Automated Communication Analysis for Interactive Situation Awareness Assessment

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Phase II SBIR N04-119
Kick Off Meeting

Objectives

- Overall
  - Create A Communication Analysis Toolset To Measure SA And Team Cognition
- This Year's Objectives
  - Identify, Select, And Test Our Chosen Metrics Of Team Cognition Against Communication Analyses

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Research Questions

- Long Range Needs
  - Team SA
  - Communication
  - Cognition
- Communication And Problems Of Assessment
- Communication Is The Best Window Into What's Going On Inside A Person's Brain (Cognition)

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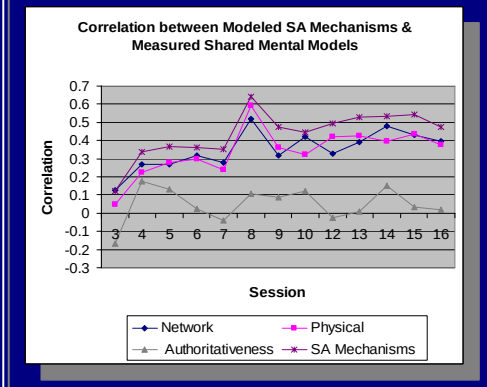
Technical Approach

SA Technologies:
Created Models of Shared SA



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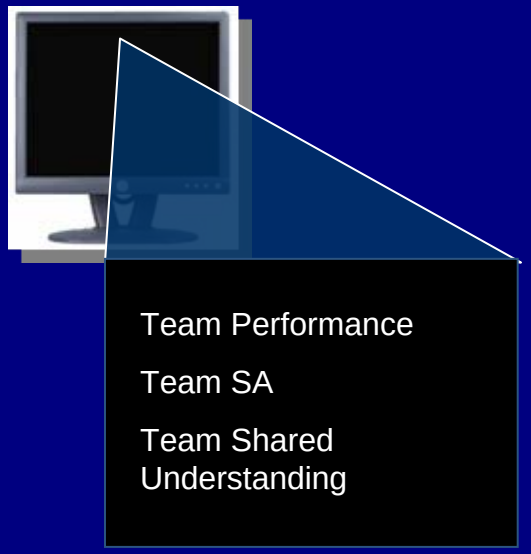
Pearson Knowledge Technologies:
Used Discourse Analysis to Predict team Performance

Phase I Results

Create A Communication Analysis Toolset To Measure SA And Team Cognition



Phase II Plan

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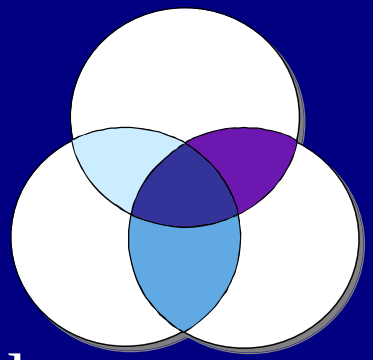
Technical Approach

- TeamPrints LSA
  - Other Computational Linguistic Approaches
- Situation Awareness Measures
  - SAGAT, Subjective, Physiological,
- Team Performance Metrics
  - Success, Work Quality, Trust, Workload
- Team Process Metrics
  - Coordination, Information Quality, Convergence Of Idea



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Technical Approach: TeamPrints

- Automatically predict team performance measures from communication
- LSA-based model of the domain knowledge
- Predict overall team and individual performance scores
- Identify utterances indicative of performance/SA issues

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Technical Approach

- Improve modeling of performance scores
  - Find most semantically similar missions and predict score based on other mission scores
  - Examine other statistical measures of language (50+)
  - Look at combination of the measures to best model performance measures as well as generalize to new data (different missions/contexts/etc.)

