



PNNL Scenario-Based Guided-Discovery Approach to e-Learning

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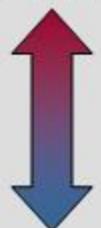
Objectives of Our Guided-Discovery Approach to e-Learning

- ▶ Develop and apply effective paradigms for learning based on sound principles of human learning and cognition
- ▶ Create innovative uses of interactive, scenario-based exercises as a foundation for a guided-discovery approach to e-Learning

Background

▶ Four instructional architectures*

- Receptive
- Directive
- Guided Discovery
- Exploratory



Passive, constrained

Active, unconstrained

▶ Receptive and Directive (“passive” learning)

- Many traditional courses adopt a receptive or directive architecture
- Information is presented in a series of lessons, each followed by objective questions to test the learner’s understanding.

▶ Guided Discovery (“active” learning)

- A more experiential approach presents realistic problems (scenarios) and provides coaching to facilitate learning.
- As the learner gains knowledge and skill, the level of coaching diminishes and more responsibility is left to the student.

*Clark, R. (1998). *Building Expertise: Cognitive Methods for Training and Performance Development*. Washington D. C.: International Society for Performance Improvement.

Ingredients of Effective Learning Environments

- ▶ Problem-based
- ▶ Actively engage students by:
 - Activating prior experience → **Relate to real world**
 - Demonstrating skills → **TELL, SHOW**
 - Applying skills → **ASK, DO**
 - Integrating skills → **Transfer to real world**

Problem: Many instructional strategies focus on more receptive/directive aspects of instruction (“TELL” and “ASK”).
More attention should be directed to SHOW and DO!

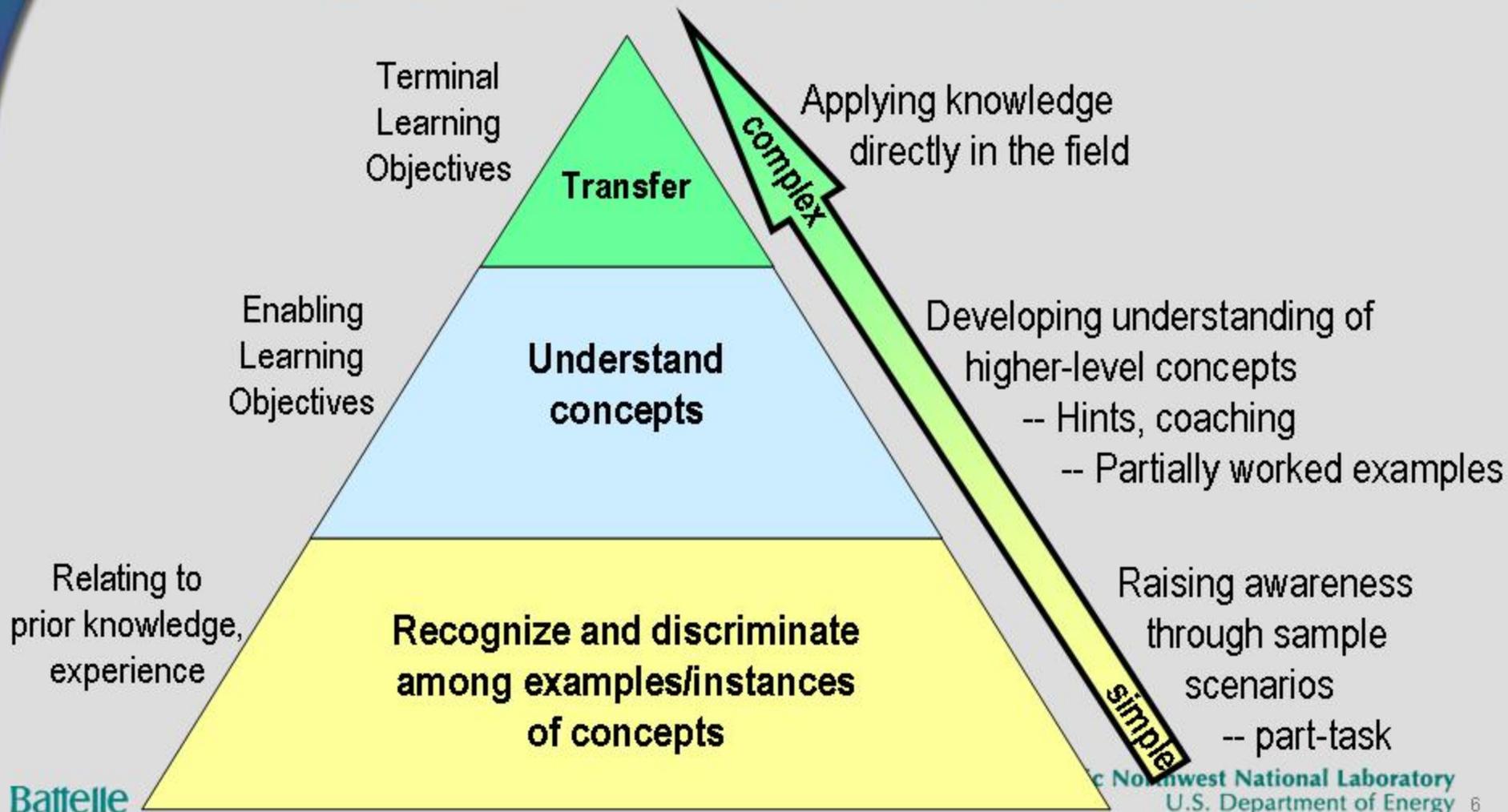
Why Guided Discovery?

