Bots and Brains: Navigating AI Integration in Process Safety

Purdue Process Safety & Assurance Center

Process Safety and Reliability Group

Taking You Further With Safety >>>>>

Ashley Craig, MSc

Process Safety and Human Factors

Principal Engineer

acraig@psrg.com

Presenter - Ashley Craig

Education

MSc with Distinction in Human Factors Engineering
Embry-Riddle Aeronautical University, Florida

BSc in Communication Theory and Kinesiology
(Psychology of Communication, and Anatomy, Physiology, Biomechanics)
Sam Houston State University, Texas

Experience

Revision of Human Factors methodology within standard PHA and various human factors analysis
Human System Integration (HSI), human factors standard requirement drafting, Hazard Analysis, Human Reliability Analysis (Task Analysis, Human Error Analysis)

SME oversight for the design, development, HITL testing, and verification of the NASA Modules and Government Furnished Equipment

Rice University Human Factors Graduate Program Mentor with HFES

Taught High School dual-credit Aerospace Engineering for 8 years

PSRG Overview

Established

- PSRG Inc. - 1997 (Houston, Texas)
- PSRG APAC - 2015 (Singapore)

Diversity

- Diverse industry experience with global offices
- Supporting more than 1000 customers in 90 countries

Experience

- More than 100 professionals
- Averaging 29+ years experience
- Hands-on plant operations experiencex

Professional Memberships

P2SAC Purdue Process Safety & Assurance Center

HUMAN FACTORS and ERGONOMICS SOCIETY

CCPS An AIChE Technology Alliance Center for Chemical Process Safety

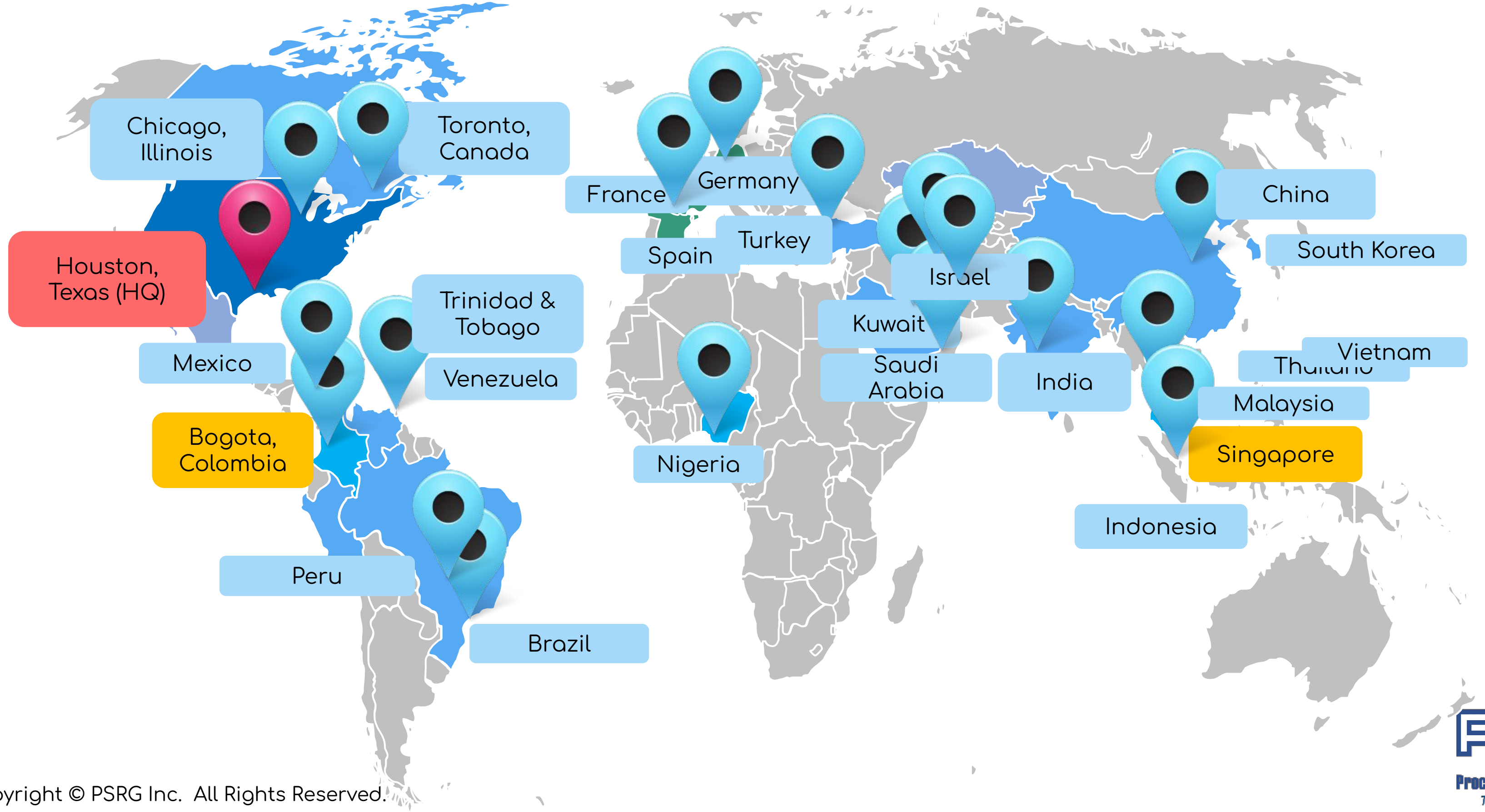
INDUSTRY MEMBER CENTER FOR Hydrogen SAFETY

