

Unmanned Cannot be Untrained: Synthetic Agents for UAV Operations Training

**Dr. Joan Ryder
Dr. Benjamin Bell**



**CERI Human Factors of UAVs Workshop
24 May, 2004**



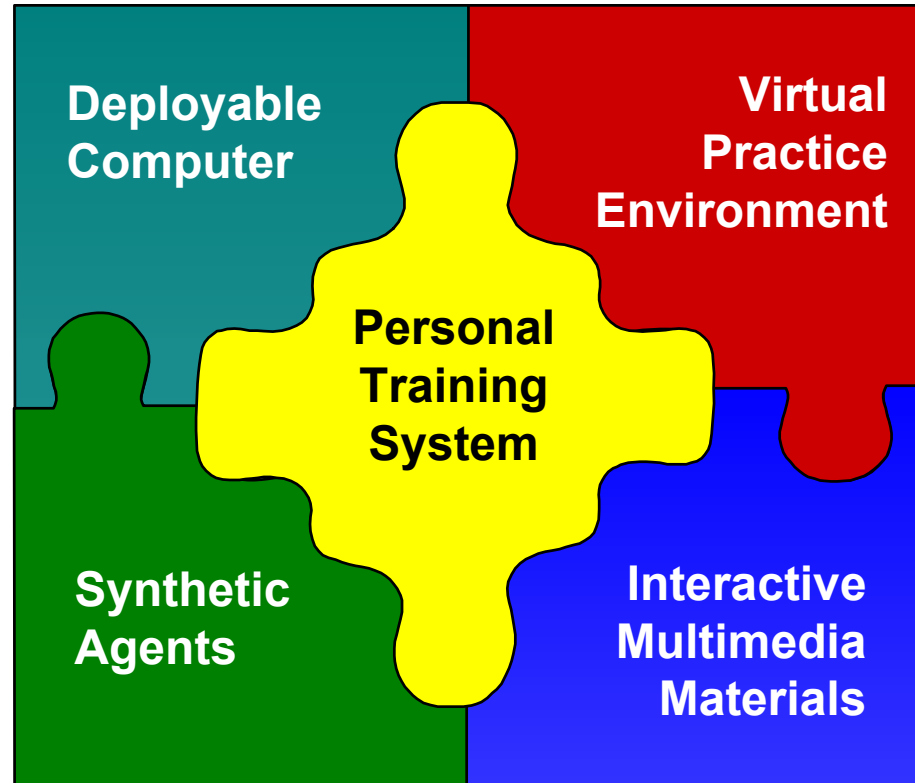
UAV Training Needs

- ◆ **Complex operating environment**
 - ◆ Multiple, complex, co-occurring tasks
 - ◆ Increasing workload as the span of control grows to multiple vehicles
 - ◆ Skills like situation awareness, crew coordination, and dynamic mission replanning prone to skill decay without practice
- ◆ **Increasing use of simulation for UAV crew training**
 - ◆ **Cost**
 - ◆ Exercises for team training
 - ◆ Number of instructors
 - ◆ Regulated access to airspace
 - ◆ Limited access to instrumented ranges and simulated threats
 - ◆ Infrequent training for emergencies and degraded operations

Personal training systems can help meet need as component of overall training approach.

What is a Personal Training System?

- Low cost
- Portable, individual
- Medium fidelity simulation
- Mission rehearsal



- Virtual tutors
- Synthetic teammates
- Introductory & refresher segments
- Reference materials



Highlights

- ◆ **Greater percentage of UAV “flying” time can be simulation-based than for manned aircraft**
- ◆ **Individual on-demand training on portable, deployable (laptop) computers**
 - ◆ Learner focused instruction always available
 - ◆ Tailored to individual needs
- ◆ **Sufficiently realistic practice environments and problems provide mission rehearsal capability**
- ◆ **Synthetic agents reduce need for instructors and scheduled exercises**
 - ◆ Virtual tutors provide assessment, coaching and feedback, and/or after-action review
 - ◆ Synthetic teammates who can interact in spoken language support coordination training even when it is not possible for a team to practice together

Synthetic agents enable *guided mission rehearsal* without the instructor or the team.



