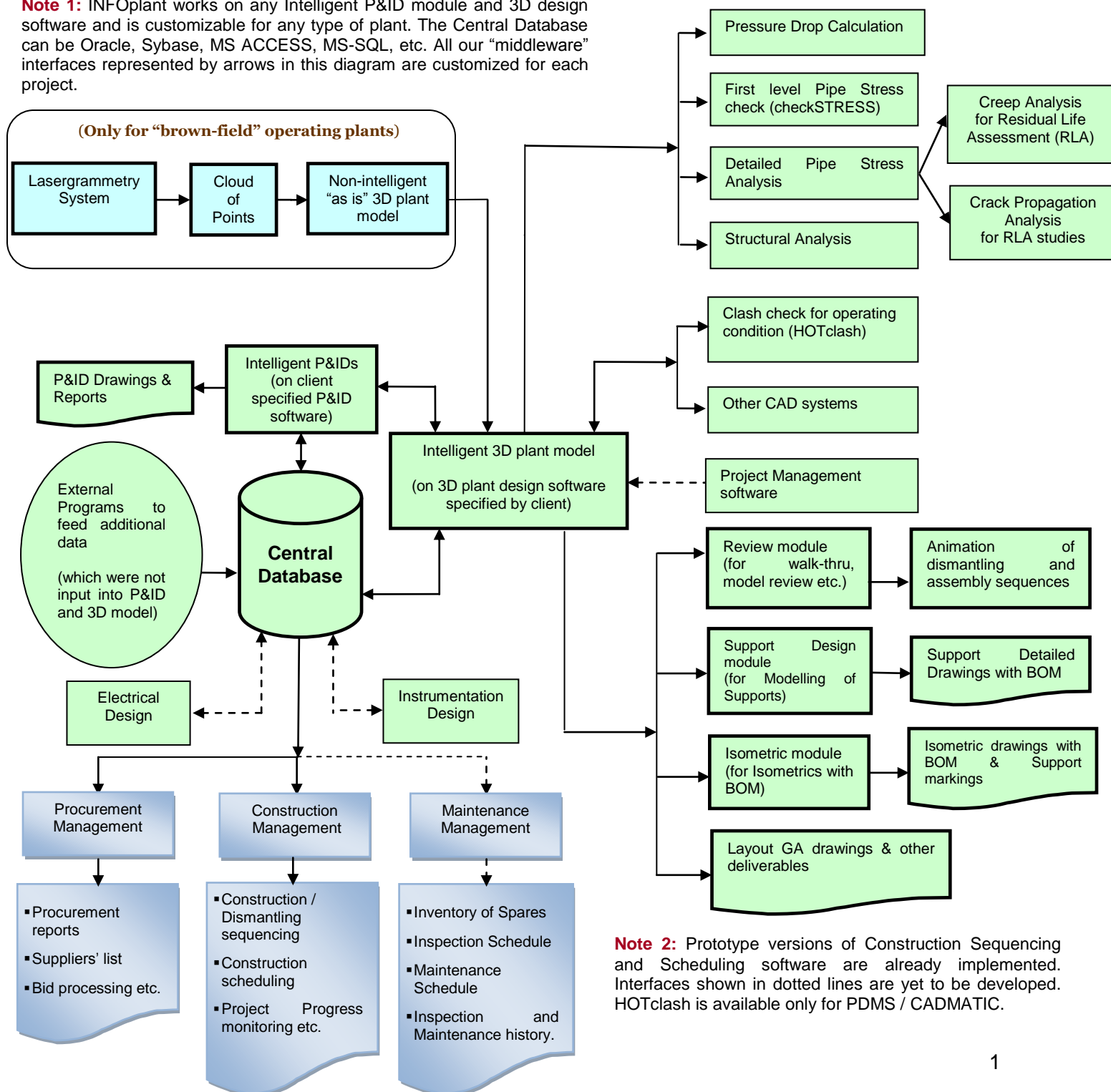# INFOplant™, Integrated Plant Information Management System

The INFOplant system schematically shown below integrates information (data, drawings and documents) related to design, engineering, procurement, construction, commissioning and other downstream activities of any industrial plant. The system consists of a Central Database and various functional software modules that are inter-connected through our "middleware" interfaces (represented by arrows) customized for each plant project. This integration allows the "intelligence" (i.e., attributes) entered at any time for any object in the plant to seamlessly flow to all downstream activities involving that object. For example, a key attribute such as "empty weight" entered for a valve while preparing an Intelligent Piping & Instrumentation Diagram (P&ID) would flow to Intelligent 3D plant model → Analyses software → Project Management tools → Drawing & Report generation modules → Procurement / Construction / Maintenance management systems, without re-entering that attribute ever again.

