Best Practices
Human Error Management
(TOR-2017-01691)

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Ball Aerospace & Technologies Corp.
How well do you manage human errors? It is accountable for over 50% of errors in the aerospace industry. They cost money, impact schedule, destroy hardware, and may cost lives. They can happen with all the preventative measures in place or the best trained employees. These errors can be minimized and managed when we have the “right” environment. Human error management (HEM) is about a culture that empowers, communicates, and supports all employees around HEM. Employees recognize their fallibility, and supervisors and managers do not point fingers. All best practices are incorporated into the company’s processes and way of thinking.
Workshop Outline

- Introduction
- Purpose of Workshop
- Background of HEM Best Practices TOR*  
  - Group Activity
- Human Error in the News
- Human Error Success Story
- Creating the “Right” Environment  
  - Group Activity
- Summary
- Acknowledgements and References

*TOR: Technical Operating Report, Aerospace Corporation
Copies available on table, leave email address if you’d like a copy emailed.
Introduction

- Ms. Laurie Stupak has 23 years of aerospace experience with the last 14 years at Ball Aerospace where she is responsible for enterprise data governance, data utilization and knowledge management. In her current role, she is also the champion for human error management and served as the MAIW industry lead and co-author of TOR-2017-01691, Best Practices Human Error Management (HEM). Prior to that, she was the Mission Assurance Manager on a spacecraft bus program where she co-led the program team through successful implementation of HEM best practices during the AI&T execution.

- Prior to joining Ball Aerospace, Ms. Stupak was a Statistician and Reliability Engineer for both Northrop Grumman Space Technologies and Boeing Satellite Systems supporting many areas including propulsion engineering, on-orbit availability assessments, constellation architecture trades, failure analyses and statistical models supporting critical risk-based decisions.

- Ms. Stupak has a Master’s degree in engineering management from the University of Colorado, a Master’s degree in statistics from the University of South Carolina, and a Bachelor of Science degree in mathematics from the University of Vermont. She is also a Certified Master Black Belt with ROI Alliance and has held Certified Reliability Engineer and Certified Quality Engineer certifications with ASQ.
Purpose of Workshop

- Overview of Best Practices of HEM as outlined in TOR-2017-01691
- Demonstrate Human error examples in the news and Aerospace
- Learn core HEM Principles and Tools thru a group activity
- Share collaborative ideas on Creating the Right Environment to bring back to your companies
Human Error—“It” Happens

Manager walked into antenna while inspecting spacecraft

C-band reflectors removed and reinstalled on wrong sides at launch base

Bolts were torqued from memory

The wrong units were used (lbs vs. Kgs)

Tools left inside spacecraft and found during spacecraft rotation

Scissor lift collided with reflector

Vibe unit exploded due to undocumented procedure step

Explored

Inadequate

Collided

Damaged

Failed

Evacuation

Gashed

Dropped

Peeled

Fell

Dumped

Heating

Hit

Wrong

Incorrect

Collapsed

Cracked

Inside

Memory

Manager walked into antenna while inspecting spacecraft

The wrong units were used (lbs vs. Kgs)
Why Human Error Management?

- Human contribution can be considered the most chaotic part of our processes
- Human error...“it” happens—and is accountable for over **50 percent** of errors in the aerospace industry
  - These errors cost money, impact schedule, destroy hardware, and cost lives
  - These errors happen regardless of the measures in place to design them out, write the perfect procedure, or train all employees on how to do their tasks

- Think about the last time you sat at your desk and wrote an email
- Think about the last time your company had an incident or failure due to human error

- Goals of the HEM Best Practices TOR:
  - Emphasize a **PROACTIVE** rather than reactive approach to managing human errors
  - Emphasize a **CULTURE** that is supported from the top down and which is based on more than just training
  - Define a uniform guideline with the objective of **REDUCED** human errors across the industry
HEM TOR Scope

- Outlines Best Practices of human error management as a guideline to be considered for implementation at aerospace and subcontractor companies
  - HEM Guideline focuses on EMPOWERING the employees to MANAGE human error
  - Provides tools, models, and ideas to manage human error opportunities
- Provides examples that focus on the right side of the Systems Engineering “Vee”
  - However, Human errors and Best Practices DO apply through entire lifecycle
- Presents a guide for companies to develop, improve, and/or strengthen their human error management strategies
How Best Practices Were Developed

