Emerging Tool for the Quality Professional: Human Factors Engineering

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Abstract

- Today's work systems are complex as a result of technology and automation advances. This technology, while advantageous for increased throughput and machine control, has changed how the human needs to perform, think, and solve problems in working with systems.

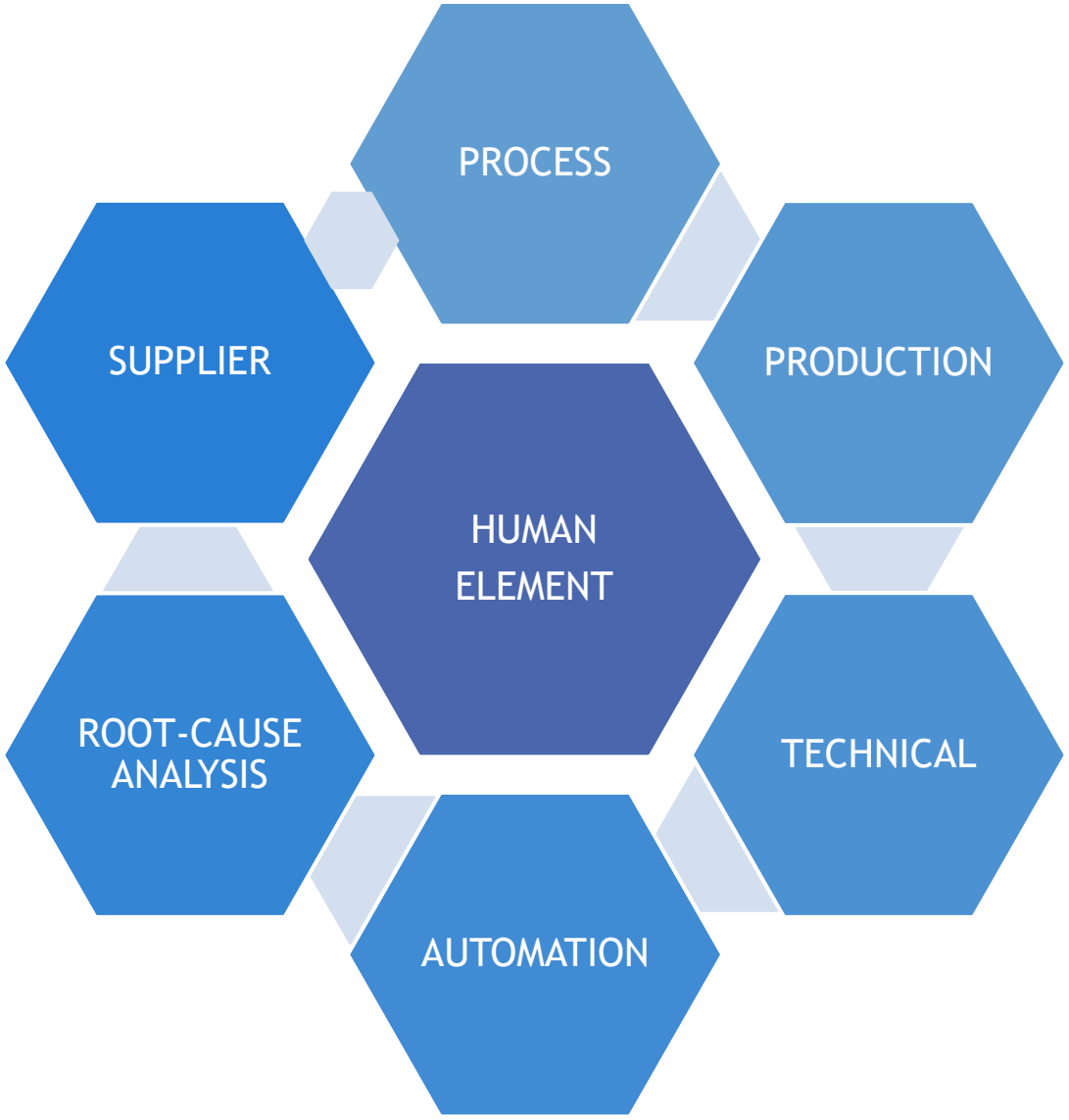
- This presentation will provide an overview of Human Factors Engineering (HFE) and the importance of HFE in understanding the new relationship between the human element and the machine and how performance can be affected when humans work in a dynamic, busy, and complex environment.

