

**APTIMA**<sup>®</sup>  
HUMAN-CENTERED ENGINEERING

# Knowledge & Experiences of Expert Labor (KEEL)

[www.aptima.com](http://www.aptima.com)  
Woburn, MA • Washington, DC

Presenters:  
Rebecca Grier, Ph.D.

Date: 15 Jan 2008



- **About Aptima (Who)**
- Background (Why)
- Development Theory (How)
- Prototype & Architecture (What)
- Development Schedule (When)
- Discussion





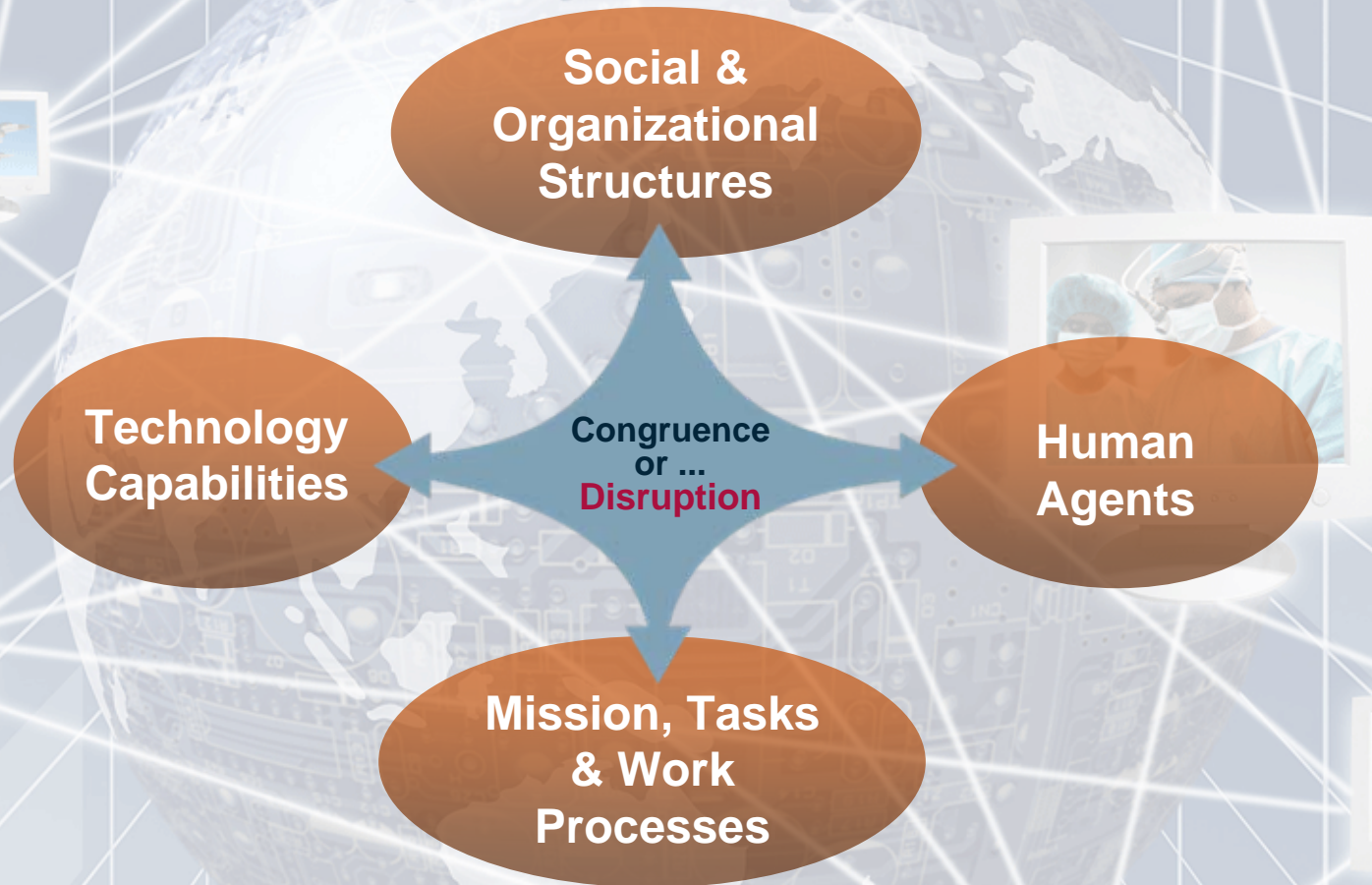
# 21<sup>st</sup> Century Organizations

Today's organizations are ***sociotechnical systems*** — complex structures of highly skilled individuals interacting with information and other people through advanced technology





# Human-Centered Engineering



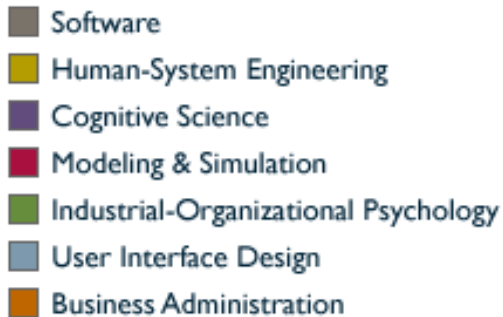


## About Us

- Founded in 1995; 50% compounded annual growth
- Clients: 33 government, 41 commercial
- 250+ contracts with the DoD
- Offices in Woburn (Boston), MA and Washington, DC

