INDUSTRY CHALLENGES

ENGINEERING, PROCUREMENT, AND CONSTRUCTION COMPANIES (EPCs)

Projects are growing more complex. They are larger, workshared with partners, built in new and emerging economies, and use new technologies for process and controls. It is clear that non-intelligent or non-integrated design solutions will not meet the business objectives of today and tomorrow.

Engineering is a key part of the project. Decisions are made here that will affect construction, plant operations, plant safety, and associated costs. It is essential to make the right decision as early as possible in the process and drive consistency through the complete design, even if parts are designed by others in other offices.

Finding a design inconsistency during design can cost $1. If that error is found later by the checker, it will cost $10. But that same error found during construction or later can cost $1,000. This “$1-$10-$1,000 rule” illustrates the impact of making the right decision early and the power of rules-driven, relationship-based design solutions.

No engineer waits for a new operating system or new software compilers. Engineers need an engineering and design solution that helps them perform their work more efficiently, driving consistency in design and deliverables to change management, showing what changed, supporting communication with other disciplines and partners, and more.
This brings value to the design process and project execution. These capabilities are found in the Intergraph® SmartPlant® Engineering & Schematics solution. This proven and industry-driven solution meets the needs of today’s projects.

In addition, project execution deliverables have changed. It is not so much about paper drawings at the end of the project. Owners have raised the bar. They expect electronic deliverables that will help lower operational risks and costs. EPCs who want to stay competitive are choosing to step up to SmartPlant Engineering & Schematics.

**OWNER OPERATORS (O/Os)**

Owners face a variety of drivers, primarily faster time to market and revenue, lower operational risks, lower costs, and maintaining a safe process and facility. Fast-track design that incorporates owners’ and local engineering practices must be enforced during project execution, even in a multiple EPC environment. Driven by rules, specifications, and standards, SmartPlant Enterprise solutions help meet that objective.

During design, you can verify safety in terms of process safety (HAZOP, area classification), personnel safety (spacing, escape routes, training), facility safety (explosion impact simulation, fire proofing), and environmental safety (process containment, stress analyses). Designing safety in the plant from the start can help the owner reduce the risk of shutdowns, maintain a safe operational image, and save significantly on late design changes.

Finally, data created in the engineering phase can be used to operate the plant. The P&ID is the key document that forms the “roadmap” of the plant and can be used to navigate to all related data, such as instruments, equipment, inspection data, and HAZOP data. The SmartPlant Engineering & Schematics tools play a key role in operational tasks, including scheduled maintenance, inspection, safety studies, and turnarounds. SmartPlant Engineering & Schematics is a part of the SmartPlant Enterprise. It is also integrated with SmartPlant Enterprise for Owner Operators, which offers change management and other operations-critical functions.

**BUSINESS = RISK MANAGEMENT**

SmartPlant Engineering & Schematics delivers true benefits for everyone. The value proposition includes the following components:

- **Solution benefits**
  - Lay out the P&ID
  - Place components in process lines and break and re-attach the lines
  - Place and manage off-page connectors

- **Competitive advantages**
  - Rules-driven design
  - Worksharing
  - Relationship management

- **Business benefits**
  - Business goal achievement, such as improved safety, quality, and productivity
  - Returning value each time the solution is used
  - Industry value

In addition, Intergraph is on the cutting edge of technology, investing millions of dollars each year to offer innovative solutions.

Quality is as important for Intergraph as it is for you. We make significant investments in quality control, such as using automatic test procedures (ATPs), maintaining a quality center, implementing
test plans and test teams, and involving customers during product development testing procedures. All of this helps bring best-in-class and top-quality products to market.

To achieve your business drivers, integration is imperative. Individual applications can offer many benefits, but the integration of disciplines delivers even more value. SmartPlant Engineering & Schematics applications make a noticeable contribution toward your bottom line in terms of saving costs, reducing execution risks, increasing design quality, and offering tools and data to support the operational phase of the plant.

**A CHANGING INDUSTRY**

Technology is the enabler to address business needs. Creating an efficient design and plant that will operate with the fewest possible risks is important. In addition to the traditional design, you can add value during execution and to the deliverables used in operations. SmartPlant Engineering & Schematics is an integral part of that business proposition.

Intergraph recognizes that making the right decision early in the engineering design process eliminates re-work, saving time and money. Industry studies show that poor design can increase the cost of a project by 15 percent or more, with errors rippling through from the critical P&ID design phase into the piping, instrumentation, equipment, and electrical phases. The earlier relationships play a key role here. The valve “knows” where it is connected in the process and its engineering properties. So, changing any of them will trigger change warnings across the design and disciplines. That is the power of Smart Engineering.

