each event and a verbal/behavioral script for the instructor, it then creates a solid foundation on which SBT can be based.

This chapter discussed two aspects of SBT: (1) using scenarios to capture and archive experience and (2) organizing the delivery of SBT in the context of these scenarios. Regarding the former, scenarios capture user experiences, perhaps embellishing them, to make a compelling, engaging story that draws the trainee in. Because scenario construction is difficult, even for technical experts, tools and techniques are needed to help SMEs and instructors fold operational experience into scenario design. Besides critical incident workshops, other effective methods for stimulating and archiving experience include structured frameworks, checklists, worksheets, and even formal scripts. Evaluations of SBT reveal that capturing operational details into scenarios increases user acceptance. But this must be balanced against giving too much detail that can overwhelm inexperienced trainees. Having an automated method of computing scenario quality, presently in its experimental stages, is likely to be an effective method in the future to ensure that experience has been correctly archived within the scenario.

With regard to organizing SBT delivery, five techniques are particularly helpful. A simple method involves placing scenarios into a library, where highlighted scenario entries have an accompanying summary window of key information items for rapid selection. Other organizing techniques include linking scenarios to training objectives and associated trainee learning goals, ordering scenarios on the basis of complexity or ease of learning, providing instructors with the means to inject training events either automatically or manually, and using a progressive or telescoping method of content development. With this latter technique, scenarios are developed in stages, starting with underlying KSAs, and followed in turn by instructional objectives, mission profile or event timeline, the events themselves, and a detailed script for the instructor and all role-playing entities.

While advances have been made in our understanding of scenario design and SBT delivery, more work is clearly needed. One area in need of more study concerns the evaluation of SBT effectiveness. As convincingly described in Salas et al. 2001, evaluations of training systems are difficult to conduct since the no-scenario control group is rarely fielded. Assessments are thus limited to demonstrating user acceptance, with scant data collected on degree of learning, transfer, or organizational impact (Kirkpatrick, 1987). Innovative techniques are needed to collect data from users possessing a corporate memory to provide valid ratings following SBT implementation of what has improved, what has declined, and what has not changed at all. Besides baseline/post-implementation differences, experimental contrasts of SBT and true non-scenario control conditions need to be conducted where practical.

A promising development in scenario design is the increasing use of powerful scenario authoring tools and wizards. Such tools will guide the novice analyst through all the steps needed to archive experiences, create storylines, define events, and piece them together on a timeline in pedagogically effective ways. Coupled with embedded performance measurement and help features, wizards can support both adaptive training, customizing training events in real-time to the trainee's current level of proficiency, and just-in-time training, while adhering to a standardized set of KSAs and training events. Authoring tools will also permit less experienced training analysts to be productive participants in training design and delivery.

Peering out further into the future, there are other new capabilities that could promote SBT. For example, one can use serious games – games intended to provide education or instruction – as a way to package scenarios in a competitive but entertaining environment (Mautone, Spiker, & Dick, 2007). Another trend involves the use of wikis to create collaborative knowledge environments that *reach back* to operational units and incorporate their feedback in drafting topical scenarios.

Finally, scenario development and delivery are part of a global transformation in training in which training is really just one aspect of an individual's personal and lifelong professional development. Thus, advances are not confined to formal training episodes in the classroom or simulator (Day & Halpin, 2003). This implies that student motivation must be emphasized to ensure that performance continues to improve beyond that required during formal training. Distance learning, where scenarios can be accessed and experienced on the trainee's home computer on their own time, must be brought under the scenario rubric to ensure that principles of effective scenario design and implementation, as discussed above, are adhered to in the ubiquitous Internet environment. Since trainees' internal transformations are mobile and long-lasting, we will need well-designed scenario tools and delivery practices to help ensure that this transformation proceeds in a positive direction.[1]

NOTES

1 Portions of the research presented in this chapter were funded by contracts from the Naval Air Systems Command (N61339-02-C-0135), Army Research Institute (DASW01-04-C-008, W74V8H-04-C-0007), and Air Force Research Laboratory (F33615-03-C-6319). The author wishes to thank the following individuals who served as contract monitors on those respective contracts: Dr. Melissa Walwanis-Nelson, Dr. Michelle Zbylut, Sharon Riedel, and Dr. Robert Nullmeyer.

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