## Interdisciplinary Small Business

Staff > 110 with 80% Graduate Degree



## Aptima's DoD Work



TRADOC: U.S. Army Training and Doctrine Command



DARPA: Defense Advanced Research Projects Agency



AFOSR: Air Force Office of Scientific Research



Naval Special Warfare Command



ONR: Office of Naval Research



NAVAIR: Naval Air Systems Command



AFRL: Air Force Research Laboratory



NSWC: Naval Surface Warfare Center

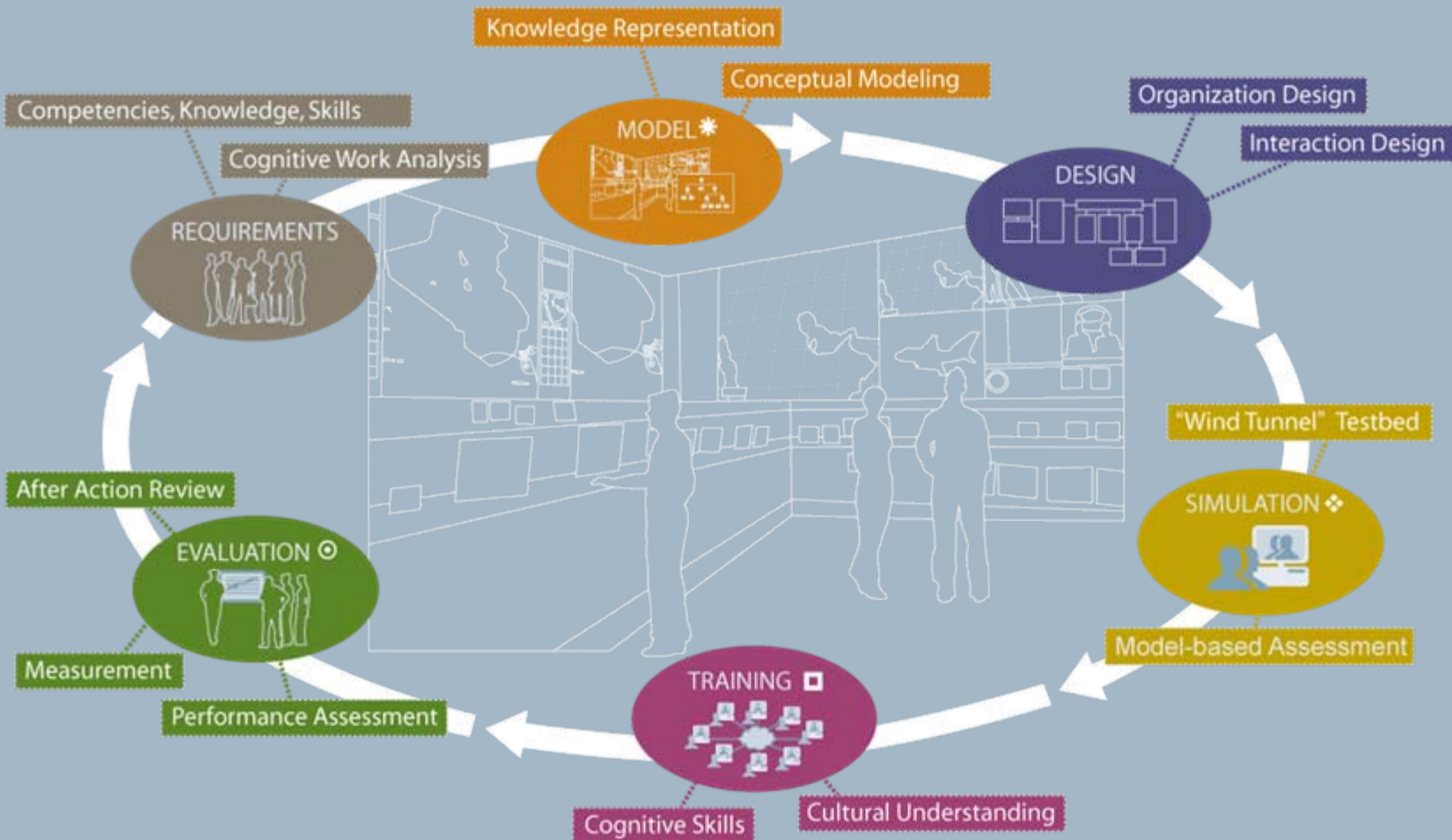
And Many Others...

