(WIP) Adaptive Guidance Tool for Systems Engineering

PRESENTED BY
Bryant M. Baldwin, MSME, PhD(c), Systems Engineer
Tom Lindgren, Systems Engineer
Dr. Seethambal Mani, Systems Engineer (Retired)
Dr. Grayson Dennis, Assistant Professor
Dr. Tom Thomas, Associate Professor (Retired)
Dr. Sean Walker, Program Coordinator & Associate Professor
Dr. Kari Lippert, Assistant Professor

September 18, 2025

UNIVERSITY OF
SOUTH ALABAMA
FLAGSHIP OF THE GULF COAST.

Agenda

- Introduction (10 minutes)
- Research Effort (10 minutes)
- Q&A (3-5 minutes)

Overview

This research addresses the challenge of enhancing product development outcomes in complex, high-stakes systems where misalignment, dynamic requirements, and skill gaps can compromise success.

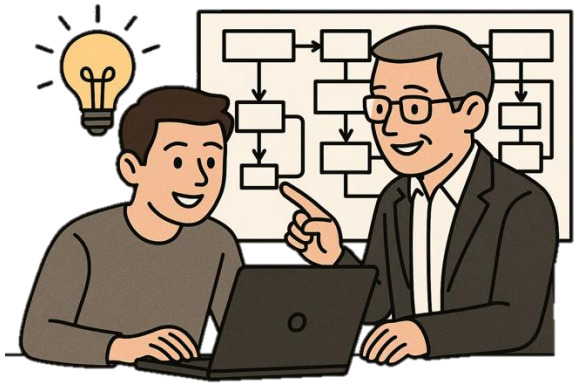
It proposes an adaptive framework that evaluates a learner's educational style and core competencies to create tailored guidance strategies and curricula, powered by digital engineering tools.

Goal: Strengthen alignment, close skill gaps, build confidence, and enhance outcomes in the development of complex systems.

Journey from Novice to Expert

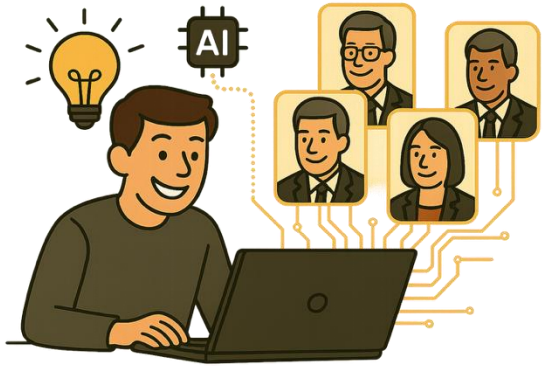
Struggles of Novice

- Overwhelmed by theory without knowing how to apply it
- Stuck translating knowledge into real designs
- Frustrated by complexity and lack of clear direction



Mentorship to Proficiency

- Provided the “recipe” to design
- Learned to see systems as **interacting architectures**
- Gained methods to **untangle complex problems** into building blocks
- Step-by-step guidance replaced uncertainty with confidence