Technology Examples

- ◆ **Virtual tutor for simulation-based practice**
 - ◆ Predator landing training
 - ◆ Practice is essential to mastery
 - ◆ Limitations on time available for actual flying
 - ◆ Landing pattern can be practiced without an instructor
- ◆ **Deployable team training with synthetic teammates**
 - ◆ Close air support application
 - ◆ Laptop flight simulation is portable
 - ◆ Team training without the team
- ◆ **Combining interactive multimedia with virtual environment practice**
 - ◆ Web-based multimedia instruction for concept introduction and refresher
 - ◆ Simulation environment with synthetic tutor and teammates for guided practice

Example 1: Virtual Tutor

- ◆ **Predator UAV Landing Trainer (for AFRL)**
- ◆ **Air Vehicle Operator (AVO) controls the aircraft acting as a remote pilot**
- ◆ **Landing training issues**
 - ◆ Predator AVOs are rated pilots transitioning from a variety of backgrounds
 - ◆ Different aerodynamics
 - ◆ No kinematic sensation
 - ◆ Restricted view (fixed nose camera with 30° FOV)
- ◆ **Predator Multi-Task Trainer (MTT)**
 - ◆ Developed by AFRL/HEA, AC2ISRC, TRSS and Parker Int'l

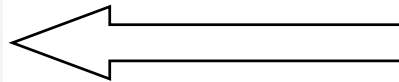
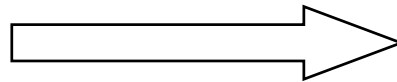


Embedded Virtual Tutor Technology

Virtual Practice Environment



Observes user actions in practice environment



Delivers feedback and tutoring



Monitor and understand problem context

Interpret and predict user actions

Diagnose user knowledge and skills

Identify and plan out tutoring opportunities

Plan future problems



Records and retrieves performance and knowledge assessments

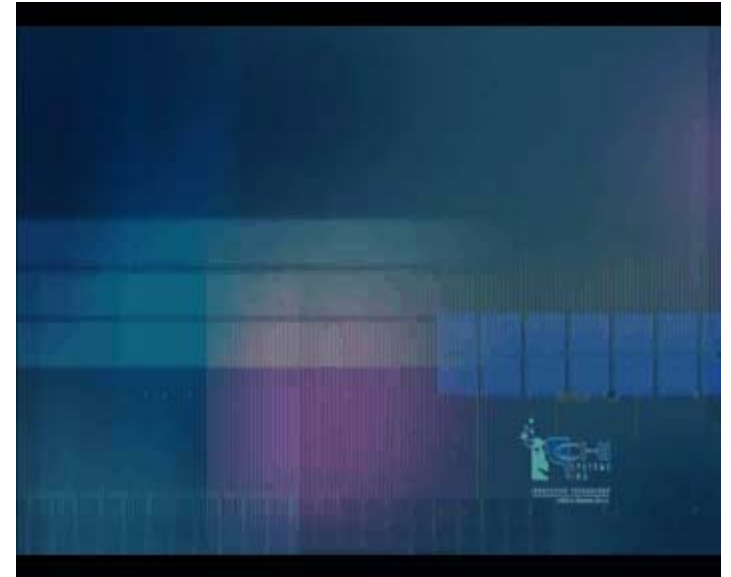
Allows tailoring based on individual performance



Individual Training History Database

Predator Virtual Tutor Feedback

- ◆ **Tracks and analyzes landing pattern behavior**
- ◆ **Provides feedback and critiquing at three levels**
 - ◆ **Real-time voice feedback**
 - ◆ **Informative – slightly out of tolerance**
 - ◆ **Directive – seriously out of tolerance**
 - ◆ **Periodic voice critiques based cause-effect analysis**
 - ◆ **Session reports – summarize performance and assessments**