## Human Centered Engineering Leader

- Analyze and design complex sociotechnical systems — military command centers, intel operations, operating rooms, air traffic control centers, etc.
- Combine social science theory with quantitative, computational methods



# Optimizing Performance in Mission-Critical Environments



- Aptima Products:
- \* A•Model
  - ❖ A•Sim
  - A•Train
  - ⊙ A•Measure



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# KEEL Problem

## ■ Explicit Knowledge

- Documentation of Work
- Captured & organized by traditional KM tools according to projects or job titles

## ■ Implicit Knowledge (Serfaty, MacMillan, Entin, & Entin, 1997 )

- In the mind of an expert
- Tricks of the trade, previous failures
- Transferred verbally through mentoring or conversations

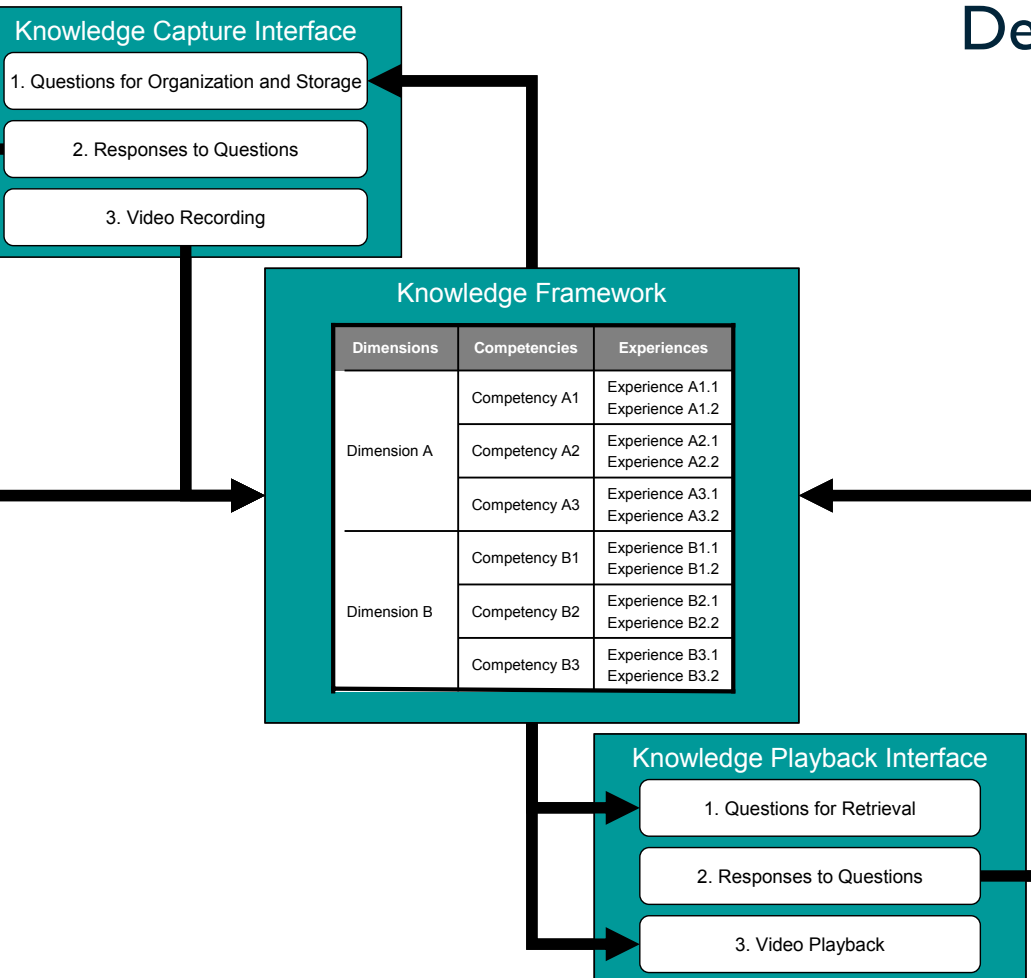


1. Create a KM System that captures implicit knowledge
2. Make this knowledge accessible to all personnel



## Develop a tool that

- Captures retiring shipbuilders’ “Lessons Learned”
- Organizes these lessons in a framework based on I/O Psychology
  - Allowing for cross job learning of skills that enable a great impact on productivity & efficiency
- Plays these lessons to novice shipbuilders to
  - Increase expertise more quickly
  - Provide on demand knowledge





