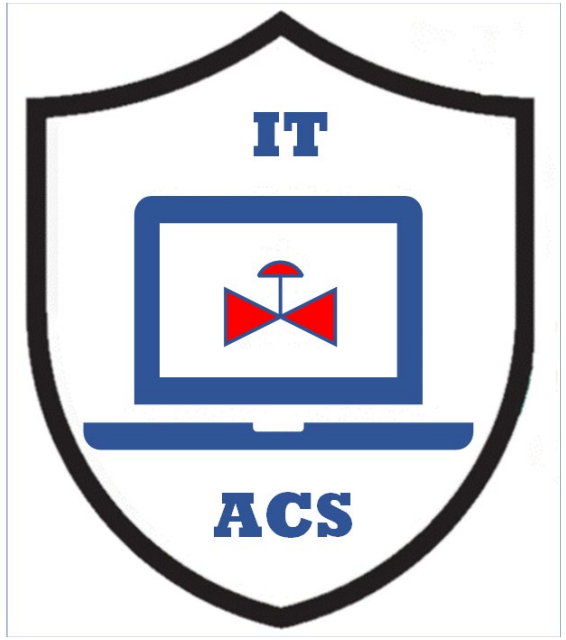
Plant AI and Human Interfaces

MLM-091-A

Industry	–	Generic Process Industry
Principal Role	–	Owner + EPC
Professional Role	–	Control Engineer
Enterprise Phase	–	Design & Operations



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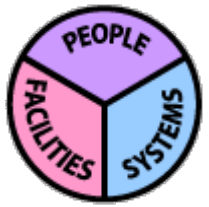
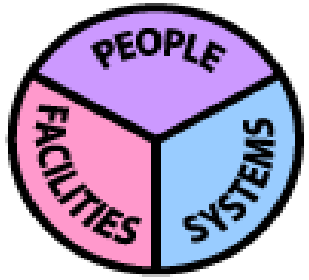
click start to begin video

START

An Enterprise Consists of 3 Major Components



These components are: People, Facilities and Systems, and each have interfaces with the other two.

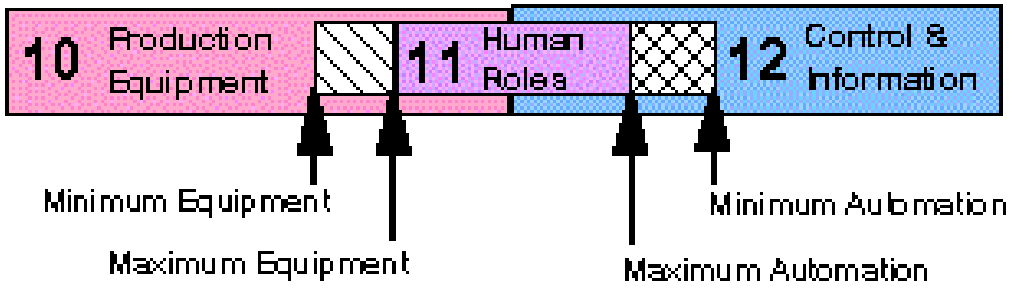


Automation is the process of reducing the role of People in the Enterprise and thereby increasing the role of Control & Information Systems and Facilities equipment. However, the degree of automation that is implemented is a conscious design decision (usually based on a cost/benefit or safety analysis).

Line of Automation

This requires establishing a “Line of Automation” between the maximum and minimum feasible level of automation between

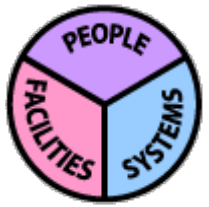
- People and Equipment, and
- People and Control & Information Systems



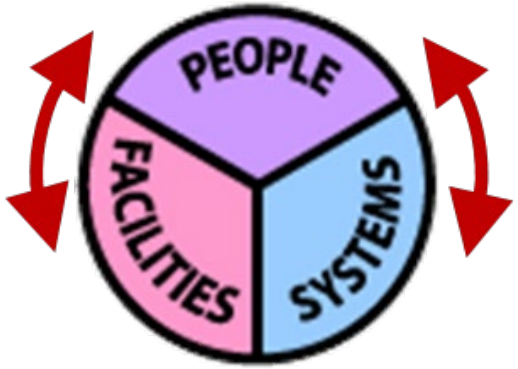
There are thus two ”Lines of Automation”:

- Replacing people with conveyors, robots or other equipment.
- Replacing people with control and & information systems.

