Setting the Standard for Automation™

ISA

Enterprise Wide Optimization built upon a Solid Foundation in Instrumentation and Automation

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Air Liquide

Applied Mathematics R&D

Standards

Certification

Education & Training

Publishing

Conferences & Exhibits

Presenter

Jeff Arbogast, Ph.D.

International Expert, Applied Mathematics R&D

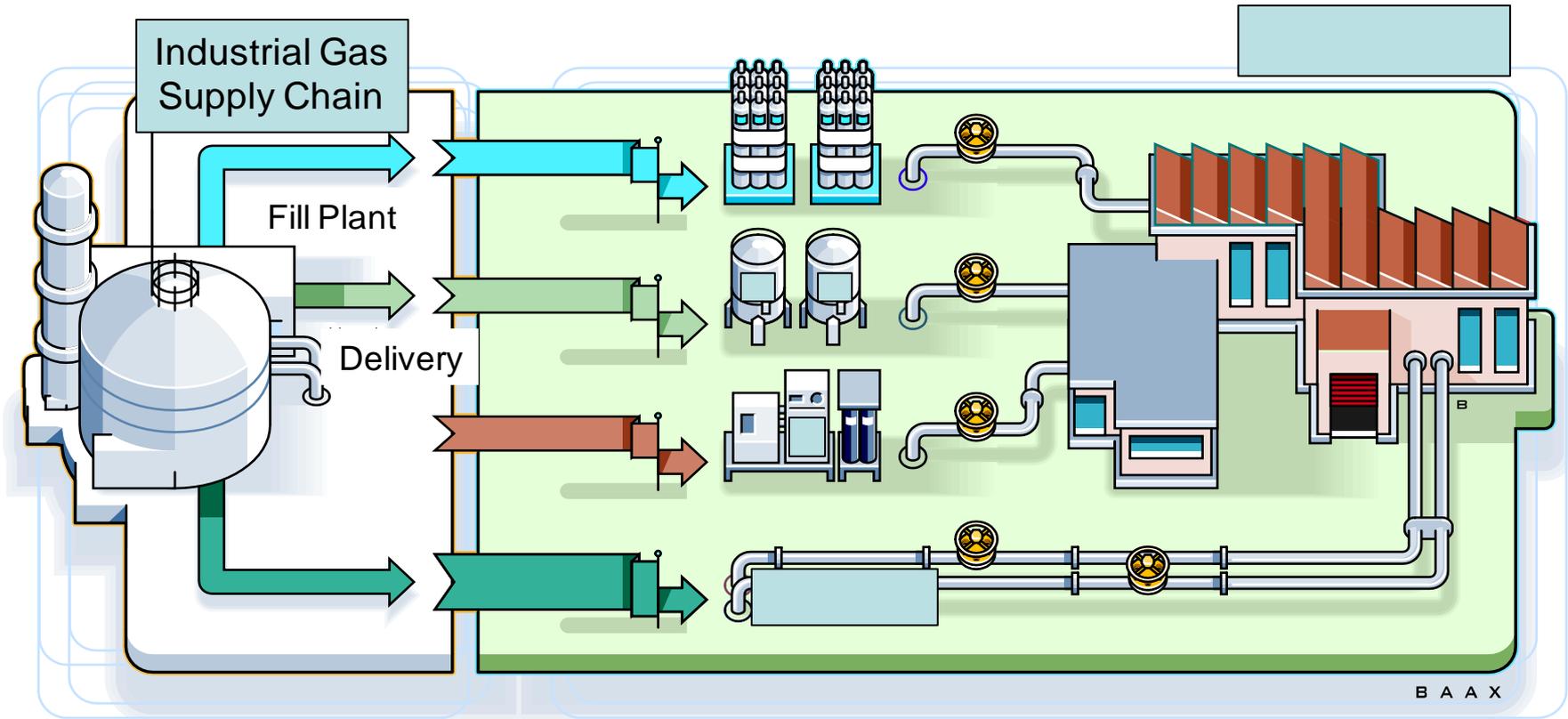American Air Liquide

Newark, DE