Click to start video

Example 2: Deployable Training with Synthetic Teammates

◆ Synthetic Teammates for Realtime Anwhere Training & Assessment

- ◆ Focus on “headwork” – mission skills, cognitive and coordination-related
- ◆ Domain: Naval Air Strike (Close Air Support)
- ◆ Deployment: “Smuggle aboard in a seabag”
- ◆ STRATA is part of DARPA Training Superiority (DARWARS)

◆ Objectives for training

- ◆ Achieve big performance improvements
- ◆ Make training fully deployable with minimal equipment requirements
- ◆ Provide on-demand practice of both individual & team-level skills





STRATA Overview

- ◆ **Synthetic teammates interact with user in mission scenarios**
 - ◆ Cognitive models give agents realistic behaviors
 - ◆ Teammates communicate in spoken language
 - ◆ Adversaries populate scenario
- ◆ **Automated mission brief, assessment, & AAR tailored to student**
- ◆ **Simulation environment**
 - ◆ COTS PCs with HOTAS controls
 - ◆ Uses AirBookUSA simulation
 - ◆ High resolution/ fidelity terrain
 - ◆ Embedded threat entities
 - ◆ Single user to multi-system linked operations
- ◆ **User decision-making & teamwork**
 - ◆ Synthetic teammates can make errors
 - ◆ Scenario events to exercise decision-making skills (e.g., retasking)
 - ◆ User must choose course of action

STRATA Scenario Preview



**Synthetic
Wingman
"Hammer 12"**



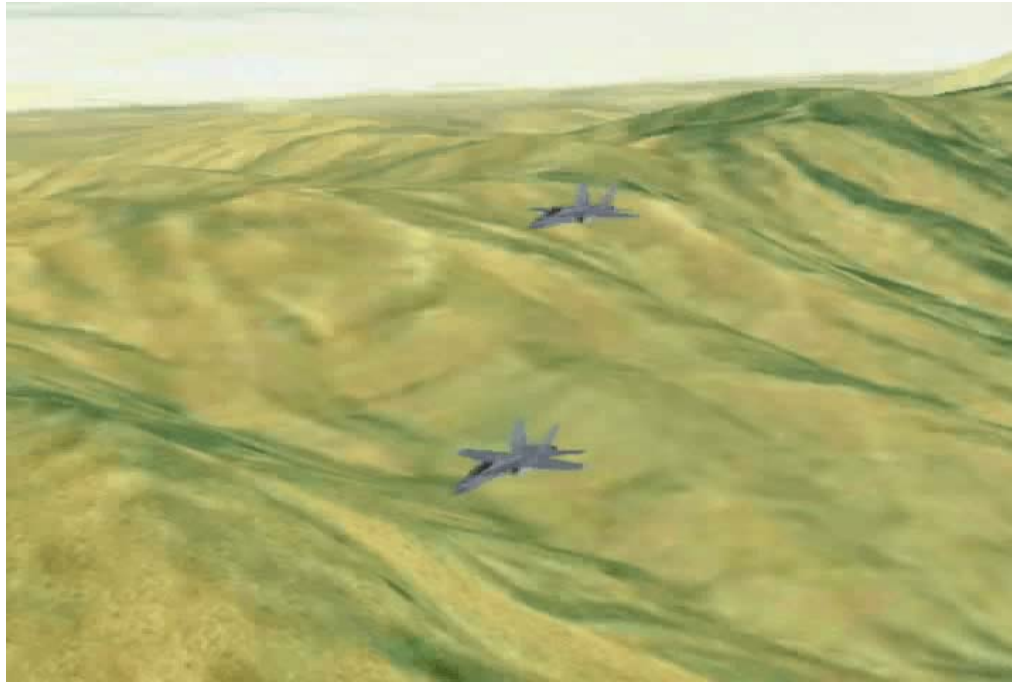
User "Hammer 11"



