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Introduction to SCADA for Renewables
(A Six Module Course)

Course Learning Objectives

1. **Describe** SCADA system basics and important differences with other control systems
2. **Demonstrate** competency of the key components of a SCADA system and their functions
3. **Describe** the different communication systems used in SCADA
4. **Demonstrate** competency of the role and capabilities of operator interfaces
5. **Demonstrate** competency of implementing SCADA in real world applications, specifically renewable energy applications (install, operation, maintenance)
6. **Identify** emerging technical trends, shifts, and innovations impacting SCADA and its application in the renewable energy sector

Introduction to SCADA for Renewables

Course Outline / Curriculum Learning Modules:

Module 1 SCADA Overview

Module 2 Components and Functionality

Module 3 Basics of SCADA Communications

Module 4 Human/Machine Interface

Module 5 Applications within Renewable Energy Industry

Module 6 Emerging Trends in SCADA for Renewables

Module 4 – Human/Machine Interface

Learning Objectives

- **Understand** key elements of an HMI and its purpose for a SCADA network
- **Understand** how HMI facilitates continuous monitoring, data collection, automatic alerts, reports, etc.
- **Create/configure** a Human Machine Interface
- **Leverage** HMI to address alarms and alerts
- **Troubleshoot** faulty equipment with HMI tools
- **Understand** data formats and database organization
- **Understand** data sources and storage
- **Understand** data visualization
- **Understand** statistics and trend analysis
- **Leverage** data collection and analytical tools to generate various reports

References and Additional Learning Material

- https://www.pas.com/resources/white-papers/high-performance-hmi

White paper titled “Maximize Operator Effectiveness Part1: Understanding High Performance HMI Principles and Best Practices”. Covers examples and discussion of current HMI design best practices.

- https://www.isa.org/products/ansi-isa-101-01-2015-human-machine-interfaces-for

ISA 101 standard on HMI for process automation systems.

- https://www.marinetech.org/files/marine/files/Curriculum/IROV/Module13/gruhnhmidesignreviewed-110722135448-phpapp02.pdf

White paper titled “Human Machine Interface (HMI) Design: The Good, The Bad, and The Ugly (and what makes them so)” by Paul Gruhn, P.E. ICS Triplex |

What is a Human Machine Interface?

- At its most basic, a HMI is the link between a human operator and an automated process
  - Information is passed back and forth between the user through the HMI and the process controller (PLC, MTU, etc.) via the communication protocol (Modbus, etc.)

- HMI has and can take a variety of forms

- HMI continues to constantly evolve with technology

Various HMI Examples

Local Push Button Control Panel

Source: atex delvalle

Local Touchscreen Control Panel

Source: mjk.com

Remote Workstation

Source: nebb.com

Mobile Device HMI

Source: Totally Integrated Automation

Basic Functions of a HMI

- Monitoring – display real time operating status of the equipment or system
- Supervision – along with monitoring, the ability to make changes to the operating conditions directly through the HMI
- Alarm – recognize unusual events and report them
- Control – ability to apply algorithms to the operating process to control key variables within a desired target range
- Historian – storage of operating data for analytic or diagnostic purposes

Design intent – Who's the Audience?

Target audience – sets design/functionality requirements

- In HMI design, the target audience is the system operator
- Additional layers and details can be accessible for other audiences (maintenance personnel, engineers, etc.) but in a format that does not create inefficiency or issues for the operator

