



Order Sequencing and Slotting

i2 Order Sequencing and Slotting™ (OS&S) is a powerful solution that improves order-to-delivery processes for discrete manufacturing of highly configurable products such as automobiles and industrial equipment. i2 OS&S supports two distinct order slotting and sequencing workflows and models, which can be integrated to meet medium-term factory objectives with near-term shop-floor metrics in a closed-loop “plan-do-check-act” workflow. The order slotting workflow creates a “bucketized” schedule of orders, while respecting production constraints such as capacities, option-based priorities, and resource choices. The order sequencing workflow creates optimal schedules, while considering detailed sequencing and production rules, and business rules such as customer priorities and due date compliance.

The solution supports diverse optimization strategies in automotive and industrial equipment sectors through built-in optimizers and operating constraints. It also provides an easy-to-use and powerful manual scheduling capability through bidirectional what-if scenario analysis and drag-and-drop scheduling. In a multi-stage automotive environment, i2 OS&S can support schedule coordination between final assembly and the paint shop, while providing flexibility (work-in-process between stages) to account for their individual production constraints. As a key component of i2’s factory management solution, i2 OS&S enables companies to strategize, plan, and execute their production processes across multiple facilities for profitable production. The solution can be seamlessly integrated into other supply chain management processes through the i2 platform, enabling an enterprise to continuously adapt to changes in the supply chain.

i2 OS&S enables companies to:

- Provide schedule stability to assembly and upstream operations
- Improve the order-to-delivery process by enabling a demand-driven production environment
- Provide global visibility of assembly line constraints with an emphasis on problem areas
- Resolve problems quickly to keep production running efficiently
- Create medium and short-term schedules at different levels of granularity
- Create a detailed feasible sequence of vehicles in their assembly plants/lines in the near term
- Provide an out-of-the box constraint library for quick time-to-value implementations

- North American OEMs currently use i2 OS&S to optimize assembly lines for more than 5 million vehicles across more than 50 assembly plants on an annual basis
- 6 out of the 10 major industrial and heavy equipment manufacturers optimize their assembly sequencing process using i2 OS&S
- Major Korean and emerging market OEMs optimize the creation of their production plans and master schedules



Supported Hardware and Software Platforms

Web Client Browser

- Windows XP
- Windows Vista

Browser

- MS Internet Explorer 7.0 or 8.0 Optimization Environment and Server Infrastructure
- Windows 2003 x64 edition
- Solaris 10
- AIX 5.3

Databases

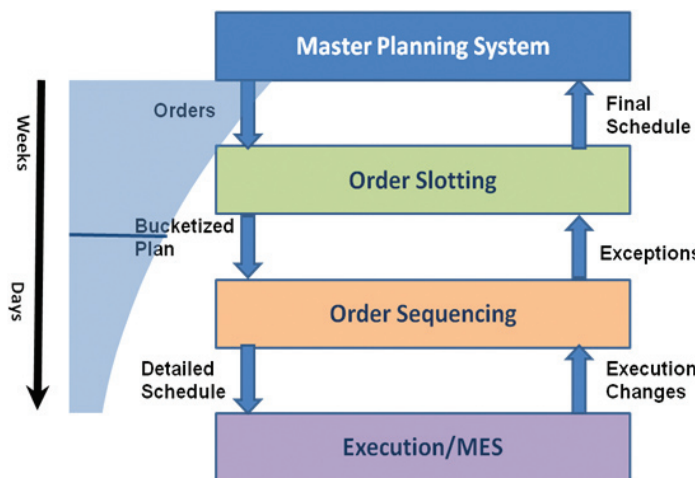
- Oracle 11gR1 - 11.1.0.6.0 supported on all platforms
- DB2 9 Viper 2 9.5 supported only on AIX platform

Business Benefits

Improved Order to Delivery

For highly configurable products such as automobiles, each order can have a different combination of options. These variations affect the efficiency of an assembly line since each order can be potentially different from the next one. This is especially true given the challenges of today's business environment where there is a push toward improved order-to-delivery processes (Figure 1). i2 OS&S can represent and work with different options for each order—enabling companies to have fewer late orders, shorter lead times, and increased customer satisfaction. i2 OS&S creates optimal schedules that take into consideration due dates and customer priorities, while allowing for option-based restrictions (e.g., only manufacturing two air-conditioned cars in a row, or only producing two cars with GPS in a sequence of five cars, etc.). As a result, i2 OS&S enables a customer's needs to drive production, improving customer focus. Additionally, i2 OS&S can be run within minutes to rapidly re-sequence customer orders, thus reducing overall order-to-delivery lead times through allowing customers to move toward daily sequencing.