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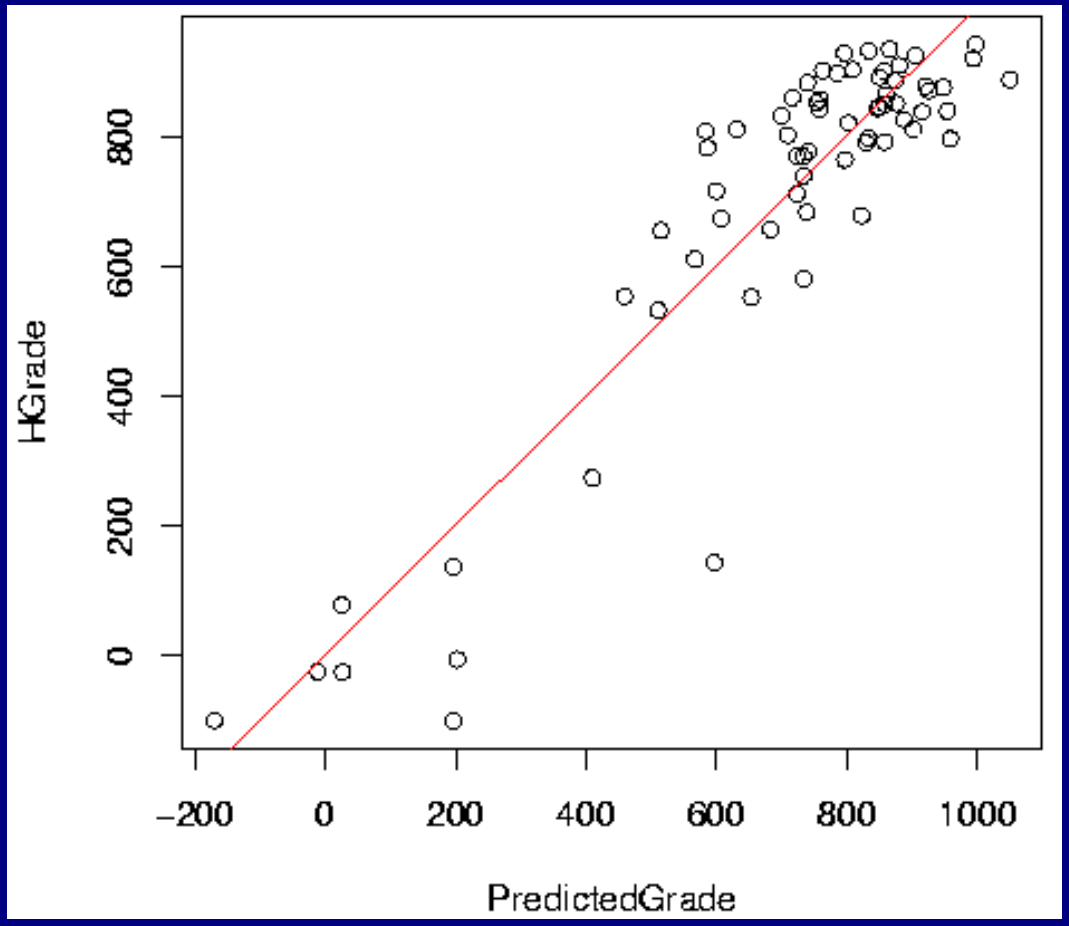
Technical Approach

Predicting Team Performance scores based on team dialogue (UAV data):