When is the Line of Automation Established?

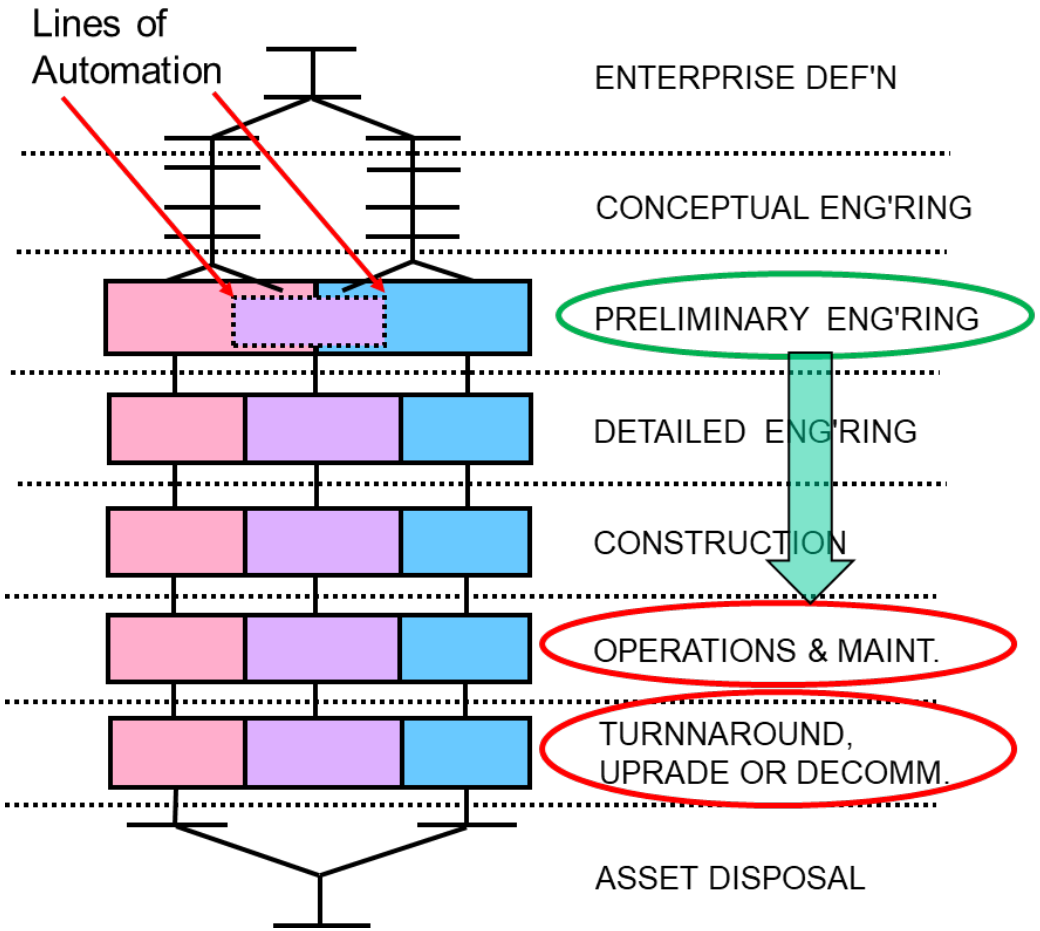


The Line Automation is established early in the design, typically during the Preliminary Engineering Phase.



Lines of automation are important because most problems and errors occur at human interfaces with control systems and facilities.