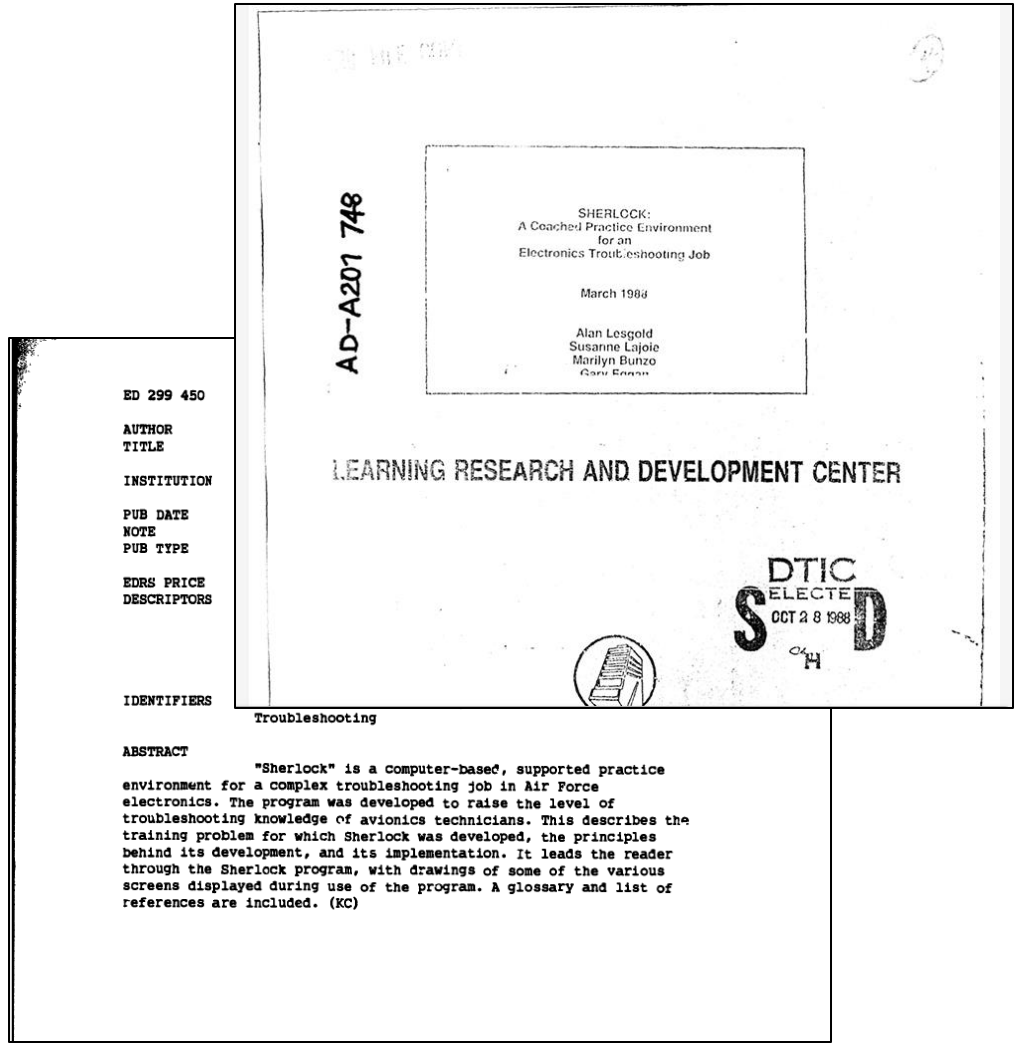


AI powered-mentorship

- Will provide the “recipe” to design a system.
- Will deliver tailored instructions and guidance
- Will evolve knowledge base
- Will provide a variety of expertise in a convenient, accessible platform

SHERLOCK (1990s)

- Target: Air Force avionics technicians in training or early career
- Demonstrated the power of ITS in high-stakes, technical environments
  - Showed that computer-based simulation and adaptive tutoring could drastically accelerate expertise
- Study Conclusions:
  - ~25 hours of Sherlock training equated to 4 years of on-the job training for F-15 avionics technicians
  - Senior apprentices who used Sherlock outperformed some experts with 10+ years of experience in given scenarios
  - **Showed the technology could support novice → (unsupervised) practitioner in accelerated pace**


