Strategies for Fast-Tracking Conceptual Plant Studies using SmartPlant Layout

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Intergraph UK & Ireland 2008
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Conceptual Plant Engineering – Intergraph’s Perspective;
- Business Drivers, Challenges & Opportunities Today …
- Industry Best Practice – General Observations
- Current Work Practices & Workflows – an EPC’s View
- Strategy Options to support Conceptual Plant Design & Layout
- Intergraph's Approach
  - SmartPlant Layout Positioning & Overview
  - Optimized conceptual plant layout workflow using SmartPlant Layout integrated with Aspen Tech Applications
  - Business Value

- Q & A

- Summary & Close
Conceptual Plant Engineering – Intergraph’s Perspective;
- Business Drivers, Challenges & Opportunities Today …
- Case Study; The Dow Chemical Company
- Industry Best Practice – General Observations
- Current Work Practices & Workflows – an EPC’s View
- Strategy Options to support Conceptual Plant Design & Layout
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- Summary & Close
“... over 80% of a project’s total cost are committed within the first 20% of the total project’s design time ...”
The opportunity cost to influence & improve asset performance is at its lowest during the early stages of conceptual & detailed design.
User Case Study...

The Dow Chemical Company
From the EPC’s Perspective:

- Boundaries between Conceptual Studies (traditional layout), FEED & Design continue to blur to support more fully integrated, complex projects
- Commercial/contractual basis supporting project execution strategies continues to poise challenges on projects

From the Owner/Operator’s Perspective …

- Major opportunity to influence overall CAPEX/OPEX
- Continued pressures to reduce schedule (time to market) & cost without any compromise to plant quality, integrity, safety & the environment
- Capital Investments continue to get larger on a global scale ~ increasing number of ‘Mega-Projects’

How to manage the resulting challenges moving from a functional (PFD) to technical (P&ID) design, into plant layout …
An EPC View Today ...  
Current Work Process/Work Flow
### Layout Strategy

<table>
<thead>
<tr>
<th>#1.</th>
<th>2D CAD-based Plot Plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>#2.</td>
<td>‘Simplified’ 3D Plant Model</td>
</tr>
<tr>
<td>#3.</td>
<td>Integrated Process/ Plant Model</td>
</tr>
</tbody>
</table>

### Estimation Basis

- Internal Rates/ Historical Data
- Internal Rates/ Historical Data
- Linked to Cost Estimation Software

### Observations

- 2D CAD-based Plot Plans
- Simplified 3D Plant Model
- Integrated Process/ Plant Model

### Comments

- ‘The way we’ve traditionally done it …’
- ‘If the customer is prepared to pay for it …’
- ‘Who will gain the overall benefits?’

**Sound familiar …?**
So, Where should 3D Plant Modeling start?

Current Approach:

Paper-based Drawing Layouts/
2D Studies; Simplified 3D CAD Models

SmartPlant® Layout

So, Where should 3D Plant Modeling start?

Alternate Approach:

Undertaking Conceptual Plant Layouts
~ Design Cases ~ using 3D plant layout tools
*Integrated* with process design

SmartPlant® 3D
**SmartPlant Layout ...**
Intergraph’s latest solution optimized for preliminary 3D conceptual plant layout

- Early plant layout, iteration & optimization
- Proposal/ tender/ RFQ/ RFP development
- More accurate/ early design estimates
- *Not intended as a “piping designer”*

**Scope ...**
Tools for optimization of plant layout;

- Layout design case management
- Selected equipment, piping, structure, space management commands
- Selected local drawings and reports
- Interfaces with cost estimation
- Pipe Auto-Routing … *Powered by Alias I-Route*
Objectives

- Targeted at Front End Engineering Design
- Starting point …
  - Process Flow Diagram \(\sim PFD\)
  - Plot size & shape \(\sim 2D\) CAD-based drawings

- Facilitate layout evolution, evaluation & plant optimisation …
  - Plant areas & zones
  - Equipment placement
  - Pipe routes
  - Structural requirements – Pipe Racks

- Input to cost estimation
- Rollover into detail design

✅ Find the minimum evaluation cost
✅ Avoid obstructions
✅ Utilise Pipe Racks & Zones
Simulation/ Process Design/ 3D Layout/ Estimation

Data Oriented Integration Workflow

Today ...