- Ph.D. in Chemical Engineering - University of Connecticut
  - Advisor: Prof. Doug Cooper
  - Research: PID Control – Robust Stability
- Currently managing project to optimize bulk (liquid) distribution
- Past projects (2007-present):
  - Alarm Management
  - Human-Machine Interface Design
  - Fault Detection & Analysis
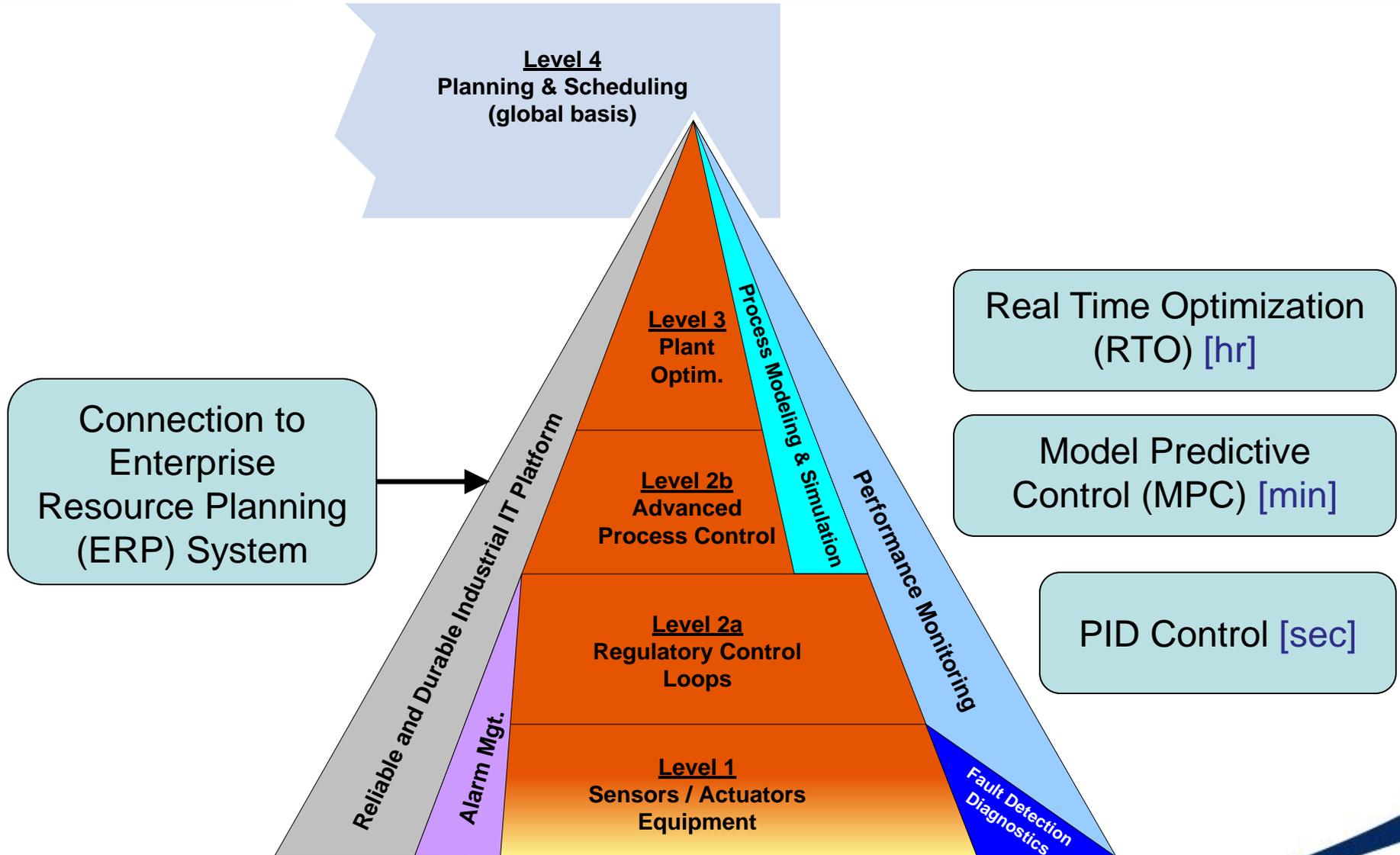 - PID Tuning software evaluation

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Delaware Research & Technology Center

