A Virtual Simulator Instructor for Training System Operators

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Outline

• Why is a Virtual Simulator Instructor (VSI) useful?
• What is an expert system operator?
• How does an expert operator make decisions?
• Capturing knowledge of expert operators and trainers.
• Certifying veterans as system operators.
• Future enhancements.

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Applications for a VSI

• Definition: Training Objectives are accomplished without presence of a human instructor.

• SMEs can focus on Analysis, Design, Development and Evaluation – independent of student population.

• VSI handles Implementation – and is scalable to a large student population.
What is an Expert System Operator?
Situational Awareness

- Perceiving of environmental elements with respect to time and/or space.
- Comprehension of their meaning.
- Projecting their status after some variable has changed; e.g. time, or an event.
Situational Awareness

• **WHAT:** Perception of environmental elements with respect to time and/or space.

• **SO WHAT:** The comprehension of their meaning.

• **NOW WHAT:** The projection of their status after some variable has changed; e.g. time, or an event.
Levels of Expertise
Dreyfus and Dreyfus 1986

- **Stage 1 Novice** – Explicit rules susceptible to context and nuance
- **Stage 2 Advanced Beginner** – Nuance and context begin to be recognized and incorporated
- **Stage 3 Competence** - Transition from calculated effort to intuitive solutions
- **Stage 4 Proficiency** – Scenarios are now being recognized as whole parts, some analysis and conscious choice remains
- **Stage 5 Expertise** – Complete contexts are recognized and performance is fluid and unselfconscious.
Novices vs Experts

Novice Pattern

- Read
- Analyze
- Explore
- Plan
- Implement
- Verify

Expert Pattern
Expert Operator Decision Model
Naturalistic Decision Making

• Typical industry training doesn’t match the way *people think*. Effective training for critical decision making must be *informed* by cognitive theories and models.

• **Naturalistic Decision Making** (NDM) is an area of cognitive science that describes how experienced individuals and teams perform in real-time, mission-critical environments.

• First NDM conference held in 1989
Example Applications of NDM

- Health Care – Surgeons, Nurses
- Command and Control
- Aviation
- Business and Industrial Applications
- Process Control
- Material Requirements Planning
- Nuclear Power Plant Emergencies
- Naval Officers in Littoral Environments
- Skilled Fighter Pilots
- Australian Rifle Team
Decision Making Challenges

- Competing Goals
- Multiple Players
- Dynamic Settings
- Time Stress
- High Task Loading
- Uncertainty
- Organizational Factors
- High Stakes
Usability Tests at Pacific Northwest National Laboratories

- Control Group with Tabular Contingency Analysis.
- Experimental Group with Graphical Contingency Analysis.
- TEST 1: Test with Seven Individual Operators
- TEST 2: Instructor lead NERC CEH Class of 16 Operators
- Recorded interview on the thought process used by each operator.
- Performance of each operator evaluated using Cues, Patterns and Actions.
- Identified desire for faster cycle times.
Capturing Knowledge of Expert Operators and Trainers
Tacit and Explicit Knowledge

• Tacit Knowledge
  – We know more than we tell.
  – Not documented
  – Intuition, Blink, Think Fast - Think Slow.
  – Slow transfer from master to apprentice.

• Explicit Knowledge
  – Documented, repeatable.

• Simulation > Spiral of Knowledge Transfer
  – Implicit knowledge of master documented as explicit library of scenarios and solutions.
  – Implicit knowledge of student develops as student studies scenarios – adapts to own situation.
PALCO Scenario Developers

- RCs and TOPs: AEP, CAISO, CETAC, ERCOT, MISO, PJM, SERC, WECC.
- Training Suppliers: APTC, Blue Water, GTS, IncSys, OESNA, QTS, SOS.
- Developed at level of enabling objectives and terminal objectives.
- Based on hypothetical scenarios on hypothetical system.
- Process started 2001 and is still going.
PALCO Scenarios and NERC TOP Exam Contents

• Coordinate the re-synchronization of transmission at preplanned locations.
• Coordinate voltage reduction as requested or directed.
• Develop and execute corrective actions when equipment ratings or operating limits are exceeded.
• Implement a plan for restoring the system to a safe operating condition following a forced outage.
• Direct actions to return the system to a secure state following a major system disturbance.
• Shed load for system reliability.
• Identify and take action when partial or full system islanding occurs.
Virtual Simulator Instructor Modes

• Presenter - FLASH Tutorials
• Demonstrator – Narrated Screen shots
• Director – “Driving with directions”
• Facilitator – “Flying on mission”
VSI Applications

  – More than NERC 2000 operators provided with CEH.
• Training of Iraq Ministry of Electricity Real-time Engineers.
  – Reliability improved from 2008 to 2011.
• Power4Vets – recruiting, training, certifying and placing veterans as system operators.
  – 39 veterans certified.
Lonnie Bush Story

A Navy Nuclear trained First Class Petty Officer (E-6) with over 7 years of experience. Stationed aboard the USS Dwight D. Eisenhower (CVN-69), home ported out of Norfolk, VA. He started Power4Vets on 14 November 2011 and landed a job with AEP in Ohio as a System Control Center Operator in July 2012.

“Quote from Lonnie Bush”

“The Power4Vets program was more hope that I can ever have imagined”

- Lonnie Bush (U.S. Navy)

Mike Anderson – AEP, Supervisor of Transmission and Real Time Operations

The Power4Vets trained veterans that we have hired has helped us close the gap in our training process by 2-4 years and putting veterans into Operator Positions rapidly. Hiring a Power4Vets graduates have proven to be a huge SUCCESS for AEP. We want more veterans like Robert Epps, Robert Grubs and Lonnie Bush.
Future Enhancements
Future Enhancements

- Video recording of actual instructors and speech to text transcription for presentation mode.
- Ability to work with Custom Models.
- Extend simulation to cover cascading outages.
- Capture knowledge from recorded student conversations.
- Challenger mode with levels of difficulty.
- Evaluator mode using NERC RSI
- Massive On-Line Grid Games – 100s of students controlling an entire region – hosted on cloud.
RAILBELT System Map

FAIRBANKS

GOLDEN VALLEY ELEC. ASSOC.

CHUGACH ELECTRIC ASSOC.

ANCHORAGE MLP

ANCHORAGE ELECTRIC ASSOC.
RAILBELT Scenarios

- Developed by Mark Sickles – retired CEA System Operator.
  - Teeland RAS
  - Kenai Island Avalanche
  - Beluga Generation Bus Fault
  - System Restoration
  - Beluga - Pt. McKenzie Line Faults
  - International Bus Fault with Stuck Tie Breaker.
  - Pt. McKenzie Transformer Fault
- Used to train 320 SERC operators in 2012, 2013.
Scenario Format

- Learning Objectives
- Time
- Event Description
- Situational Awareness
- Expected Actions
- Expected Notifications
- Common Mistakes
- Scenario Options – Complicating Factors
- Safety Issues
Summary

• Industry has shared knowledge capture for the Generic PALCO system.

• Opportunity exists to share knowledge capture for system specific simulations.

• Barriers:
  – System operators are reluctant to use planning models for simulator training.
  – TOPs are reluctant to share breaker oriented models.

• Solution – Model factory to build models for specific drills.
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