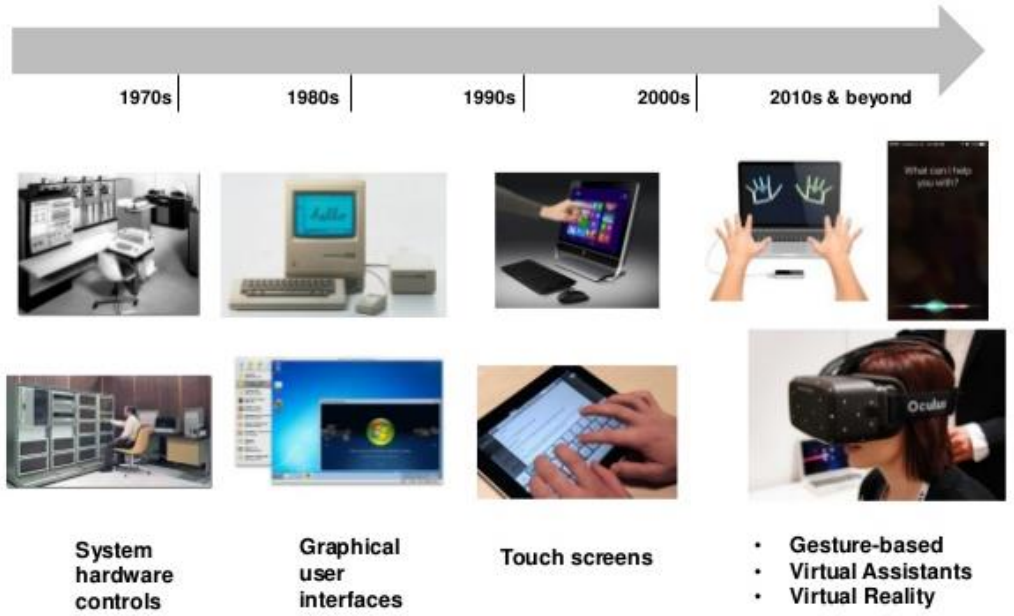
HMI Design Evolution

- HMI continues to evolve with technology
- From hardware controls to digital versions of a P&ID with poor/confusing style to more modern, intuitive designs leveraging IOT and cloud to make HMI mobile/wearable/etc.

Evolution of the Telephone

Source: Gulf News

Evolution of HMI



Source: Daniel Zahler

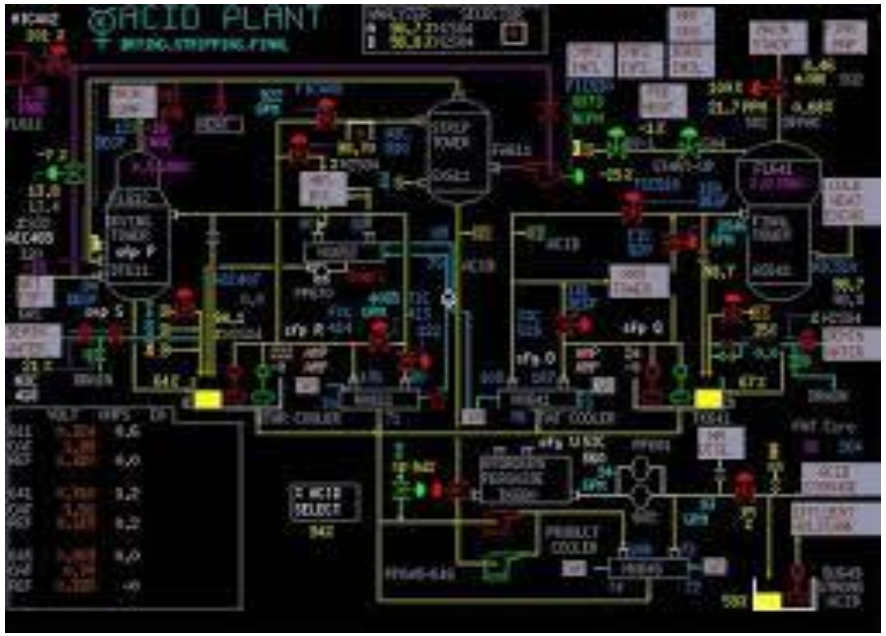
Why is good HMI design important?

- **Concern:** Sophisticated computer-based control systems being operated with ineffective and/or problematic HMIs, designed without adequate knowledge.
- **Countermeasure:** Redesign these systems in accordance with proper HMI principles to greatly improve their functionality and effectiveness.