Models: Input from Literature

Implementation: Current Company Programs and Practices

Lessons Learned: Company Experiences and Culture

Best Practices – Human Error Management

Human Error Vs Work Place Management: Areas to consider - Soumen Chakravety, 2011
Human error and hazard analysis - Human error tables, Nils Paulsson, 2017
Human Accident at Three Mile Island – Charles Perrow, 1984
Evaluating Accident Models from Recent Aerospace Accidents - Nancy Leveson
Human Error Models and Management – James Reason, 2000
Skills, Rules, and Knowledge: Signals, Signs and Symbols, and Other Distributions in Human Performance Models – Ann Rasmussen, May 1993
Contextual Control Modes During and Airline Rescheduling Task – Karna Fugl, Amy Pritchett, Richard Sueda
Toward a Theory of Situation Awareness in Dynamic Systems – Mica R. Endsley, 1989

~ Ball Aerospace
~ The Boeing Company
~ Harris Corporation
~ Lockheed Martin Corporation
~ Northrop Grumman Corporation
~ Raytheon Company
~ SSL
5 Best-Practice HEM Elements

- Training
  - Purpose
  - Objectives and content
  - Development
  - Implementation

- Communication Forums
  - Meetings
  - Company media
  - Reports
  - Program milestones

- Closed-Loop Assessment
  - Identify
  - Track
  - Analyze
  - Improve

- Principles
  - Sources of HE
  - Management Areas
  - Pitfalls/Mind Traps
  - Tools

- Organizational Environment
  - Top-down support
  - Empowered employees
  - Roles and responsibilities
  - Pride and purpose

- Culture

Successful HEM Programs Include All 5 Elements
Best Practices: Principles

Management Areas

- Situational awareness management
- Workload management
- Attitude management
- Group dynamics management
- Risk management
- Communication management

Pitfalls and Mind Traps

- Task saturation
- Distractions
- Repetitive tasks
- Communication breakdown
- Accommodation of risk
- Group think
- Hidden agenda
- Co-worker syndrome
- Excessive professional courtesy
- Hero/cowboy syndrome
- Alpha-dog syndrome
- Perceived pressure
- Risky attitudes
- Emotional stress
- Physical stress
- New situation/out of order
- Low workload (bored)
- High workload

Tools

- [I'M SAFE]
- [Gut feel]
- [Time out]
- [TEBS®]
- [Asking: What could go wrong?]
- [Checklists]
- [Assertive statement]
- [Signs of loss of situational awareness]
- [Slow down to speed up]
- [ASK questions]
- [Questioning attitude]
Best Practices: Highlights

Communication
- Human Interactions
- Milestone Reviews
- Communication Forums
- Media
- Reports

Training
- Purpose
- Objectives & Content
- Evaluation
- Implementation
- Development

Closed-loop Assessment
- Identify
- Improve
- Measure Themes
- Track
- Analyze

Read TOR-2017-01691 for details!
Human Error in the News

Emergency Alert
BALLISTIC MISSILE THREAT INBOUND TO HAWAII. SEEK IMMEDIATE SHELTER. THIS IS NOT A DRILL.

Slide for more
Human Error in the News

Incident: A false ballistic missile alert in Hawaii was sent on Jan. 13 because an emergency worker believed there really was a mission threat.
What Happened?

8:05 a.m. the agency’s midnight shift supervisor began a no-notice ballistic missile defense **drill** during a shift change.

8:07 a.m. the day shift warning officer responded by transmitting a **live incoming ballistic missile alert** to the state of Hawaii.

8:09 a.m. the agency alerted the Hawaii governor that the false alert had been sent.

It took until 8:20 a.m. for the agency to post to its Twitter and Facebook accounts that there was no missile threat to Hawaii.

The governor didn’t retweet that notice of no threat until 8:24 a.m.

A correction, thru the emergency alert system wasn’t sent until 8:45 a.m. (38 minutes later!)
It took until 8:20 a.m. for the agency to post to its Twitter and Facebook accounts that there was no missile threat to Hawaii.

The governor didn’t retweet that notice of no threat until 8:24 a.m.

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Situational Awareness (SA)

What is it?