"Much value has been lost in not bridging the gap between design, construction, operations, and maintenance. We expect value measured in multiple millions of dollars annually from the capture and broad use of the plant information asset."

Bob Donaho  
Director, Design Engineering/Design Technology  
The Dow Chemical Company
Engineering is the method that creates a plant, and technology is the enabler for the engineering team and operational team to execute their specific tasks. Each phase in the plant life cycle has its own focus and associated value propositions. For example, engineering wants to execute its tasks as quickly as possible; construction wants to ensure all materials are just-in-time; commissioning wants to see all systems verified and documented to start plant operations; and finally, operations wants to reduce production risks. You need to select a solution to address all parties’ needs, from engineering to safe and reliable plant operations. Each group has its own drivers, but in the end, the operational plant is the common goal. SmartPlant Engineering & Schematics is a task-oriented solution. The data and interface are presented to you based on your role in the life cycle, optimizing the task at hand.

**SOLUTION**

Intergraph’s Engineering & Schematics tasks fit today’s and tomorrow’s project execution and plant operational tasks and challenges, meeting engineering and design needs in the process, power, and marine industry segments. Designed with and for these industries, customer involvement in developing these solutions has been a cornerstone of Intergraph strategy for decades. The unique solution offers great value for your company and meets your business objectives by offering worksharing; task-driven, rules-driven architecture; change management; integration with upstream and downstream tasks; and interfaces with complementary partners such as ETAP, Emerson/Honeywell, ABB, Yokogawa, and Endress+Hauser.

Rules and knowledge are captured to drive the best-practice design. The solution promotes the internalization of lessons learned, while minimizing the risk of errors and the associated costs. By capturing rules and knowledge, the solution provides an efficient mechanism to ensure that the best practices are applied consistently across projects. This not only enhances the quality of the design but also improves the efficiency and productivity of the engineering team.

“The company chose SmartPlant Instrumentation because it has a complete database and update for instrumentation projects. All deliverables link with a report and an intelligent database to have better control of all information.”

Elisa Guinea Corres  
Project Manager of Operations  
Krupp Uhde Jacobs Engineering de Mexico, S.A. de C.V.
decision-making process, especially helpful with an aging workforce by enabling junior engineers to make senior decisions.

Data from one task can be leveraged to another task. For example, P&ID data is used to drive automatic HAZOP analysis creating cause-and-consequence reports based on a knowledge base. This helps users understand the risks and decide where mitigation is needed to ensure a low-risk operation.

Intergraph enables the rule-driven P&ID design of an intelligent plant asset configuration, the instrumentation engineering of the control system life cycle, safe and reliable electrical engineering systems, and safety validation with automatic HAZOP analysis. The logical design and engineering of the plant are described in terms of process, control system, and power distribution.

Engineering & Schematics applications include a variety of powerful Intergraph software solutions:

- SmartPlant Electrical Basic
- SmartPlant Electrical Detailed
- SmartPlant Explorer
- SmartPlant Import Assistant
- SmartPlant Instrumentation
- SmartPlant Isometrics
- SmartPlant P&ID
- SmartPlant P&ID Design Validation
- SmartPlant Process Safety
- SmartSketch®

DIFFERENTIATORS

Engineering & Schematics applications offer a variety of functionalities and benefits simply unmatched in the industry, including the following:

- **Intelligent plant assets** – Create and maintain connectivity for all plant items, such as valves, vessels, and lines, which hold knowledge based on their engineering data.
- **Automation** – Compress schedules with fewer iterations because you can automate some design tasks and take advantage of best practices with customizations.
- **Deliverables** – Automatically create deliverables consistent with the true representation of the design data.
- **Validation** – Check and flag the engineering content consistency and compliance to engineering practices and standards in your design, both pre-HAZOP and during design.
- **Integration** – Share relevant data once across all tasks. Display sets are based on data, and the open solutions include a delivered API.
- **Data management** – Manage the revision, notification, and distribution of engineering and workflows, improving safety management and risk mitigation.
- **Market-leading solutions** – Rely on the worldwide market-leading solutions currently in use in both small and large projects, delivered by a company with more than 40 years of experience.
- **Partner in project execution and plant operations** – Take advantage of Intergraph’s approach to work closely with customers, offering services and support in 60 countries, supplied by engineering professionals with thousands of hours of experience.
THE SOLUTION: ENGINEERING & SCHEMATICS

Intergraph’s Engineering & Schematics applications break down the discipline silos in your organization with an integrated solution. Each task, such as SmartPlant P&ID, offers a step change in engineering and design, and dramatic benefits. When used in the SmartPlant Enterprise environment, the equation 1+1 = 3 becomes a reality. Much greater value is generated when information flows between the tasks, changes are managed, and engineers are notified if changes are made in associated tasks. Management processes are enhanced with tools such as a to-do list.