- ▶ Great potential for cognitive skills training
 - Emphasizes problem solving
 - Start with tasks the learner knows
 - Provide coaching/hints
 - Gradually add complexity and decrease coaching

(This is similar to the constructivist approach to learning)

Challenge: Cognitive Load in Discovery Learning

To construct realistic training scenarios that do not overwhelm the learner early in the training program, we must manage the complexity of learning content...



Application:



ESTHER Self-Directed Study

Scenario-Based Training on Human Errors Contributing to Security Incidents

**Pacific Northwest
National Laboratory**

Operated by Battelle for the
U.S. Department of Energy



ESTHER e-Learning

- ▶ The Enhanced Security Through Human Error Reduction (ESTHER) program provides tools to help identify factors that contribute to human errors in security incidents
- ▶ Training on ESTHER aims to raise awareness on human errors and promote accurate documentation by DOE security inquiry officials
 - Los Alamos National Laboratory developed and conducts ESTHER workshops
 - Pacific Northwest National Laboratory developed an interactive, self-directed computer-based training program to complement the workshops.

Background: Error Contributing Factors

Data Flow	Work Setting	Work Planning/Control	Employee Readiness
<input type="checkbox"/> Information	<input type="checkbox"/> Distractions	<input type="checkbox"/> Job Pressure	<input type="checkbox"/> Preoccupation/Inattention
<input type="checkbox"/> Procedures/Directions	<input type="checkbox"/> Material/Resources	<input type="checkbox"/> Time Factors	<input type="checkbox"/> Stress/Anxiety
<input type="checkbox"/> Communication	<input type="checkbox"/> Environmental	<input type="checkbox"/> Task Difficulty	<input type="checkbox"/> Fatigue/Boredom
<input type="checkbox"/> System Status/Feedback	<input type="checkbox"/> Management Systems	<input type="checkbox"/> Task Aversion	<input type="checkbox"/> Illness/Injury
	<input type="checkbox"/> Security Practices	<input type="checkbox"/> Change in Routine	<input type="checkbox"/> Drug Side Effects
		<input type="checkbox"/> Task Planning	<input type="checkbox"/> Misperception
		<input type="checkbox"/> Management	<input type="checkbox"/> Memory
		<input type="checkbox"/> Ability	<input type="checkbox"/> Reasoning/Judgment
		<input type="checkbox"/> Experience/Skill	<input type="checkbox"/> Values/Attitudes
		<input type="checkbox"/> Knowledge	

Error Contributor: Data Flow

Data Flow	
<input type="checkbox"/>	Information
<input type="checkbox"/>	Procedures/Directions
<input type="checkbox"/>	Communication
<input type="checkbox"/>	System Status/Feedback



Confusion about complicated procedures...