AD-A201 748

SHERLOCK:
A Coached Practice Environment
for an
Electronics Troubleshooting Job

March 1988

Alan Lesgold
Susanne Lajoie
Marilyn Bunzo
Gary Eggan

LEARNING RESEARCH AND DEVELOPMENT CENTER

DTIC
ELECTE
S OCT 2 8 1988 D

ED 299 450

AUTHOR
TITLE

INSTITUTION

PUB DATE
NOTE
PUB TYPE

EDRS PRICE
DESCRIPTORS

IDENTIFIERS

Troubleshooting

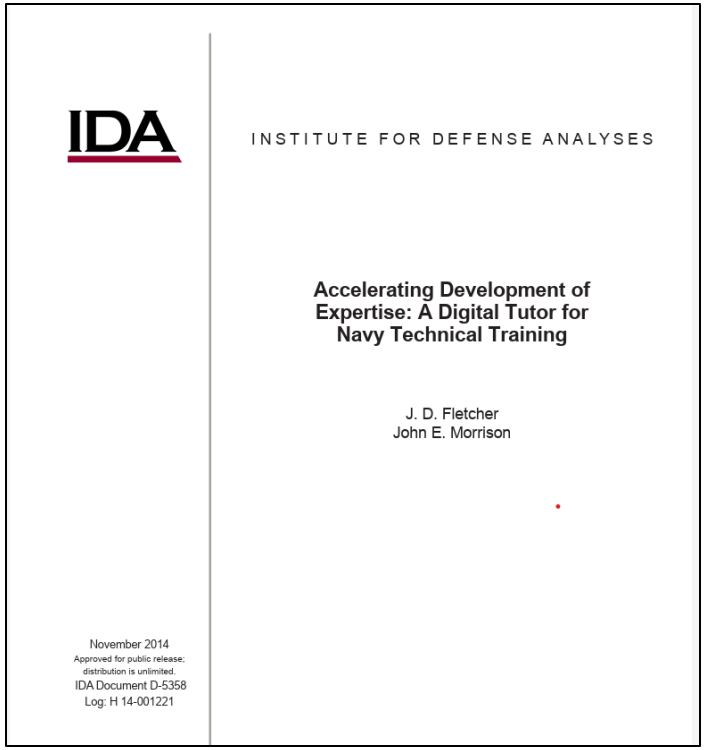
ABSTRACT

"Sherlock" is a computer-based, supported practice environment for a complex troubleshooting job in Air Force electronics. The program was developed to raise the level of troubleshooting knowledge of avionics technicians. This describes the training problem for which Sherlock was developed, the principles behind its development, and its implementation. It leads the reader through the Sherlock program, with drawings of some of the various screens displayed during use of the program. A glossary and list of references are included. (KC)

ITS: Intelligent Tutoring Systems

DARPA Digital ITS (2010s)

- Target: U.S. Navy IT systems administrators with little to no IT background
- Demonstrated the power of ITS produce expert-level capability in weeks, instead of years
- Study Conclusions:
  - 32 students completed a 16-week training program
    - 2 weeks of ITS instruction
  - Post-training test:
    - Trainees and Experts were given 3 different test
      1. Simulated environment
      2. Physical lab with real equipment
      3. Operational Setting (Navy Ship)
  - **Results: trainees outperformed experienced technicians averaging 12 years in the field**


IDA

INSTITUTE FOR DEFENSE ANALYSES

Accelerating Development of Expertise: A Digital Tutor for Navy Technical Training

J. D. Fletcher
John E. Morrison

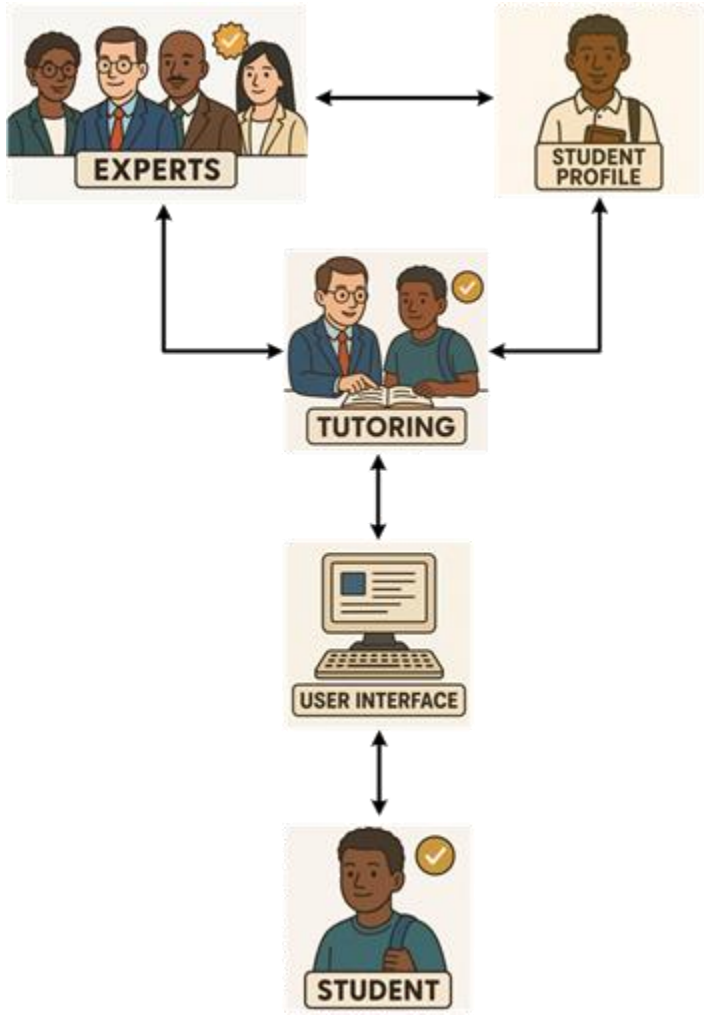
November 2014
Approved for public release; distribution is unlimited.
IDA Document D-5358
Log: H 14-001221