VPP Voluntary Protection Programs An OSHA Cooperative Program

IChemE Safety Centre

PSRG Process Safety and Reliability Group Taking You Further With Safety >>>>>

PSRG – Global Reach



Process Safety and Reliability Group
Taking You Further With Safety >>>>>

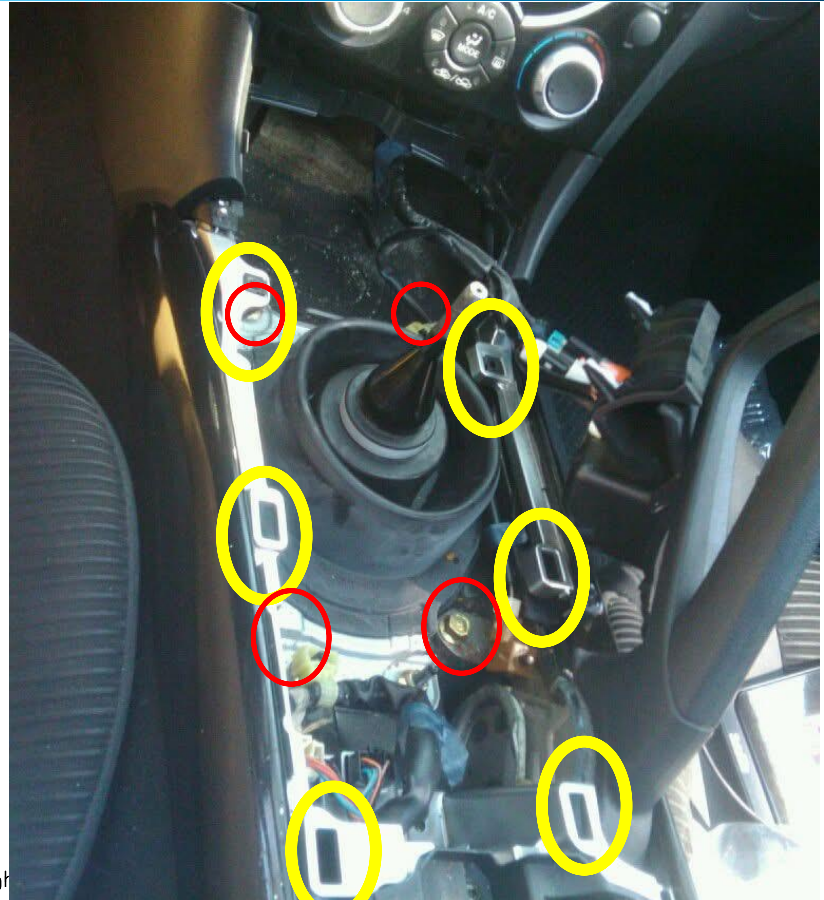
What is Human Factors Engineering?