Error Contributor: Work Setting

Work Setting	
<input type="checkbox"/>	Distractions
<input type="checkbox"/>	Material/Resources
<input type="checkbox"/>	Environmental
<input type="checkbox"/>	Management Systems
<input type="checkbox"/>	Security Practices



Messy office...

Error Contributor: Work Planning & Control

Work Planning/Control

- Job Pressure
- Time Factors
- Task Difficulty
- Task Aversion
- Change in Routine
- Task Planning
- Management
- Ability
- Experience/Skill
- Knowledge



Balancing time constraints and safety...

Error Contributor: Employee Readiness

Employee Readiness
<input type="checkbox"/> Preoccupation/Inattention
<input type="checkbox"/> Stress/Anxiety
<input type="checkbox"/> Fatigue/Boredom
<input type="checkbox"/> Illness/Injury
<input type="checkbox"/> Drug Side Effects
<input type="checkbox"/> Misperception
<input type="checkbox"/> Memory
<input type="checkbox"/> Reasoning/Judgment
<input type="checkbox"/> Values/Attitudes



Distractions...

Objectives of the ESTHER e-Learning R&D

- ▶ Develop a blended learning architecture by coordinating the workshop and computer-based training programs
- ▶ Provide distinct and varied pathways to learning by triangulating instructional approaches
- ▶ Implement a guided-discovery learning approach as the foundation for self-directed computer-based instruction.

ESTHER Pathways to Learning

Classroom

Human Error
Overview

Overview of
ESTHER
system

ESTHER Causes
& Contributors
To Error (Terms)

**Focus of this
presentation**

Self-
Directed

Discovering
Contributors,
Prompted

Using
Contributors,
Unprompted

Documentation
Using ESTHER
Terms

3-level feedback

3-level feedback

3-level feedback

Field
Application

Incident Inquiry

Documentation
ITAC
using ESTHER
terms

Data Aggregated
For
"Lessons Learned"

Managing Complexity of Learning Content

Discovery learning imposes a greater cognitive load on the learner...



Terminal Learning Objectives

Transfer
Conduct Inquiry

Applying knowledge directly in the field



Enabling Learning Objectives

Understand concepts

Developing understanding of higher-level concepts
-- Hints, coaching
-- Partially worked examples

Human Error Contributors

Relating to prior knowledge, experience

Recognize and discriminate among examples/instances

Raising awareness through sample scenarios
-- part-task

Observations

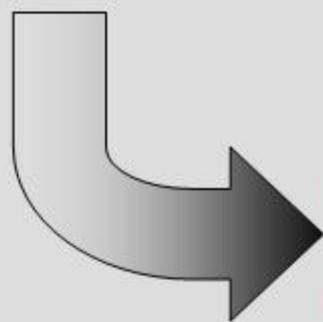
complex

simple

Structuring Guided Discovery Material

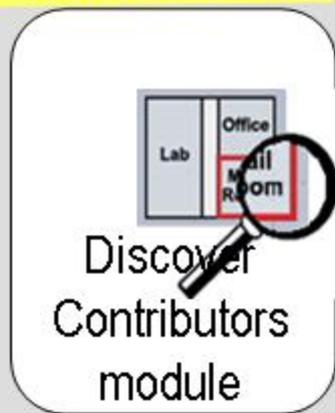


Managing Complexity of Learning Content

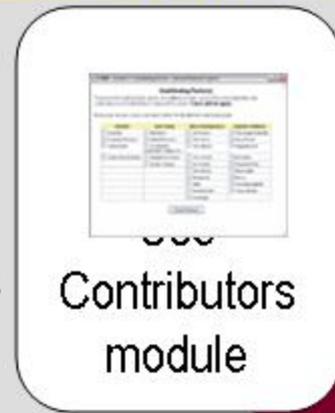


- ▶ Progress from simple to complex tasks
- ▶ Part-task methods to divide task into basic components
- ▶ Provide multi-level coaching (hints)

Respond with Observations



Respond with Contributors



Drop back to guided discovery if necessary

Discovery Module – Scenario Description

Learner “explores” evidence to discover observations that apply to the scenario...