Actual Team Performance Score



Computer Predicted Team Performance Score

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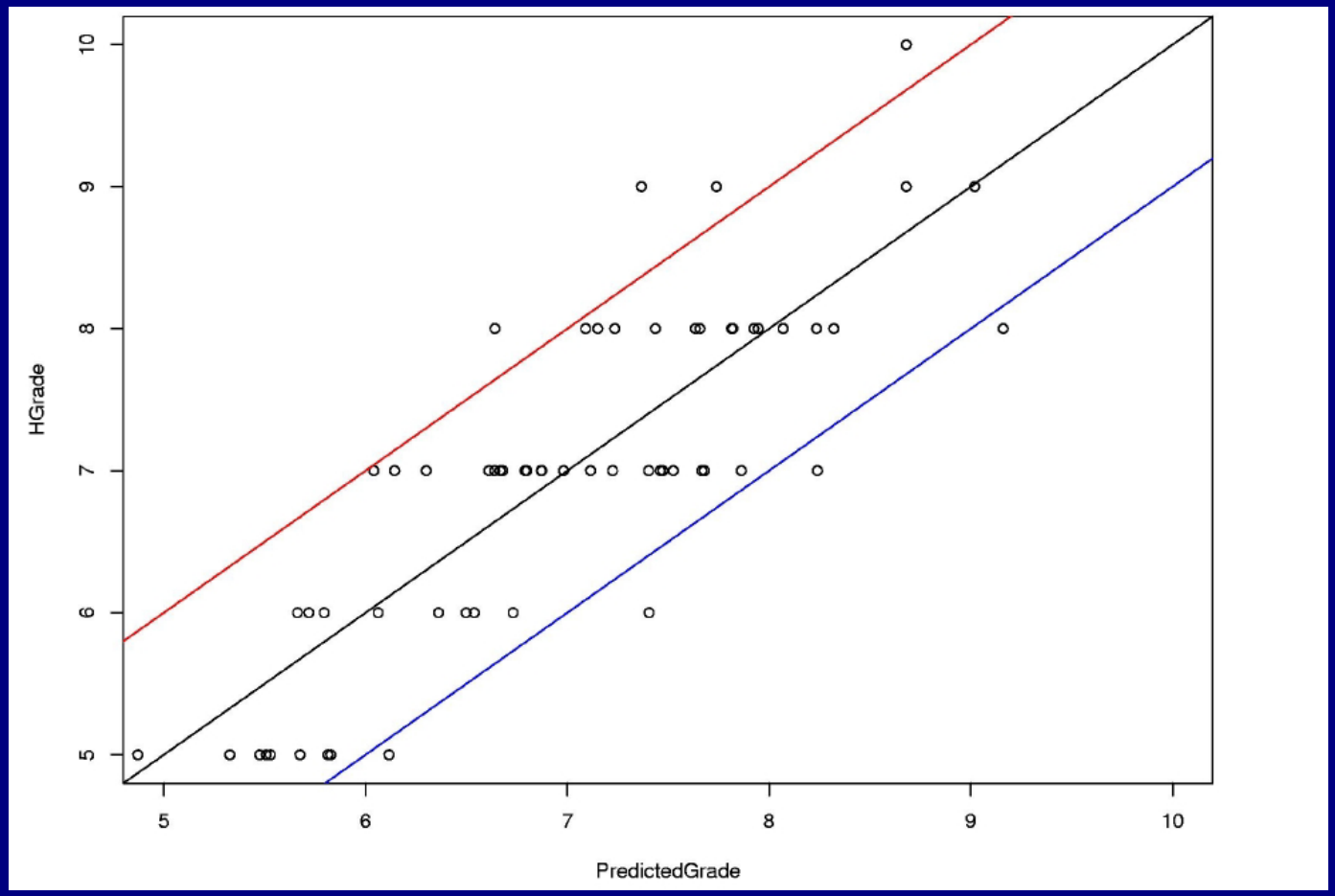
Technical Approach



Tadmus Missions Leadtot Agreement between Predicted and Human Evaluation

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How well does it measure SA?

- TADMUS

Measure	Jack-knife Corr. to SME ratings
Leadership (guidance + priority)	0.73
Clarity	0.68
Completeness of reports	0.63
Passing information	0.61
Proper phraseology	0.78
Seeking sources	0.57
Situation update	0.45
Providing & requesting backup/assistance	0.62
Providing guidance	0.61
Stating priorities	0.73

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Technical Approach

- To What Extent Can LSA Find SA?
- Based on verbal communications: identify
  - Level 1
    - Misperceptions (e.g., disorientation)
    - Omissions (data not observed, forgotten, and not communicated)
    - Lack of coordination statements
  - Level 2
    - Statements showing incorrect mental model of current state
    - Over-reliance on default behaviors when model suggests other communicated behaviors would be more appropriate
  - Level 3