Note 1: INFOplant works on any Intelligent P&ID module and 3D design software and is customizable for any type of plant. The Central Database can be Oracle, Sybase, MS ACCESS, MS-SQL, etc. All our "middleware" interfaces represented by arrows in this diagram are customized for each project.

Note 2: Prototype versions of Construction Sequencing and Scheduling software are already implemented. Interfaces shown in dotted lines are yet to be developed. HOTclash is available only for PDMS / CADMATIC.

Implementation of INFOplant on Industrial Plants

The comprehensive integrated INFOplant system has already been successfully implemented on:

- A new Generic Power Station (green field), and

- An operating Petrochemical plant (brown field).

The implementation details are given below.

Intelligent P&IDs

The first step in implementing INFOplant system on any industrial plant is to develop Intelligent P&IDs for the systems involved using client-specified P&ID software.

Intelligent P&IDs for piping systems are generated using symbols and keys as well as general elements such as title, size of drawings, etc. customized as per the client's procedure. The intelligence would consist of minimum required attributes for 3D design, analysis, procurement, maintenance etc. The engineering inputs for such intelligence would be originating from process flow sheets, instrumentation schematics, equipment data sheets, valve and instrumentation specification sheets, piping material specifications, etc. In addition, the information stored with each Intelligent P&ID can be in the form of drawings and documents.

The P&ID database so generated from Intelligent P&IDs is linked to the Central Database for the entire plant / project, which, in turn, leads to numerous advantages over conventional non-intelligent P&IDs, as listed below.

Benefits for new "green-field" plants:

As project progresses, Intelligent P&ID

- Captures, organizes and updates data related to design, procurement, construction, maintenance etc.

- Provides single data entry with outputs such as Line List, Valve List, Equipment List, Instrument List, etc.

- Associates engineering data, drawings and documents to graphics.

- Checks the integrity between the Processes (captured in that Intelligent P&ID) and the Intelligent 3D Plant model at all times and helps in resolving discrepancies between them.

- Alerts layout designers about process changes.

- Generates standard AutoCAD files with built-in intelligence.

- Highlights graphically in Intelligent P&ID the equipment, valves, instruments and specialties that are placed in the 3D Plant model.

- Generates reports on items placed in Intelligent 3D Plant model in line with Intelligent P&IDs for review.

Benefits for operating "brown-field" plants:

- From Intelligent P&ID database, plant operating and maintenance (O&M) personnel could at any time rapidly retrieve attributes of equipment, nozzles, pipe lines, valves etc. For example, if a pipeline starts leaking, then the O&M personnel could immediately retrieve the Intelligent P&IDs that include this line and identify the valve(s) that should be closed to stop the leak.

- The plant O&M personnel could use Intelligent P&IDs to arrive at alternate processes in case of failure of any equipment (such as a pump), valve etc.

- Intelligent P&ID database can be extended to include customized inspection / maintenance management functions or can be linked directly to the client's in-house database systems.

- The Intelligent P&IDs will also help in any future retrofit / expansion projects.

Intelligent 3D Plant Model

The second stage in developing INFOplant system for any type of industrial plant is to develop intelligent 3D plant model for the plant. A brief methodology and benefits of developing an intelligent 3D plant model is as follows.

Methodology and Benefits for new "green-field" plants:

The client-specific 3D Plant Design software is used to develop first the conceptual layout and then the detailed 3D model for the entire plant. This 3D plant model includes

- equipment (process, ventilation, electrical and instrument and control), piping, cable tray (including cable routing) and ducting systems and their supports,
- civil & steel structures, foundations, Embedded Parts (EPs) in concrete, tunnels and trenches, platforms, staircases, ladders, railings, roads, access ways etc., and
- reserve volume for travel of mechanical handling equipment such as cranes and hoists, reserve space required for inspection, maintenance, repair etc.

As in the case of Intelligent P&IDs, the 3D design module of INFOplant can store information related to design, engineering, procurement, construction and other downstream activities against each 3D object. Such attached information can also be in the form of drawings and documents.

The intelligent 3D plant model is developed in such an integrated manner that the following benefits would accrue (over conventional 2D drafting method) during the design and detailed engineering stage.

- 3D routing of piping and ducting systems is guided by the corresponding 2D Intelligent P&IDs.