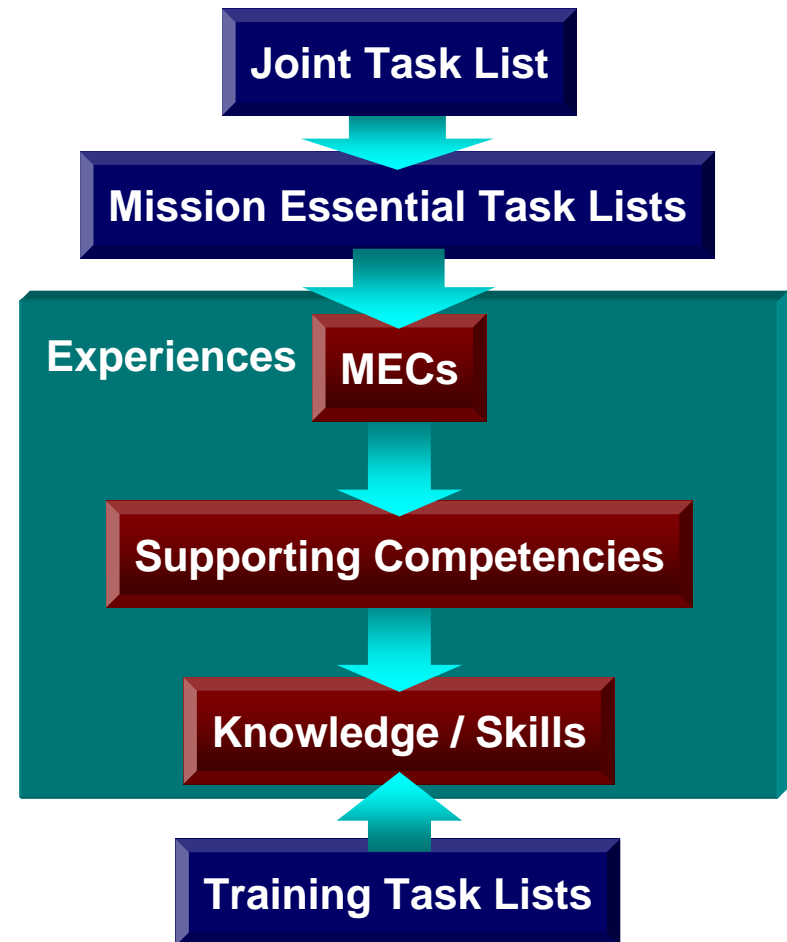
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Process by which higher-order individual, team, and inter-team competencies necessary for successful mission completion under adverse conditions are derived.

- J-METL and METLs describe operational mission-level tasks and objectives
- MECs bridge the gap by describing what you need to know to perform in a given domain to achieve mission-level objectives
- Training Task Lists help teach how to “operate” a system



*MECs Project lead Mike Garrity won 2007 M. Scott Myers Award for Applied Research in the Workplace*



# Designing for Serendipity

- Serendipity Is Important For (Foster & Ford, 2003; Toms, 2000):
  - Building connections between topics
  - Learning via discovery
  - Increased creativity
  - Stimulate curiosity
- In Designing for Serendipity...
  - One must maximize ability to explore (O'Connor, 1988)
  - Allow users to assess what's available (Newman et al, 2002)





- Experienced workers...
  - Tell a story
  - Describe the value of the story
- Junior workers...
  - Have a question for exploration
  - Select & listen to a story
  - Extract relevant learning points
  - Continue exploration



And Vice Versa:  
Junior → Experienced



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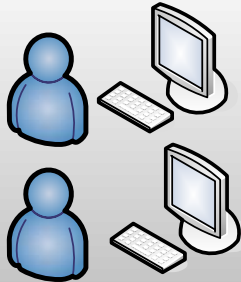


# KEEL Architecture

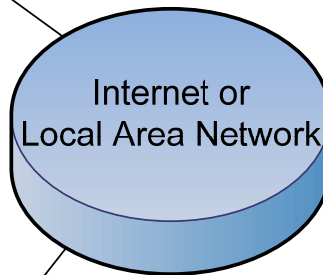
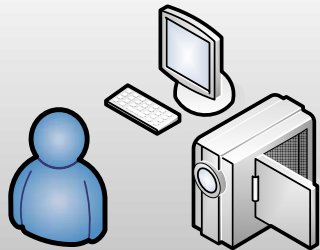
## Rich Client Technology

Adobe Flash/Flex

### Knowledge Retrieval



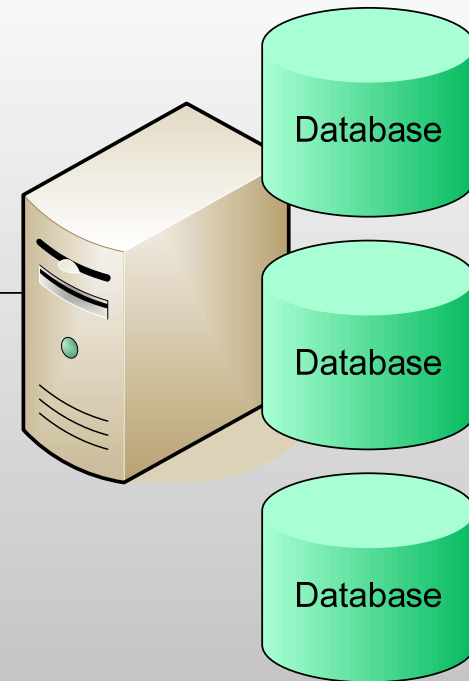
### Knowledge Capture



## KEEL Content Storage

Microsoft Server

### Flexible, Scalable Content Storage





- Based on Successful Competency Definition Process
- Hierarchical:
  - Topic Areas:
    - Themes that cut across jobs in the shipbuilding industry that are characteristics of everyone's job
    - When done well ensure the ship will be delivered on time and at or below cost.
  - Competencies:
    - A set of KSAs that, when properly performed, facilitate the completion of a topic area.
  - KSAs
    - Fine grain characteristics required to complete a job/task successfully:
      - Knowledge: a body of information that can be applied to a specific task
      - Skills: an observable sequence of actions that can be successfully executed
      - Abilities: attributes of an individual to perform a behavior

| Topic Area: Risk Management      |                                      |
|----------------------------------|--------------------------------------|
| Competency: Integration of Ideas |                                      |
| Secondary Grouping               | KSA                                  |
| Knowledge                        | Knowledge of Human Machine Interface |
|                                  | Knowledge of Requirements            |
| Interpersonal                    | Negotiating with Other Departments   |
| Skills/Abilities                 | Organizational Skills                |
|                                  | Ability to Compromise                |
| Components of Analysis           | Identification of Assumptions        |



