



Real-time Coaching in Virtual Worlds

Bruce Roberts
BBN Technologies

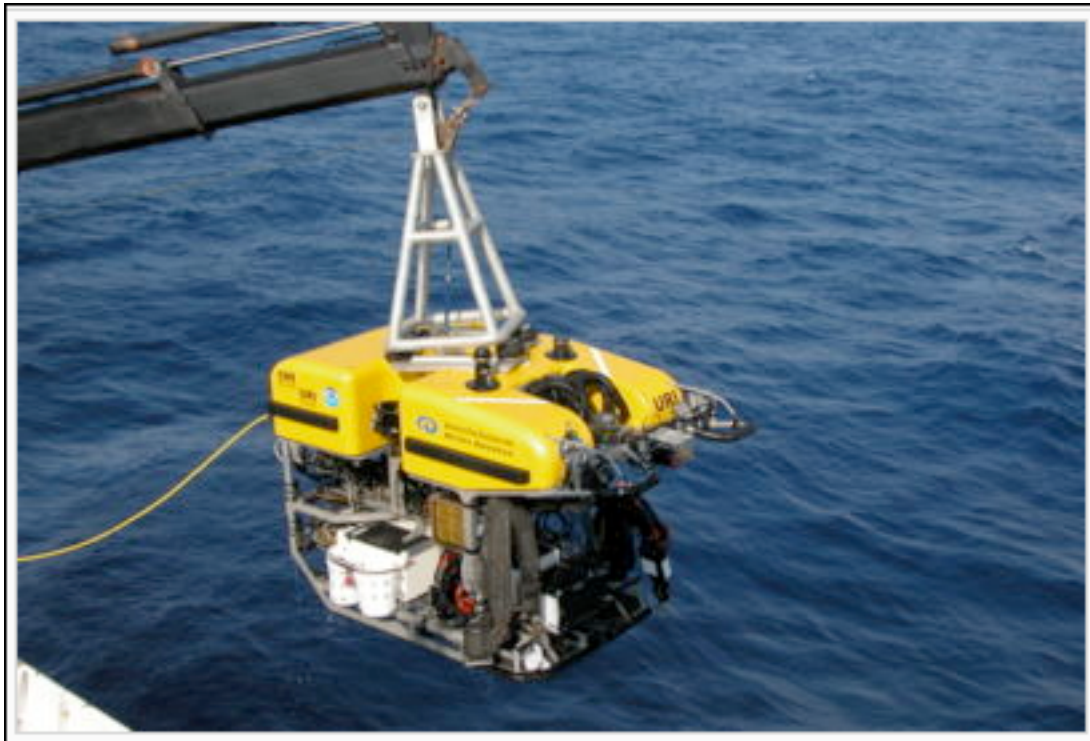
broberts@bbn.com

August 24, 2006

Relevant Projects

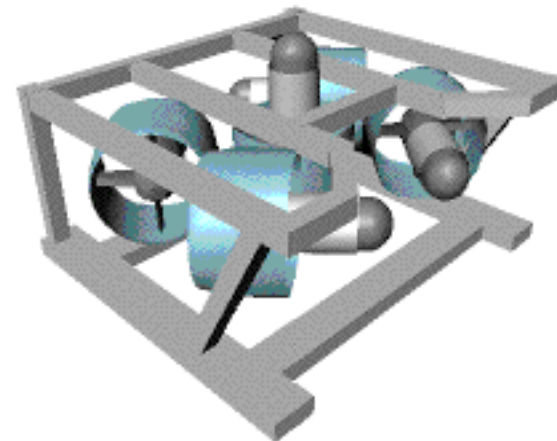
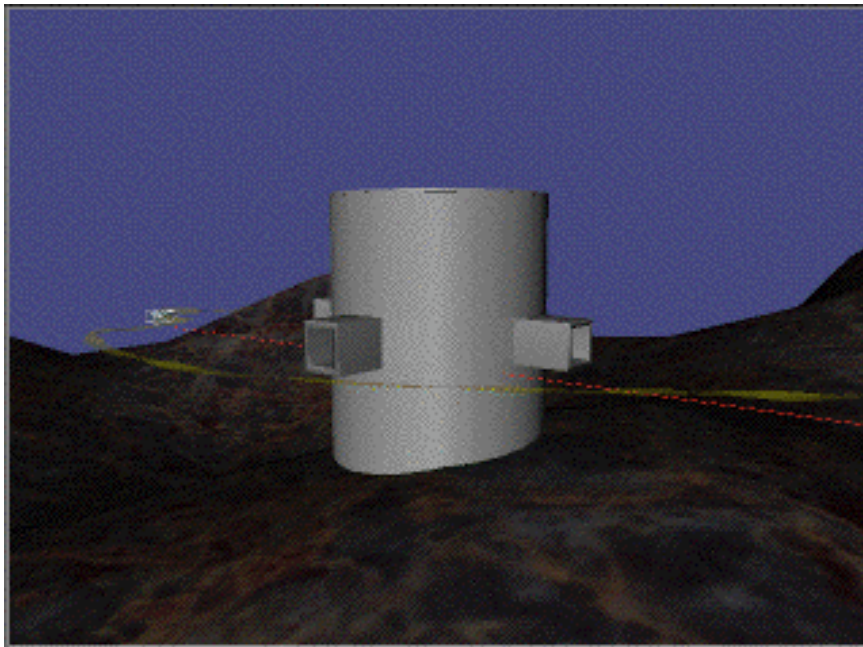
- **VETT (Virtual Environments Technology for Training)**
 - Office of Naval Research
- **TRANSoM (Training for Remote Sensing and Manipulation)**
 - Office of Naval Research
- **COVE (Conning Officer Virtual Environment)**
 - NAVAIR Training Systems Division
- **AWO (Air Weapons Officer) Tutor**
 - Air Force Research Laboratory

Piloting remotely operated underwater vehicles



Coached practice in a real-time 3-D task

- A genuinely difficult spatial task