    Statements showing appropriate projection into the future

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Technical Approach

- Determine What Team Members Are Saying By Tagging Utterances
- **Goal:** Tag utterances from transcripts for types of dialogues
  - Frequency and sequences of tags can predict team performance (e.g., Bowers, Jentsch, Salas, & Braun, 1998)
  - Human tagging takes approximately 1.5 hours per transcript, computer, with current algorithm, takes approximately 1 minute.
  - Tags: *Uncertainty, action, acknowledgements, planning, factual, non-task related, response …*

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Technical Approach: Method for Tagging

- Humans tag a subset of the transcripts
- Machine learning algorithm for processing utterance and predicting tags
  - Based on similarity to human tagged utterances and rudimentary discourse structure rules

TAGGER-AGREEMENT	KAPPA
Human-Human	0.62
Computer-human	0.58

- Performance within 6% of human-human agreement
- Method critical for advancing identification of good/bad
- discourse (e.g., planning, problem solving, etc.)
- Frequency of acknowledgments r = .35 to team performance)

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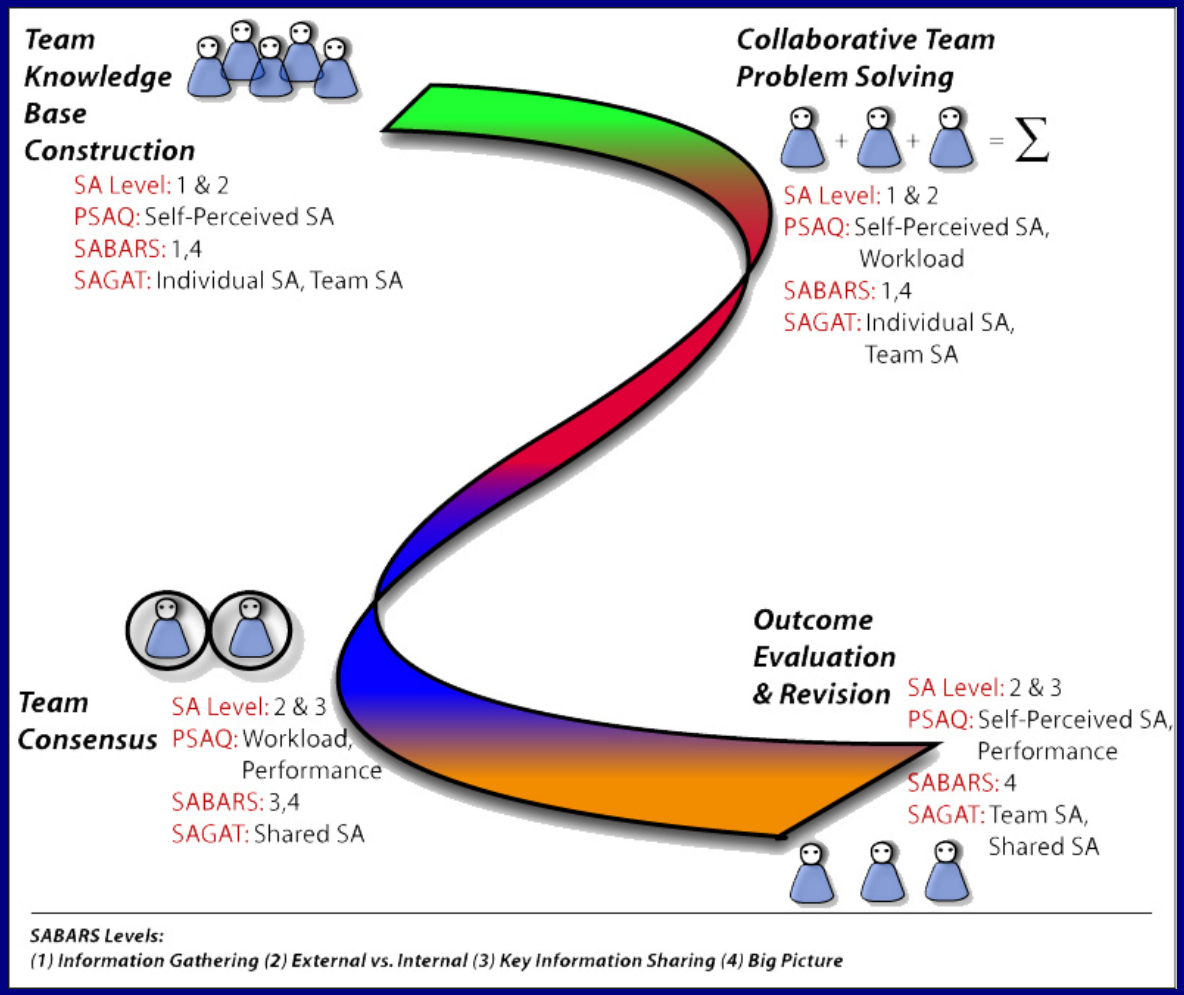
Technical Approach