Situational Awareness

A continuous perception of self, human fallibility and environment in relation to task accomplishment and the ability to manage those actions based on that perception!
SA Pitfalls & Mind Traps

Pitfalls and Mind Traps

- Task saturation
- Distractions
- Repetitive tasks
- Communication breakdown
- Accommodation of risk
- Group think
- Hidden agenda
- Co-worker syndrome
- Excessive professional courtesy
- Hero/cowboy syndrome
- Alpha-dog syndrome
- Perceived pressure
- Risky attitudes
- Emotional stress
- Physical stress
- New situation/out of order
- Low workload (bored)
- High workload

Most Pitfalls / Mind Traps Impact Situational Awareness
# Commercial Off-the-Shelf HEM Tools

## TEBS® - Center for Error Management
- TEBS® is a methodology and set of tools that can be applied to organizations and processes to manage human errors
- CEM “has developed a series of broadly applicable and cost-effective tools that impact the bottom-line by reducing, managing and in some cases eliminating human errors from a variety of business processes”


## AESOP™ - Error Prevention Training Institute
- AESOP is a set of trademarked processes and tools developed by the Error Prevention Institute that is used by many aerospace companies and government agencies to enhance their human error management programs
- Error-prevention technique used to ensure that all personnel associated with an operation are familiar with and understand their roles and responsibilities, and that risks of failure are identified and mitigated

[https://smartpeopledumbthings.com/](https://smartpeopledumbthings.com/)

<table>
<thead>
<tr>
<th>TEBS®</th>
<th>AESOP™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task</td>
<td>Assignment</td>
</tr>
<tr>
<td>Equipment</td>
<td>Equipment</td>
</tr>
<tr>
<td>Barriers</td>
<td>Situation</td>
</tr>
<tr>
<td>Skills</td>
<td>Obstacles</td>
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<td></td>
<td>Personnel</td>
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</table>

Get control of the task and associated risks with asking “What Could Go Wrong?” & conducting [I’M SAFE](https://smartpeopledumbthings.com/) for personal risk readiness.
Situational Awareness Activity

- Activity Purpose: Bring awareness to typical mind traps and tools used in Human Error Management.
- Activity Steps:
  1. Break-up into small groups. (15 minutes)
  2. Choose an Activity (work scenario) from handout.
  3. Review “Asking the Right Questions” list from handout.
     - Choose appropriate questions for your chosen Activity
  4. Choose someone to brief workshop (not all groups will have time to out brief) (10 minutes)
Successful Best Practices Story

**Situation:**
- Large, wide, and heavy piece of critical ground support equipment (GSE) was delivered on a truck bed that was too long to back into facility loading dock (*vendor error*)
- Vendor insisted on attempting to maneuver truck to get into the building (*bad decision*)
- After many two-point turn attempts to situate the truck perpendicular to the loading bay, not only did many trees need to be cut down, but the truck became stuck in the facility landscaping
- Due to weight of GSE, the truck could not be moved until GSE was removed

**What now?**
- Vendor did not have equipment to remove GSE off of truck bed
- Prime contractor had crane “inside” the building prepared to remove GSE once truck was inside

**New and unplanned task:**
- Critical GSE needs to be safely removed from the truck without damage to the hardware or building or risking the safety of personnel
Successful Best Practices Story

**Training**
Employees on program team had been proactively trained in the principles of HEM

**Culture**
- Proactive training
- HEM Openly discussed
- Successes & activities openly communicated to customer

**Principles**

**Group Dynamics**
Group think, excessive professional courtesy, strength of an idea, hesitant to critique others. “TEBS® was used as a tool to manage lift and safety,” per RE who made a special effort to share how well the team did.

**Situational Awareness**
Distractions due to numerous observers, sudden loss of judgment, communication breakdown. Early on, RE requested barriers be put up and that only those needed remain.

**Workload Management**
New situation, excessive/high workload, emotional stress (frustrating situation), physical stress (long day, manual labor).

“Shout out to Bob and Sally for encouraging a stop-and-think approach when it came to next steps and human safety.”

**Attitude Management**
Hero syndrome, perceived pressure, risky attitudes, pressure/get-it-done, anti-authority, hero/show-off syndrome.

“Even I got told to stop what I was doing.” ~ Responsible Engineer (RE)

**Risk Management**
Continuous critical thinking about what can go wrong, and appreciation of outcome.

“Lots of ideas; we were careful to not take risks despite everyone involved” ~ Safety Engineer

**Communication**
Communication barriers between prime and vendor, excessive professional courtesy. Pre-meeting for lift defining remove and replace was held per system safety engineer.