 - Primary focus: situation awareness skills
 - Obstacles, tether, waypoints, terrain
 - Tasks: search, way-finding, identification
 - Prerequisite: maneuvering skills
 - transit, hover, orbit, dock
- ...in the presence of high currents, poor visibility and limited field of view

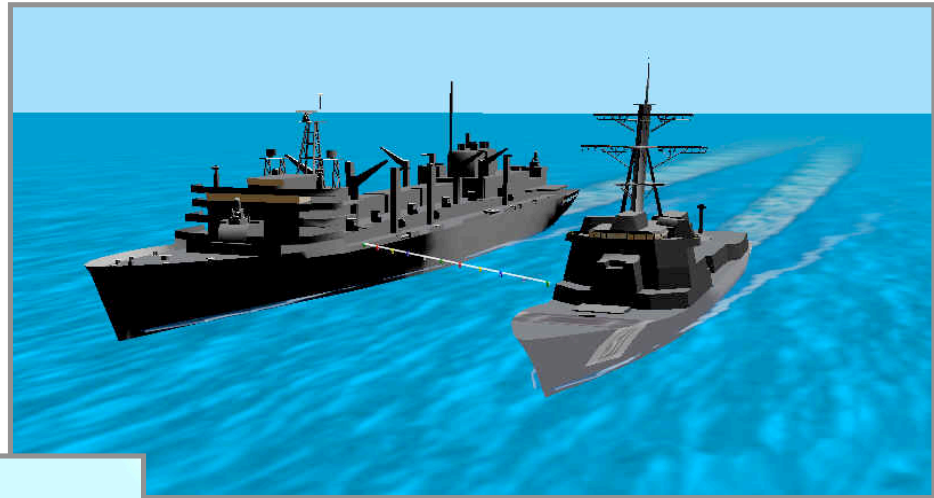


Conning Officer Virtual Environment



Shiphandling relying on “Seaman’s Eye”

Underway
Replenishment



Pierwork

Seaman's Eye

*What inner sense told him when to shift his rudder, when to stop his engines? How did he judge his distances, how could he tell his speed? Seafaring men have long had a name for it. They call it "Seaman's eye."
— Crenshaw, 1975*