Proper HMI design Principles enable:

- Improved operator situational awareness
- Improved safety
- Reduced likelihood of expensive mistakes
- Reduced incident response time to abnormal conditions

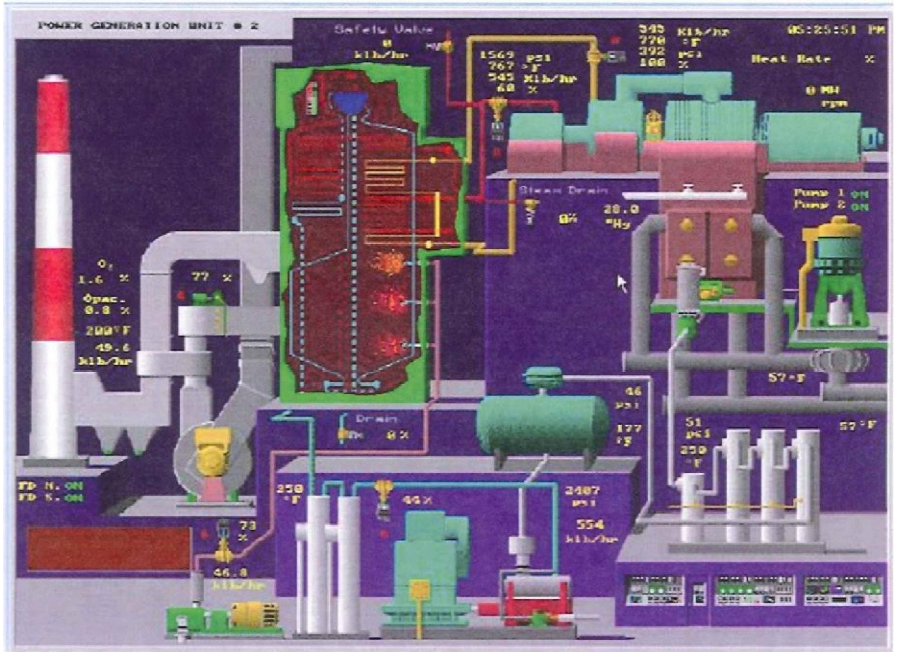
Early era HMI examples with poor design…



Source: ACS (Advanced Control Systems)

P&ID style with data overload and poor color scheme.
Hard to use and understand.

Overdone use of “realistic” graphics but not informative or intuitive to use and understand.

