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Is There Room for Human Factor Engineering In Design?

By

Kenneth E. Arnold

Paragon Engineering Companies

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What Does HFE Address?

- **Trip, slips and falls**
 - **Reduce Injuries**
- **Simplifying Maintenance and Operations Tasks**
 - **Reduce Downtime**
 - **Reduce Injuries**
 - **Reduce Fatalities (Low to Medium Number/Occurrence)**
- **Reacting to Abnormal Situations**
 - **Reduce Loss of Installation**
 - **Reduce Injuries**
 - **Reduce Fatalities (Medium to High Number/Occurrence)**



Trips, Slips and Falls

- **Easiest Place to Concentrate (New Design)**
- **Well Covered in Literature**
- **Standards - Ladders, handrails, stairways, walkways, etc.**
- **Implement by Training and Auditing**
- **Still Major Problem On Existing Facilities In GoM & North Sea**



Simplifying Maintenance and Operations Tasks

- **Medium difficulty to implement**
 - **Access, Access, Access!**
 - **Lifting, Lifting, Lifting!**
- **Task analysis with help from O&M Staff - Rethink design**
- **No longer a matter of simply applying standard. Have to think through and visualize the O&M process.**



Reacting to Abnormal Situations

- **The real prize! The most difficult to obtain!**
- **Major accidents are almost always caused by a series of escalating events.**
- **At any point human interaction can accelerate or decelerate the magnitude of consequences.**
- **How do we design so that the natural reaction is to take action which mitigates the consequences?**



Human Factors

- **“80% of all accidents are caused by human error”
(Bob Bea)**
- **Amato corollary “and 80% of these are caused by failure of management systems”**
- **Arnold corollary “yes, but 80% of all accidents are also caused by design which does not encourage the correct human response”**
- **Examples**
 - **Three Mile Island (\$4B)**
 - **Ocean Ranger (84 Fatalities)**
 - **Piper Alpha (167 Fatalities)**



Three Mile Island (1979)

- **Popular conception - Operator training**
- **What happened**
 - **Steam System Went Down**
 - **PV Valve on Pressurizer tank opened**
 - **As Pressure Decreased Control Room Light Went Out Indicating Signal to Open PV Valve No Longer Existed**
 - **Pressure Relief Valve Stuck Open, Staff thought it had closed**
 - **Pressure Decreased Further in Pressurizer Tank. Water Level Rose**
 - **To keep from packing the pressurizer tank leading to an immediate overpressure. Operators dumped water.**
 - **110 alarm lights flashing**
 - **Fixed on lowering water level in pressurizer tank**



Three Mile Island (1979) - Continued

- **Given low pressure in pressurizer tank but high level, multiple alarm sirens and no direct indication of leak, operators fixed on controlling level. Ignored other indicators of loss of water in cooling system: temperature rise in containment building, vibration of circulating pumps (cavitation)**
- **Design problems**
 - **No water level indicator in reactor**
 - **Temperature of PV drain limited by computer to 280°F max output even though actually 600°F**
 - **No direct readout that PV was actually closed**
 - **Too many alarms**



Ocean Ranger (1982)

- **Popular Conception - Operator Training**
- **What happened -**
 - Storm wave breaks port light window shorting ballast control panel
 - Sea valves started opening and closing randomly
 - Shut-Off Power - Valves close
 - Decided to turn on power to deballast to higher level
 - Started settling by bow
 - Screwed in brass by-pass rods to cause valves to close
 - By-pass rods actually caused valves to fail open
 - Could not launch survival craft in storm with list



Ocean Ranger (1982) - Continued

- **Design problems**
 - **Easy to short out panel in ballast control room**
 - **No way to isolate panel and still activate pumps or check status**
 - **Brass by-pass rods opened sea valves**
 - **No way to launch survival craft with rig tilted down by the bow**



Piper Alpha (1988)

- **Popular Conception - Failure of Permit to Work System, Operator Training**
- **What happened -**
 - Day crew isolated pump for maintenance
 - Day crew removed PSV on condensate pump for annual safety check
 - Did not properly install gasket, blind flange and bolts
 - Night crew unaware and put pump in service
- **Design Problem**
 - Decoupled PSV from Pump It Protected
 - Gas Heard Escaping In Compressor Room But Source Unknown