Incident tab provides description

ESTHER - Scenario 1 - Microsoft Internet Explorer

ESTHER Self-Directed Study

Home Discover Contributors Use Contributors Resources

Scenario 1

Incident Overview

Reported Category: Improperly transmitted material:
US Mail

Reported Incident: Envelope came open before
reaching its target destination, revealing Secret
Restricted Data (SRD)

Report Date: May 28, 2004

Instructions

Examine the materials available to you and, using the categories at the bottom of the page, select all observations that you believe may have contributed to the reported incident.

When you have finished selecting your observations, check your answers by clicking the Check Observations button. You will have three tries to find all relevant observations.

Select a tab on the left to begin.

Scenario 1
Selected Observations:
Check Observations

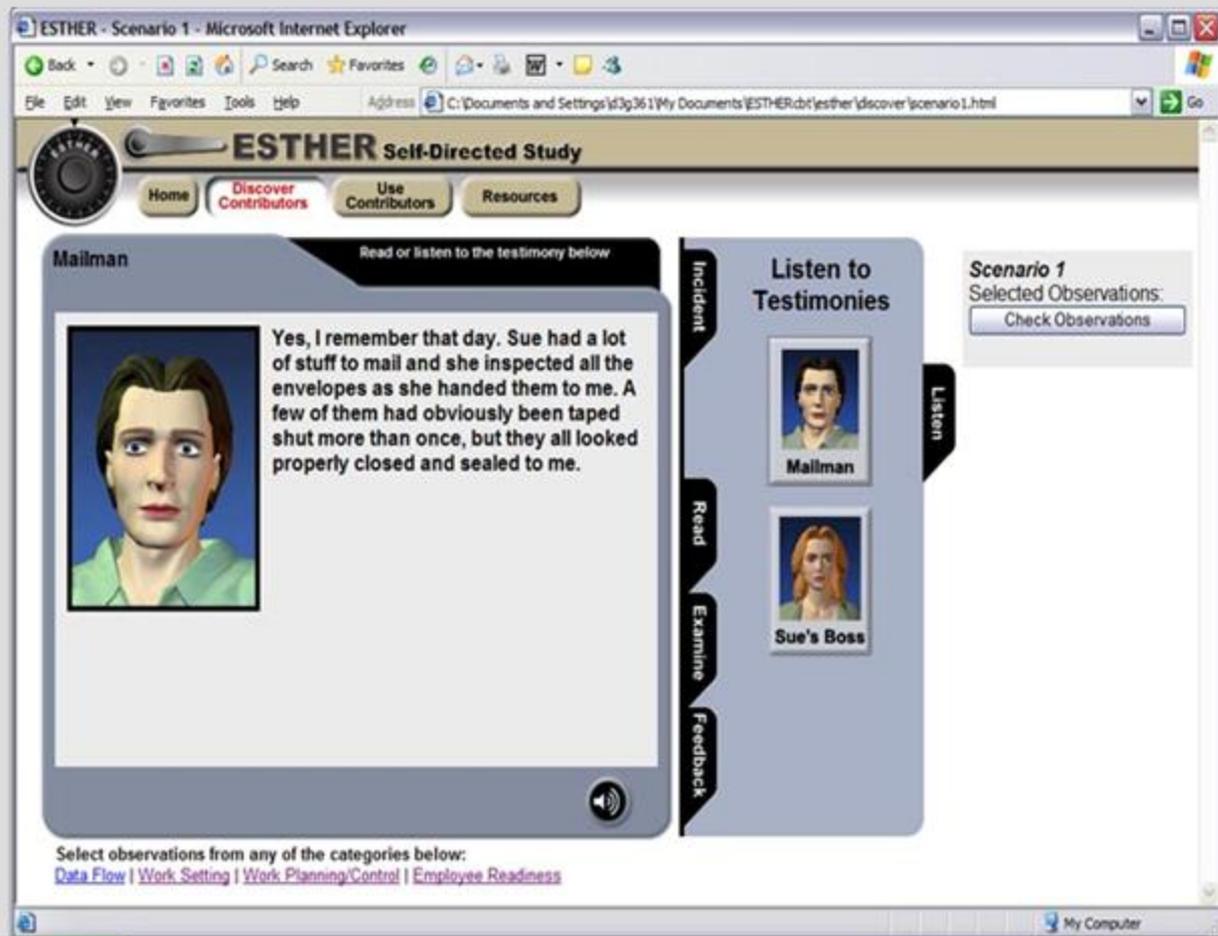
Select observations from any of the categories below:
[Data Flow](#) | [Work Setting](#) | [Work Planning/Control](#) | [Employee Readiness](#)

