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QUEST — QUEUEING EVENT SIMULATION TOOL

Joseph Hugan

Deneb Robotics, Inc.
3285 Lapeer Road West
Auburn Hills, MI 48321-4687, U.S.A.

ABSTRACT

QUEST® is a 3D general purpose simulator that uses physical and logical relationships to rapidly model everything from complex manufacturing systems to business process re-engineering (BPR) opportunities. QUEST's flexible, tightly integrated environment allows users to create a single interface where they can build, run, and analyze their systems using familiar terminology and customized output.

This tutorial covers the main features of QUEST and its model building approach. An example model will be built to demonstrate the discussed features. The integration of QUEST with other Deneb products will also be discussed.

1 QUEST SOFTWARE

QUEST allows users to take either a physical or conceptual approach to simulation modelling. The 3D world that serves as the basis for every model can import scaled CAD drawings from many different packages or merely be used as a 3D white board for conceptual modelling of non-physical situations.

To facilitate rapid model building, QUEST offers a wide variety of predefined processing and routing logic that can be used "as-is" or modified by the user. QUEST also has a high level procedural language that makes the modelling of complex situations straightforward, and more importantly, reusable. Models can be executed with or without animation and changes can be made interactively during a run session. Access is provided to a full range of analysis features including multi-run analysis, confidence interval, bottleneck identification, and custom summaries for resource usage and system performance.

2 MODELLING METHODOLOGY

2.1 Menu System

QUEST's patented three-tier menu system provides a mouse-driven interface through which every function is no more than two mouse clicks away. The three tiers of buttons are conceptually referred to as contexts, pages, and actions. There are 10 contexts in QUEST shown across the top of the screen. Each context has a group of up to six pages associated with it. Under each page there are several action buttons that perform specific functions. For example, the model context has a workcell page that has a create workcell action button. These buttons are highlighted in the sample model shown in Figure 1.

2.2 CAD Interface

QUEST includes a full-function 3D CAD system that allows users to quickly create geometry to represent even the most detailed system. QUEST also has a wide range of data translators for combining geometry from many different CAD packages into the same environment. Direct translators are available for IGES, DXF, CATIA, Pro/ENGINEER, Unigraphics, Stereolithography, and STEP.

2.3 Basic Modelling Entities

QUEST models are constructed through the combination of a few basic entities. These include widgets, sources, sinks, workcells, labor, and buffers. Each of these entities has characteristics and default logic options that facilitate rapid model construction.

Sources and sinks are used to describe the arrival and departure of widgets from the model. They are used to specify inter-arrival times, lot sizes, and product mix for the system being modelled (see Figure 2).

Workcells are used to emulate any time taking activity in the system. They can require any combination of widgets and labor to perform a task. Built-in route logic is also provided to handle most common routing algorithms. Buffers are used for modelling storage areas in a model. Buffer capacity can be set and default logic is also provided to allow for LIFO, FIFO and special sorting of widgets in the buffer.