How does our SA analyzer fit in with the CKM framework?



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Work Plan

Activity Name	Year 1				Year 2			
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Task 1: Identify Relevant Data Sets								
Task 2: Identify the Possible Cognition and SA Metrics								
Task 3: Evaluation and Selection of the Metrics								
Task 4: Develop the Methodology for Testing the Metrics Against LSA								
Task 5: Test the Metrics Selected in Task 3								
Task 6: Develop Prototype Set for Measuring Cognition in Real-Time								
Task 7: Validate the Toolset Measures (Option1)								
Task 8: Add Additional Features to the Toolset and Test Generalization (Option 2)								
Task 9: Write Final Report								

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Experiments Planned: Data Collection

- Obtain Datasets
  - TADMUS, NEO (NavAir), NPG, Weather Data
  - Create Optimal Dataset
- Identify/Evaluate Potential Metrics
  - Situation Awareness
    - SAGAT, Levels of SA, Individual SA, Team SA, Shared SA
    - SABAR (Situation Awareness Behaviorally Anchored Rating Scale)
    - PSAQ (Post Subjective SA Questionnaire)
  - Performance/Process
    - Workload
    - Self-Perceived Performance
    - Information Gathering/Seeking
    - Solution Focus

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Experiments Planned: Refine LSA Metrics

- Create generalized communication analysis architecture
- Refine:
  - Overall team prediction algorithm
    - With focus on SA measures
  - Uni-dimensional prediction algorithm
  - Methods for automatic tagging of utterances
    - Adapt analysis for utterances most predictive of SA

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Technology Demo's Planned

- Demonstrate Tool for Small Distributed Team Tasks
  - First - Task Environment Similar to Those Used in Creating the Toolkit
  - Second - Other Possible Team Task Domains

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Current Issues

- Acquiring Useful Data
- Limitations
  - Currently Limited to One Channel of Communication
  - Distributed Teams Only (No face-to-face)
  - Text Based Only
    - Works with ASR, but not as accurate
  - Limitations of SA Measurement
    - Lack of Correlation
    - Multiple Measures

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Expected Final Products From Phase II

- Robust toolset for automated communication analysis
  - Real-time analysis
  - Predicted SA and other cognitive measures
- Report reflecting improved theories of the role of communication and SA