- The scientific discipline focused on the interactions between humans, technology, and environments to optimize well-being and system performance
- Designing and evaluating system interfaces and operations for human well-being and optimized safety, performance and operability, while considering human performance characteristics as they affect and are affected by environments and operating in expected and unpredicted conditions
- A framework that evaluates human interactions with worksite software, hardware, environment, their organization and internal thought processes.
  - Fit the task/system to the person, not the person to the task/system.
  - Helps to identify gaps between system components.
  - Uncovers small issues in safety defenses can align to cause accidents.

Great, can you say that in simple terms?

Can you give an example?

“Oh, that’s an easy swap!”



Quick Cognitive Human Factors Analysis

Your Choice: Quantitative/Qualitative

(Quant- need timer/stopwatch)

Test Subject Selection: Yourself

Duration: Less than 30 seconds x 3

Disclaimer: Participation is completely voluntary, you will not be compensated in any way, you may stop participating at any time and self-initiated participant removal from this analysis will not impact future considerations for selection.

Quick Cognitive Human Factors Analysis

Reflect:
Did you finish the task in more or less time?
Did you make more or less errors the second time?

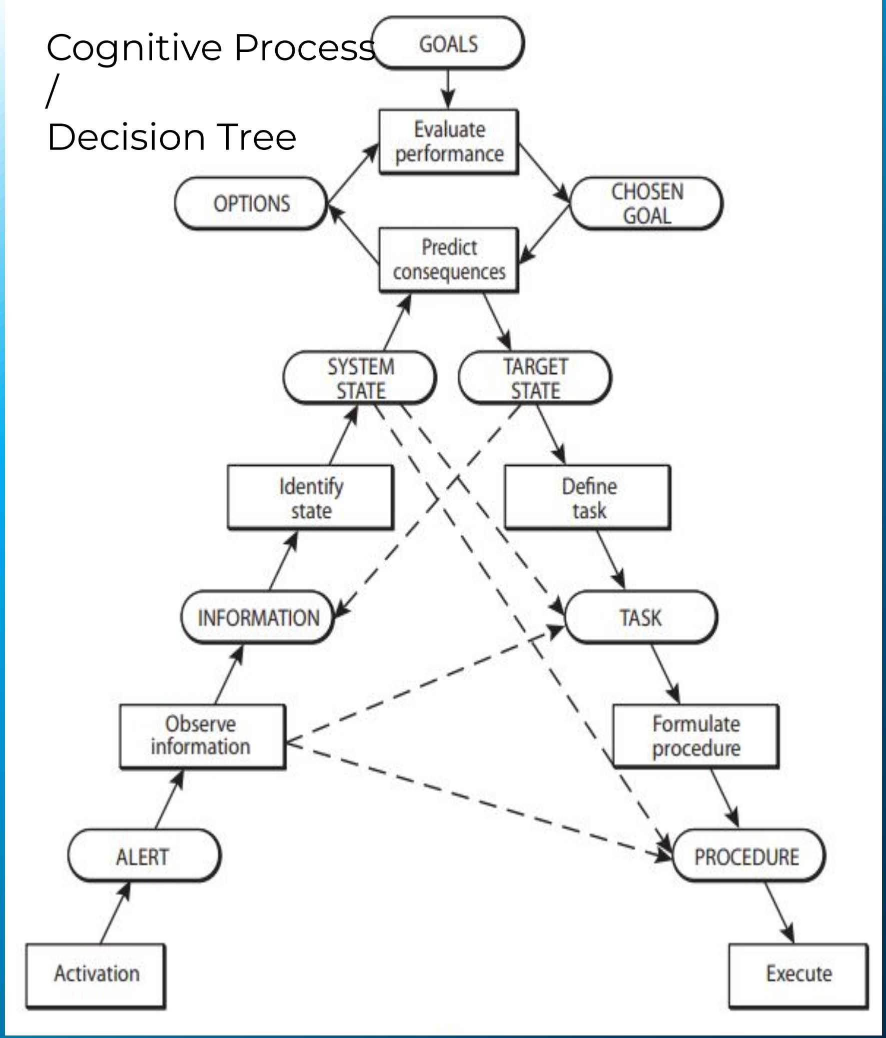
Step 3

Wait for me to say go

As fast as you can say your **entire name** out loud

Raise your hand once you are finished

Process Safety and Reliability Group
Taking You Further With Safety >>>>>



When we allow AI and/or automation to remove certain human tasks, the system enables a more streamlined and efficient approach that, by design, can remove a task that could have an error.

