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SDI SUPPLY CHAIN BUILDER: SIMULATION FROM ATOMS TO THE ENTERPRISE

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ABSTRACT

The SDI Supply Chain Builder Product Suite is a high-level simulation toolset that provides solutions to enterprise problems. The product suite contains four specific elements for enterprise modeling: SDI Supply Chain Builder for supply/distribution chains, SDI Plant Builder for multi-stage plants driven by schedules, Extend+Industry for high-speed, high-volume production line modeling, and the SDI DataFramework for high-speed data import and export. These elements can be expanded for use in modeling of smaller projects such as a single packaging line to large-scale projects such as a worldwide supply chain.

1 INTRODUCTION

SDI Supply Chain Builder is a simulation platform for understanding complex supply chains through studying the impact of changing demand, logistic decisions, and production policies on key performance measures. It is used to model demand patterns, ordering policies, forecast, physical configuration of suppliers and customers, and trucking and routing policy. Included in the package is SDI Plant Builder for drop-in plant models; and Extend+Industry, which provides the capability to use general-purpose constructs in supply chain models.

Primary model building is done through templates and Supply Chain Builder's DataFramework, which is used to describe products, demand, locations, sourcing, and policy. Using the SDI DataFramework, the basic supply chain blocks are easily scaled to represent large numbers of products and/or locations.

Critical resources such as containers, trucks, ships, or other entities are treated as items with their own inventories and logistic rules. The hierarchical shipment structure allows for any number of items to be contained within one another. In addition, resources and materials can be shipped according to highly flexible routings, which are defined in the database.

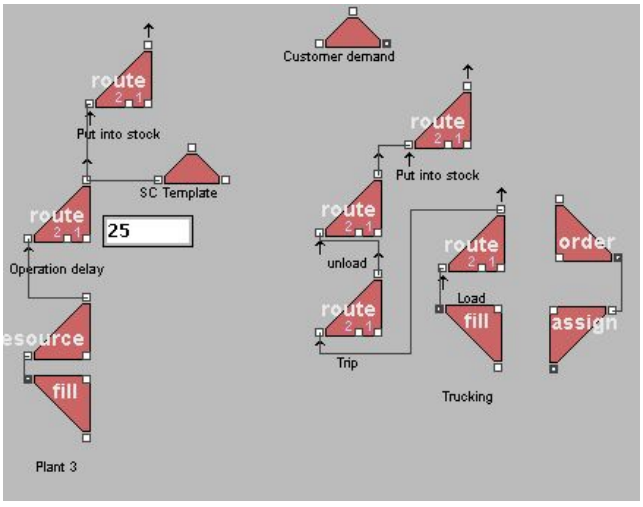

Figure 1: Portion of a Simple Supply Chain Model

Blocks in Supply Chain Builder's library allow progressive development. With the Supply Chain blocks inventory levels, unassigned and assigned orders, and shipments can be passed between block connectors. The user can easily link supply nodes to the raw materials of SDI Plant Builder plant models, and plant finished goods inventory can be linked to downstream distribution nodes.

The ability to "drop-in" a production plant model into the Supply Chain Builder model produces valuable information about how improvements can be made to both. The results of running the two models in an integrated overall model can be significantly different than running the models separately.

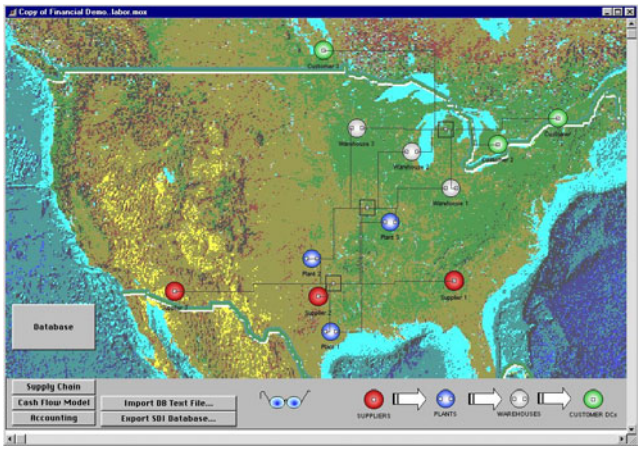

Figure 2: Top Level of a Complex Supply Chain

2 SDI PLANT BUILDER: SIMULATE MULTI-STAGE PLANTS DRIVEN BY SCHEDULES

SDI Plant Builder™ is a high-level tool for building models of entire plants. It provides pre-built templates of blocks and data, and it manages all standard issues in a plant such as scheduling, distribution, and line coordination.