Overview of Human Factors Engineering (HFE)

- HFE
  - Incorporating the science of human performance and information processing to systems, process, and machine design
    - Physical ergonomics
    - Cognitive ergonomics

- HFE and the Quality Professional
  - The pursuit for Quality
  - The changing demands of work
    - Risk-based thinking and Human Factors
    - Safety and human performance

The Human Element is part of the System



Systems, Technology, and the Human Component

- Automation
  - The irony with automation
  - Two intelligent systems
- Dealing with complexity
  - Complex technology = task complexity
    - Drives the need for higher-level cognitive tasks
      - Inference, judgment, diagnosis, and decision-making
    - Performance matters
- Performance can be a function of BOTH the system and the operator

“When we change the work we necessarily change the way we interact and think about the work…” Erik Hollnagel (2003) Handbook of Cognitive Task Design

Human Factors Engineering can inform how we interact, think, and perform in a complex environment

Complexity, Incidents, and Human Error

- Accidents/Errors
  - The term “Human Error” as a category of failure
  - ISO 9001:2015 Clause 8.5.1.g
    - Actions to prevent human error
- Herbert Heinrich Accident Causation Model (1931/1941)
  - 88/10/2
  - Behavior-based liability referred to as Human Error
    - The machine/technology was considered more perfect
- Problem with the term “Human Error”

“To blame is human” Holden (2009)

“Try harder” has become the response

However, “try harder” is not a sufficient corrective action

We are “programmed” to think, see, and act in certain ways

> “We can not change the human condition but we can change the condition under which humans work.” James Reason (1990) Human Error

- Nature of Error
  - Latent versus active errors
  - Humans are typically at the “Active” or end of the accident pathway where “Latent” errors are the precursors
- Poor performance does not mean the human is at fault

Human Performance and Information Processing

- Understanding how we process input information
- Human Memory System
  - Short-term memory (STM)
    - Decays to about 50% in 6 seconds
    - After 18 seconds, our short-term memory approaches zero recall
  - Long-term memory (LTM)
    - Theoretically limitless memory capacity
- Human Factors and Human-centered design

Information Processing with the Human-machine system

- Systems and processes not always designed with human processing capabilities
  - Data: too much, too little, speed
  - Multiple displays
  - Clumsy technology
  - Data clutter
- In combination with
  - Interruptions (alarms)
  - Distractions
  - Attention

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Modeling Human Performance

- Adding value to the system performance by incorporating HFE knowledge

- Human Performance is a function of the:
  - Task
  - Task environment
  - System complexity
  - Cognitive processes
    - How our brain works

Memory and Human Performance

- Understanding how we process information and the limitations of working memory with:
  - Distractions, interruptions, method of information presentation, data clutter, and method of delivery
  - Better identification of error causation for root-cause analysis and corrective action
- More training will not solve the problem
  - It is about how the mind works

Human Factor Tools

- Maps the dynamic nature of workflow, task, and knowledge with both systems (machine and human)

- Some methods:
  - Task Analysis
  - Cognitive Task Analysis (CTA)
  - Usability Analysis
  - Process Charting - Event Tree Analysis

Human Factors Method
Task Analysis - Data Collection

- A different view of the human interface to the system
- Data Collection
  - Task steps and sequence
  - Define level of automation and technical interfaces
    - E.g. controls, displays, keyboards
  - Nature of environment (individual or teamwork)
- Team communication
  - Mix of experts versus non-experts

Human Factors Method
Task Analysis

- Task analysis and workflow – what is dynamic nature of work
  - Work-as-planned versus work-as-is
  - How many steps
  - Time pressures
  - Overlapping tasks
  - Sustained performance
  - How complex problems are solved
  - Team dynamics
  - Fixation errors – attention tunneling
  - Other attention demands; e.g., interruptions and distractions

Human Performance and Decision-making

- Humans “best at” thinking, problem-solving, and strategy
- Speed of technology and systems
  - Extensive use of data with decisions made in short time
    - Use of heuristics
    - Implicit problem solving skills
- Technology has elevated decision-making from procedural to higher-level cognitive thinking
  - Each individual can have a different approach
  - What is optimal?