Great, how do we do that?

Targeted Questions:

- How can AI enhance process safety?
- What are the potential risks associated with AI and/or automation in high-stakes environments?

Known applications in the chemical industry

- Data analysis, report generation, and anomaly detection (alarm triggers) etc
- Advantages: Increase productivity and consistency by reducing human error (will come back to this later)
- Disadvantages: lets discuss…

Process Safety and Reliability Group
Taking You Further With Safety >>>>>

What happens when we remove Human-Centered Design?

1. Situational awareness (case study included later)
2. Operator judgment lost in complex situations
3. Non-standard (off-nominal) scenarios (troubleshooting)
4. Subjective ethical or moral decisions
5. Assess complex human factors
6. Operator overreliance on technology
7. Trust in AI
8. Diminished ability to innovate and problem-solve unless there is prior data to reference
9. Cybersecurity threats
10. Personal responsibility and accountability

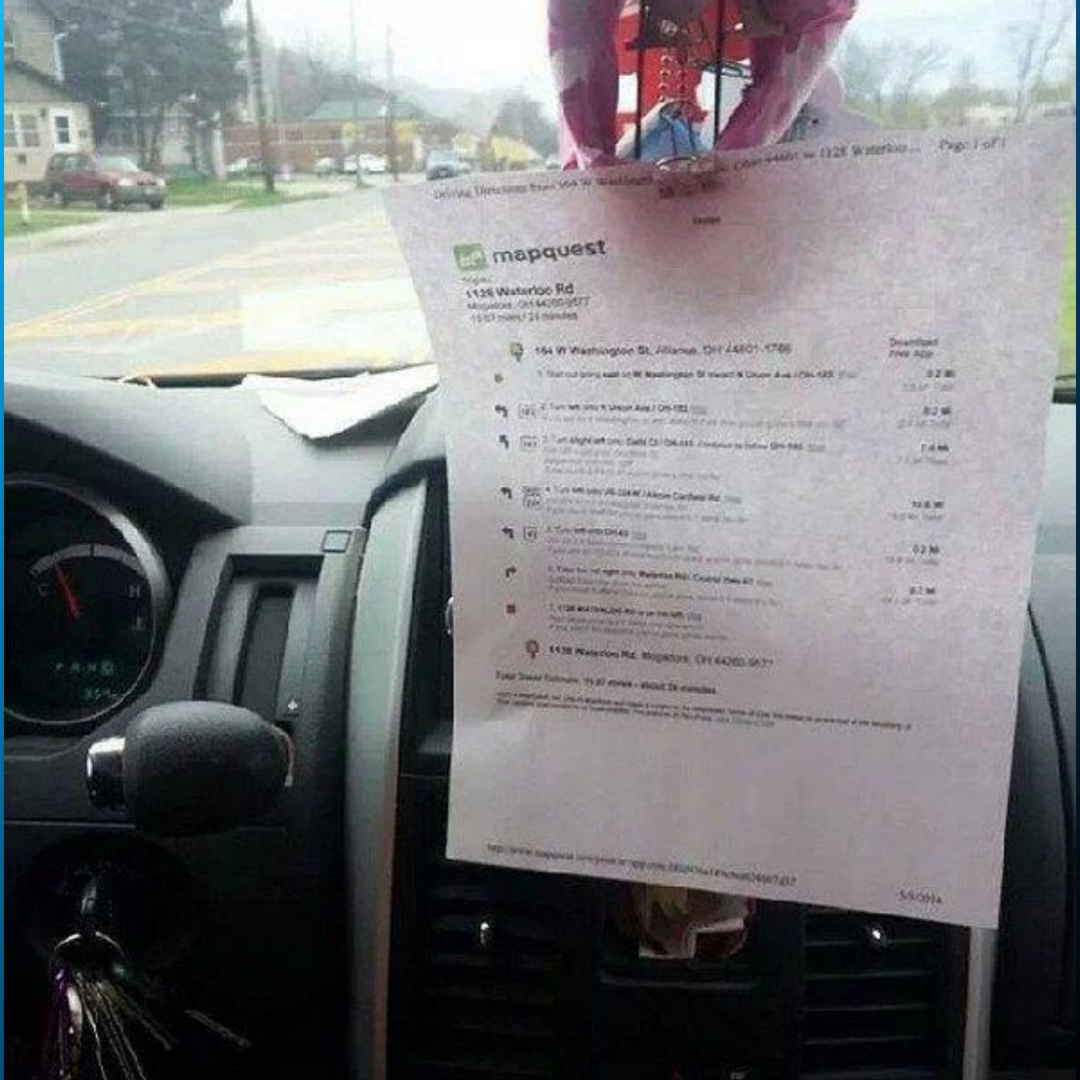
PSRG
Process Safety and Reliability Group
Taking You Further With Safety >>>>>