Figure 1
Factory scheduling solution
using i2 OS&S



Lean Manufacturing and Supply Stability

In lean environments where material stability is required for suppliers, i2 OS&S can be used to provide level sequences and schedules. It can be used as Heijunka or Pacemaker for creating a level assembly schedule. i2 OS&S is also applicable in environments moving toward Supplier Inline Vehicle Sequencing because it can provide a feasible sequence for suppliers to follow. Lean manufacturing at the supplier side and customer response at the demand side are often conflicting objectives that must be addressed simultaneously. With

proven capabilities in the automotive and industrial environments, i2 OS&S can handle each order differently and generate schedules that accommodate production constraints based on the options and combination of options—enabling the manufacturer to have minimal finished goods and work-in-process inventory, reducing total inventory carrying cost.

Improved Production Efficiency

i2 OS&S considers production constraints such as capacity constraints, availability of parts, resource requirements, and attribute- and option-based constraints while creating a schedule—which results in increased throughput, reduced overtime, and improved schedule compliance. While creating optimal schedules, order sequencing takes into consideration multiple production constraints such as changeover, skip, X in Y, scatter, minimum run, maximum run, and daily capacity.

In the automotive industry, there is a paint purge problem, where the changeover of the paint tool results in fixed costs to the company as well as environmental costs. EPA regulations dictate the extent to which paint purges can happen within a day. i2 OS&S can help minimize paint purge rates by grouping similar orders to reduce the number of changeovers, while meeting other production constraints such as volume goals of individual colors, option smoothing, etc. i2 OS&S can also generate a paint shop sequence to help improve adherence to the final assembly sequence in a multi-stage assembly environment.

Ease of Creating and Manipulating Schedules

Creating schedules manually can be time-consuming and often requires many man-hours of effort, leaving little time for testing different scenarios. i2 OS&S provides optimal schedules quickly using patented genetic algorithms, while simultaneously taking into account all the constraints imposed on the system. Once the schedule is generated, the user also has the ability to modify the schedule manually using the solution's intuitive visualization capabilities, which include drag-and-drop orders, what-if analysis and reverse what-if analysis. This enables the scheduler to modify rules and test different scenarios and respond to any changes that occur on the shop floor.

Key Features

Rich Representation of Constraints

Hard constraints represent rules that determine whether a schedule is feasible or not, while soft constraints have penalties associated with the violation. A violation of a soft constraint results in a feasible but undesirable schedule. Since the optimizer never violates a hard constraint and tries to minimize the total amount of penalties due to soft constraint violations, it always creates feasible schedules, while working on generating an optimal schedule.

Figure 2
i2 OS&S dashboard with different metrics

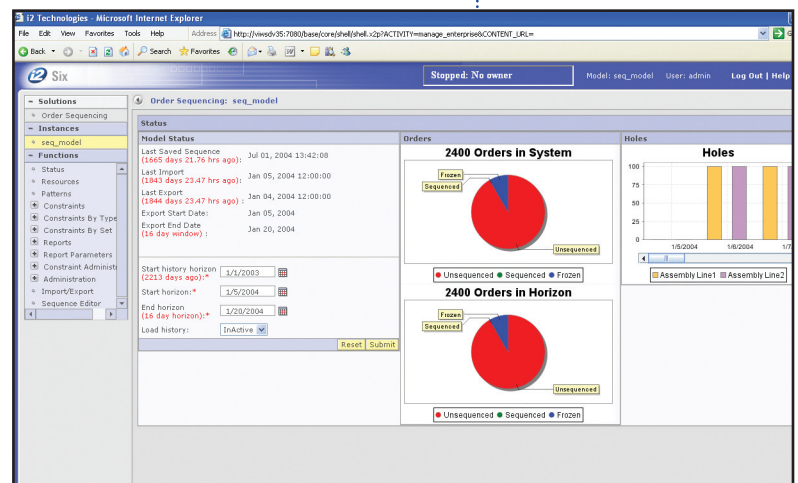
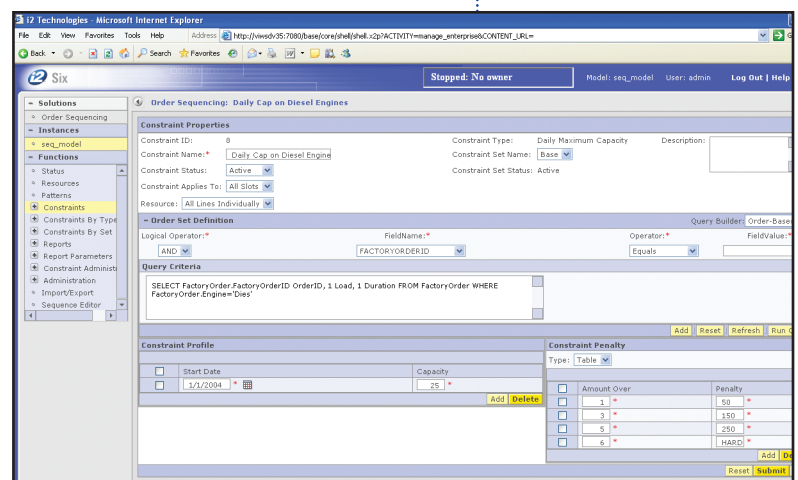


