U.S. Army Research, Development and Engineering Command

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Collaborative Development of a Mine Detection Training Device

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Briefing Outline

- The Challenge
- Finding the Right Skills to develop the Training Device
- Collaborative Partners
  - Army Research Laboratory
  - Academia
  - Industry
- Funding Source
  - Leonard Wood Institute
  - Awarded on a Competitive Basis
- The Training Device
- Transitioning to the Army

AN/PSS-14 Handheld Mine Detector

- AN/PSS-14 uses two sensors:
  - Induction coil (metal detector)
  - Ground Penetrating Radar (change in di-electric constant detector)
- Can only detect what it passes over – every square inch of the lane must be swept with the detector head close to the ground
- Employs internal algorithms that must be trained to soil similar to that to be searched
- Requires relatively frequent recalibration

U.S. Army Combat Engineer with PSS-14 near Bagram Airport, Afghanistan, April 2004

Training

- AN/PSS-14 Training
  - Learn detector switchology – start up, algorithm training, maintaining calibration
  - Learn to sweep – covering every square inch of the lane at the right sweep speed and with the detector height the right distance above the ground
  - Target investigation – with the metal detector and the Ground Penetrating Radar
    - How to convert the auditory information from the detector to a spatial image of the target in the ground, primarily based on the location of the detector head when the sound is emitted.
  - And to do so with such proficiency that they are willing to bet their life and others on their performance capability
- Studies have shown that the skill degradation of AN/PSS-14 operators significantly decline in as little as 30 days
- Development of good training lanes are very labor intensive and require expensive simulants
- Training is dependent on weather conditions
- Regular training is logistically prohibitive for many units – particularly Reserve Component units
- A simulator can address many of these training issues

Objective

- Develop a highly realistic Landmine Detection Simulator that closely resembles the form, function, and responses of the AN/PSS-14 built around an easy to assemble, operate, and low-cost platform.
- Required Team Skill Set:
  - Programming capability
  - Understanding of how the detector works
  - Understanding of what detector features are key to effective training
  - Understanding of how the detector is swept and output is interpreted
  - Ability to write the equations to define the appropriate auditory output for a variety of target types
  - Understanding of the human factors issues such that fidelity is appropriate
  - Ability to fabricate the prototype hardware
  - Knowledge of how to apply the most cost effective technology

Collaborative Team

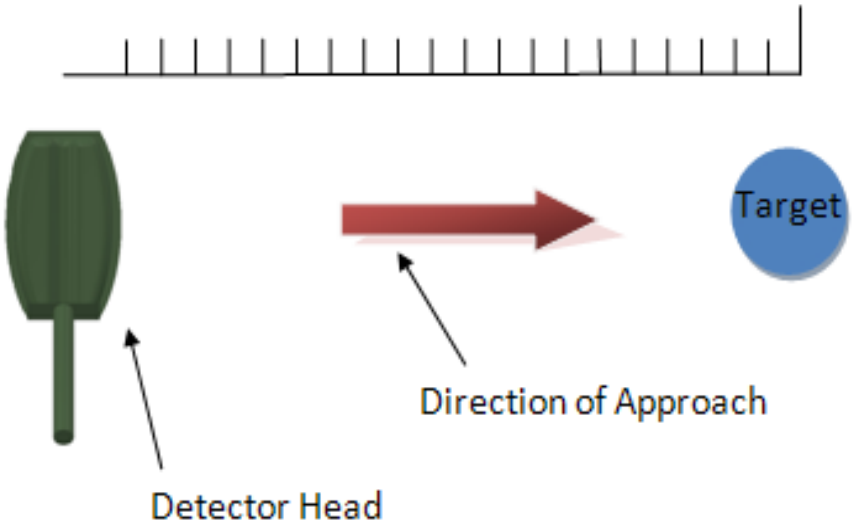
- Industry
  - Advanced Military Equipment, Inc.
  - Advancia
- Academia
  - Missouri University of Science and Technology
  - Lincoln University
- Government
  - U.S. Army Research Laboratory

Funding Source

- Missouri S&T Submitted a proposal based on a Leonard Wood Institute solicitation
  - Leonard Wood Institute funded via a Congressional ad coming through the U.S. Army Research Laboratory
  - Proposal selected on a competitive basis
    - Technical Reviewers
    - Operational Reviewers
    - Academic Reviewers
    - LWI and ARL Reviewers