Intelligent Tutoring Systems – What are they?

- Educational tools designed to deliver **personalized targeted instruction** across domains and skills
- Replicate human tutor capabilities for tailored learning experiences
- Enable adaptive feedback and dynamic, individualized guidance

Personalized Learning: Used to describe the various learning experiences, instructional approaches, educational programs and systematic academic strategies aimed at meeting the learning needs of individuals.

Intelligent Tutoring Systems: Simple Architecture



Traditional Architecture

- **Expert Module**
  - Accommodate expertise information (Domain knowledge)
  - Responsible for developing questions with the associated answers
- **Student Model Module**
  - Maintains the Learner's Profile
  - Contains details of the student knowledge, behaviors, and attributes
- **Tutoring Module**
  - Detects the knowledge deficiency in students
  - Focuses on the strategies and methods of teaching for compensating the identified shortage
- **User Interface**
  - Controls the interaction between the user and system

Intelligent Tutoring Systems – ASEGT Stakeholder Needs (Use Cases*)

Adaptive Systems Engineering Guidance Tool (ASEGT)

- Guide/Navigate the Systems Engineering (SE) Process ☆
- Help assess and mature individual SE Core Competencies ☆
- Assess quality of design package

Expected Impact

- Fewer redesign cycles and less rework
- Faster resolution of design gaps
- Accelerated progression from novice to competent SE