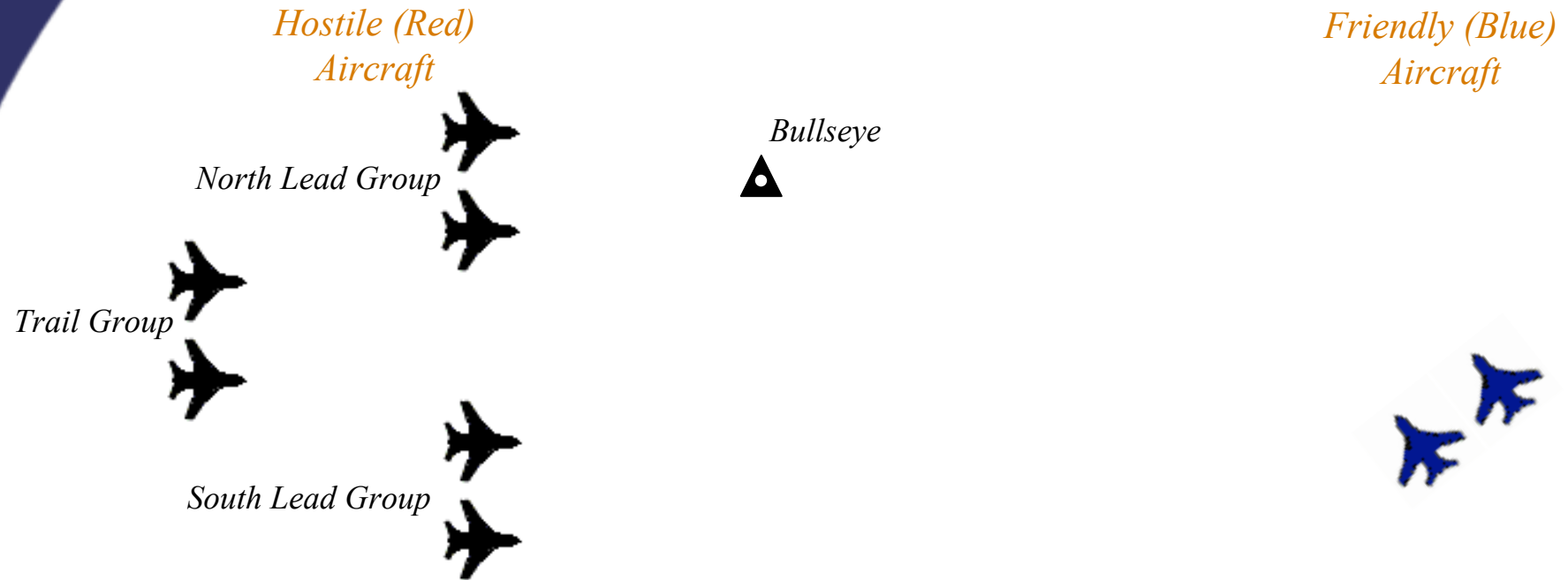
- Use perceptual cues
- Interpret available information
- Understand ship dynamics
- Predict effects of commands
- Apply rules of thumb for responding to situations

AWACS Air Weapons Officer (AWO)



- AWOs communicate with aircraft under their control ...
... to provide “big picture” information on the location & movement of nearby friendly & hostile aircraft

Picture Call



Champagne: Three distinct groups with two in front and one behind

**Darkstar, 3 groups champagne, azimuth 15, north
lead group bullseye 270/10 24 thousand, hostile**
Darkstar, trail group range 10



Training Objectives: Critical Team Processes

| Dimension | Definition |
|------------------------------|--|
| Information exchange | <ul style="list-style-type: none"> ● Utilize information from all available sources ● Provide information prior to requests ● Provide “big picture” situation updates |
| Communication | <ul style="list-style-type: none"> ● Use proper phraseology ● Provide complete standard reports ● Avoid excess chatter ● Ensure clear communications |
| Supporting behavior | <ul style="list-style-type: none"> ● Monitor and correct team errors ● Provide and request backup when needed |
| Team initiative / leadership | <ul style="list-style-type: none"> ● Provide guidance or suggestions to team members ● State clear and appropriate priorities |