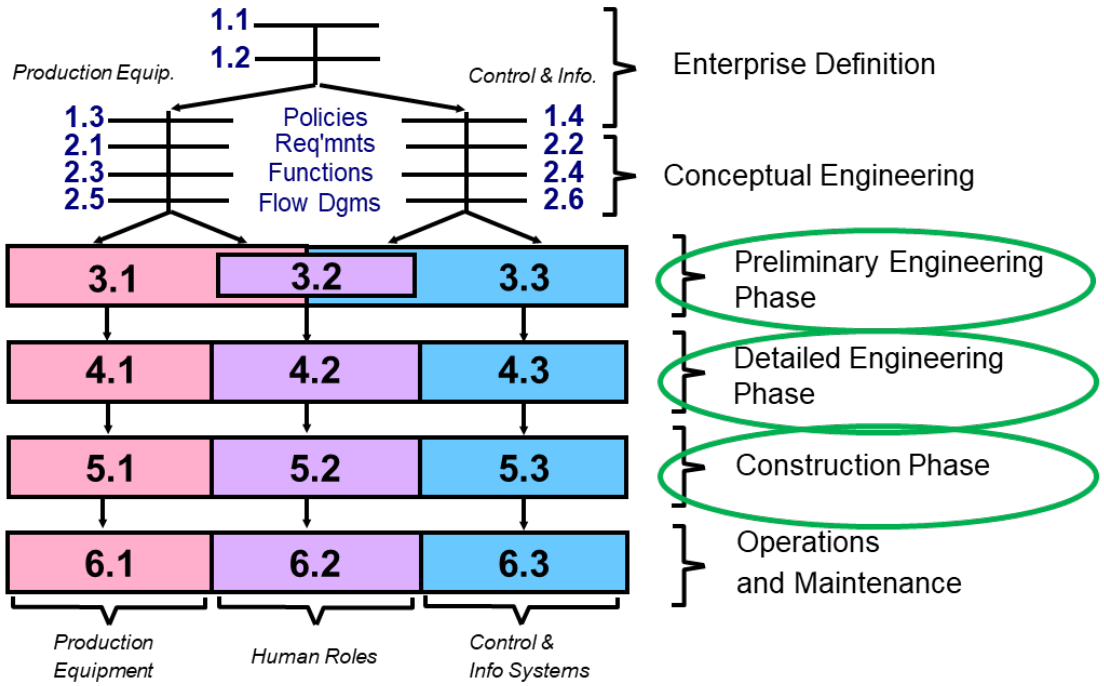
Line of Automation has a Major Effect on Design



The Line Automation is typically established during the Preliminary Engineering Phase. After this, Detail Engineering & Construction develop the facility based on this.

However, if a “simple” replacement of Human Activities by AI Agents or Humanoid Robots is introduced during Operations or Maintenance, the analysis and documentation done during Detail Engineering, Procurement, and Construction should be repeated.

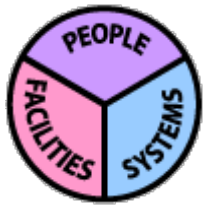
Changes in Human Roles have Major Effects on the Entire Design



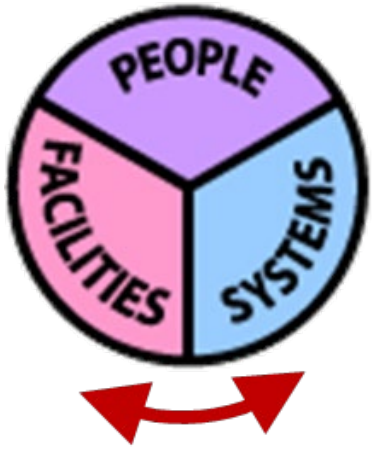
1.1 Feasibility Studies, Business Plan		
1.2 Mission, Vision, Values, etc.		
1.3 Production Policies e.g. Distributed Manufacturing	1.4 Info. Policies - e.g. Corp. Network Standard	
2.1 Prod. Requirements - e.g. 2 Plants + 1 Warehouse	2.2 Info Requirements - e.g. Maint. Mgt. System	
2.3 Prod. Modules - e.g. Generic Unit Operations	2.4 Info Functions - e.g. Work Order Tracking	
2.5 Prod. Networks - e.g. PFD, Mat'l Balance	2.6 Info Networks - e.g. Systems Arch, Dataflow	
3.1 Preliminary Engineering Production Equipment e.g. P&ID's Plant Layouts	3.2 Preliminary Engineering Human Roles & Org. e.g. Organization Chart, Staffing Levels	3.3 Preliminary Engineering Control & Info. Systems e.g. Control & Info Network Diagram, ISA Logics
4.1 Detailed Engineering & Design Production Equipment e.g. Piping & Conduit Drawings	4.2 Detailed Design Tasks, Training Plan e.g. Operation & Maint. Manuals	4.3 Detailed Engineering Hardware & Software e.g. Configuration, Programming
5.1 Construct, Checkout & Commission Production Equip. e.g. Machinery Install & Test	5.2 Staffing, Training Checkout Plant Procedures e.g. Simulator Training	5.3 Assembly, Test & Commiss. Control & Info. Systems e.g. DCS Checkout, Program Testing
6.1 Plant Operation e.g. Throughput Optimization Cost & Quality Improvement	6.2 Operate & Maintain e.g. Ongoing Training, Performance Improvement	6.3 Operation of Info & Control Systems, e.g. Maintenance Debug & Upgrade