To execute projects more quickly, ensure design consistency, and implement best practices for constructability and operability, you rely on your best, most experienced engineers who have performed many of these types of projects in the past. With a younger workforce, some of this experience is leaving the industry.

Our Engineering & Schematics applications can capture this experience in the rules to ensure your complete design and safety analysis in the most efficient way, providing the highest design quality based on your company’s years of experience. At the same time, the tools offer fast and easy modification to enable innovation and adjustments based on new technologies.

Plant safety is a key element, and strictly enforced by regulations. SmartPlant Process Safety enables you to automate design analysis to ensure the design is sound. In case process conditions change or equipment fails, the plant returns to a safe state thanks to protective devices, for example.

Engineers and designers can essentially validate the design as it evolves. This produces more error-free design, minimizing costly modifications during construction and lowering the risk of incidents sometimes caused by poorly documented on-site changes. Additionally, SmartPlant Process Safety can assist in conducting more efficient explosion impact studies and area classifications.

Intergraph solutions can also dramatically reduce the time it takes to perform HAZOP analyses through automation. Time savings enable more frequent studies at a lower cost while increasing consistency and auditability, as well as producing cause-and-consequence reports that allow engineers to make faster and more accurate risk mitigation decisions.

SmartPlant Explorer is your solution for viewing, querying, and reporting on data generated by Engineering & Schematics applications via the Web. SmartPlant Explorer turns design data into usable information that fits your needs. The software provides a “common user experience” for all supported applications, enabling you to navigate through and report on SmartPlant P&IDs, SmartPlant Instrumentation data, SmartPlant Electrical data, and PDS 3D model information. This promotes easy, live data access. Benefit from a role-based process.
SmartPlant P&ID provides data that is more accessible and consistent. This saves us time in both engineering tasks and material procurement. SmartPlant P&ID was selected because it gives data intelligence to pipe and instrumentation diagrams, and uses that intelligence to leverage the accessibility of the data to other specialties. It also enables our process engineers to work directly in final designs.

Miguel Villalobos
Information Technology Manager
Tecnoconsult
## BEST PRACTICES

### VALUE PROPOSITION: REDUCE RISK OF DESIGN CHANGES DUE TO SAFETY STANDARDS

#### Solution Benefits
- Create layout with process/electrical/instrumentation
- Assign area classification
- Report on equipment

#### Competitive Advantages
- Manage change
- Automate placement and connection
- Validate against P&ID

#### Business Benefits
- Identify conflicts during design using rules
- Maintain relationships between process area, equipment, and classifications during design modifications

### BASE PROJECT/SCOPE
- 500 P&IDs
- 2,000 equipment items
- 15,000 instruments
- 700 electrical loads/panels-switches
- 50 GAs

### USERS
- Design labor cost $60/hour
- Engineering labor cost $100/hour
- Checker labor cost $80/hour

### RETURN ON INVESTMENT

#### Key Drivers
- Optimize equipment cost and reduce checking – save $2,000,000
- Cycle – avoid $128,000 in costs
- Late design changes – avoid $181,000 in costs

Total $2,309,000 savings

### COSTS
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<tr>
<th>Description</th>
<th>Cost</th>
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<tr>
<td>Solution cost</td>
<td>$600,000 (maintenance $120,000)</td>
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<td>Implementation cost</td>
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### QUANTITATIVE/TANGIBLE BENEFITS
<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>Savings in first year</td>
<td>$1,529,000</td>
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<tr>
<td>Savings in following years/projects</td>
<td>$2,189,000</td>
</tr>
</tbody>
</table>

### QUALITATIVE/INTANGIBLE BENEFITS
- No late changes
- Better communication between the disciplines, electrical/process/instrumentation
- Schedule impact

#### SOLUTION COMPOSITION
- 10 Smart 3D
- 4 SmartPlant P&ID
- 15 SmartPlant Instrumentation
- 10 SmartPlant Electrical Basic and Detailed

Example calculation for informational purposes only.
Your actual savings may vary. Information shown is subject to change without notice and should not be considered a commitment by Intergraph.
BEST-IN-CLASS WORK PROCESS

Engineering & Schematics applications offer the opportunity to implement your best-in-class work process for project execution and plant operations. Intergraph goes beyond the CAD world of mere graphic depictions with limited data on symbols. Streamline your workflow with access to plant items and their relationships to understand change impacts, create scenarios for engineering updates, and more. SmartPlant Engineering & Schematics is a true engineering and design solution that assists you in the execution of your tasks and helps in making accurate, consistent decisions.

