Topics Covered in this Presentation

Introduction – Intro to SmartPlant Piping and Instrument Diagrams
Issues – Current problems with SmartPlant Piping and Instrument Diagrams
Standards – Applying Instrumentation Symbols and Identification Standards
Databases – Data Properties of SmartPlant Piping and Instrument Diagrams
Integration – P&ID integration with other SmartPlant Automation Tools
The current Work Process when developing a P&ID is for Process Engineers to make Sketches and send them to Graphics Designers to create the working drawings.

The adage that “a picture is worth a thousand words” seems to be the current accepted philosophy when developing P&IDs.
There is a tendency to put less and less on P&IDs by using graphic symbols to represent the instrument components as well as the process interoperability and loop associations.

This practice was initiated to streamline and de-clutter the diagrams but requires much interpretation by the users.
The addition of a data layer to the P&ID has resulted in what is commonly called the Smart Piping and Instrument Diagram.

An Smart P&ID contains both graphic and meta data and is the source of all the information needed to develop the Process Equipment Sequence and the Instrument Control Schemes.
Multiple Standards for P&ID Symbols

- There are many different standards for the symbology used in the development of Piping and Instrument Diagrams.
- Standards serve a particular purpose or market, for example: ISO/IEC-14617 standards are used for PFD equipment, while PIP and ANSI/ISA-5.1 standards are for Instrument P&ID Symbols.
Legend Sheets show all the Symbols, Identifications, Naming Conventions and Abbreviations used on the P&ID

Additional Properties are assigned to the Symbols to add more information and Intelligence to the P&ID

Most Properties are not displayed on the face of the Diagram
Out of Date Instrument Diagram Symbols

- Most Company Legend Sheets and Symbols are based on Older Standards or Historical Project legends but more recent Versions of Standards render the existing Symbols Out of Date.
- Updating the Legend Sheets and Symbols can be a costly effort but will enable the use of Emerging Technologies.

### Table 5.1.1 — Instrumentation device and function symbols

<table>
<thead>
<tr>
<th>Old Symbols</th>
<th>New Symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Old Symbols" /></td>
<td><img src="image2.png" alt="New Symbols" /></td>
</tr>
</tbody>
</table>

*Symbols vary depending on the type and needs of the diagram.
Use of Abbreviated or Typical Symbols

- Abbreviated symbology used to de-clutter the drawing results in Implied Tag Instruments not being shown on the P&ID.
- Implied Instrument Tags cannot be represented in the SmartPlant P&ID database as they do not have a symbol in the body of a P&ID to attach the Tag Data properties.
Use of Tabular Data in Place of Symbols

- Creating One Typical P&ID for Duplicate Equipment, Trains or Units and using Tables or Tag Prefixes to Reference the Tags across the duplicate systems limits relationship to the Database.

- Using Tables to List Instruments Associated with each Loop instead of showing Symbols for each Tag does not provide enough detail to reflect the actual design conditions of the Control System.
Use of Complex Naming Conventions

- Trying to put too much information in the Tag numbering convention can overly complicate the Tag naming process.
- A simple ISA naming convention should be adequate to give each tag a unique ID and any additional information can be added as Data to the Properties of the Symbols.
Most P&ID workflows are focused on the graphics and visible part of the diagrams with little attention to the Data Properties.

SmartPlant P&ID workflows should direct attention to the data-centricity capabilities of the P&ID and provide mechanisms for Data Input, Validation and Integration.
Emerging Instrument Technologies

- Instrumentation Technologies have changed dramatically over the last few years but most Projects still use outdated Symbols on the P&IDs that do not represent current emerging technologies.
- Different Instrument Systems and Wiring methods need to be correctly represented on the Intelligent P&IDs so that all of the information used to define the properties of the control networks are accounted for.
PIP PIC001:2008