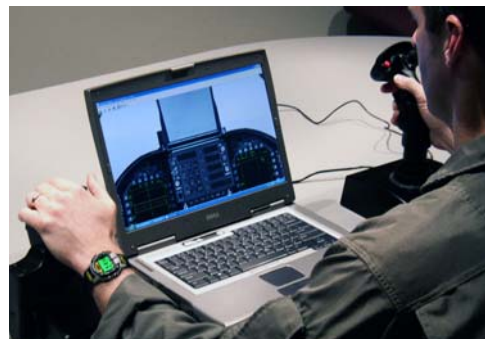
**Synthetic FAC
"Nail 21"**

- ◆ **Close Air Support scenario, 2-ship F/A-18 section**
- ◆ **Synthetic Forward Air Controller/Airborne (FAC/A)**
- ◆ **Trainee is flying lead, Synthetic Teammate is wingman**

STRATA Scenario Clip



**Synthetic
Wingman
"Hammer 12"**



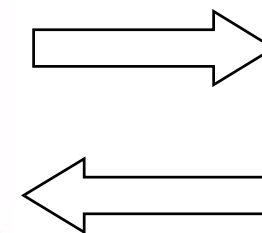
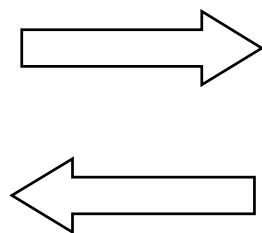
User "Hammer 11"



**Synthetic FAC
"Nail 21"**

Example 3: Incorporating Interactive Multimedia

- ◆ Conversational Agents in a Pattern Operations Training Environment (for AFRL)
- ◆ PC-based training system to train pattern ops and radio procedures during traffic pattern operations
 - ◆ Practice for voice comms (hearing/talking)
 - ◆ Building pattern Situational Awareness (SA)
- ◆ Provide capability for self-study on PCs



CAPOTE Design

◆ Guiding principles

- ◆ Focus on building pattern understanding & decision making rather than flying skills
- ◆ Range of modules progressing in complexity
- ◆ Highly interactive and graphical to promote active learning and motivation to use
- ◆ Student control to support individualized learning styles

◆ Two main units, each with multiple modules

◆ Pattern Orientation

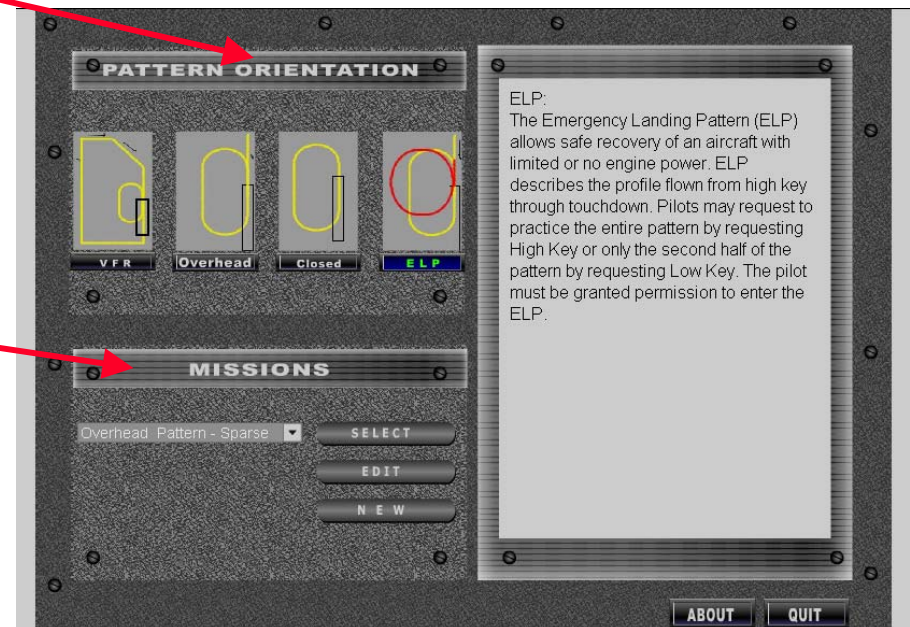
- ◆ modules to introduce pattern geometry, decision points, and radio comms