# Knowledge Capture



## KNOWLEDGE AND EXPERIENCES OF EXPERT LABOR (KEEL) KNOWLEDGE CAPTURE

### 1. Select a Problem Area

### 2. Record Video

### 3. Tell Us More About Your Video

Please click on a problem area related to an experience that you have had, which will be helpful to other SMC personnel.

**Bolded Problem Areas** need more stories.

After selecting a Problem Area, click **NEXT**.

#### PROBLEM AREAS


- Change Order Management
- Leadership
- Process Control
- Requirements Management
- Customer Relations
- Lean's 5 S's (Sort, Stabilize, Shine, Standardize, Sustain)
- Productivity
- Self Quality Control
- Design for Production
- Organizational Management
- Project Management/ Workflow
- Supply Chain/Logistics
- Elimination of Waste**
- Problem Solving/Flexibility
- Risk Management**
- Teamwork**

**MORE INFO**

**NEXT**




# Knowledge Capture



**KNOWLEDGE AND EXPERIENCES OF  
EXPERT LABOR (KEEL)  
KNOWLEDGE CAPTURE**


1. Select a Problem Area      **2. Record Video**      3. Tell Us More About Your Video

- First think of a story related to Risk Management
  - A difficult situation that taught you a lesson
  - A situation you handled really well
  - Something unusual that happened
  - Or select a lesson needed:
- Click Record 
- Look at Camera & tell your story
  - Start with a problem/situation
  - Then tell all relevant details
  - Then tell what you did in response to problem/situation
  - Then tell what you would do again and why
  - Finally tell what you would do differently if you could and why
- Click Stop
- Click NEXT button

**BACK** **NEXT**



# Knowledge Capture



**KNOWLEDGE AND EXPERIENCES OF  
EXPERT LABOR (KEEL)  
KNOWLEDGE CAPTURE**

**1. Select a Problem Area**      **2. Record Video**      **3. Tell Us More About Your Video**

1. Please enter a short name for your video:   
A good name would tell the user what makes your story unique.  
[View existing names](#)

2. Please select your job title:

3. What project does this story relate to?   
Add project name:

4. Choose up 3 competencies below that your video relates to:

**COMPETENCIES**

|   |   |   |
|---|---|---|
| <input type="checkbox"/> Advocacy                 | <input type="checkbox"/> Idea Integration                   | <input checked="" type="checkbox"/> Risk Mitigation |
| <input checked="" type="checkbox"/> Communication | <input type="checkbox"/> Risk Assessment/<br>Quantification | <input type="checkbox"/> Situational Awareness      |
| <input type="checkbox"/> Creativity               | <input type="checkbox"/> Risk Identification                |   |

**BACK**      **NEXT**



# Knowledge Capture



## KNOWLEDGE AND EXPERIENCES OF EXPERT LABOR (KEEL) KNOWLEDGE CAPTURE

1. Select a Problem Area

2. Record Video

3. Tell Us More About Your Video

**3b. Choose Categories**

Please click on the concepts (up to 2 in each box) to which your story relates.

When finished, click **NEXT**.

### Communication

- Knowledge of Engineering Constraints
- Ability to receive, provide, and optimize feedback
- Exchanging Information
  
- Willing to Communicate Issues to Higher Management
  
- Knowledge of Operator/End-User
- Understand others' perspectives

**BACK**

### Risk Mitigation

- Identification of Critical Physical Components
- Knowledge of Engineering Constraints
- Knowledge of Requirements
- Knowledge of Operator/End-User
- Knowledge to Support Process Selection
- Manage Customer Expectations
- Negotiating with Other Departments
  
- Organizational Skills
- Resourcefulness
- Cause-Effect Identification
- Identification of Ex
- Parameter Quantification
- Root Cause Analysis
- Validation Through Testing

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**NEXT**



# Knowledge Retrieval

## KNOWLEDGE AND EXPERIENCES OF EXPERT LABOR (KEEL) KNOWLEDGE RETRIEVAL

1. Tell Us
2. Select the Item
3. View the Item

Please choose items that you'd like to view: Keyword Search:

| PROBLEM AREAS   | COMPETENCIES                   | CONCEPTS  | JOB TITLE             | PROJECT   | DOC/VIDEO | RATING        |
|---|--------------------------------|---|-----------------------|-----------|-----------|---------------|
| Change Order Management                                     | Advocacy                       | Identification of Critical Physical Components                        | Software Engineer     | CGX       | Document  | ★★★★          |
| Customer Relations  | Communication                  | Knowledge of Engineering Constraints                                  | Reliability Engineer  | CVN 21    | Video     | ★★★           |
| Design for Production                                       | Creativity                     | Knowledge of Requirements   | HSI Engineer          | DDG 1000  |           | ★★            |
| Elimination of Waste  | Idea Integration               | Knowledge of Operator/End-User Knowledge to Support Process Selection | Senior Project Leader | LCS       |           | ★             |
| Leadership  | Risk Assessment/Quantification | Manage Customer Expectations  |                       | Security  |           | Not Yet Rated |
| Lean's 5 S's (Sort, Stabilize, Shine, Standardize, Sustain) | Risk Identification            | Negotiating with Other Departments                                    |                       | Six Sigma |           |               |
| Organizational Management                                   | Risk Mitigation                | Organizational Skills   |                       |           |           |               |
| Problem Solving/Flexibility                                 | Situational Awareness          | Resourcefulness   |                       |           |           |               |
| Process Control   |                                | Cause-Effect Identification   |                       |           |           |               |
| Productivity  |                                | Identification of Excursions  |                       |           |           |               |
| Project Management/Workflow                                 |                                | Parameter Quantification  |                       |           |           |               |
| Risk Management   |                                | Root Cause Analysis   |                       |           |           |               |
| Requirements Management                                     |                                | Validation Through Testing  |                       |           |           |               |
| Self Quality Control  |                                |   |                       |           |           |               |
| Supply Chain/Logistics                                      |                                |   |                       |           |           |               |
| Teamwork  |                                |   |                       |           |           |               |

Title 1

★★★★

Lorem ipsum dolor sit amet, consectetur adipiscing elit.

Title 2

★★★★

Title 3


★★★★

Title 4

★★★★



# Knowledge Retrieval







**KNOWLEDGE AND EXPERIENCES OF  
EXPERT LABOR (KEEL)  
KNOWLEDGE RETRIEVAL**

1. Tell Us
**2. Select the Item**
3. View the Item

Found: 3 Documents / 1 Video  
With keyword(s): Protocol Problems

**Select a file to view and click NEXT.**  
Click on any of the headers to sort by. If several files are of interest you can hold them for viewing later.

| HOLD                     | DOC/<br>VIDEO   | TITLE                 | PROBLEM<br>AREA                                       | COMPETENCIES   | RATING        | <b>MORE +/-</b> |
|--------------------------|---|-----------------------|---|--|---------------|-----------------|
| <input type="checkbox"/> |    | Data Organization     | Systems Engineering                                   | Risk Mitigation<br>Big Picture/Situational Awareness | Not Yet Rated | <b>MORE +/-</b> |
| <input type="checkbox"/> |    | Data to Customer      | Systems Engineering                                   | Risk Mitigation<br>Communication                     | ★ ★ ★         |                 |
| <input type="checkbox"/> |  | Holiday               | Resourcefulness<br>Negotiating with Other Departments | Risk Mitigation                                      | ★ ★           |                 |
| <input type="checkbox"/> |  | Wireless Alert System | HSI<br>Security                                       | Risk Mitigation<br>Developing Mitigation Strategy    | ★ ★ ★ ★       |                 |

**BACK**
**NEXT**



# Knowledge Retrieval

**KNOWLEDGE AND EXPERIENCES OF  
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KNOWLEDGE RETRIEVAL**

1. Tell Us      2. Select the Item      **3. View the Item**

**Wireless Alert System**

**Vince Quintana**  
HSI Engineer

View related document to this video

**BACK**      **NEXT**



KNOWLEDGE AND EXPERIENCES OF  
EXPERT LABOR (KEEL)  
KNOWLEDGE RETRIEVAL

## Wireless Alert System

Please rate this video to help future users:

- ★★★★★
- ★★★★
- ★★★
- ★★
- ★
- This video has questionable content and should be reviewed

Would you like to see another video or record your story?

- View a new video with same options
- View a new video with different options
- I have a story to share
- I'm finished

**BACK**

**NEXT**



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# Software Development

| Milestones                            | Dates             |
|---------------------------------------|-------------------|
| Software Architecture                 | March 15, 2008    |
| Software Requirements                 | March 15, 2008    |
| Spiral I: Integrate with Media Server | May 11, 2008      |
| Spiral II: Integrate with Database    | August 11, 2008   |
| Spiral III: Flesh Out User Interfaces | November 11, 2008 |
| Manuals & Release Notes               | December 11, 2008 |



| Milestones             | Dates            |
|------------------------|------------------|
| Topic Areas Defined    | March 31, 2008   |
| Focus Groups Conducted | August 15, 2008  |
| Framework Defined      | October 15, 2008 |



# Option Periods (may be revised)

| Milestones                    | Dates                  |
|-------------------------------|------------------------|
| Knowledge Capture Beta Test   | Option Period 1 – 2009 |
| Refine Framework              | Option Period 1 - 2009 |
| Knowledge Retrieval Beta Test | Option Period 2 - 2010 |
| Software Refinement           | Option Period 2 - 2010 |