Discovery Module – Testimonies

Learner “explores” evidence to discover observations that apply to the scenario...

Listen tab shows testimonies

Read tab shows documents



Discovery Module – Simulation/Animation

Learner “explores” evidence to discover observations that apply to the scenario...

Examine tab shows simulated interactive re-enactment of one or more scenes

The screenshot shows a web browser window titled "ESTHER - Scenario 1 - Microsoft Internet Explorer". The address bar shows the URL: "C:\Documents and Settings\j3g361\My Documents\ESTHER\cbt\esther\discover\scenario1.html". The page header includes the "ESTHER Self-Directed Study" logo and navigation buttons for "Home", "Discover Contributors", "Use Contributors", and "Resources".

The main content area is titled "You are in the Mail Room" and includes the instruction: "Search for clues in the scene and select them for examination". It features a 3D animated scene of a mail room where a woman in a white shirt and yellow skirt is handing a yellow envelope to a man in a green uniform. A sign above the woman reads "Mail Pickup 3:00 pm". A progress bar is visible at the bottom of the scene.

To the right of the scene is a vertical navigation menu with tabs for "Incident", "Listen", "Read", and "Feedback". The "Examine" tab is currently selected, showing the "Examine Scene" section with a "Go to Mail Room" link and a "Check Observations" button. Below this, it says "Scenario 1 Selected Observations:".

At the bottom of the page, there is a section titled "Select observations from any of the categories below:" with links for "Data Flow", "Work Setting", "Work Planning/Control", and "Employee Readiness".

Discovery Module – Feedback

Multilevel feedback is provided after learner selects observations that apply to the scenario

Levels of Feedback:

General



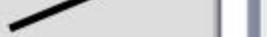
Response Feedback:
Some selected observations are not relevant to this scenario. One or more relevant observations are missing. Keep trying. Review the evidence again to find any other relevant observations.