Interactive Multimedia

◆ Missions

- ◆ scenarios with varying traffic density to build SA and allow comms practice

Virtual Practice Environment with Synthetic Agents and Intelligent Tutoring



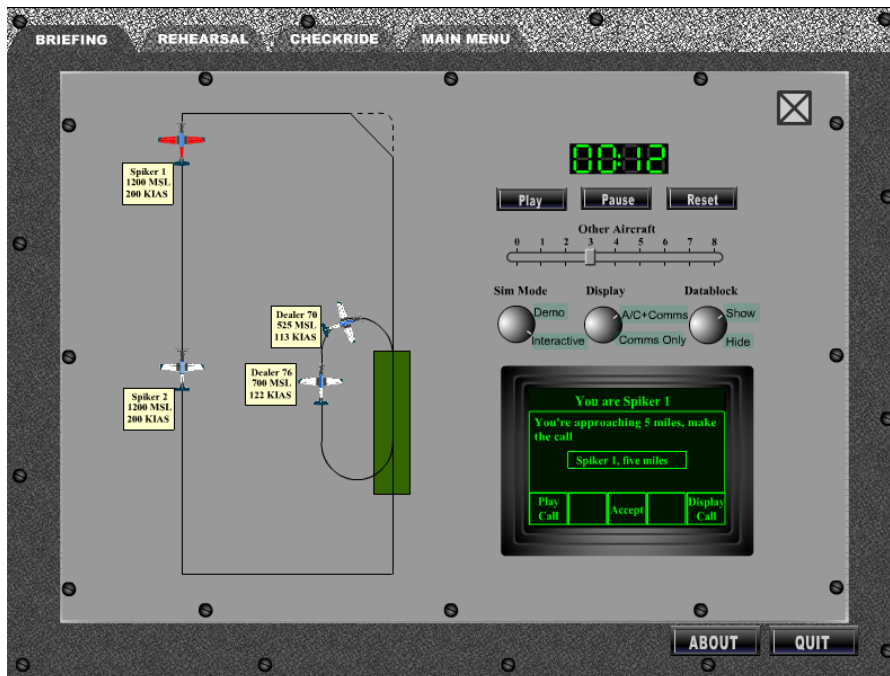
Pattern Orientation – Brief

◆ Pattern “tour”

- ◆ Step through pattern looking at schematic view with explanations of each important position/decision point

◆ Pattern “demo”

- ◆ Watch and listen to aircraft maneuvering in pattern
- ◆ Listen to radio calls from aircraft and RSU directives
- ◆ Interactive mode allows student to associate radio call w/pattern position
- ◆ Controls can show/hide aircraft icons and vary traffic density



Start Demo



Summary of Examples

- ◆ **Predator landing training illustrates virtual tutor**
- ◆ **STRATA highlights laptop flight simulation with synthetic teammates and automated brief, assessment, and AAR**
- ◆ **CAPOTE combines interactive multimedia with virtual environment practice for instructor-less on-demand learning system**



Benefits of Personal Training Systems

- ◆ **Force readiness through deployable, on-demand training**
- ◆ **Capability for individual practice on low cost medium fidelity simulations on laptops or personal computers**
 - ◆ Multimedia components supplement scenario-based practice
- ◆ **Complement costly large-footprint dedicated trainers**
 - ◆ PC-based low-footprint technology: small, cheaper, more agile
- ◆ **More efficient use of training resources**
 - ◆ Effective team training without the team
 - ◆ Large-scale reductions in instructor manpower
 - ◆ Escape from “20 to train 1”



Lessons for Successful Application

- ◆ **Cognitive agents valuable for believable, human-like teammates**
 - ◆ Verbal interaction one key to believability, utility
 - ◆ Current technology supports constrained grammar situations
- ◆ **SMEs needed for synthetic agent development**
- ◆ **Require PC simulation providing ‘just enough’ fidelity**
- ◆ **Integration pragmatics can provide substantial challenges**
 - ◆ Temporal, representational, communicational mismatches can constrain development
 - ◆ Testing/debugging/validation of synthetic agents requires stable simulation and data communication
 - ◆ Can account for up to 40% + of development costs