SmartPlant P&ID represents a completely different approach from any CAD system because the graphics represent the data. Data are primary, followed by graphics. It also supports engineering standards like KKS, PIP, and DIN.

Take advantage of unique capabilities, such as multiple projects for what-if scenarios. You can compare the what-if scenario with your original design, and consolidate them if the change is approved. Copy your existing design, and during the copy, a transmission routine can modify the original design on-the-fly. For example, change the symbology tag numbers and process data, and then the P&IDs with the newly modified design are recreated from the database. This gives you a valuable jumpstart on your new projects, boosting productivity, data consistency, and innovation.

Plant editing allows you as an engineer to edit all properties of all the P&IDs in the plant without having to open the P&IDs. Once the P&IDs are opened, the changes will be reflected in the graphics, such as labels.

This extremely powerful capability enhances productivity and enables engineers to make fast, consistent changes. And, since Intergraph supports version control, you can always compare P&IDs with earlier versions to see what has changed and roll back, if needed.

Engineering & Schematics applications streamline your plant process and configuration design with data validation, your link from safety analysis to design safety and operability in the plant.

As part of the work process, SmartPlant Instrumentation will expand your functional control system design from the P&ID through macro expansion into the physical design, offering support for new technology, such as fieldbus, and links to vendors like DCS catalogs.

SmartPlant Electrical will help create safe and reliable power distribution, taking the input from the mechanical drawings and P&IDs to interface with other vendors’ analysis products, such as ETAP to verify design. SmartPlant Electrical’s Basic and Detailed modules create all of the design and deliverables required for an electrical system, from concept to detailed design.

SmartSketch is the engineering companion to assist with conceptual designs and deliverables throughout the plant life cycle.
MEASURING THE RETURN

• Industry research reveals that an environment using Engineering & Schematics technology delivers engineering efficiency increases of up to 28 percent, and handover savings of up to 60 percent. For a $2 billion, six-million-tons-per-year capacity LNG plant project involving 700 P&IDs, 900 equipment items, 1,200 control loops, and two product trains, with engineering communications spread across three countries, total estimated savings of 19 percent using Engineering & Schematics on the project were quantified at $683,000, or 11,384 labor hours.
• Dow Chemical’s project savings estimate for the SmartPlant environment is 0.3 percent of total installed costs.

THE INTEGRATED SMARTPLANT FAMILY

Beyond standalone use, Engineering & Schematics is also part of the SmartPlant Enterprise. SmartPlant Enterprise offers best-in-class applications and a low-risk, step-wise implementation approach to realizing a truly integrated engineering enterprise. SmartPlant Enterprise includes:

• 3D Modeling & Visualization
• Analysis
• Information Management
• Engineering & Schematics
• Procurement, Fabrication & Construction
• SmartPlant Alliance Program

NEXT STEPS

Engineering & Schematics applications are fully supported by Intergraph’s global service network and can be tailored to meet your specific requirements. The solution can be up and running within weeks, including user training. In addition, we offer SmartPlant Import Assistant and data conversion services to move legacy data such as P&IDs or instrumentation data into the SmartPlant world. To discover how this solution could help your business, contact us today.
ABOUT INTERGRAPH

Intergraph is the leading global provider of engineering and geospatial software that enables customers to visualize complex data. Businesses and governments in more than 60 countries rely on Intergraph’s industry-specific software to organize vast amounts of data to make processes and infrastructure better, safer, and smarter. The company’s software and services empower customers to build and operate more efficient plants and ships, create intelligent maps, and protect critical infrastructure and millions of people around the world.

Intergraph operates through two divisions: Process, Power & Marine (PP&M) and Security, Government & Infrastructure (SG&I). Intergraph PP&M provides enterprise engineering software for the design, construction, operation, and data management of plants, ships, and offshore facilities. Intergraph SG&I provides geospatially powered solutions to the public safety and security, defense and intelligence, government, transportation, photogrammetry, and utilities and communications industries. Intergraph Government Solutions (IGS) is an independent subsidiary for SG&I’s U.S. federal and classified business.

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