- PIP Piping Industry Practice - PIC001 “Piping and Instrumentation Diagram Documentation Criteria” has symbols for Process Piping and Equipment as well as basic Instrument symbology
- This standard can be used to create a complete P&ID and is the basis for most SmartPlant P&IDs
- PIP PIC001 refers to ISA 5.1 as the basis for Instrument Symbols and the two standards should be used in conjunction for the most up to date representation of Control Systems Instrumentation Technology
The latest version of ANSI/ISA-5.1-2009 Instrumentation Symbols and Identification has significant changes over the previous version ISA-5.1-1984 (R1992)

This standard has been updated to include new and evolving Instrument Technology, Control Systems and Computer Networks

This standard addresses only the graphic layer of the documents and does not address the Data or Attribute layer of Intelligent P&IDs but the symbols are easily adapted to add data properties links
Table 5.2 is a new table for Measurement Notations, Descriptions and Functions to be used with symbols (e.g. OP-MH = Orifice Plate Multi-hole, LSR= Laser, GWR = Guided Wave Radar, etc…)

Table 5.2.3 - Primary element symbols with several new symbols for special orifices and measurement technologies (e.g. Concentric, Eccentric, Quadrant and Multi-hole Orifice Plates)

Table 5.2.5 - Measurement symbols for auxiliary and accessory devices (e.g. the addition of “Probe” function for sample probes connection)

Table 5.3.2 - Line symbols for instrument-to-instrument connections with new symbols or signal types (e.g. Wireless, Fieldbus and Smart or Serial signals)

Table 5.4.2 - Final control element actuator symbols with new positioners and partial stroke testing device symbols (e.g. Added Valves with Positioner to eliminate the use of I/P Transducer)
Annex A has expanded Tables for Allowable Loop, Tag & succeeding letter combinations for instrument functions (e.g. Added Function modifiers FF = Ratio, FQ = Total, FS = Safety & FZ = SIS - ISA now recognizes over unique 1000 Instrument Type identifiers)

Annex B “Graphic symbol guidelines” (Informative), is a new informative clause that replaces the examples formerly given in Clause 6, “Drawings,” to provide some limited assistance in the application of the symbols in Clause 5. (e.g. the use of “FC” Field Controller for Fieldbus Virtual Field Device) These examples are more generic and limited in nature than the previous ANSI/ISA-5.1-1984 (R 1992)
The standards when applied to the Legend sheets define naming conventions that define the mechanical, electrical, process, Piping Lines and instrument systems.

The naming conventions give unique Tag Names to the symbols and elements on the P&ID.

On SmartPlant P&IDs the Tag Name text is placed in the Symbols as a Tag Property that is associated to the Database Tables as Key Fields.

The P&ID Database has separate tables for each type of Symbol.

Additional columns in each table allow the placement of additional properties added to each Tag Name.
Since the Database contains the intelligence of the P&ID it is important that the data be input and managed by the engineers that are responsible for that Data.

Piping and Mechanical Engineers should edit and manage the Piping Line and Equipment Databases to support the graphics provided by the Process Engineer.

Control Systems Engineers should have access to the Instrument Tag and Loop data tables for editing.

Management of change is important as the P&ID is the primary source document for all engineering.
SmartPlant P&ID Instrument Data

- The P&ID Instrument Data Properties include the Loop and Tag Names, Service Descriptions, Signal Types, Process Operating Conditions and additional Monitoring or Control data.
- The Instruments, especially Control Valves, have the largest number of Data Properties of any of the P&ID elements.
- The Symbols used on P&IDs should convey a minimum Data set such as Device Type, Signal Type, System Type and Measurement Technology.
- Sufficient Instrument Data can be loaded into the P&ID Database that Instrument Indexes and I/O lists can be created directly from the P&IDs.
SmartPlant P&ID Reports and Exports

- Most Intelligent Piping and Instrument Diagram software have provisions for generating reports from the database.
- The Report generators also have the ability to Export in other File Formats using Open Database Connectivity (ODBC).
- Typical Reports and/or Exports from the P&ID database are:
  - Instrument Lists and Indexes
  - P&ID drawing Lists
  - Electrical Load Lists
  - Inline Device Lists
  - Piping Line Lists
  - Equipment Lists
  - I/O Lists
- The Exports are used for Integration DATABASES
P&ID Integration with other SmartPlant Tools