Human Factor Method
Cognitive Task Analysis (CTA)
Individual and Team Problem Solving

- Cognitive Task Analysis (CTA)
  - Cognitive problem solving
  - Insight into the knowledge your teams use to solve problems
    - What do your teams see or hear when a problem occurs?
    - What information is used?
    - What past experiences do they automatically assign to the problem?
    - What shortcuts (heuristics) do they use?

Human Factor Method – CTA
Team Communications

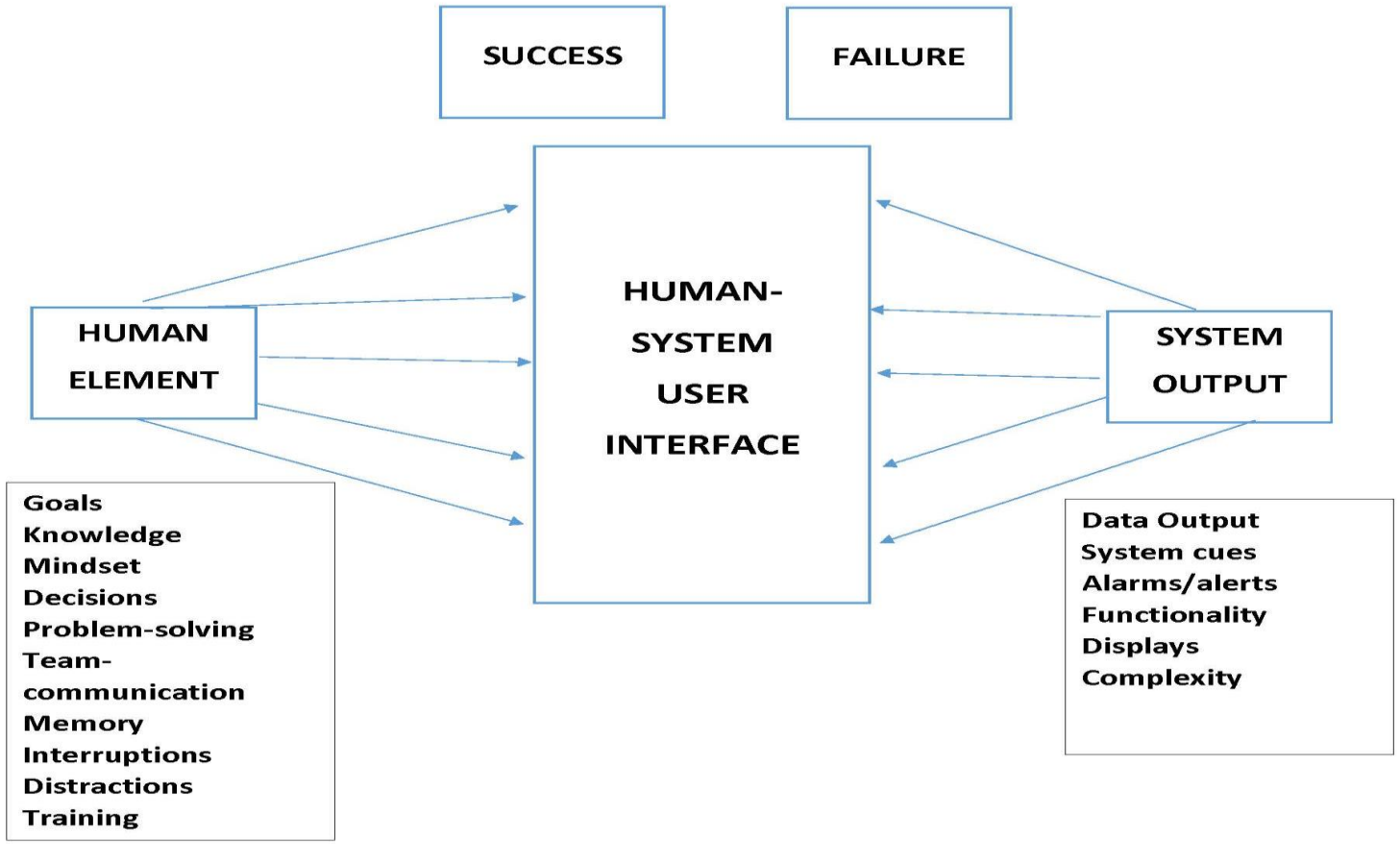
- Technical complexity has driven the need for group problem-solving
  - No one person has all the answers
  - How well do your teams communicate?