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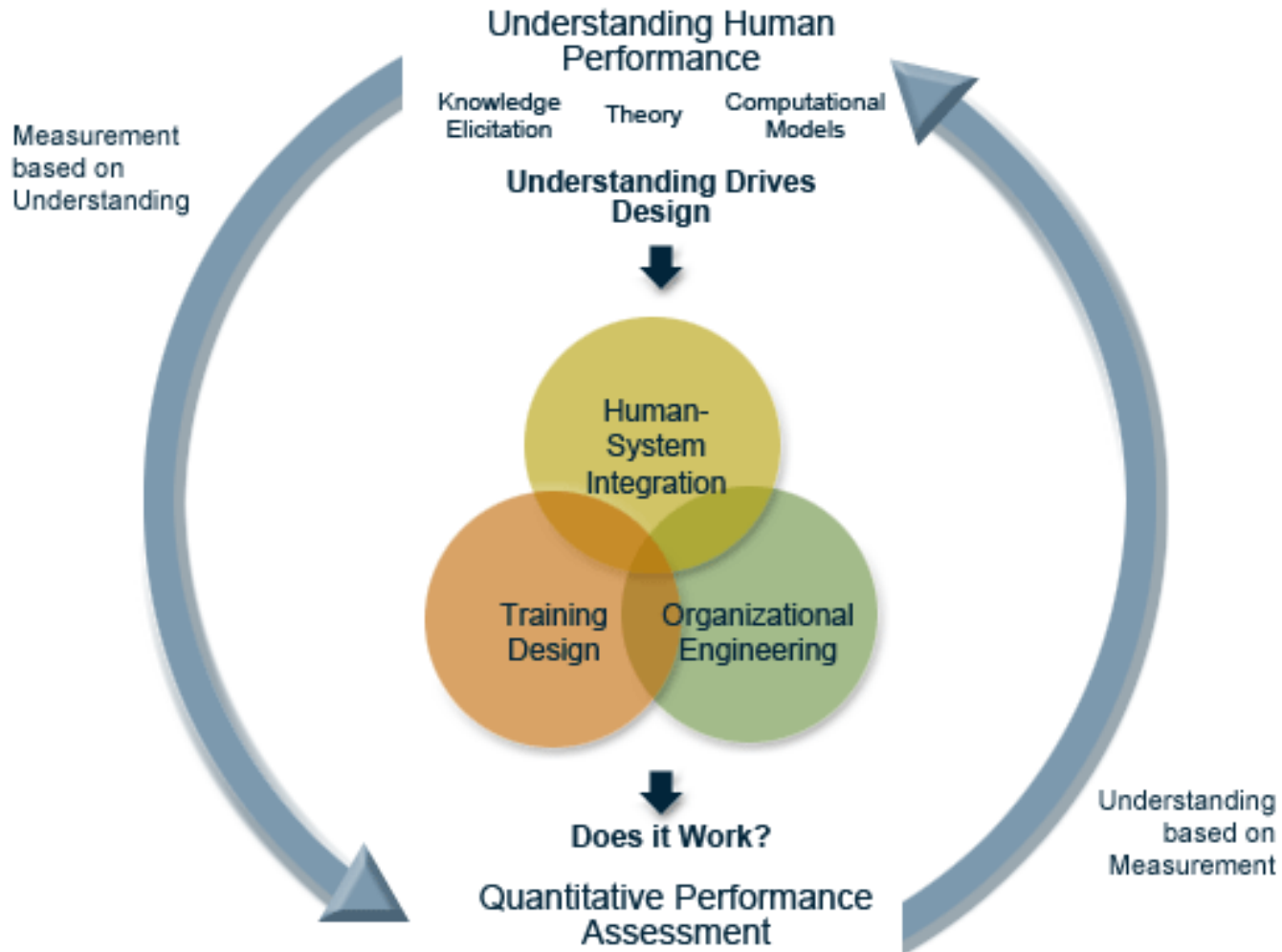
# Discussion

# Questions





# Aptima's Approach





## Mission

- Build the three pillars of organizational effectiveness

## Methods

- Optimize the structure & processes of organizations using advanced computational models
- Make organizations more effective and adaptive with training in leadership and multi-cultural management