- **K-Base**
  - PFD’s
  - Equipment Data Sheets
  - Equipment Lists
  - Stream Data Sheets

- **Zyqad**
  - P&IDs

- **SmartPlant P&ID**
  - P&IDs
  - Reports

- **SmartPlant 3D**
  - 3D Model & Data
  - ISO Drawings
  - Ortho Drawings
  - Reports

- **SmartPlant Layout**
  - Piping MTO
  - Structural MTO
  - Correlated P&IDs

Future ...

- **K-Base**
  - PFD’s
  - Equipment Data Sheets
  - Equipment Lists
  - Stream Data Sheets

- **Zyqad**
  - P&IDs

- **SmartPlant P&ID**
  - P&IDs
  - Reports

- **SmartPlant 3D**
  - 3D Model & Data
  - ISO Drawings
  - Ortho Drawings
  - Reports

- **SmartPlant Layout**
  - Piping MTO
  - Structural MTO
  - Correlated P&IDs
SmartPlant® Layout Architecture

- SmartPlant Layout – Stand-Alone Product
  - Based on Intergraph’s SmartPlant 3D (full license)
  - Pipe Auto-Routing powered by Alias I-Route engine
  - Optimized for rapid plant layout, MTO reporting & drawing production

SmartPlant® Layout Tools
- 3D Modeling Tools
- Reference Data

SmartPlant® 3D
Common
3D Interference Detection

- Systems & Specifications
- Catalogue
- Grids
- Space Management
- Structural Analysis
- Equipment & Furnishings
- Piping
- Hangers & Supports
- Electrical (Cable Tray)
- HVAC
- Drawings & Reports

Project Setup & Reference Data
Design Aids
Multi-discipline 3D Modeling
Ortho/ISO Drawings & Reports

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**Optimized SmartPlant Layout Workspace**

**Layout Tools:**
- Define Connections
- Limit Path
- Auto Route

**Modeling Tools:**
- Place Equipment
- Place Zones
- Place Pipe & Components
- Place Structural

**Reference Data (OOTB):**
- Layout Equipment
- Pipe Auto-router Rules
- Layout Piping Specifications
- Code Lists
- Layout Drawing & Report Templates
- Intelligent ‘Smart’ Grid Wizard assists initial site layout
- Dynamic creation of Pipe Racks
  - Identical to SmartPlant 3D Structure
- Equipment placed from SmartPlant Layout reference data catalog
  - Based on identical SmartPlant 3D Equipment objects
Piping can be placed in the 3D model from various sources;
- SmartPlant P&ID
  • Import of line connection data & correlation
- 3D Model
  • User routes piping & then applies rules
  • *Auto-routing pipe*
- Spreadsheet
  • Import of line & connection data from Excel

Connectivity between;
- Equipment origins
- Equipment bounding boxes
- Equipment nozzles
- 3D points
- Connection zones
- Runs
Goal is to find the minimum cost route while avoiding obstructions …

… resulting route driven by space objects (3D volumes & zones) initially created in the SmartPlant Layout 3D model …

- 3D Volumes & Zones (with special attributes)
  - Attraction
  - Pipe Rack
    - ‘Via’ zones
  - Avoidance
  - Connection
- Obstructions
- SmartPlant Layout 3D Plant Objects
Rules
‘Forcing’ the Route

#1. Connection Zone  #2. PipeRack Zone

#3. Interference Volume  #4. Avoidance Zone

#5. Attraction Zone  #6. Via Zone

#7. SmartPlant Layout 3D Plant Objects
Pipe routed through the rack if:

\[ X \times 1 > (Y \times 2) + (X \times 0.2) \]
Auto-router defines minimum cost routes, while …
- Complying with defined zones
- Avoiding obstructions
- Complying with rules