- Knowledge structure of your teams
  - Expert users versus non-experts
    - Use different problem-solving strategies
  - Implicit versus explicit problem-solving skills

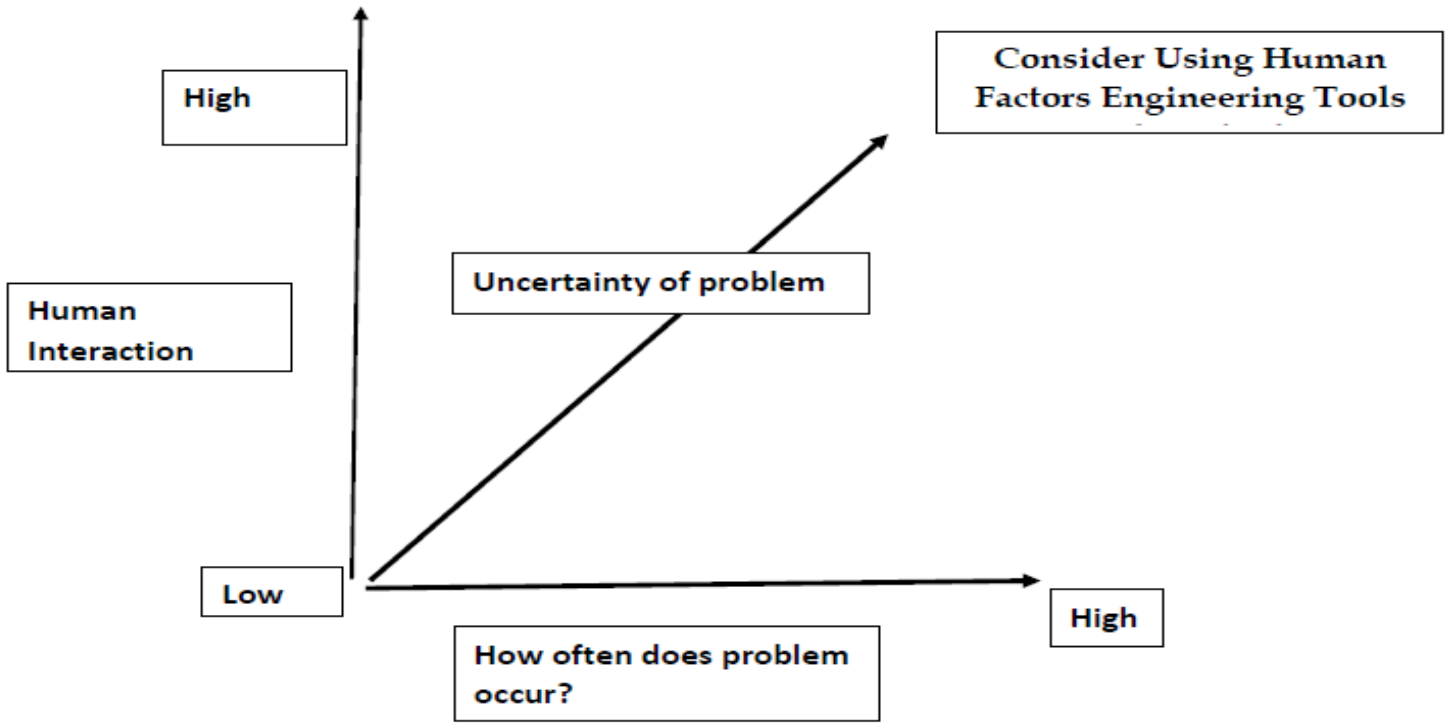
Human Performance and Workload

- Workload is perceived differently by individuals
  - Both heavy and light workload will negatively influence performance
  - Workload characteristics
    - Mental, physical, temporal, frustration, effort
- All problem solving is not created equally and not all problems are solved efficiently
  - In combination with perception of workload
  - In combination with how teams think and communicate