Smith-Jentsch, Johnston, & Payne (1998)

Coaching Interventions

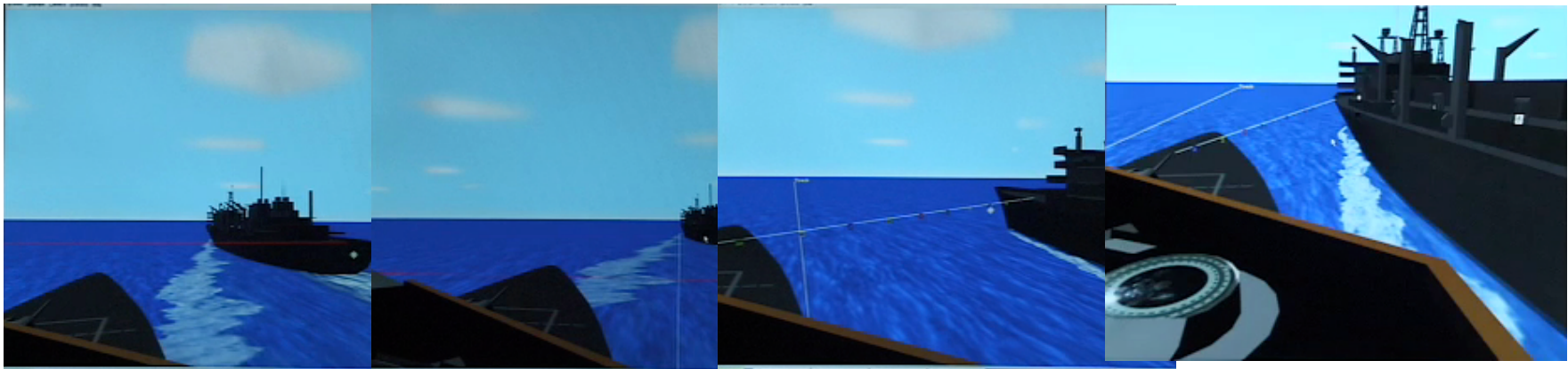
Questions to be asked...

- When should one intervene?
- Who is the intervention agent?
- What is the form of the intervention?
- What is the structure & content of the intervention?

Remember: Do no harm

When should one intervene?

- Can't it wait (until the AAR)?
 - Necessary to stay within the instructional envelope
 - Prompt to ensure shared intent (“Beginning slide-in phase”) or to drive the training forward (“Use the radian rule...”)
 - Draw attention to key aspects of the situation
 - Perceptual cues, Gaze (“Check the phone and distance line”)
 - Phenomena (“Remember the venturi effect”)
 - Note a situation for later review



When should one intervene?

- Is this a good time?
 - Does the pace of the task allow it?
 - How long will it take? ...to deliver ...to assimilate
 - What else is happening? [workload]
 - What might happen next? [interruptions, context/phase shift]
 - Will there be a chance to use the information again soon?
 - Is it a recurring problem?
("You're still too far away from the oiler")
 - Is motivation needed? ("Good")

When should one intervene?

- Pedagogical considerations
 - Priorities
 - Skill level
 - E.g., a novice may need more timely, more detailed, more supportive, more prescriptive feedback
 - Scaffolding

Who should “intervene”?

- Internal vs external instructional agent
- Take advantage of a natural mentor, partner, onlooker, opponent or other participant in the virtual world
 - Explicit
 - Implicit (instructional agents in cahoots with the tutor)
 - Make mistakes
 - Create challenges
 - Introduce variability

What form does the intervention take?

- Modality
 - Text, speech, sound, & graphics
... and combinations thereof
- Augmenting the virtual world
 - Does it really help?
 - Best:* Draw attention to cues in the world (that will still be there when you withdraw the highlighting)
 - Worse:* Create a distraction, an artifact that changes the task
 - Necessary:* Supply information that is available in the real world but can't be rendered adequately in the virtual world

What's the structure of the intervention?