Correct/Incorrect



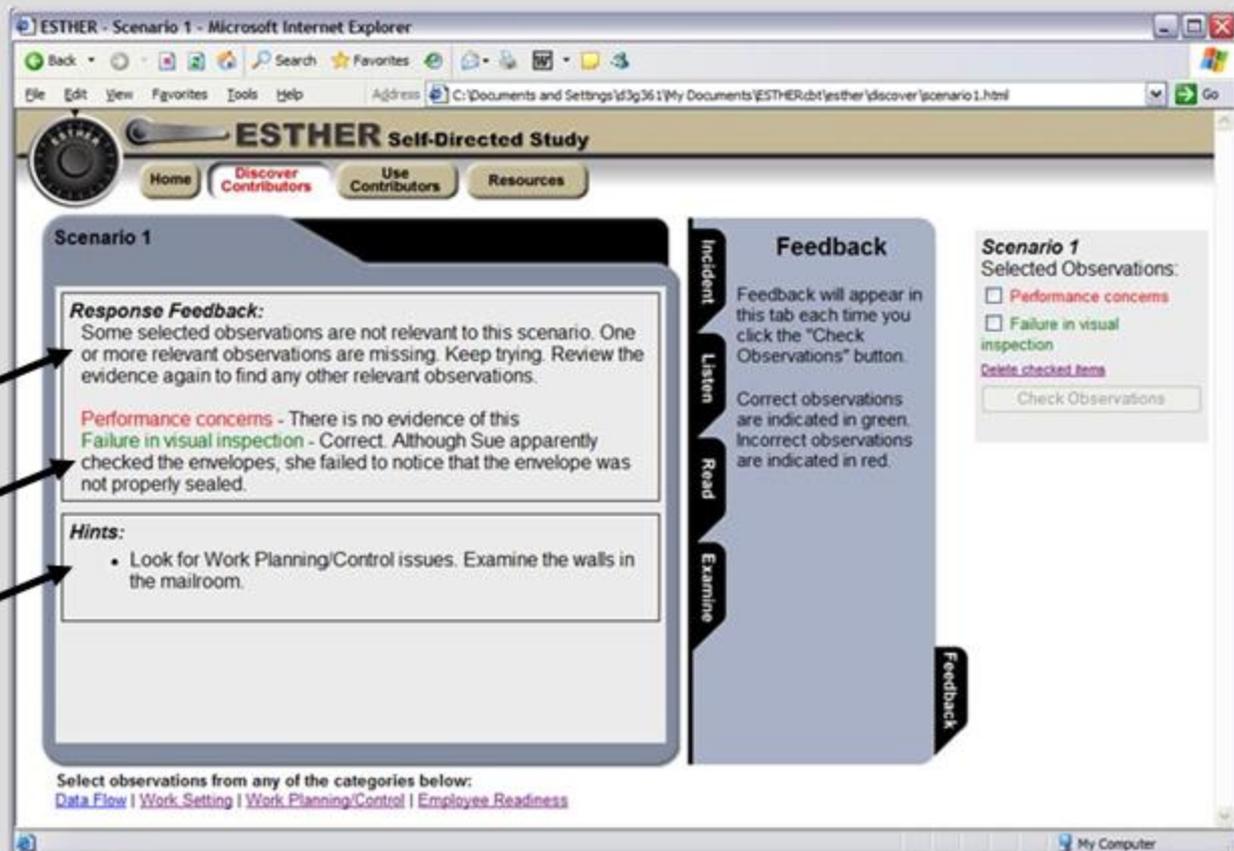
Performance concerns - There is no evidence of this
Failure in visual inspection - Correct. Although Sue apparently checked the envelopes, she failed to notice that the envelope was not properly sealed.

Hints



Hints:

- Look for Work Planning/Control issues. Examine the walls in the mailroom.



Discovery Module – Higher Level Concepts

Observations are related to the ESTHER contributors on the reporting form

ESTHER Self-Directed Study

Home Discover Contributors Use Contributors Resources

Solution for Scenario 1

Congratulations! You have completed this scenario. Click on "Discover Contributors" to try another.

Click observations to highlight ESTHER contributors. Click contributors to highlight corresponding observations. Note the descriptions entered by the Inquiry Official on the ITAC form.

Relevant Observations:

Deadline

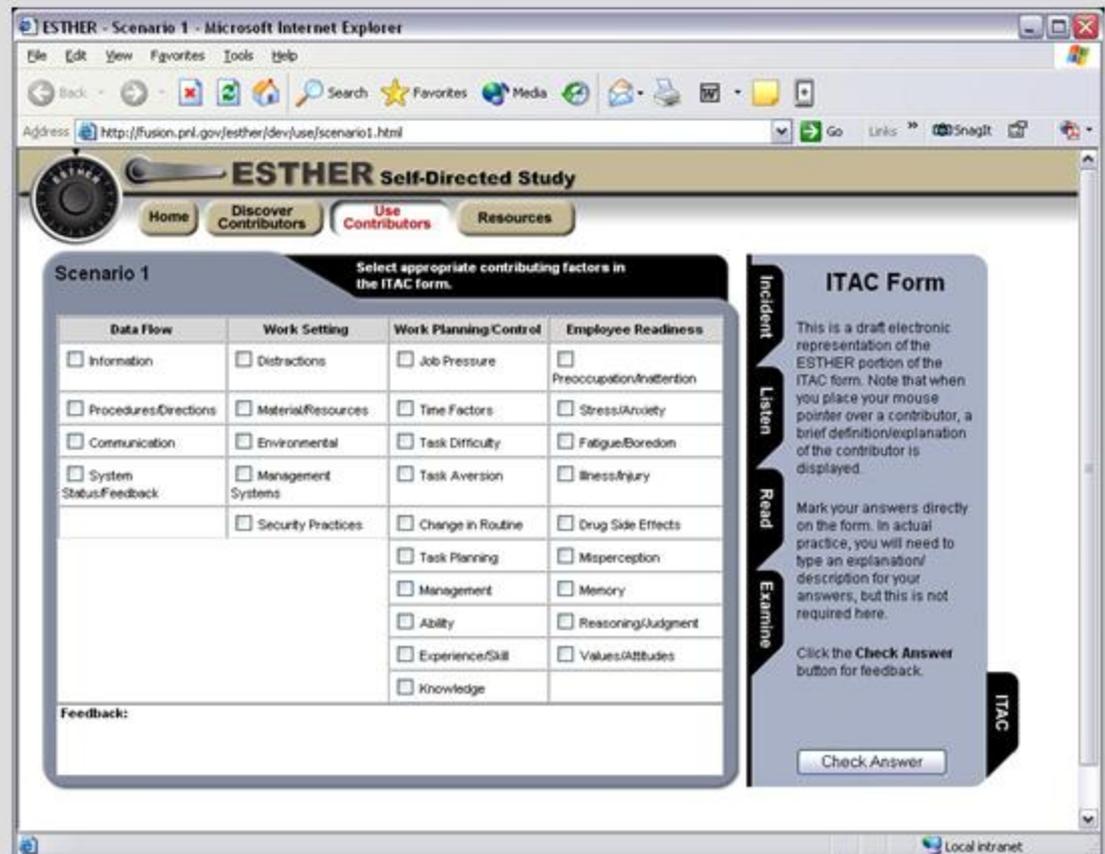
Failure in visual inspection

ITAC			
Incident ID: Scenario 1			
Determination of Inquiry: Contributing Factors			
Data Flow	Work Setting	Work Planning/Control	Employee Readiness
<input type="checkbox"/> Information	<input type="checkbox"/> Distractions	<input type="checkbox"/> Job Pressure	<input type="checkbox"/> Preoccupation/Inattention
<input type="checkbox"/> Procedures/Directions	<input type="checkbox"/> Material/Resources	<input checked="" type="checkbox"/> Time Factors	<input type="checkbox"/> Stress/Anxiety
<input type="checkbox"/> Communication	<input type="checkbox"/> Environmental	<input type="checkbox"/> Task Difficulty	<input type="checkbox"/> Fatigue/Boredom
<input type="checkbox"/> System Status/Feedback	<input type="checkbox"/> Management Systems	<input type="checkbox"/> Task Aversion	<input type="checkbox"/> Illness/Injury
	<input type="checkbox"/> Security Practices	<input type="checkbox"/> Change in Routine	<input type="checkbox"/> Drug Side Effects
<p>Description:</p> <p>Project/work-related deadline was not met.</p>		<input type="checkbox"/> Task Planning	<input checked="" type="checkbox"/> Misperception
		<input type="checkbox"/> Management	<input type="checkbox"/> Memory
		<input type="checkbox"/> Ability	<input type="checkbox"/> Reasoning/Judgment
		<input type="checkbox"/> Experience/Skill	<input type="checkbox"/> Values/Attitudes
		<input type="checkbox"/> Knowledge	