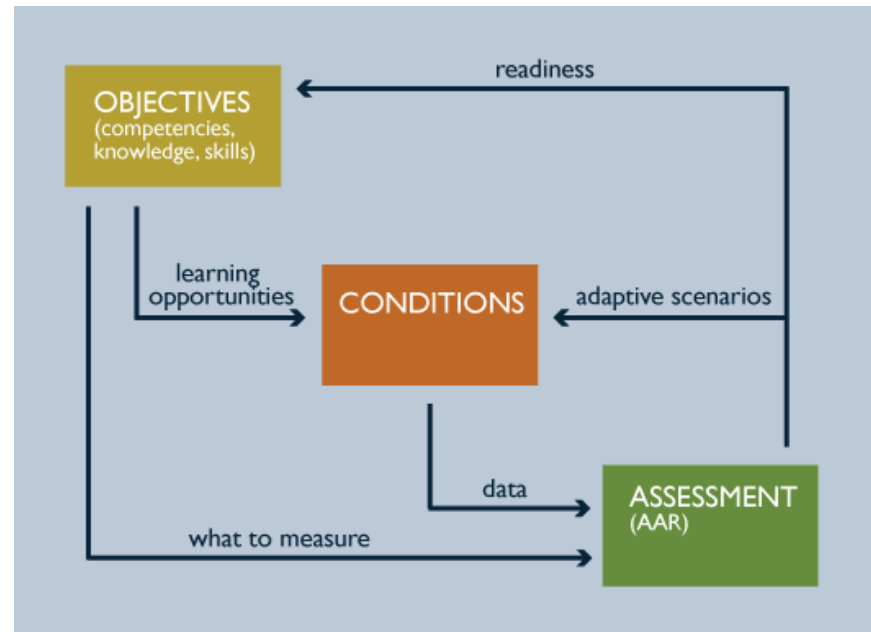
# Training Design Services

## Mission

- Accelerate learning at reduced cost

## Methods

- Identify training needs and goals
- Create simulated and live exercises
- Measure competency, assess it, and provide feedback to enhance it





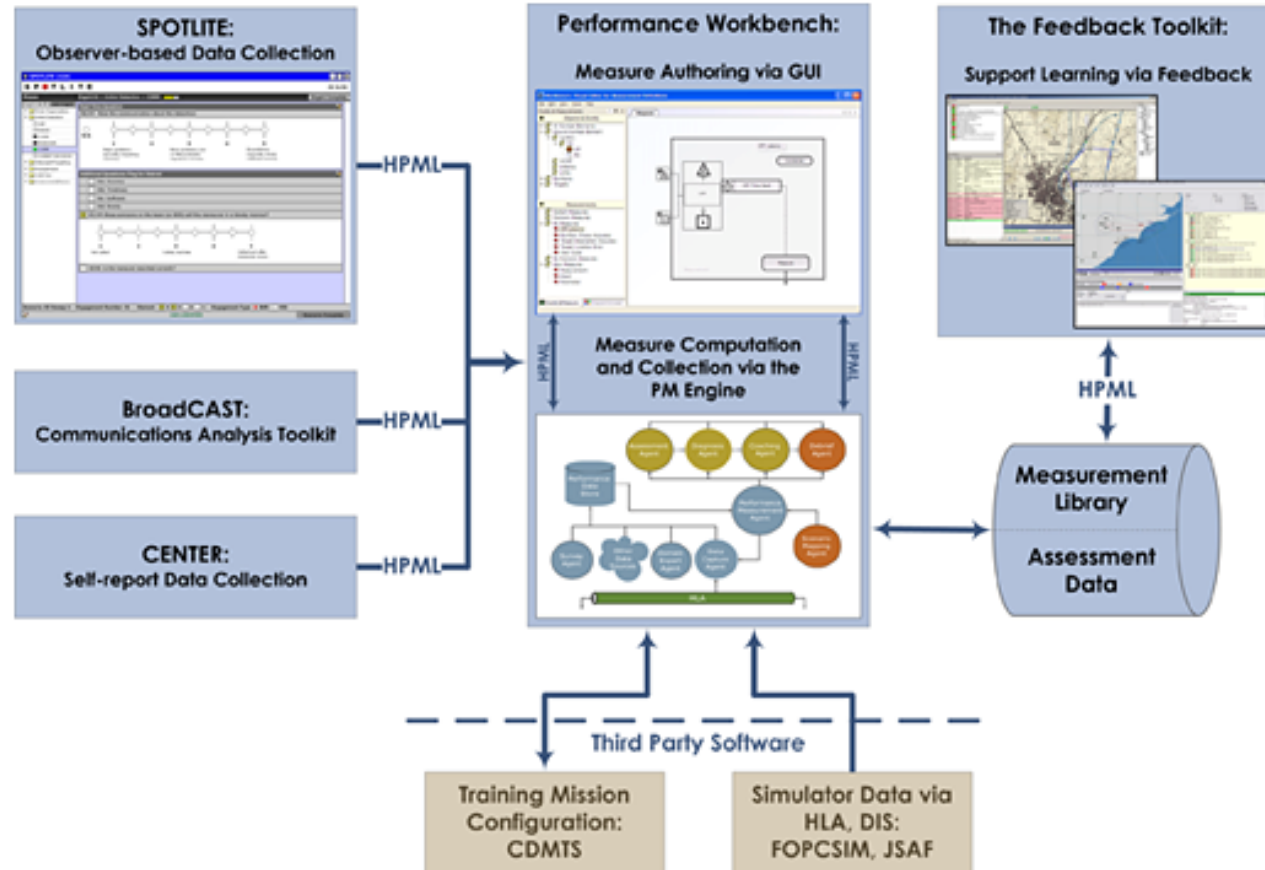
# Performance Assessment Services

## Mission

- Deploy technology for efficient, quantitative measurement of people, technology & work

## Methods

- Rapidly implement measures, take measurements, and present feedback using technologies based on a new science of performance measurement





## Mission

- Adapt technology to users for optimal decision making and action

## Methods

- Create integrated socio-technical systems using Work-Centered Design & Cognitive Systems Engineering
- Evaluate new technologies at the concept stage using modeling; at the prototype stage using field analysis