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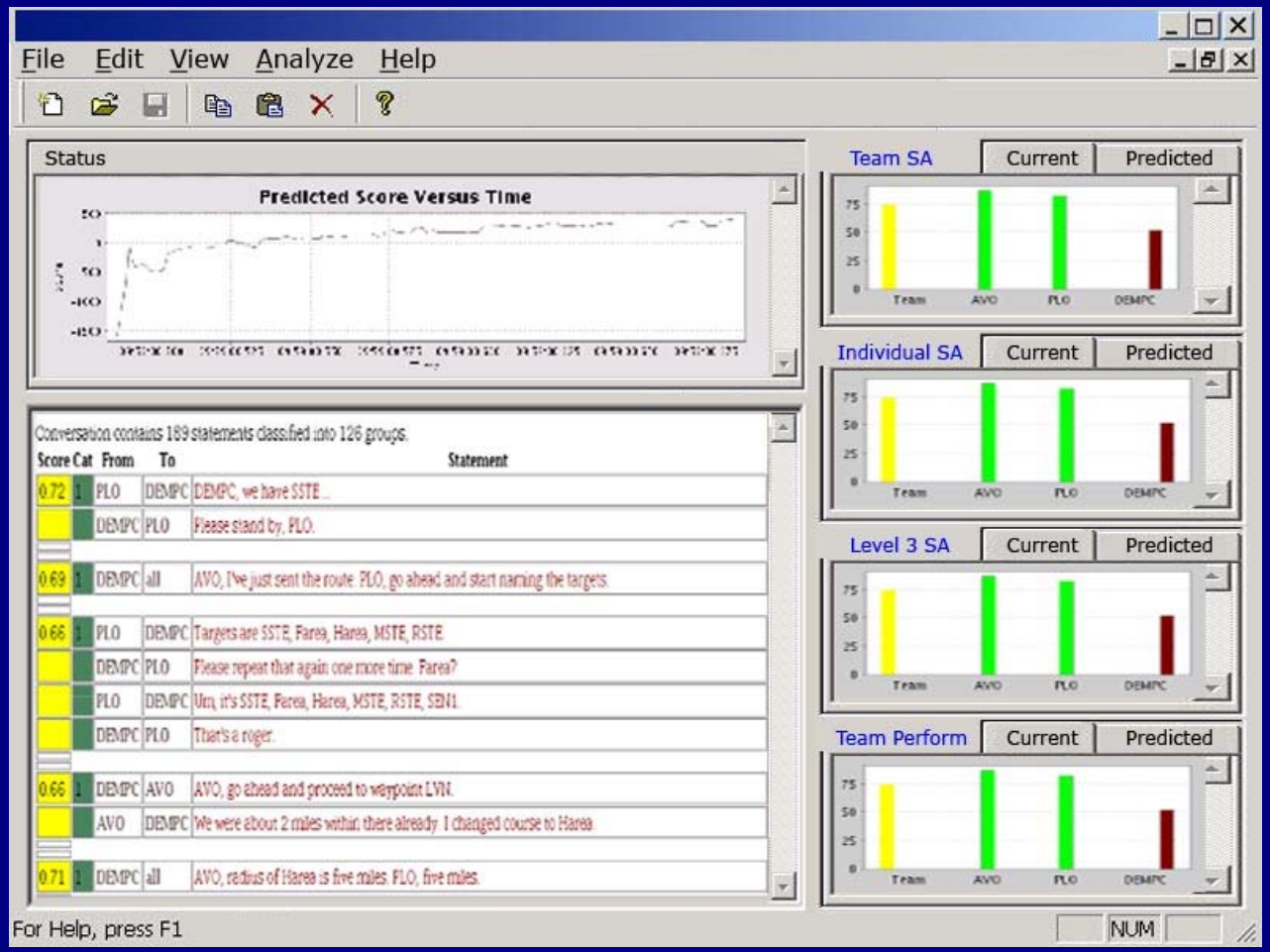
Expected Final Products From Phase II



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Potential Operational Use

- Will have identified and validated a range of tools and techniques
- Goal: Expand to additional training and operational contexts
- Greater integration with modeling techniques
- Can be adapted to more robust toolset integrated into training systems for:
  - Detecting individual and team errors and knowledge gaps
  - Predicting overall team performance, failures in team process, cognitive workload
  - Monitoring group dynamics
  - Detecting appropriate and inappropriate contexts for the mission.
  - Adapt training to user's level
  - Generate automated AARs
  - Automatically adapt system interface to team's current context

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Identify Recent or Planned Publications

- Project began in December 2005.

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