- In a Data Centric Engineering Environment the Integration of data between each Discipline Automation tools is essential.
- SmartPlant P&ID is the source for most of the data that initializes the other Engineering Automation Project databases.
- Several mechanisms are used to pass data between tools.
SmartPlant P&ID Integration Data Sets

- SmartPlant Foundation is a complementary offering to Intergraph’s SmartPlant Suite, acting as a data exchange hub between SmartPlant P&ID and SmartPlant Instrumentation.
- Certain Key Fields (Usually Tag Names) must be correlated between the databases to establish record matching.
SmartPlant P&ID Integration Data Mapping

- SmartPlant Foundation Data Validator can be used to map SP-PID data to SPI for verification before loading Publishing.
- Intimate knowledge of both data structures is necessary for mapping and in some cases data may need redefinition.
Legend Sheets for Intelligent P&IDs

- Following are a few simple Rules and Practices to take full advantage of Data Centric SmartPlant P&ID and Legend Sheets
- The Legend Sheets need to be based on the latest standards
- Naming Conventions for all Key Tag entities should be defined on the P&ID Legend Sheet
- Be sure all the Primary Symbols defined on the Legend Sheets have attributes linked to the database
- Update the Legend Sheets as design develops to show actual usage of symbols and tag naming
- The Legend Sheets need to address naming conventions and symbology for Emerging Instrument Systems
Provide for New and Emerging Technologies

- Instrumentation Technologies Have changed dramatically over the last few years but most Projects still use outdated Symbols on the P&IDs that do not represent emerging technologies
- Different Instrument Systems and Wiring methods also need to be represented and Identified on the P&IDs
- Instrumentation Systems
  - Basic Process Control Systems (BPCS)
  - Safety Instrumented Systems (SIS)
  - Equipment Protection Systems (EPS)
  - Burner Management Systems (BMS)
- Emerging Wiring Systems
  - Conventional 4-20 ma Instruments
  - Smart Digital Instrument Systems
  - Bus Based Instrument Wiring Systems
  - Wireless Instrument Systems
Do Not Take Drafting or Data Shortcuts

- The Piping and Instrument Diagrams and SmartPlant P&ID Database are the most important source of information on any project.
- The P&ID is the wrong place to try to save time or money when developing the content of the Process and Control Systems.
- Every Tagged Element needs to be shown on the face of the P&ID so they will have a record in the database.
- The P&ID Data layer properties define all of the engineering requirements of a project so do not think of the SmartPlant P&ID as simply graphics.
- The owners of the individual types of data need to be the ones editing and validating the content of the P&ID Graphics and Data.
Develop Data Centric P&ID Work Processes

- Most work processes for developing P&IDs are focused on the Graphics layer of the documents with little regard to how the data properties are populated or validated.
- The P&ID Database contains information from several disciplines so members of those departments should be defined in the Data Centric Work Process.
- A typical Data Centric Work Process:
  - Process Engineering is responsible for overall Graphics and Process Data.
  - Piping, Mechanical and Instrument Engineering are responsible for their respective data properties.
  - It may be necessary for other entities to have input to the database (e.g. Plant Operations or Safety Engineering).
- Make provisions for Data Integration.

**PRACTICES**
The primary reason to use SmartPlant P&IDs is to create a data source for other Automated Engineering Applications.

SmartPlant P&ID has interfaces that allow the data to be formatted and exported to other tools.

The extent of the Integration will depend on the quantity and quality of the Data in the Database.

Some common Integration data sets:

- Equipment Lists with Properties
- Piping Line Lists with Properties
- Instrument Lists with Properties
- Electrical Load Lists with Properties
- Process Design Conditions
“One man's 'magic' is another man's engineering.”
~ Robert A. Heinlein

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