Models are built using templates comprised of hierarchical levels, and the models naturally include the detail of how campaigns of material are scheduled and coordinated, even through multi-stage production departments.

Benefits of SDI Plant Builder include rapid model building using pre-built templates, realistic simulation of schedules within plants, simulation of the schedule generation process, as well as open code and development capability.

The suite of tools in this package focuses on frameworks for building entire plants or warehouses, schedule definition, managing material flow from one end of a plant to the other, and advanced resource definition.

The templates are comprised of the standard **major** elements of a multi-stage plant. In such a plant, we find the following:

1. A warehouse of raw materials and finished goods inventories;
2. A scheduling department;
3. A stage of multiple production systems (e.g. mixing);
4. Distribution bins followed by a stage of production systems (e.g. packing); followed by distribution bins, etc. (for more stages).

Plant Builder provides templates for modeling all of the above. The warehouse (1) is modeled via a Warehouse library, which allows you to model the reordering of materials for the warehouse from the plant and use the information derived from the model to drive the production planning and scheduling processes for the plant.

The scheduling department is modeled via the Schedule Builder library, which allows you to apply a variety of scheduling scenarios to your plant simulation model. The variations in throughput allow you to determine the most effective scheduling approach for your particular system.

The stages of production systems (3) are modeled by multiple **system** templates. For example, a stage of four mixers is represented by four system templates. The system template itself is comprised of hierarchical templates. Inside a system template is an operations template, which in turn contains equipment templates.

The systems level reads the production schedule and shift schedules, and controls the operation startup and shut down sequence for the operations contained within.

The operations level coordinates with production schedules and changeovers. The model database provides operation performance parameters.

The equipment level models process fundamentals such as storing, conveying, splitting and joining streams of product. Specific equipment behavior is built from these components combined with control elements such as failure and repair modules and batch cycle controllers.

In many plant configurations, there are groups of bins (4) between production systems. Sometimes referred to as in-process inventory, these areas can be viewed as product tank farms. SDI Plant builder includes an H-block template and controllers for easily modeling these tank farms, in what it calls a Distribution System.

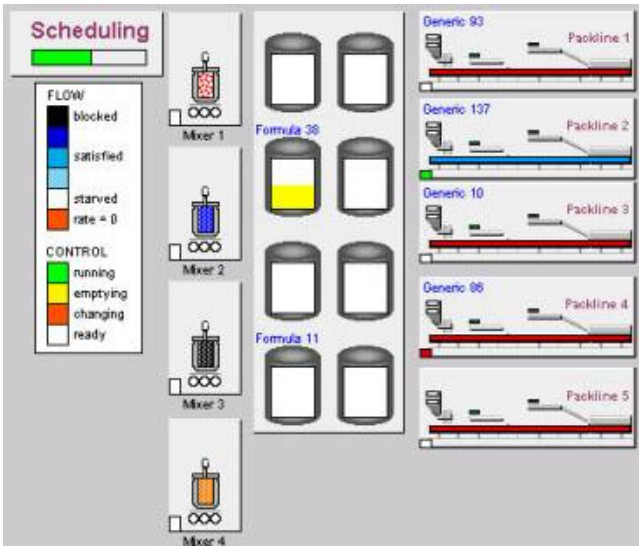

Figure 3: Multi-Stage Plant With Embedded Finite Capacity Scheduler

3 SDI INDUSTRY: GENERAL PURPOSE SIMULATION WITH UNPARALLELED FLEXIBILITY

Extend+Industry™ adds to Extend a data management system and blocks which enable extraordinary detail and range in modeling industrial processes. Foremost in Industry is a complete data management system built for simulation modelers.

Extend+Industry is a true "general-purpose" simulation platform, with no limits to what can be modeled. It provides the following:

1. A customizable, easy-to-use visual environment, which promotes understanding through full visibility of logic and dynamics,
2. A wide breadth to what can be modeled, through robust building blocks conforming to both discrete-event and non-traditional paradigms,
3. A complete system for managing simulation model data,
4. Extreme flexibility and low-level modeling through open source, a true language, a built-in compiler and debugger, DLLs, and OLE,
5. High-level modeling through templates, reusable hierarchical blocks (unlimited nested sub-models) and a well-evolved market of add-ons to support specific problem classes.