Evolving Scope
toward Enterprise Wide Optimization

- **ISA has evolved**
  - from Instrument Society of America
  - to International Society of Automation

- **Carnegie Mellon's CAPD has evolved** (for example)
  - from Center for Advanced Process Design (early 1980s)
  - to Center for Advanced Process Decision-making (today)

- **Research emphasis has evolved** (over my career)
  - from Plant-Wide Control & Optimization (10+ years ago)
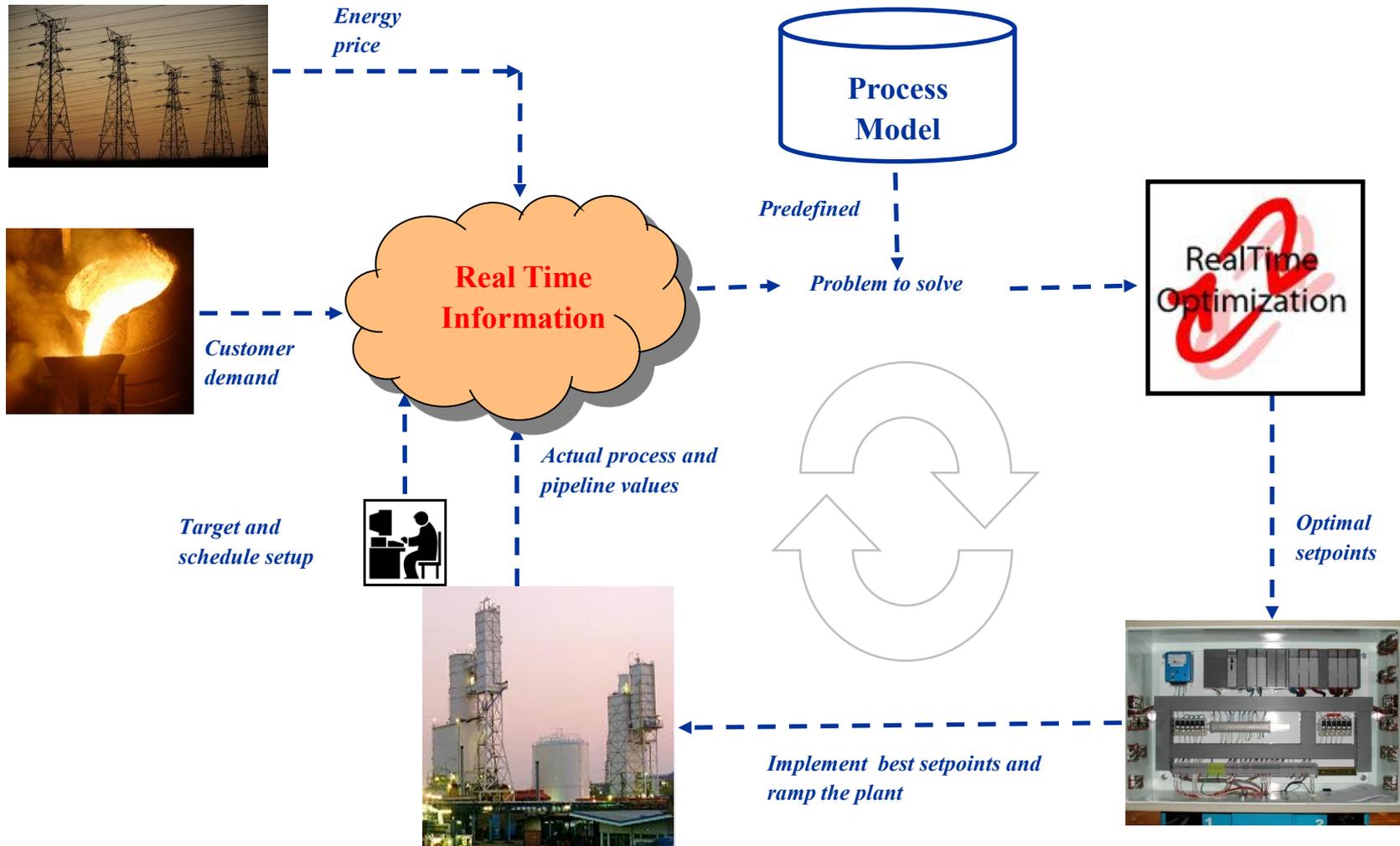 - to Enterprise Wide Optimization (today)