- Integration of data between various disciplines is achieved in the 3D plant model; for example, a query on a pipe support shows "to which Embedded Part (EP) on the concrete building structure that pipe support is attached". Similarly, a query on an EP lists the support attached to that EP and the corresponding pipelines carried by that support.

- All types of clashes encountered in the virtual 3D plant model are removed at the time of layout engineering, thereby eliminating costly rework at plant site. Even clashes that may arise during plant operation (due to thermal expansion of pipes) are removed during layout stage using our "HOTclash" software; this feature of removal of "hot" clashes is available only if the 3D plant model had been built using either PDMS or CADMATIC 3D software.

- First-level pipe stress check is carried out by piping designers using our checkSTRESS software while routing piping in 3D plant model, resulting in
    - code-compliant layouts,
    - reasonably correct selection and location of pipe supports, and
    - significant reduction in layout iterations between piping design and pipe stress departments, which, in turn, saves project execution time and costs.

- The customized "middleware" interfaces supplied with INFOplant system are then used to expeditiously complete detailed analyses. The interfaces electronically transfer 3D piping and steel layouts from the 3D plant model to piping flow analysis, pipe stress analysis and structural analysis software respectively, saving substantial engineering man-hours and eliminating errors introduced during manual entry of data.

- The 3D plant model is reviewed to ensure the operability and maintainability requirements are met.

- Customized construction drawings generated from clash-free 3D plant model are accurate and revisions to these drawings are less likely during construction. Such construction drawings include:
    - GA drawings for equipment, structures, piping, cable tray and ducting systems,
    - Piping isometrics and spool drawings,
    - Location drawings for penetration, embedded parts, foundations etc., and
    - Detail drawings for supports to piping, ducting and cable trays.

- Customized Bills of Quantities (BOQ) generated from clash-free 3D plant model are accurate and changes in BOQ are less likely during construction.

  Such customized procurement reports include:
    - BOQ for piping, cable tray and ducting systems and their supports,
    - BOQ for steel structures, and
    - Schedules for Insulation, Supports, Penetrations, EPs etc.

Methodology and Benefits for operating "brown-field" plants:

For an operating "brown-field" plant, the 3D plant model is built using point cloud data captured by 3D laser scanning instruments installed at various locations of the operating plant. Intelligence related to design, engineering, procurement, construction and other downstream activities (including Residual Life Assessment RLA) could be then added to each object in the 3D plant model.

Since the Intelligent P&IDs generated for the operating plant are linked to the Intelligent 3D plant model, the discrepancies between the 3D plant model database and the P&ID database can be identified and corrected.

Additional Benefits for new "green-field" plants and operating "brown-field" plants:

The following are the additional benefits that would accrue from INFOplant system.

- By way of an interface with project management software, the 3D plant model with attached documents can be used for monitoring works during initial construction / retrofit / expansion / shut down of the plant.

- Construction sequences can be identified in the 3D virtual plant in advance, thereby significantly reducing the construction time and costs.

- Construction scheduling can be dynamically decided based on the then inventory of available materials, leading to "just-in-time" procurement activities. Similarly, dismantling sequences and scheduling can be worked out using the virtual 3D plant model.

  For example, the Construction Scheduling module of INFOplant identifies the systems / structures in the 3D plant model that could be currently built with the materials available in the stores as well as with materials arriving shortly from vendors.

  This software can also identify the missing parts (i.e., parts that are presently not available in the stores) that are required to complete the construction of respective systems, so that the procurement department can take the necessary action to obtain those missing parts from vendors.

- Project progress stages in terms of constructed area, under construction, under procurement, under testing and under design can be visualized.

- Intelligent 3D plant model updated to the "as-built" status and then continually updated to the "as-is operating" status helps in training operating and maintenance personnel. It is also helpful in performing safety studies and in rapidly deciding emergency response by accessing data instantaneously.

- This 3D model can be further utilized during plant maintenance to record and query maintenance procedures, schedules, history, spare part list, spare part suppliers, inventory list etc., by either adding custom-made modules to our INFOplant system to perform these functions or interfacing with the client's in-house or third party maintenance management software system.

- Connecting INFOplant database with real time data acquisition system permits remote monitoring of equipment condition leading to timely preventive maintenance. Reduced shutdown period for maintenance results in increased plant productivity.

- Management can rapidly retrieve information related to operations, inspections, maintenance, etc. from the INFOplant system.

  In effect, the comprehensive 2D-3D INFOplant system would serve through the entire plant life cycle, i.e. commencing from Design & Engineering phase through Procurement & Construction phase to Operation & Maintenance phase and in Decommissioning.