Best Practices
Management Areas
Tools
Pitfalls/Mind Traps
Creating the “Right” Environment

- Organizational Environment & Culture are critical “Best Practices” in creating the ‘right’ environment for a sustainable Human Error Management Program
Creating the “Right” Environment

- Best Practices - Organizational Environment
  - “An error avoidance culture can only develop by considering the existing leadership and workforce culture, adapting training appropriately, planning for strategic and tactical implementation, and developing a follow-up strategy to incorporate changes.” (7-1)
  - “Ideally, an organization and its leadership create an environment where it is expected for individuals to feel free to speak up without the fear of retribution” (7-1)
  - “Individual awareness, leadership roles, and organizational culture must be considered in creating the right environment for avoiding human error.” (7-1)
# Company Roles & Responsibilities

<table>
<thead>
<tr>
<th>Role</th>
<th>HEM Responsibility</th>
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</table>
| **Individual**              | • Understand specific task demands and personal unique capabilities and limitations  
| (Person-in-Charge, Technician, Inspector, Engineer, Planner, QA, Safety, etc.)  | • Demonstrate personal accountability and raise any concern  
| **Team**                    | • Watch for one another  
| (Program team, product line team, functional team, etc.)  | • Encourage team members to bring up concern and to stop unsafe operation(s)  
| **Leadership & Management** | • Encourage open communication, promote teamwork, and reinforce desired behaviors  
| (Program Managers, Functional Managers, Mission Assurance [MA] Managers, Team Leads, etc.) | • Foster communication of bad news and acknowledge human fallibility  
|                              | • Lead by example and reinforce the desired jobsite behaviors  
|                              | • Allow employees to recognize their fallibility without supervisors and managers pointing fingers  
| **Corporation**             | • Empower, communicate with, and support all employees around human error management  
|                              | • Incorporate all best practices into company processes and way of thinking  
|                              | • Cultivate culture of error avoidance and strengthen integrity of defenses to mitigate consequences of an error  
|                              | • Create environment to share errors and corrective actions with others  
|                              | • Create culture of trust, not fear, in leadership  

## Company Culture & HEM Best Practices

<table>
<thead>
<tr>
<th>Best Practice</th>
<th>Culture Component</th>
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| **Principles**           | • Including HEM Principles into the company processes, training, and way of thinking is the first step in creating a 5 Best Practices culture that is long lasting.  
                           • Continual renewal of HEM Principles within the company culture is important to keep HEM methods from becoming stale.                                                                                           |
| **Organizational Environment** | • Organizational leadership defines and supports company’s HEM challenges and areas of emphasis  
                                  • HEM roles and responsibilities of every employee are embedded in company culture  
                                  • HEM requires continual review and assessment of all 5 Best Practices to ensure long-term sustainment                                                                                                      |
| **Training**             | • Training is a critical piece of sustaining a HEM program and the organizational environment culture.                                                                                                                    |
| **Communication**        | • A culture that empowers, communicates with, and supports all employees around human error management  
                                  • A culture where individuals feel free (and possibly are rewarded) to speak up if something does not seem right and know that there will be no retribution                                                                 |
| **Closed-Loop Assessment** | • Proactive, open culture enables employees to share errors and corrective actions                                                                                                                                 |

4/16/2018
### Environment/Culture Brainstorming

- **Activity Purpose:** Bring awareness to importance of company environment and culture & Brainstorm ideas to bring back to YOUR organization.

- **Activity Steps:**
  1. Return to your small groups. *(15 minutes)*

<table>
<thead>
<tr>
<th>Company Culture (left side of room)</th>
<th>Company Roles (right side of room)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow Sticky: Provide examples of what your organization currently does well for each/any of the Best Practices</td>
<td>Yellow Sticky: Provide examples of how your organization currently demonstrates HEM responsibilities for each of the roles.</td>
</tr>
<tr>
<td>Red Sticky: List ideas how your organization (or any) can improve the culture component of the Best Practices</td>
<td>Blue Sticky: List ideas how your organization (or any) can improve the HEM responsibilities for each of the roles.</td>
</tr>
</tbody>
</table>

2. Out brief: each group will share 1 example from a yellow sticky and 1 example from a red/blue sticky. *(15 minutes)*
Summary

- HEM TOR Outlines Best Practices of HEM
- HEM TOR Facilitates the learning of HEM Best Practices through use of examples
- HEM TOR Provides a guide for HEM evaluation and implementation

- Human error management is not simply about taking a training class or about the card we all wear on our employee badges, it IS also about culture:
  - A culture that empowers, communicates, and supports all employees around HEM
  - A culture where employees recognize their fallibility, and supervisors and managers do not point fingers
  - A culture that incorporates all Best Practices into the company’s processes and way of thinking
Acknowledgements - TOR Authors

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Northrop Grumman Mission Systems
Raytheon Space and Airborne Systems
SSL
Missile Defense Agency
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• AESOP™, Error Prevention Training Institute, https://smartpeopledumbthings.com/

• (7-1) AT-M-06A, 1-Dec-1998, CREW RESOURCE MANAGEMENT (CRM) BASIC CONCEPTS, and adapted by CEM for classroom and computer based training

Backup