Illustrative Example:
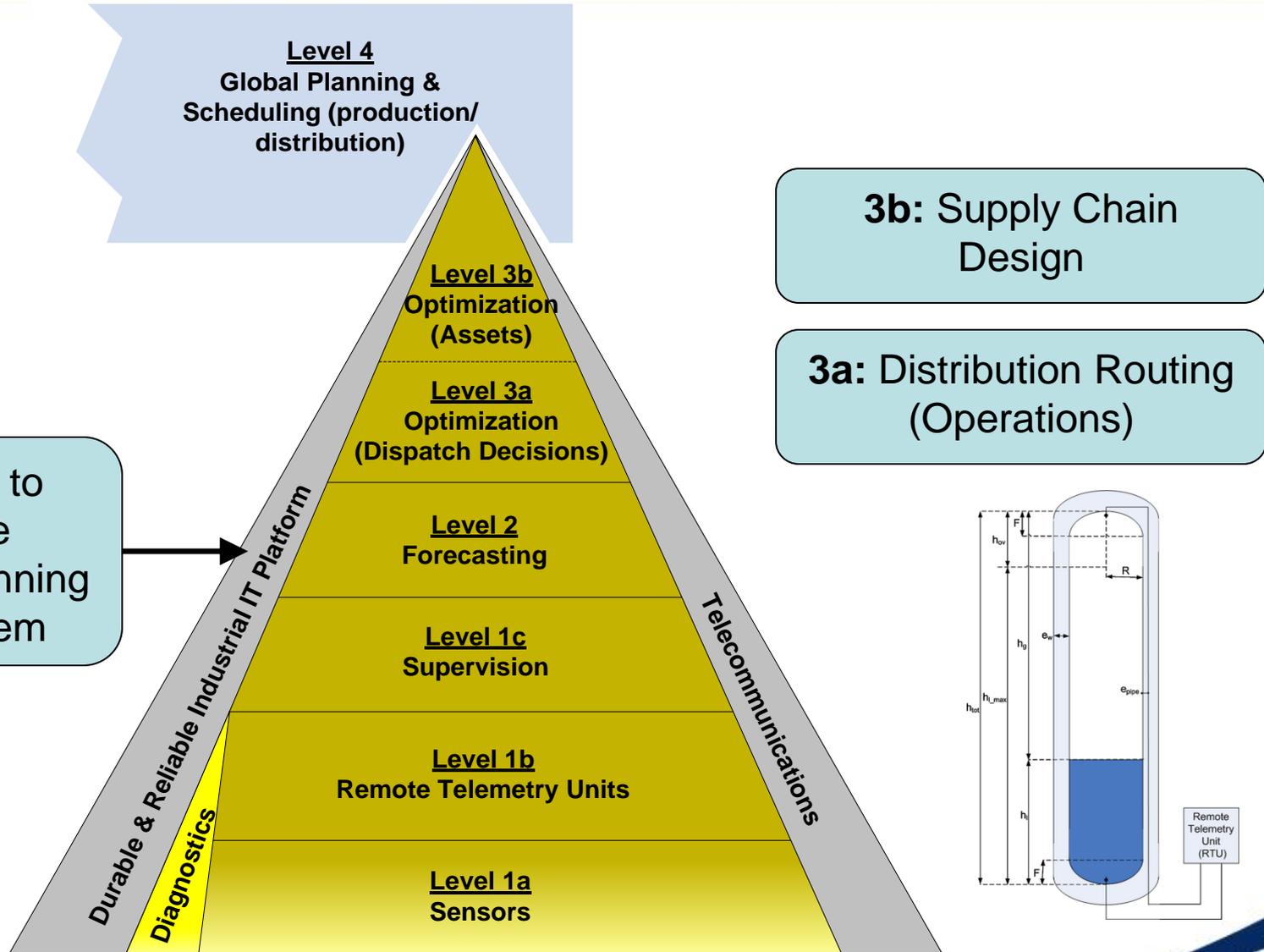# Industrial Gas Supply Chain

Hierarchical Pyramid (w/ ISA-95 levels): Process Control & Optimization (Production)

Level 4
Planning & Scheduling
(global basis)

Level 3
Plant Optim.