Why Did Paragon Form HFE Group

- **Improve designs by better safety, operability and maintainability**
- **The client deserves the option. (Problem: Will he pay?)**
- **Implementation**
 - **Upper Management Support**
 - **Acquire/Develop Expertise**
 - **Develop Specifications and Standards**
 - **Develop Implementation Plan**
 - **Train Engineers and Designers**
 - **Convince Project Managers to Include HFE as Integral Part of Team**
 - **Convince Clients of Value**
- **Need for HFE Professionals**
 - **Educational Background**
 - **A thought process and not just “common sense”**
 - **Compromises will be made**



Paragon Success Stories

British Petroleum Mardi Gras Pipeline

- HFE has been integrated into project from inception
- Reduced time for redesign by implementing HFE standards and comments into initial design
- Improved safety for maintenance, materials handling and pigging operations by incorporating HFE principles
- As a result of this work we are providing HF training and support to project members of the other projects that form part of BP GoM Deepwater Development Program

FPSO Project

- HFE involvement in evaluation and design of LQ save \$5 -10 million by reducing square footage requirement



Paragon Success Stories (Continued)

Shell Offshore Inc URSA Platform

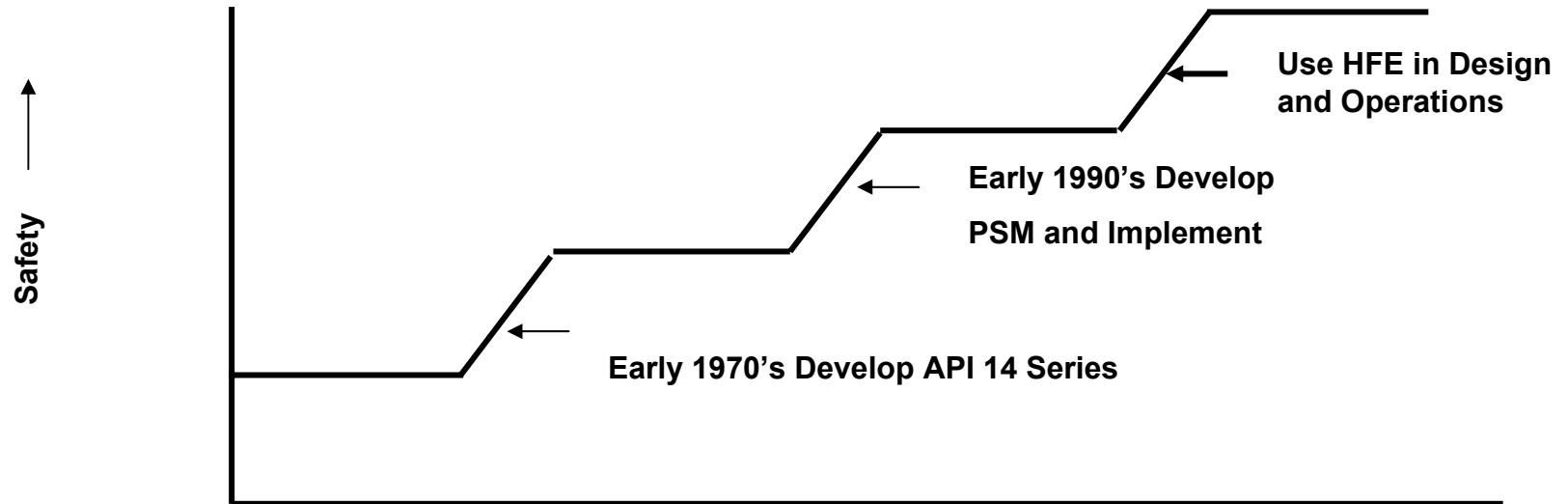
- Implementation of redesigned control room has improved worker satisfaction
- Operability and maintainability of the control room equipment has been improved through well thought out design
- Environmental characteristics have been improved through application of proper lighting, noise and ventilation control
- As a result of this work we were also asked to conduct a HF review of Auger control room

Survival Capsule Study

- Research showed that capsules could not accommodate the rated number of persons due to difference in physical size between the “average” offshore worker and population anthropometrics used in the design and rating of the capsules
- MMS has issued a safety alert as a result of this work
- A number of GoM operators have de-rated the capacity of some survival capsules at their facilities due to this research



Where Are We In Design Safety



- We are today where we were with regard to Hazard Analysis in 1980's
 - “Common Sense”
 - “ We do it already”
 - “ Why do we need a separate hazard analysis?”
 - “It is only good engineering practice”
- The truth is we needed the discipline of Hazards Analysis to force us to make sure we implement what we knew.
- The one way to make a step change in safety after implementing SEMP is through HFE. We need the discipline of HFE professionals and an implementation plan.