- Progressively more directive (if there's time)
 - Point out cues ➡ Say what's wrong ➡ Say how to fix it
 - Objective:
 - Good performer gets no coaching
 - Poor performer eventually gets told exactly what to do
- Simple discourse model
 - Within an intervention
 - Introduce ➡ Interpret ➡ Act (correct, resume) ➡ Resolve
 - Across interventions
 - "You're *still* too far from the oiler"
 - Interruptions
 - "New problem!"

COVE
Perceptual cues
Dynamics

What's the structure of the intervention?

- Performance Measures
 - Timely, complete, brief, correct structure, accurate content
- Coaching types
 - Warn
 - “Your call was too early”
 - Direct
 - “Make a picture call now”
 - Model
 - “Say ‘Trail group range 15’”
 - Give the rule
 - “You should respond to bogey dope calls within 3 seconds”

AWO
Communications
Situation Awareness

What's the structure of the intervention?

| Error / Coaching | Direct | Model | Warn | Rule |
|--------------------------|--------|-------|------|------|
| Timeliness | | | | |
| Completeness | | | | |
| Content/Semantics | | | | |
| Priority | | | | |
| Brevity | | | | |
| Style/Syntax | | | | |

| | |
|------------------|--|
| Coached | |
| Can't be coached | |
| Won't be coached | |

Architectural considerations

- Cognitive Modeling Environment
 - Model both proactive and reactive behaviors
 - Event-driven: respond to whatever happens whenever it happens
 - Goal-driven: carry out sustained focused interactions
 - Represent human multi-tasking behaviors
 - Represent mixed teams of humans and agent
 - Plays well with agent-based system architecture

COVE and AWO both used OMAR as a modeling environment

Architecture Example (COVE)

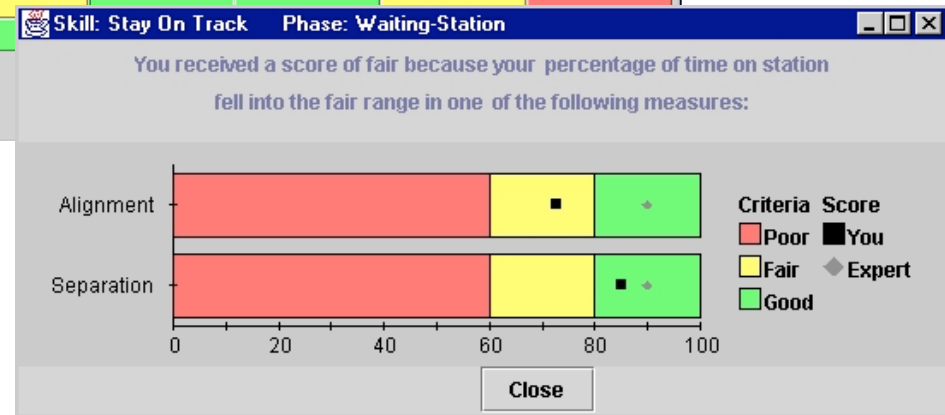
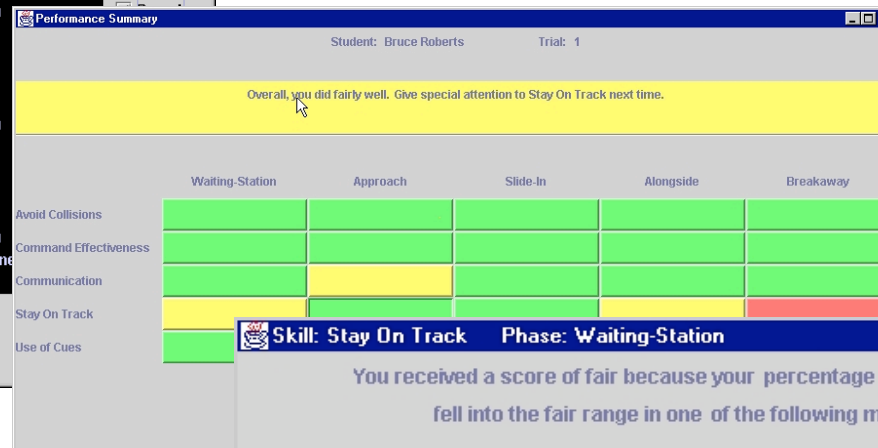
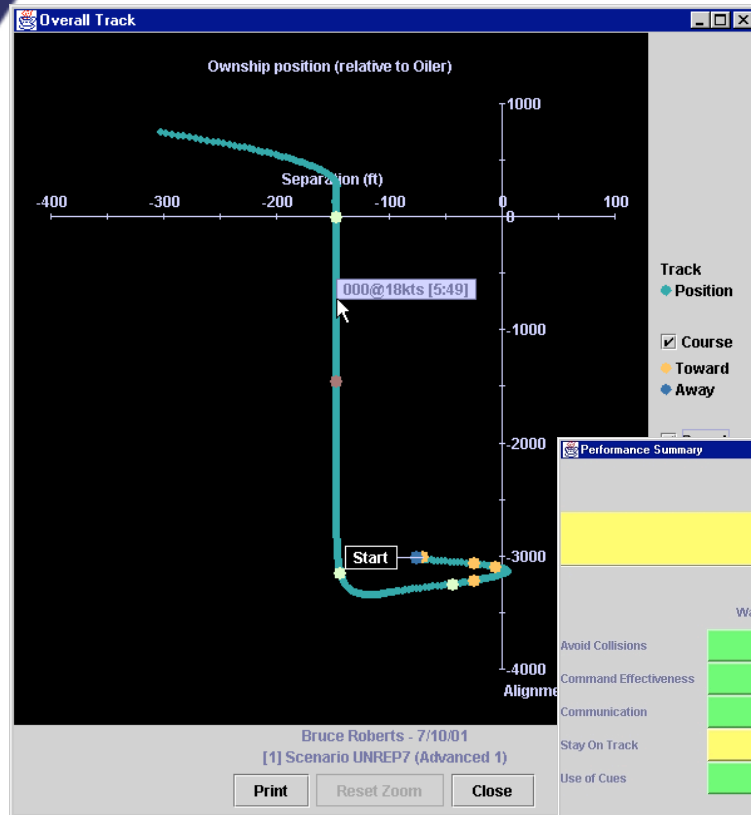
- Multiple “coaches” operate independently
 - Approach (use radian rule), Slide-In, Phone & Distance line, Alongside (separation & alignment)
- Instructional events act as triggers
 - E.g. the “right moment” to initiate slide-in, drifting away from the alongside position