*Use Cases acquired from 10 Customer/End User Interviews

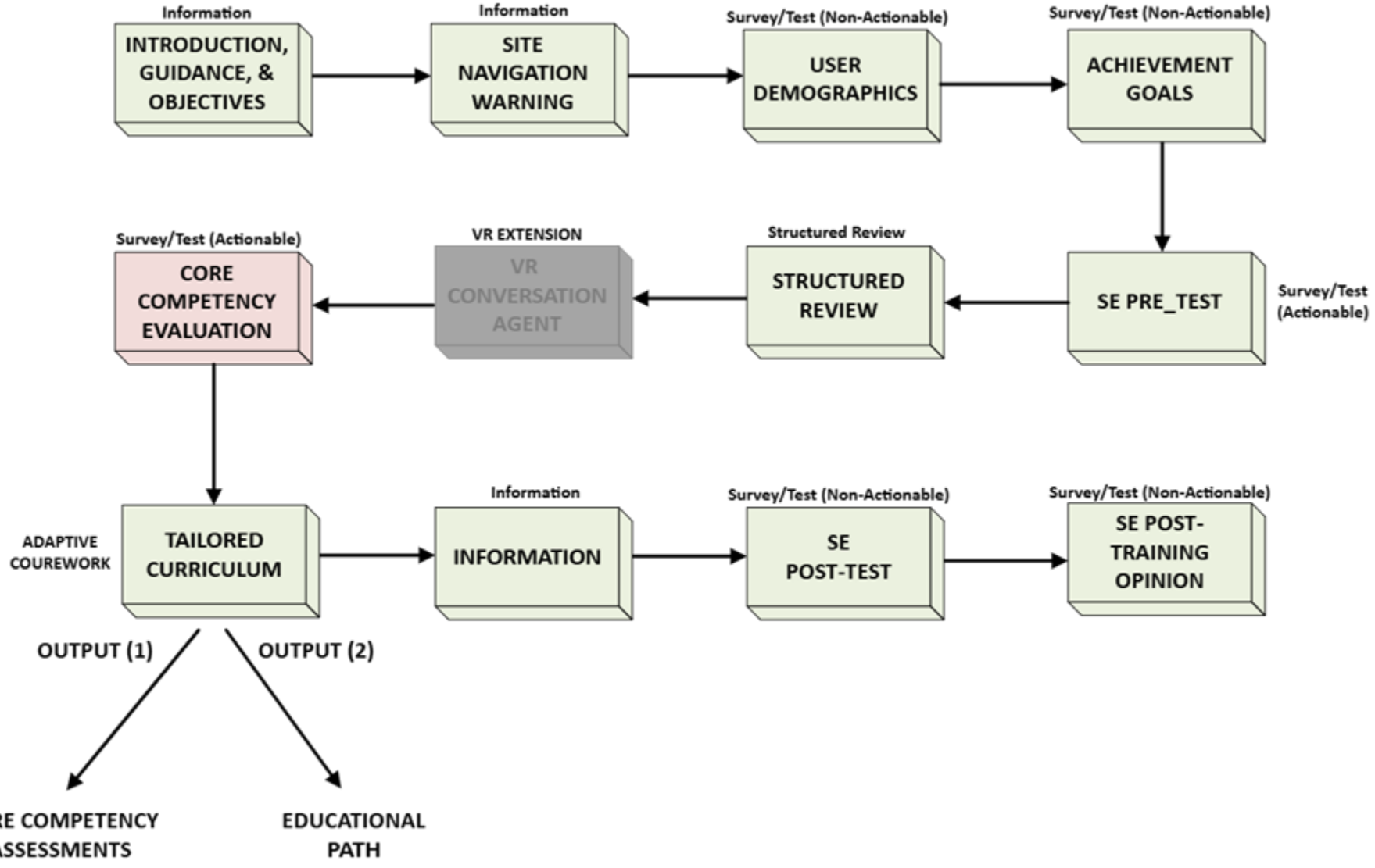
☆ = Focus of the Research

Research Effort

Adaptive Systems Engineering Guidance Tool – Proposed Tool

- What specific phases of the Systems Engineering lifecycle should the ITS support?
- How will the system handle cross-disciplinary inputs and outputs in SE projects?
- How and when will Systems Engineers engage the tool?
- How can complex SE tasks be broken into subtasks to reduce cognitive load?

ASEGT - Architecture



Current Development Strategy

- Develop Systems Engineering ITS System
  - ✓ Develop Sample Training Curriculum
  - ✓ Develop educational environment
  - Integrate AI/Digital Tool Interface
- Deployment and Monitoring of ITS
- Validation Surveys for Effectiveness metrics
- Conclude Study

Would you like to be involved?

Please send inquiries or comments to:

Contact: Bryant Baldwin

bmb1523@jagmail.southalabama.edu

Extras

Imagine…

Virtual Agent = Stakeholder

Stakeholder (Jack): Hello _____, I really appreciate your willingness to work on this project for me. The main problem I would like to solve is the team needs a way to track client requests more easily. Right now, it's all in spreadsheets and it's hard to see status updates.

User: *That makes sense. So you'd like a system that shows requests and status. What else would you like?*

Stakeholder (Jack): Well, if I could get updates from my phone, that would be great too. I'm always on the go and I need convenience. Also, perhaps if the system tracks "In process" or "Completed" it would definitely be helpful.

User: Perfect. I'll draft a first version with those stages. Once I have a prototype, could we do a quick review together?

ADAPTIVE SYSTEMS ENGINEERING GUIDANCE TOOL

Imagine… (Feedback)

Virtual Agent = Stakeholder

Stakeholder (Jack): Okay_____ That was pretty good. I like that you verbalize your understanding, and you scheduled a plan for the next meeting, (insert feedback). I noticed that skipped to the end pretty abruptly. How did you know that you gathered a complete understanding of the problem you're trying to solve?

I recommend that you…

ADAPTIVE SYSTEMS ENGINEERING GUIDANCE TOOL