You may have felt that some observations apply even though they were not considered "correct." This is open to interpretation and certainly depends upon individual circumstances. Some contributing factors may be expected to occur together. See the [ESTHER Crosswalk](#) job aid for further insight about potentially related contributors. Try the following scenarios, which may help explain why some observations or contributors were deemed significant in one scenario but not in another. **Scenario 2, Scenario 3**

Advanced Module – Use Contributors

Learner works on similar scenarios but must respond directly using ESTHER contributors on the reporting form



ESTHER - Scenario 1 - Microsoft Internet Explorer

Address: http://fusion.pnl.gov/esther/dev/use/scenario1.html

ESTHER Self-Directed Study

Home Discover Contributors **Use Contributors** Resources

Scenario 1 Select appropriate contributing factors in the ITAC form.

Data Flow	Work Setting	Work Planning/Control	Employee Readiness
<input type="checkbox"/> Information	<input type="checkbox"/> Distractions	<input type="checkbox"/> Job Pressure	<input type="checkbox"/> Preoccupation/Inattention
<input type="checkbox"/> Procedures/Directions	<input type="checkbox"/> Material/Resources	<input type="checkbox"/> Time Factors	<input type="checkbox"/> Stress/Anxiety
<input type="checkbox"/> Communication	<input type="checkbox"/> Environmental	<input type="checkbox"/> Task Difficulty	<input type="checkbox"/> Fatigue/Boredom
<input type="checkbox"/> System Status/Feedback	<input type="checkbox"/> Management Systems	<input type="checkbox"/> Task Aversion	<input type="checkbox"/> Illness/Injury
	<input type="checkbox"/> Security Practices	<input type="checkbox"/> Change in Routine	<input type="checkbox"/> Drug Side Effects
		<input type="checkbox"/> Task Planning	<input type="checkbox"/> Misperception
		<input type="checkbox"/> Management	<input type="checkbox"/> Memory
		<input type="checkbox"/> Ability	<input type="checkbox"/> Reasoning/Judgment
		<input type="checkbox"/> Experience/Skill	<input type="checkbox"/> Values/Attitudes
		<input type="checkbox"/> Knowledge	

ITAC Form

This is a draft electronic representation of the ESTHER portion of the ITAC form. Note that when you place your mouse pointer over a contributor, a brief definition/explanation of the contributor is displayed.

Mark your answers directly on the form. In actual practice, you will need to type an explanation/description for your answers, but this is not required here.

Click the **Check Answer** button for feedback.

Check Answer

Local intranet

Interactive Multimedia Implementation

- ▶ Experiential learning approach places a premium on use of interactive graphics/multimedia
 - 3-D modeling software (Maya 3D) used to render scenario environments (offices, mail room, various objects, etc.)
 - Macromedia Director and Shockwave used to produce interactive scenes

Assessing Outcomes*

- ▶ **Level 1 (learner response)**
 - assessed through written evaluation forms
- ▶ **Level 2 (learner skills acquisition)**
 - assessed via workshop observations and recorded CBT performance
- ▶ **Level 3 (application)**
 - will be assessed by analyzing inquiry reports obtained via the online reporting system
- ▶ **Level 4 (organizational impact)**
 - may be assessed over a longer period of time by analyzing trends in frequency and type of security incidents across the DOE complex.

*Kirkpatrick, Donald. (1998). *Evaluating Training Programs: The Four Levels*. 2nd Edition. San Francisco: Berrett-Koehler.

Plans

- ▶ Implement more comprehensive guided-discovery scenarios
- ▶ Gradually shift training emphasis from on-site Workshops to e-Learning
- ▶ Pursue further research and application of this work:
 - Use Guided Discovery approach to train general staff to identify and eliminate error contributing factors and *prevent* security incidents
 - Adapt ESTHER and Guided Discovery tools to support safety/accident prevention programs
 - Apply this technology to other training and assessment applications.

Conclusions

- ▶ The guided-discovery e-Learning implementation represents a relatively new approach to computer-based training
- ▶ This work has broad implications in forming a foundation for cognitive-based performance support systems for learning and sustaining complex cognitive skills.



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