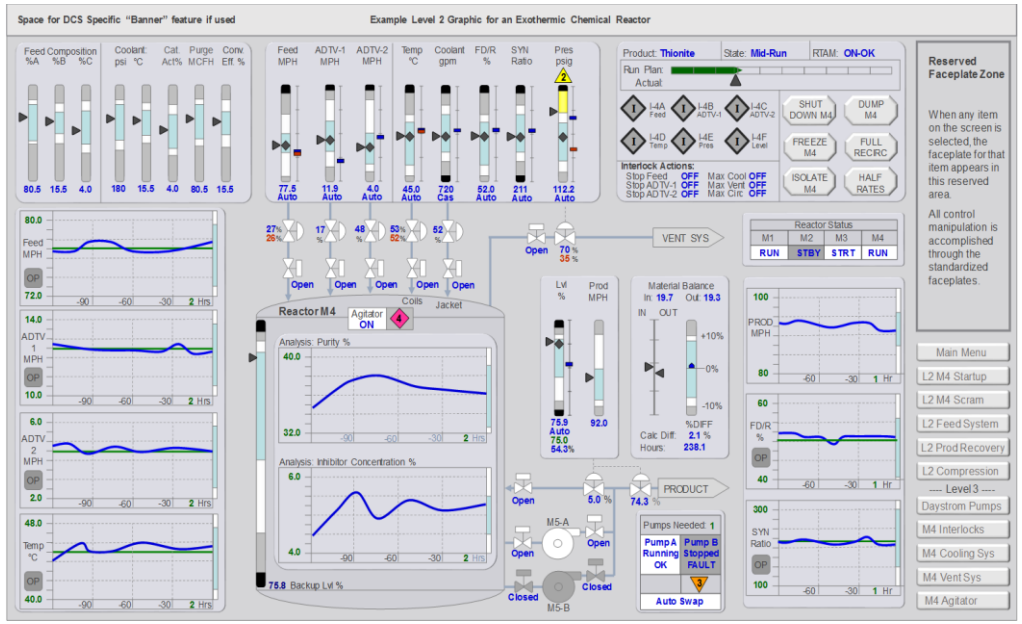


Source: The High Performance HMI Handbook

Modern HMI Design standards

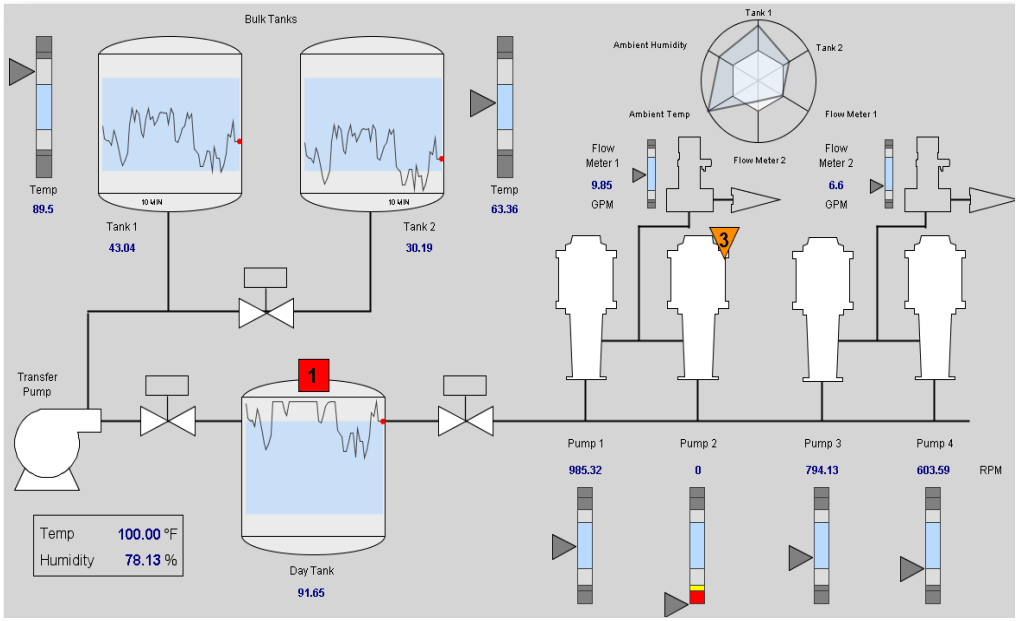
- With advancing HMI technology, the need arose to set standards and best practices
- In 2015, the International Society of Automation (ISA) published ISA 101 HMI Design Standard
- This document lays out the principles and design standards for High Performance HMI design

…and newer, High Performance HMI designs



Source: PAS

Provides critical information rather than simply data.



Consistent color scheme and visuals.

Source: Inductive Automation

Display Hierarchy

High Performance HMI display hierarchy

- **Level 1:** Overall situational awareness
- **Level 2:** Detailed view (sub-system or more granular view)
- **Level 3:** Equipment level detail
- **Level 4:** Diagnostics

Display Hierarchy - Example

High Performance HMI display hierarchy

- **Level 1:** Overall PV power plant operation
- **Level 2:** Specific array or module operation
- **Level 3:** Detail on a specific inverter
- **Level 4:** Performance data and analytical tools