Human performance for action on a task is a function of many variables



Human Factors Engineering and Root-cause Investigation



Change, Complexity, and Human Performance

- Humans develop specific strategies when performing tasks and solving problems in a changing environment
  - What are these strategies?
- Humans are variable because systems are variable
  - Systems are seldom stable
    - Material, equipment, environment, other
  - The human is adaptable

HFE and the Adaptable Human-in-the-loop

- Resilience Engineering = a system that reacts or recovers from disturbances with minimal effort

  Hollnagel, Woods, Leveson (2006) Resilience Engineering

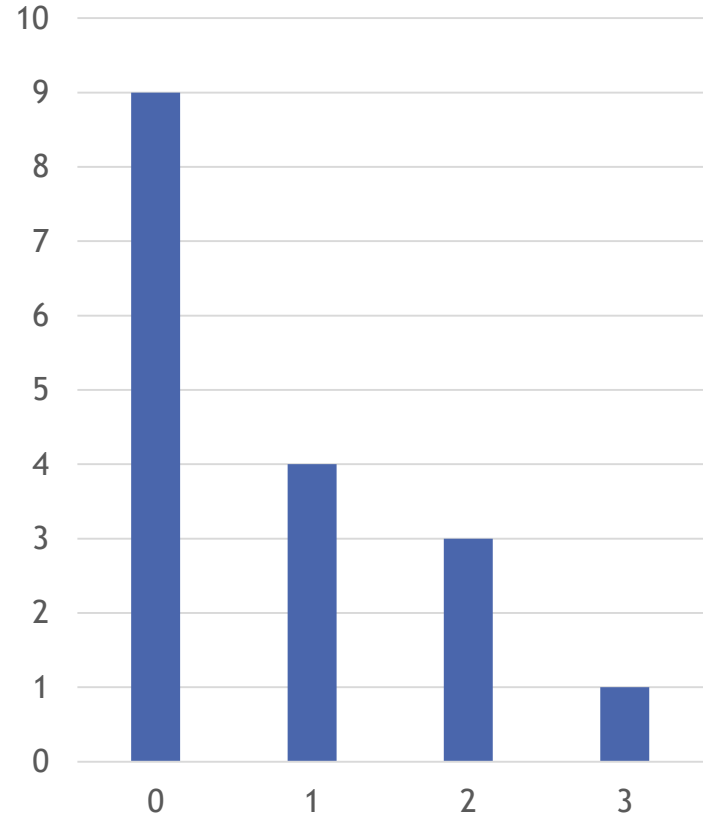
  - Adaptations with complex work

- Are we looking at the right data to understand safety?
  - Degrees of safety
  - A focus on “what goes right”
  - Good risks in addition to bad risks (ISO 9001:2015)

Human performance in working with complexity is mostly correct

- Proactive measures for system safety
  - How do people learn and adapt?
  - Systems change so must the human
  - Are we investigating the information we need to achieve safety?
  - Why do we not have errors?
    - Investigations of accidents and investigations of safety