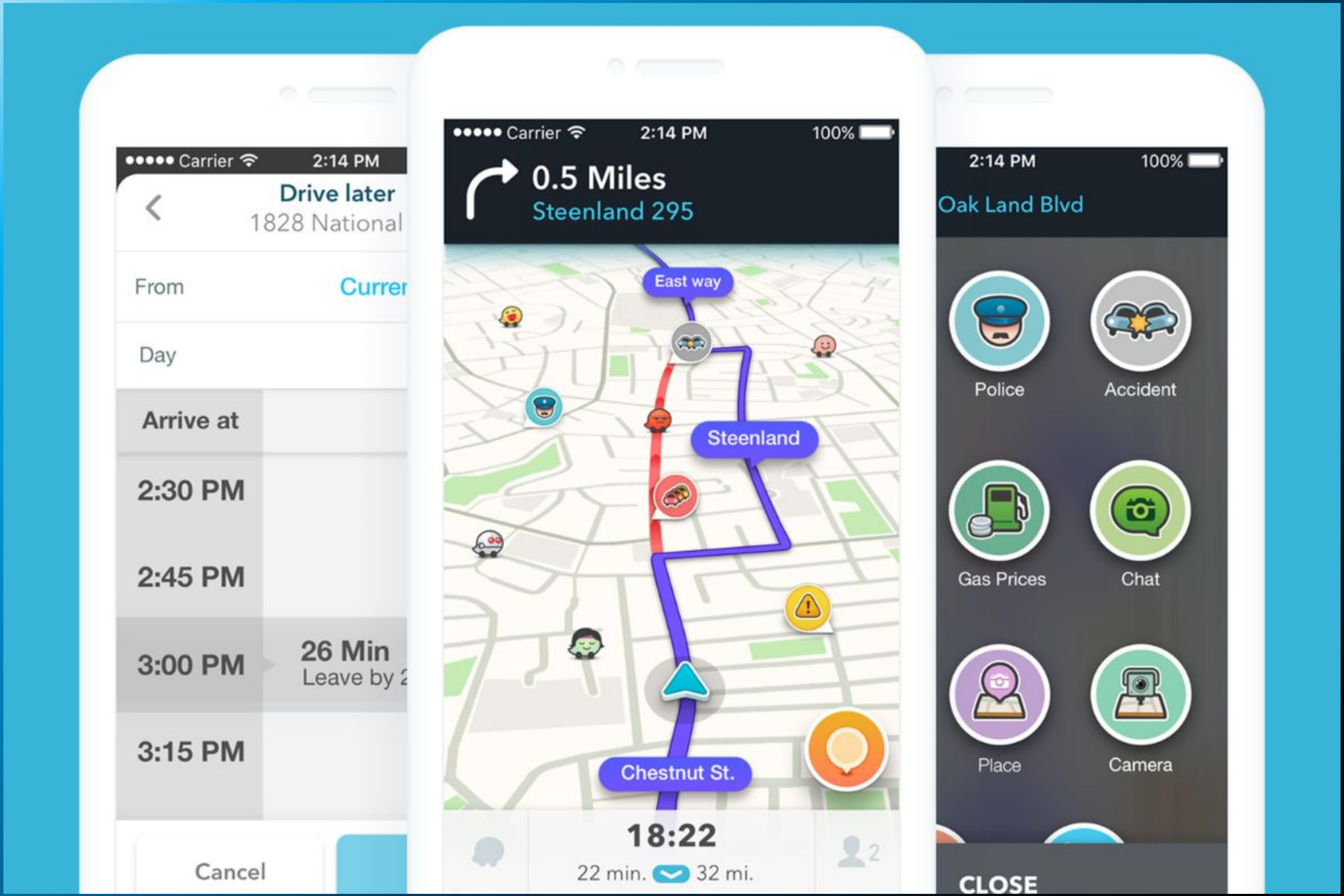
Cognitive Challenges with AI Integration