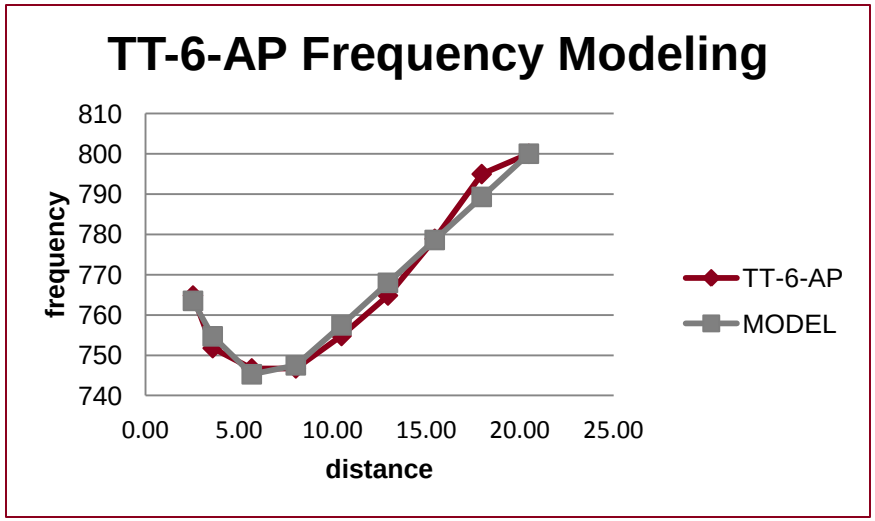
Sound Model Development Process

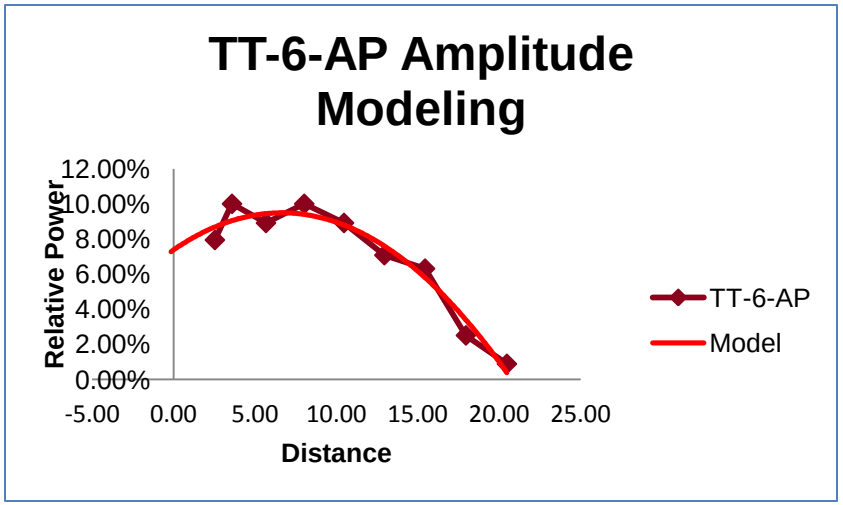
- Utilizing buried clutter, simulants, and defused mines
- Frequency and amplitude readings were taken at incremental distances to the target
- Data was then plotted accounting for target depth and total distance



Metal Detector Sound Modeling

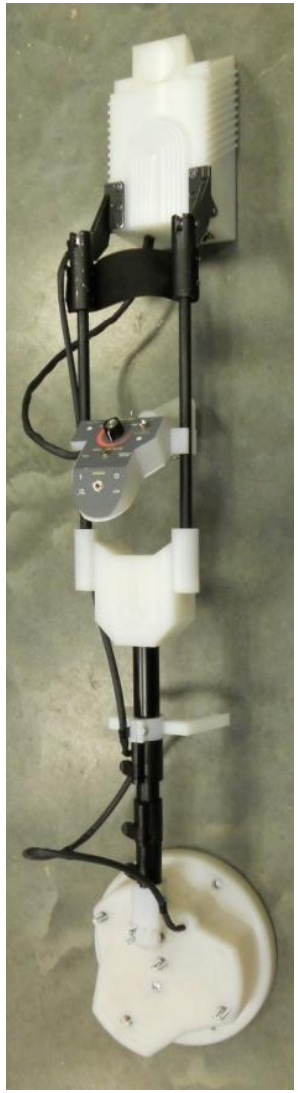
- **Polynomial regression method of analysis**