Architecture Example (COVE)

- Coaches receive information from simulation & maintain their own model of the world
 - **Phase** (what stage of an evolution you are in)
 - Waiting Station, Approach, Slide In, Alongside, Breakaway
 - **Physics** (what the ship is doing)
 - Position, Speed, and Heading
 - Use oiler coordinate system (separation, alignment) for convenience
 - **Commands** (what you said, and when)
 - Control (“right standard rudder”)
 - Information (“mark your head”)
 - **Gaze** (what you looked at, and when)
 - Identified locations in the scene
- Coaches are *aware* of other coaching activity
 - Active/Inactive coaches
 - Prior feedback given
 - Interruptions

After Action Review

COVE
Self assessment



After Action Review

DARWARS Ambush!
Instructor led

DARWARS Ambush! After Action Review

File

Events

Show All Events Filter Events...

POSITIONED - 7-Ton Cargo Truck (22)
 POSITIONED - Stryker Recon (20)
 POSITIONED - Civilian2 (18)
 POSITIONED - Civilian5 (16)
 POSITIONED - Civilian3 (14)
 POSITIONED - Civilian5 (12)
 POSITIONED - Civilian10 (ganun4)
 POSITIONED - Rifleman (Hardrock02)
 POSITIONED - Rifleman (Hardrock05)
 POSITIONED - Rifleman (Hardrock06)
 POSITIONED - OPFOR-2 (opfor10)
 POSITIONED - OPFOR-4 (opfor6)
 VEHICLE - Rifleman (Hardrock01) INTO Stry
 VEHICLE - Rifleman (Hardrock06) INTO Stry
 VEHICLE - Rifleman (Hardrock02) INTO Stry
 VEHICLE - Rifleman (Hardrock05) INTO 7-Ton
 VEHICLE - Rifleman (Hardrock04) INTO 7-Ton
 VEHICLE - OPFOR (opfor7) INTO Bus (23)
 VEHICLE - OPFOR (opfor7) OUT OF Bus (23)
 FIRED WEAPON - OPFOR-4 (opfor6)
 HEALTH LEVEL CHANGE (88) - Rifleman (Har
 HEALTH LEVEL CHANGE (84) - Rifleman (Har
 VEHICLE - Rifleman (Hardrock05) OUT OF 7-Ton
 VEHICLE - Rifleman (Hardrock04) OUT OF 7-Ton
 VEHICLE - OPFOR (opfor7) INTO Civilian Tru
 FIRED WEAPON - OPFOR-2 (opfor15)
 FIRED WEAPON - OPFOR-2 (opfor15)
 FIRED WEAPON - OPFOR-2 (opfor15)
 VEHICLE - OPFOR (opfor7) OUT OF Civilian T
 FIRED WEAPON - OPFOR-2 (opfor15)
 FIRED WEAPON - OPFOR-2 (opfor15)
 FIRED WEAPON - OPFOR-2 (opfor15)
 VEHICLE - Rifleman (Hardrock02) OUT OF St
 FIRED WEAPON - OPFOR-2 (opfor10)
 FIRED WEAPON - OPFOR-2 (opfor10)
 FIRED WEAPON - Rifleman (Hardrock04)
 FIRED WEAPON - OPFOR-2 (opfor10)
 FIRED WEAPON - OPFOR-2 (opfor10)
 FIRED WEAPON - Stryker Recon (20)
 FIRED WEAPON - Rifleman (Hardrock05)
 FIRED WEAPON - Rifleman (Hardrock04)
 VEHICLE - Rifleman (Hardrock02) INTO Stry
 FIRED WEAPON - OPFOR-2 (opfor10)
 VEHICLE - Rifleman (Hardrock01) OUT OF St
 FIRED WEAPON - Rifleman (Hardrock05)
 FIRED WEAPON - Rifleman (Hardrock05)
 FIRED WEAPON - Rifleman (Hardrock05)
 FIRED WEAPON - Rifleman (Hardrock05)
 FIRED WEAPON - Rifleman (Hardrock05)
 FIRED WEAPON - Rifleman (Hardrock05)
 FIRED WEAPON - Rifleman (Hardrock04)

Map and Media Display

Mission Map

FOB Seahawks

meters (4109.98, 8360.75) - pixels (250,6)

Media List

IITSEC_AAR_Demo
11-11-2005
11:58:11

IITSEC_AAR_Demo
11-11-2005
12:02:37

FlashpointResistance
2005-11-11 12-04-57
-00.avi

FlashpointResistance
2005-11-11 12-03-30
-67.avi

Timeline Controls

12:06:10 (00:03:33)

11-11-2005 12:02:37

11-11-2005 12:18:27

Questions?

References

Deutsch, S.E. & Adams, M.J. The Operator Model Architecture and its Psychological Framework. *Proceedings of the 6th IFAC Symposium on Man-Machine Systems*, Cambridge, MA, 1995.

Freeman, J., Diedrich, F., Haimson, C., Diller, D., & Roberts, B. Behavioral Representations for Training Tactical Communication Skills. *Proceedings of the 12th Conference on Behavior Representation in Modeling and Simulation*, May 2003.

MacMillan, J., Roberts, B, Diller, D., Deidrich, F. & Deutsch, D. Training Team Skills Using Computer-Generated Forces. *Proceedings of the 11th Conference on Computer-Generated Forces and Behavior Representation*, Orlando, FL., May 2002.

Roberts, B. COVE – A Ship Handling Trainer with an Attitude. *Proceedings of the 2001 Interservice/Industry Training, Simulation and Education Conference*, Orlando, FL, December 2001.

Roberts, B., Pioch, N., & Ferguson, W. Verbal Coaching During a Real-time Task. *International Journal of Artificial Intelligence in Education*, 11(2000).