Bias and Varying levels of Trust in AI

- Dependency and over-reliance
  - Complacency in worksite
  - Degrading of skill
- Distrust and skepticism
  - Resistance to use
  - Hesitance to react

Process Safety and Reliability Group
Taking You Further With Safety >>>>>


mapquest
Waterloo Rd



Carrier
2:14 PM
Drive later
1828 National
From
Currer
Day
Arrive at
2:30 PM
2:45 PM
3:00 PM
26 Min
Leave by
3:15 PM
Cancel
Carrier
2:14 PM
100%
0.5 Miles
Steenland 295
East way
Steenland
Chestnut St.
18:22
22 min.
32 mi.
2
2:14 PM
100%
Oak Land Blvd
Police
Accident
Gas Prices
Chat
Place
Camera
CLOSE

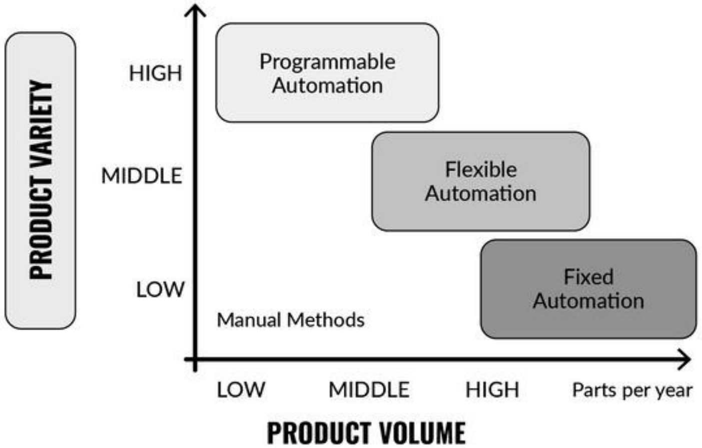
AI : Automation Blended Approach

AI: Constantly evolving concept or practice based on learned repeated patterns with prediction models and library of input support

Automation: Rule based redundancy equivalent to a baseline processes

Established Framework: 4 levels of commonly recognized automation

1. No automation
2. Assisted Automation
3. Conditional Automation
4. High Automation



Process Safety and Reliability Group
Taking You Further With Safety >>>>>

Commonly Recognized Levels of Automation

These descriptions and examples include a Human-Centered Design methodology

Level 1
Manual Control
(No automation)

Humans perform all tasks, make decisions, and are in full control of the system's operation.

In a chemical plant, a human operator manually adjusts controls, monitors process variables, and responds to changes or alarms without any automated assistance.

Process Safety and Reliability Group
Taking You Further With Safety >>>>>

Commonly Recognized Levels of Automation

These descriptions and examples include a Human-Centered Design methodology

Level 2

Assisted Automation

(Human performs primary tasks, system provides support)

The operator is responsible for managing the system and decision-making, but the system provides automated suggestions, alerts, or partial control over tasks. The operator remains in the loop for oversight and final decisions.

In an oil refinery, the system could automate real-time data analysis and present predictive maintenance alerts, but the operator would still review the information and make final decisions regarding system changes.