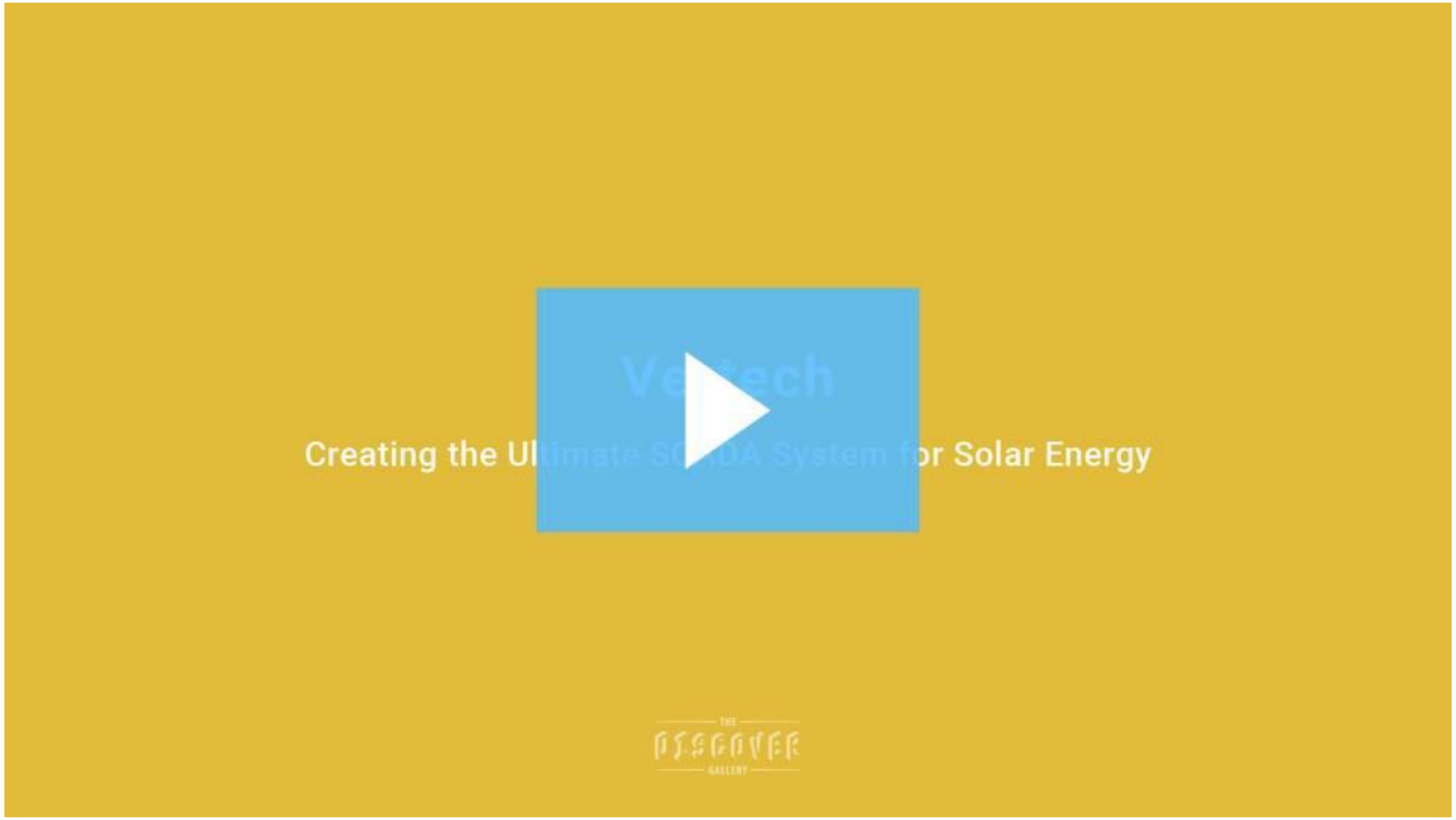

High-Performance
By Gregory Durvasc
HMI

How an HMI uses Data

- Monitor and historize operating conditions and parameters over time
- Establish relationships between operating variables/conditions/etc.
- Enables troubleshooting, optimizing, etc. of the process
- Export data for further analysis with other software – e.g. Excel

Considerations with HMI Data

- Data storage – local data historian server(s) and cloud integrated storage
- Data synchronization – ability to merge and exchange data across historian servers
- Speed – data collection speed, auto-archiving capability
- Compatibility with open standards and new technologies
- Performance calculation ability and intelligent asset technology
- Data insertion capability – insert data into the historian
- HMI data visualization tools – analysis toolkit within the HMI software
- Extensive redundancy and system security – reduce/minimize chance of operating losses or performance issues



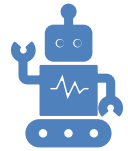
[Creating the Ultimate SCADA System for Solar Energy | Inductive Automation]

Trends in HMI (1)

Cloud connectivity (local, remote, mobile, etc.)

IOT

AI – big data analytics



AR/VR and haptic technology for system operators

UAV – unmanned aerial vehicle integration

Trends in HMI (2)

QUESTIONS?