The amount of effort (shown in green) involved in changing the role of humans can be very substantial!

Speed of Interfaces has a Major Effect on Control

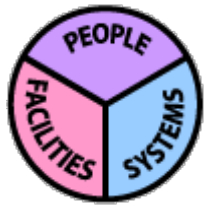


We have learned that as the Response and Resolution of the interface between facilities and control systems is improved, a dramatic improvement in the quality of control is possible.



This is related to the stability of control loops (see Bode Plots), but the same mathematics applies to the Response & Resolution of any interface.

Artificial Intelligence Introduces new Human Interface Problems

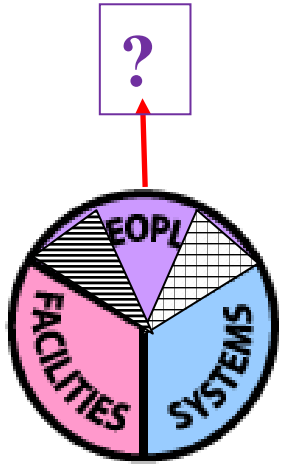


The new AI interfaces (shown as black arrows) may be faster and better than a human.

For example, an AI Agent might communicate with a control system at millions of Bits Per Second (BPS); while an Operator with a screen and keyboard might manage only a few BPS.

This also changes the interface for human operators (crimson). Traditional user interfaces to Control and Information systems and to plant equipment have evolved over many years and are thoroughly understood and well-documented. However, the reliability, Response, Resolution, and Repairability of new AI interfaces may not be known, and may even be unpredictable.

Artificial Intelligence Introduces new Human Interface Problems



As the role of AI Agents and Humanoid Robots increase, humans must find a way to understand what is happening, as interfaces that are hundreds of times faster, more accurate, and eventually more intelligent, take over.

Key Messages

The Line of Automation must be carefully considered and documented during the Preliminary Engineering Phase and later whenever human roles are changed.

Operating procedures have evolved over many years to ensure that operators can always intervene to maintain safe operations. There can be serious unintended consequences when the role of the Plant Operator is modified.

At the very least, AI agents or humanoid robots must inform the operator “after the fact” of any initiative that was taken, and the reasons for its actions.

It has been suggested that truthfulness must be the first law of AI. (Elon Musk).

More Reading

Related MLMs:

- MLM-090-A An Engineer's View of AI.
- MLM-090-B AI Applications in Process Industry.

References

- ISA TR84.00.09-2017, 'Cybersecurity Related To The Functional Safety Lifecycle'
- IEC PAS 63325 Ed1, 'Lifecycle Requirements for Functional Safety and Security of IACS'

Author

Gary has more than 40 years of experience with enterprise integration and optimization projects, including PERA master planning and project management.

As one of the initial authors of the PERA Handbook of Master Planning, he has used PERA Enterprise Architecture and Master Planning methodologies throughout his career including control and information systems for oil production, pipelines, refining and marine loading, petrochemicals, coal, gas, and oil-fired power plants, polyethylene, ammonia, explosives, paint, pulp and paper, food and beverage, and pharmaceuticals. LNG facilities included world-scale arctic, European, and US Gulf coast complexes.

infrastructure facilities included Fire, Police, and Emergency Response systems for major US cities, as well as emissions reporting and trading systems for more than 100 US Power Plants,

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