Figure 3
Example of an i2 OS&S constraint



Some features are as follows:

- Intelligent trade-off between due date compliance and customer priority
- Constraints can be grouped together as constraint sets, and constraint sets can be copied to another constraint set in order to create scenarios around constraints
- Capacity constraints can be modeled at a slot, daily, weekly or monthly levels
- Real-world scenarios can be modeled such as limiting the number of changeovers in a paint shop, while simultaneously ensuring that the percent of daily capacity of different colors is met
- Group constraint ensures that orders with the same final destination are scheduled together — resulting in significant transportation cost savings
- Parts constraint ensures that orders are not scheduled if parts are not available, and can be used to let the scheduler know of any part shortages when scheduling a task
- Constraints can be applied to all the slots or a portion of slots using sub-schedules, and can be used for merging or diverging assembly lines
- A paint shop sequence can be created based on final assembly restrictions through use of slack policy constraints
- Grouping and leveling of painted bodies within the final assembly sequence can improve paint shop sequencing

Flexible Schedule Generation

- The fast and scalable genetic algorithm optimizer considers all the constraints in the system simultaneously, and has the ability to plug in custom optimizers if needed
- Constraint violations are represented in colors for quick visual feedback
- Manual drag-and-drop scheduling facilitates scheduler override
- Scheduling user interface updates the system status as schedules or constraints change
- What-if capability finds the best order to fill an empty slot in a sequence, and places a high priority order in the best available slot

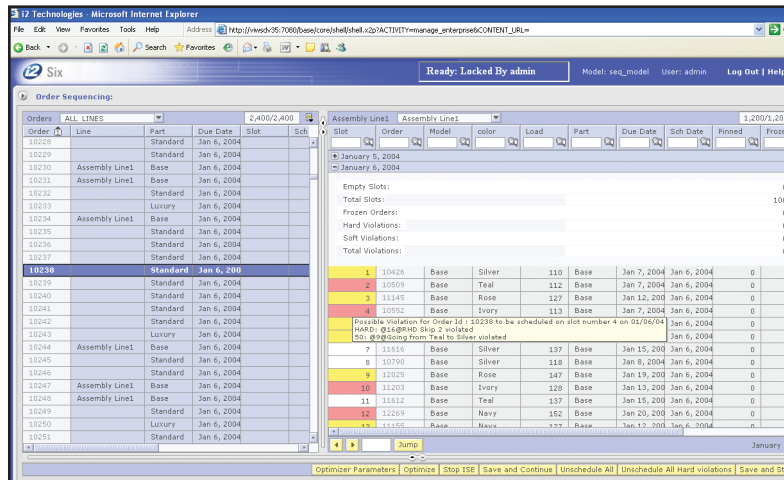


Figure 4
i2 OS&S provides powerful visual feedback for manual scheduling

Configurable User Interface and Workflows

- i2 OS&S is built on the i2 Platform, which enables easy extensibility and customizability of the user interface and workflows
- One single install and data model for medium-term capacity planning through order slotting and detailed sequence generation through order sequencing
- Easily integrates with other i2 supply chain management solution processes
- Architected for centralized deployment at corporate data center in a multi-factory environment

Reporting

- Role-based dashboard with different schedule quality KPIs
- In-memory reports, including schedule quality summary by day, constraint violations, and constraint target misses for different spacing constraints
- Ability to quickly add customer-specific reports using i2 Studio

For more information on i2 Order Sequencing and Slotting and other i2 solutions, visit www.i2.com.



The Supply Chain Company®

11701 Luna Road
Dallas, Texas 75234, USA
Phone 1.877.926.9286
Email info@i2.com
Web www.i2.com