Level 2b
Advanced Process Control

Level 2a
Regulatory Control Loops

Level 1
Sensors / Actuators Equipment

Process Modeling & Simulation

Performance Monitoring

Reliable and Durable Industrial IT Platform

Alarm Mgt.

Fault Detection Diagnostics

Connection to Enterprise Resource Planning (ERP) System

Real Time Optimization (RTO) [hr]

Model Predictive Control (MPC) [min]

PID Control [sec]

Example:
Real Time Optimization (RTO)

Energy price

Process Model

Customer demand

Real Time Information

Predefined

Problem to solve

RealTime Optimization

Actual process and pipeline values

Target and schedule setup

Optimal setpoints

Implement best setpoints and ramp the plant

Li, et al. (2011)

Hierarchical Pyramid (w/ ISA-95 levels): Distribution Optimization

Level 4
Global Planning & Scheduling (production/distribution)

Level 3b Optimization (Assets)

Level 3a Optimization (Dispatch Decisions)

Level 2 Forecasting

Level 1c Supervision

Level 1b Remote Telemetry Units

Level 1a Sensors

Durable & Reliable Industrial IT Platform

Telecommunications

Diagnostics

Connection to Enterprise Resource Planning (ERP) System

3b: Supply Chain Design

3a: Distribution Routing (Operations)

Example:
Inventory Routing Problem (IRP)

- Conceptually simple but challenging to solve

- An IRP optimization tool makes several decisions
  - **When** to deliver to each customer
  - **How much** to deliver to each customer
  - **How** to deliver to each customer
    - **From where?** Which depot? / Which source (production plant)?
    - **With what resources?** Which tractor / trailer / driver?
    - **In combination with what** other customer deliveries?

- Reliant on data from many sources / several layers of foundation (sensors, remote telemetry, server / supervisory software, soft sensor, forecast)
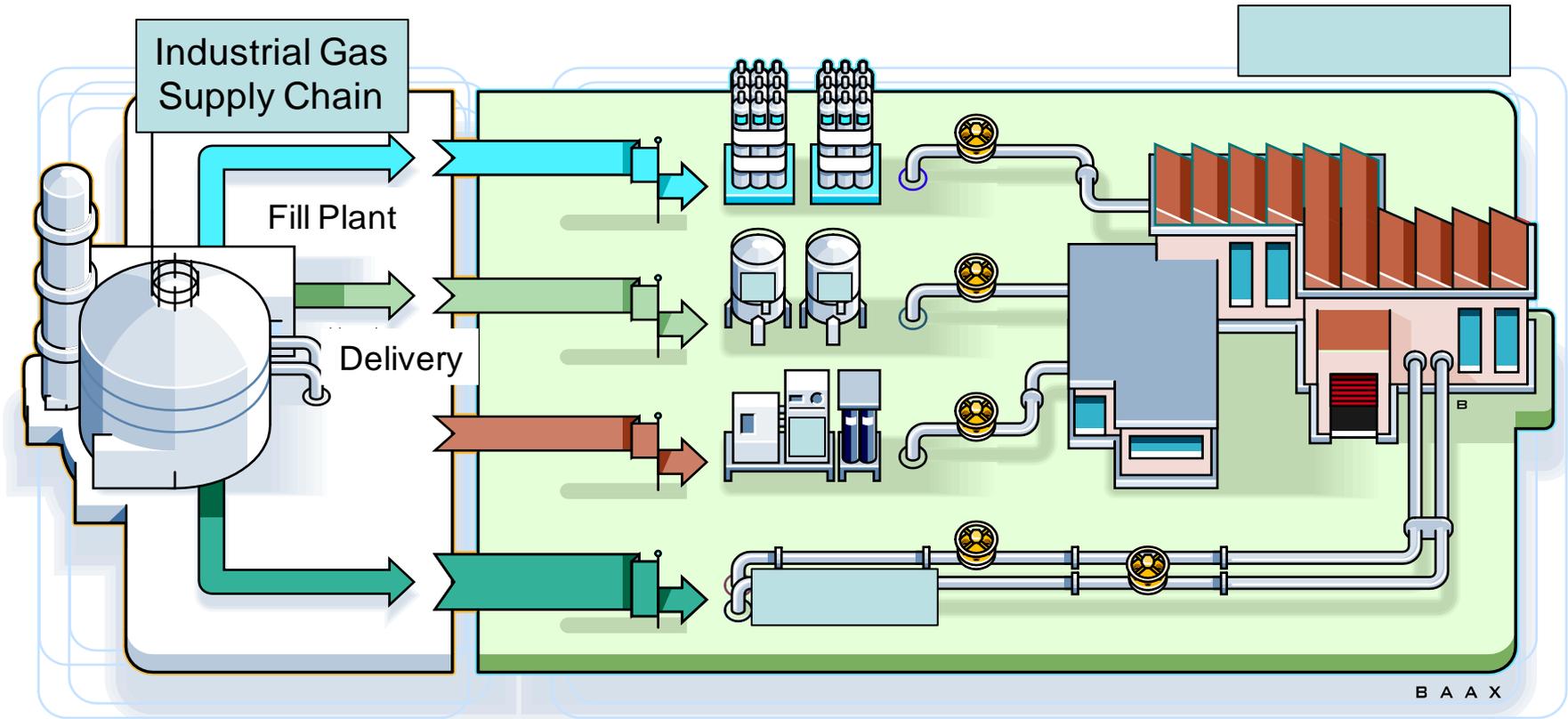
Achieving Long-Term Buy-In and Sustainability – Avoid "Shelf-Ware"