- Poisson Distribution



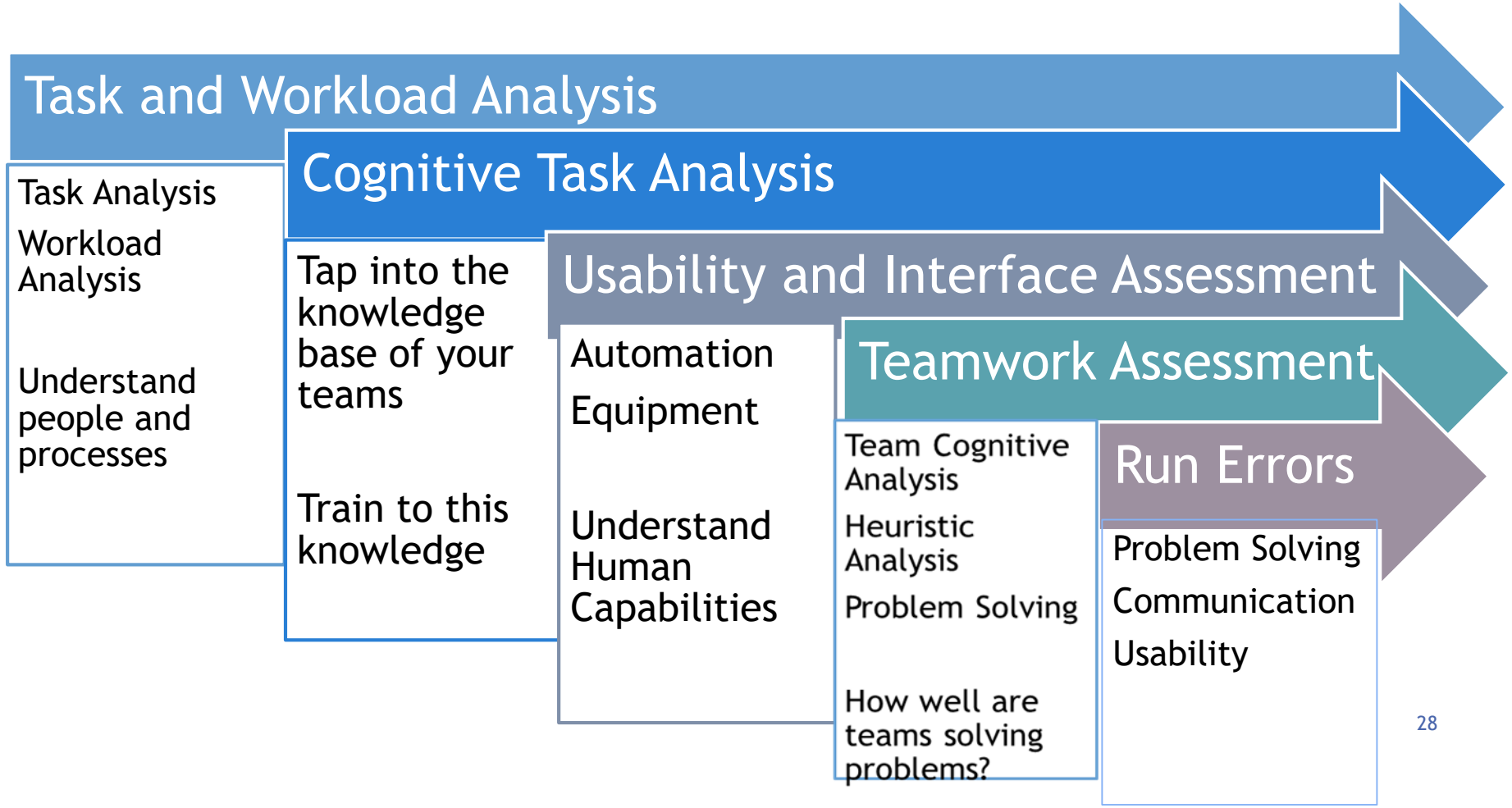
Human Error or Human Performance Deviations?

- Error can be driven by complex technology in combination with situational factors
  - The Human-Machine-System
- “Human Error”
  - Is a consequence NOT a cause
  - A performance “breakdown with complexity”
  - Should be the beginning of an investigation – NOT the end

The Role of HFE in Quality

- Should be considered in the design of the initial process and system
- Should be considered in changes to the process and system
- The human is a component of the process and system
- The human is the interface to the process and system
- Many Quality tools support the incorporation of HFE concepts
  - E.g., Cause and Effect diagrams

Using HFE tools to Analyze Performance



Emerging Tool for the Quality Professional: HFE

- The work of the future is planning, problem solving, and teamwork
  - Based on underlying principles of Human Factors Engineering
  - Our new role is cognitive
- We need to understand the capabilities of the human system as well as the capabilities of the technical-machine system

Summary

- Transformative technologies
  - Will continue
  - Has changed the way we work with technology
- Understanding the Human Factor component will enable investigations considering both systems
- The human component is an strength – not a liability
- Human Factors Engineering
  - Part of the Quality tool box

Thank You

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