Simulated Detector

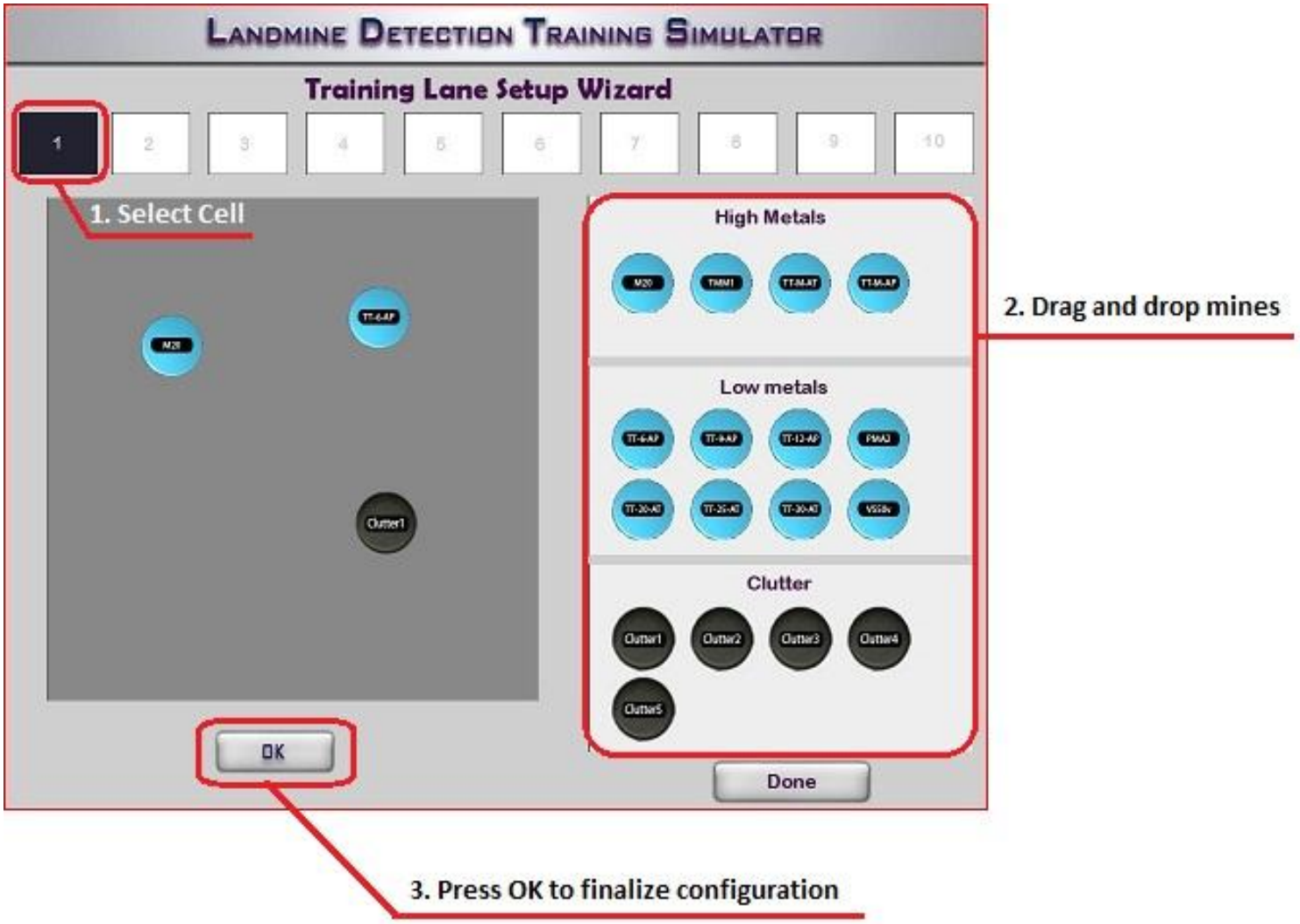
- Simulated detector features:
  - Similar controls
  - Similar size and weight distributions to provide same swing moment of inertia as the actual detector
  - Four IR LEDs were attached to the mine detector head to identify its position and orientation.



Wiimotes Stereo Vision System

- Two Wiimotes were used to form a stereo system which provides 3D position of the mine detector
- The Wiimote stereo vision system is set at 45^{o} relative to the vertical direction, 2 m from the ground, and the coverage is 1.6m ×1.8m

Training Lane Set-up



Instructor Screen

Benefits of the Simulator

- Relatively inexpensive
- Fundamental program could have other algorithms that define performance parameters of any other handheld detector plug in – thus would be comparatively easy to evolve device into a simulator for any of the different types of handheld mine detectors the Army uses
- Enables training indoors in a space as small as 6 by 10 feet
- Can focus training on the tasks that need to be trained
- Provides visual history of performance for the Soldier
- Enables tailoring the lane difficulty to the Soldier's skill level
- Provides comparative performance over time

Good News Story

- The Army, academia, and industry all came together to produce a product that none of the agencies alone could have accomplished
- While yet unproven, there are reasons to believe the landmine simulator could improve efficiency of refresher training
- The concept can readily be adapted to any number of other handheld mine detectors
- The landmine simulator provides a new and innovative way to train handheld detection with the many advantages of simulation
- Though not being used now, it demonstrates what is possible in another area of simulation training