Routes driven by space elements in 3D model …
- Zones
  - Attraction
  - Pipe Rack
  - Avoidance
  - Connection
- Other obstructions/objects

Routes driven by rules …
- Branch gap
- Air gap
- Standout
- Etc.
• **Branch Gap**
  The separation between adjacent branches connecting to the same header. If the branch gap value is greater than the in line length, this value will take precedence.
• **Pipe Air Gap**
The separation required between adjacent pipes. If the Piping Materials Class has butt welded joints, the nominal pipe diameter (NPD) & this value determines the pipe separation. Where adjacent pipes have different NPD sizes, the separation is half that for pipe 1 plus half that for pipe 2.
Standout 10cm + Min Pipe Length
• Defines Piping Specifications used in Layout
  ... ‘Generic’ ~ limited ~ specifications of basic piping components

Pipe Specs

Can be either SmartPlant Layout specific specs
or “standard” SmartPlant 3D Specs
- Defines spacing of pipes

  ... Defines cost factors – straight vs. bends
• Defines Equipment in Layout
  … can be saved and reused

Allows definition of Layout Equipment, its dimensions, location & orientation for use in alternate scenarios
Workflow

Initial Starting Point

Initial Layouts & Sketches
~ P&ID & Plan Layout

Initial ‘Intelligent’ SmartPlant P&ID
Define Site Grid, Plant Zones & Pipe Racks

Create/ Position Equipment

Define / Import Pipe Runs

Document Design Case

Layout OK?

Adjust Layout (Optimization)

Tender Layout Drawing(s)
MTO Reports (Pipe, Piping Components, Structure)
Design Case Alternatives
Design Case Comparison/ Analysis Reports (MS Excel)
MS Excel report export to 3rd Party Estimation Tools

No

Yes

Preliminary P&ID’s Initial Line List(s)
Optimize layout through adjustments to site grid(s), pipe racks, zones & equipment position

Alternatives (Design Cases) for equipment & volume position - parameters can be saved & recalled

Results can viewed …
- On-screen
- Via intelligent orthographic drawings
- Via intelligent reports

Direct integration via SmartPlant Review for layout walk-thru. & visualization

Output for cost estimation; Aspen Icarus™ (Kbase)
- Pipe/ Fittings
- Steel
SmartPlant Layout 3D data (MS Excel reports) are imported into Aspen Technology’s Kbase for cost evaluation.
Speed & quality improvements compared to manually drafted layouts;
- Improved preliminary designs
- Increased estimate accuracy based on actual layout
- Higher Quality Proposals

leading to …

- 10% reduction in concept development man-hours
- 90% reduction in material estimate man-hours
- 10-20% reduction in detailed design man-hours
- 5-10% reduction in total plant installed cost
- Reduction in materials requirements

SmartPlant Layout Customer Comments:

“… Strong points include compatibility with SmartPlant 3D, user-friendliness & easy to configure & learn …”

“… a good replacement for our current 3D plant layout solution …”

“… the equipment task, input definition of pipeline data, rules setup & connectivity were easy to use ”

“… no other product on the market today (is capable of) producing a FEED model from within a detailed design solution integrated to process & cost estimating tools …”
Summary & Close
SmartPlant Layout is a new, standalone solution for conceptual 3D plant layout & design for use by the EPC OR the Plant Owner!

Preliminary 3D plant layout benefits are well documented compared to manual methods …
- Significant modeling/ layout productivity
- Data integration,
- Layout optimization
- Conceptual layout quality improvements

When integrated with SmartPlant 3D & SmartPlant P&ID …

SmartPlant Layout delivers further incremental benefits to your projects …
- Conceptual/ preliminary designs seamlessly evolve into early detailed design phase
- Improved preliminary cost estimates
- Over 85% reduction in re-modeling man-hours during the conceptual design phase
- Over 90% reduction in model data reuse from proposal to initial detailed design phase of project
- Improved design quality
- Lower administrative burden
Process, Power and Marine Division

Integrating the Engineering Enterprise...