By separating your data from your model, the system improves your ability to include detail, implement scenarios, perform analyses, and manage your simulation project. An included Excel Add-In supports transforming Excel into a model interface.

Also in Industry is a system of "Discrete Rate" blocks, which expand the range of what can be modeled (e.g., high-speed/high-volume), by treating material as rates of flow. The Flow blocks in SDI Industry are a general break-through in the way that material is represented in simulation models. For representing high-volume or high-speed production (e.g., processing or packaging), or where there is the ability to view material flow in terms of rates (e.g., cash flow, document processing, facilities planning), the Discrete Rate flow blocks are a natural fit. An example application of Flow blocks is in simulating the flow of materials through complete cereal plants, from batch and continuous processing operations through high-speed packaging lines.

The Discrete Rate technology employed by Flow blocks reduces the events in a model to only those that cause rate changes. Models using Flow have been shown to increase execution speeds by 100 times. Flow blocks ensure that changes in the potential rates in a network automatically propagate to other blocks on a "need to know" basis. Thus it is possible to build arbitrary networks of Flow, with complex controls, and account for material flow and ensure mass balance. Flow blocks use this information to animate using a color scheme, which dynamically presents whether they are satisfied, blocked, or starved as the model runs.

Discrete rate Flow has been applied in a Call Center model, resulting in fantastic acceleration of execution. Flow has also been used to model the long-range planning of nuclear waste systems, where waste streams, facility learning curves, and processing capabilities are best viewed as rates that adjust over long periods of time.

4 SDI DATAFRAMEWORK: MANAGE VAST AMOUNTS OF DATA

SDI's DataFramework adds the capabilities of a general-purpose embedded database to Extend. The data management system is designed specifically for simulation projects. By separating model data from the model itself, the system enables better project and experiment management, as well as more powerful model constructs. Figure 4 below shows a typical SDI database table reflecting the changeover times required when changing production from one ice cream flavor to another.

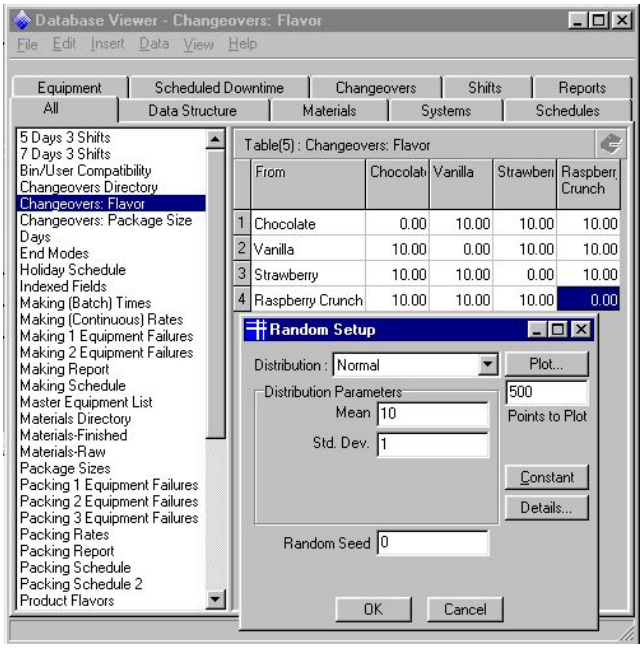

Figure 4: Typical SDI Database Table

The DataFramework also allows for flexibility in creating, viewing and manipulating the data through the centralized management of data. Because the database is unconcerned about whether there are 10 products or 10,000, it eliminates concern about the ability to handle detail or to scale the model. Use of the database also yields substantial benefits in simulation project management. Database-

aware blocks can create tables as the model runs, aiding in reporting capability.

5 CONCLUSIONS

Simulation Dynamics has delivered powerful solutions to customers in a wide spectrum of challenging simulation modeling projects for 10 years. The tool of choice for ultimate usability and flexibility has been the Extend simulation platform.

The block architecture and development system has inspired Simulation Dynamics to evolve the state of the art in modular model building, and to refine the system of blocks for addressing classes of problems in a general and flexible way. The SDI Industry Product Suite provides tools that allow rapid modeling of systems, from simple lines to plants and entire enterprises. For enterprise modeling, the tools can be used to assemble vertical model architectures that have varied degrees of detail as necessitated by the problem.

SDI Industry's suite of tools has significant problem-solving potential, and they can be exploited by practitioners of simulation at any level of interest or proficiency.

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