- Make Certain the Foundation is Strong

- Manage Reasonable Expectations

- Proactively Engage Stakeholders (particularly end-users)

- "Do As Well" then "Do Better" then "Do More"

- Maintain Reliable Data (responsibility/accountability)

- Support End-Users (diagnostics, HMI, training, docs)

- Industrialize & Standardize Solution and Monitor Use

Manage Reasonable Expectations

- Articulate an inspiring vision (something worth following)
- Outline a clear path towards achieving your vision
  - Set reasonable (SMART) objectives / milestones
  - Identify opportunities for success (victories) along the way
- Don't let the perfect be the enemy of the good
  - **1st goal**: Perform better than before
  - First Do Better, eventually Do Best (if possible)
- Set reasonable expectations
  - What appears simple and straightforward often is not so
    - Make sure all stakeholders **appreciate** the level of the challenge
  - If end-user can do better / improve upon solution, train them to expect this and encourage them to try

Proactively Engage Stakeholders (particularly end-users)

- Proactively Identify and Involve Potential Stakeholders
  - **Management** [business value, $, resources]
  - **Subject Matter Experts** [problem definition, validation]
  - **Operations** [end-user of tool <u>or its results</u>]

- Genuinely Solicit Stakeholder Feedback and Respond with Empathy
  - If you **solicit** feedback, you should be genuine and **consider it**
  - Respond with necessary detail, including rationale
  - Respond with empathy, understand stakeholder's perspective

- Identify and Address Underlying Question, Concern, Request or Need

Proactively Engage Stakeholders (particularly end-users)

- Evaluate "Launch Customer" for Trials
  - Strong team to support the trial
  - Complete pre-requisites (strong foundation) to support tool
  - Everyone can't be the "launch customer" (nor do they all really want to be)

- Articulate a SMART Short-Term Value Proposition for End-Users' Efforts
  - SMART: Specific, Measureable, Attainable, Realistic, Time-bound
  - Long-term value proposition is necessary but insufficient to maintain morale and buy-in
  - Short-term value proposition significant relative to effort required

"Do As Well" then "Do Better" and then "Do More"

- **Do As Well**: vs. existing tools or previous versions
  - **Problem**: Nothing destroys buy-in like regression
  - **Mitigation**: Thorough (ideally, automated) testing

- **Do Better**: within existing model/scope/functionality
  - **Problem**: Reporting same issues again kills end-user morale
  - **Mitigation**: Clearly outline response and update on progress

- **Do More:** expand model/scope/functionality
  - **Problem**: Moving on to address needs of new end-users may alienate current users whose needs have not been satisfied
  - **Mitigation**: Focus on addressing needs of your current users first

Maintain Reliable Data (Responsibility / Accountability)