Commonly Recognized Levels of Automation

These descriptions and examples include a Human-Centered Design methodology

Level 3

Conditional Automation

(System takes over certain functions, operator monitors and intervenes when needed)

The operator supervises the system and intervenes when prompted by alerts or system limitations. The system can perform most tasks, but human oversight is required for high-level decision-making or handling outliers.

The system autonomously controls a distillation column operation, adjusting the heating element, flow of liquids, and reflux ratios to maintain optimal separation efficiency. The AI uses predictive models to make continuous adjustments and handle routine changes in feed composition or temperature fluctuations without human intervention.

Case study reference (pg 31/32)

Process Safety and Reliability Group
Taking You Further With Safety >>>>>

Commonly Recognized Levels of Automation

These descriptions and examples include a Human-Centered Design methodology

Level 4

High Automation

(System manages all operations with human backup only when required)

The human operator is not actively involved in day-to-day operation **but can step in** if the system encounters a failure or a scenario beyond its programmed capabilities.

A continuous production line that manufactures a specific chemical, such as sulfuric acid or ammonia. The system would operate with full autonomy under normal conditions, handling all tasks required for efficient production. However, human intervention would only be necessary in case of an emergency, system failure, or when dealing with unforeseen circumstances.

Process Safety and Reliability Group
Taking You Further With Safety >>>>>

Practical Approaches AI Integration

Method of Integration	Context
Mandatory training on AI limitations and capabilities	Real work simulations of use
Implement operator checks and human oversight with the 4 recognized levels of automation	Mandatory oversight period, AI verification via operator, audit trails and logs
Utilize AI to enhance, not replace, human awareness	AR, contextual alerts, decision support systems
Promote a standard of continuous monitoring and feedback	Status dashboard, real-time systems check
Implement redundancy and contingency plans	Manual override, scenario-based plan activation and emergency procedures
Provide AI confidence indicators and transparency	Scoring matrix or system to demonstrate AI confidence, explainable AI, self-initiated anomaly detection
Maintain operator engagement and cognitive load management	Task rotation, cognitive load monitoring

Process Safety and Reliability Group
Taking You Further With Safety >>>>>

Future Directions and Considerations for AI in PSM

- Enhanced Situational Awareness and Decision Support
- Reducing Human Cognitive Load and Enhancing Worker Engagement
- Improved AI-Driven Automation with Human Validation at Key Stages
- Fostering Trust in AI Systems
- Optimizing Workflow and Resource Allocation
- Enhancing Safety and Risk Management
- Cultural and Behavioral Adaptation

Thank you!

[PSRG Website]

[Professional Website]

Ashley Craig, MSc

Process Safety and Human Factors

Principal Engineer

acraig@psrg.com

P²SAC
Purdue Process Safety & Assurance Center

PSRG
Process Safety and Reliability Group
Taking You Further With Safety >>>>>

Definitions

AI Incident/ Hazard

Actual/ Potential

(a) **injury** or **harm** to the **health** of a person or groups of people;

(b) **disruption** of the management and operation of **critical infrastructure**;

(c) **violations** to **human rights** or a breach of obligations under the applicable law intended to protect fundamental, labour and intellectual property rights;

(d) **harm to property, communities or the environment.**

Serious AI Incident/ Hazard

Actual/ Potential

(a) the **death** of a person or **serious harm** to the health of a person or groups of people;

(b) a **serious and irreversible disruption** of the management and operation of **critical infrastructure;**

(c) a **serious violation of human rights** or a **serious breach of obligations** under the applicable law intended to protect fundamental, labour and intellectual property rights;

(d) **serious harm to property, communities or the environment**

Process Safety and Reliability Group
Taking You Further With Safety >>>>>

Definitions

AI Disaster

Serious AI incident that **disrupts the functioning** of a community or a society and that may **test or exceed its capacity to cope**, using its own resources.

The effect of an AI disaster can be **immediate and localised, or widespread** and lasting for a long period of time

These working definitions are based on the definitions of disaster by the United Nations Office for Disaster Risk Reduction and the International Federation of Red Cross and Red Crescent Societies (UNDRR, 2023[4]; IFRC, 2023[5]).