- Reliability of any control or optimization tool is directly tied to the **reliability of the data** provided to it (e.g., from Enterprise Resource Planning (ERP) system)

- Industrial IT platform technology (e.g., based upon ISA-95) alone is insufficient

- Particularly true for "open-loop" decision support tools
  - Regular, specific end-user action required to implement solution
  - Early stage "open-loop" tools rely on end-user to collect data
  - Development and deployment of tool increases reliance on ERP (compared with pre-existing manual methods)
  - Generally infeasible for end-user to take responsibility for every piece of data needed

Support End-Users
(diagnostics, HMI, training, documentation)

- Provide Diagnostic Tools for Actionable Analysis of Input Data Quality

- Provide an Intuitive and Interactive Human-Machine Interface (HMI) (e.g., ISA-101)
  - Provide the end-user with clear information to build and maintain confidence in the tool (avoid developing "black boxes")
  - For "open-loop" tools, facilitate end-user experimentation to challenge the solution and simulate results (with KPIs)

- Provide Targeted Training and Documentation
  - Targeted to end-user, end-user's manager, key users (support)

Industrialize & Standardize Solution and Monitor Use

- Industrialize and Standardize Solution
  - **Objective**: Tool will be used and provide value for years to come
  - **Sustainability**: Clean Code and Documentation
  - Anticipate common changes and incorporate into design

- Monitor for Sustained Use and Benefit

Conclusions
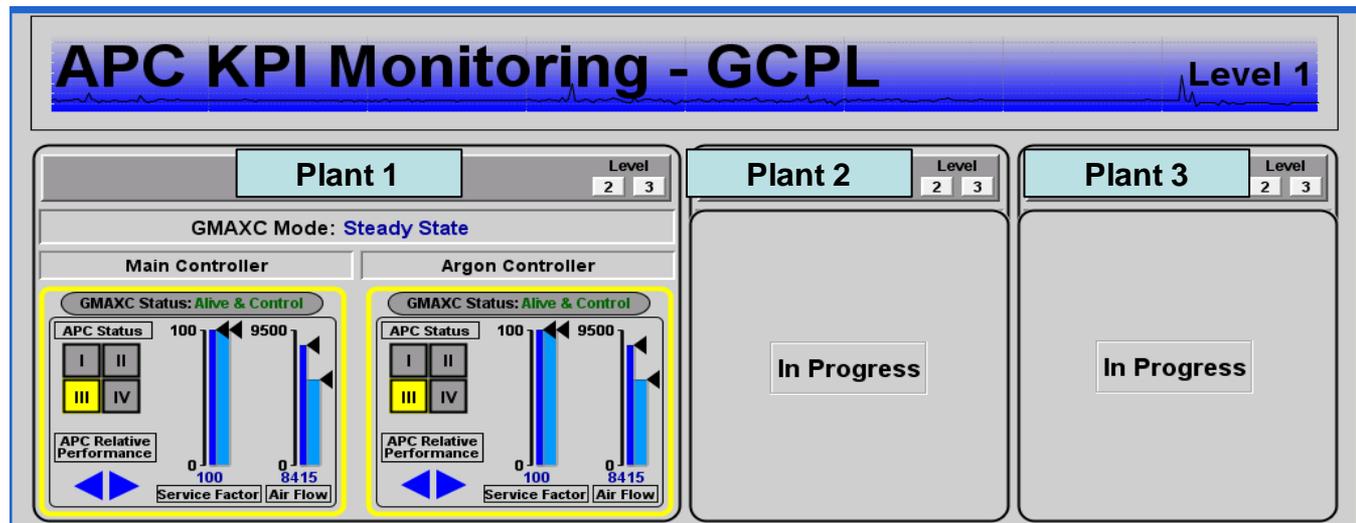
- Advancing up the pyramids toward Enterprise Wide Optimization increases the perceived value of the underlying foundation of instrumentation and lower-level automation
  - MPC motivates improved maintenance of PID loops
  - RTO motivates the development & maintenance of MPC
  - Optimization in Vendor Managed Inventory (VMI) context motivates development and deployment of remote telemetry

- Establish responsibility and accountability for data at the data owner level to account for
  - Large number of data points and data sources
  - Distance between tool end-user and data sources / data owners

Thank You!
Any Questions?

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