Figure 1: QUEST Menu System

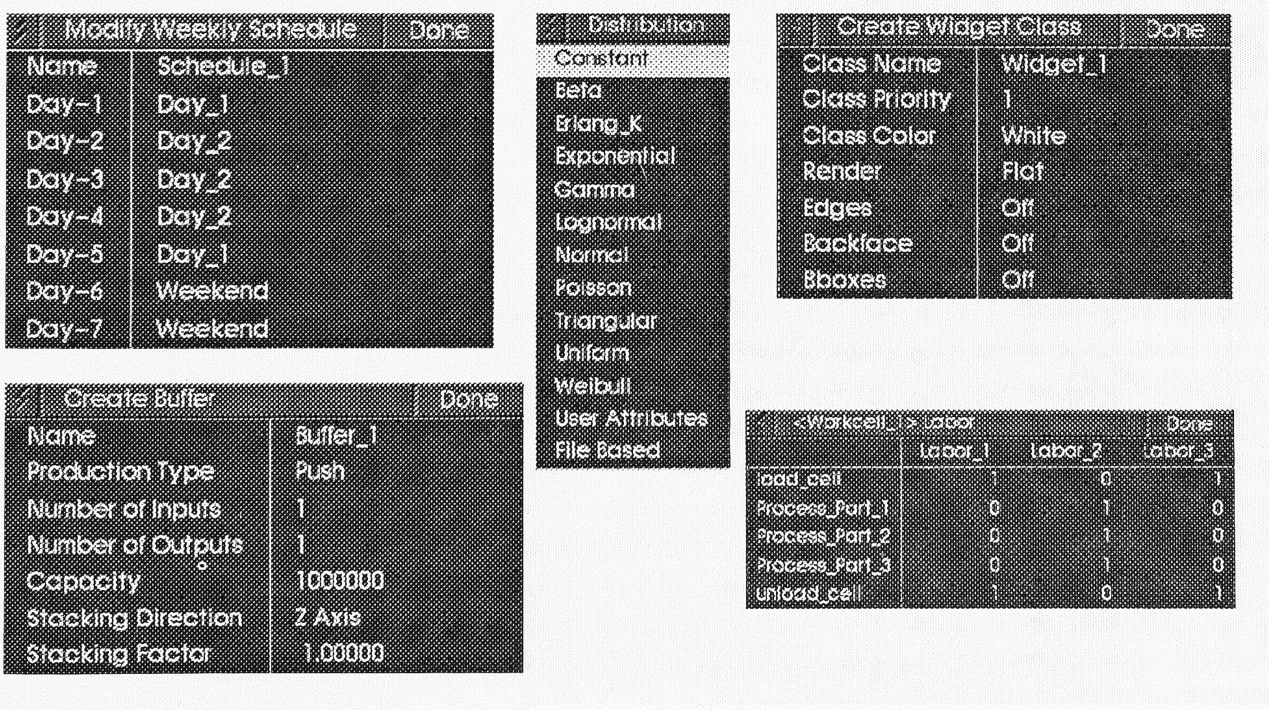

Figure 2: Model Creation Popups

2.4 Material Handling

In addition to the basic entities, QUEST provides advanced material handling constructs for modelling conveyors, power and free, Automatic Guided Vehicles (AGVs), and Automatic Storage and Retrieval Systems (AS/RS).

Each of these have unique characteristics designed to allow for the modelling of large, complex material handling systems without the loss of the natural flow of material and information. Since QUEST is based on the physical dimensions of the elements of the model, the impact of aisles, columns, beams, etc., on the storage space requirements are addressed during the modelling.

2.5 Simulation Control Language

Simulation Control Language (SCL) is QUEST's high-level procedure language that is the basis for all logical considerations made while modelling. All of the default logic for routing, processing, and queueing in QUEST has been written in SCL. The novice user simply makes selections from popups in the QUEST menu system to model the majority of common situations. An example route logic popup is shown in Figure 3.

The more experienced user has access to all of the built-in SCL logic. Unique modelling situations can be addressed naturally through the modification of these procedures. These changes can be kept in a common area for use by many users or separated based on the individual using the system. For model development, SCL has interactive tracing features and a real-time debugger.

For more advanced applications, SCL also supports the creation of user popups, the assignment of data structures, and a suite of UNIX socket commands for communication with everything from an external 'C' program to shop floor PLCs.

3 ANALYSIS

3.1 Reporting

Graphs, bar charts, pie charts, histograms, dynamic strip charts, and custom ASCII file output reports can be created through QUEST. The system automatically tracks and/or graphs resource utilization, average buffer length, widget throughput time, resource production rates, bottleneck identification based on utilization, and other key analysis statistics. Reports can be displayed on the screen and/or sent to a file for viewing at a later time. A sample output graph is shown in Figure 4.

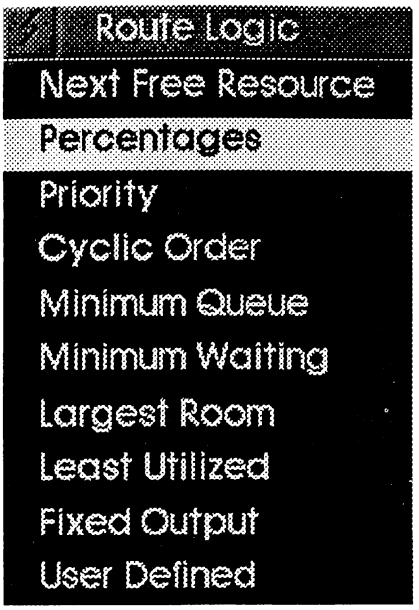

Figure 3: Route Logic Popup

3.2 Model Tracing and Debugging

QUEST also offers a wide variety of model tracing and debugging features. Users can trace events related to any entity, widget, or model. SCL code can be viewed line-by-line while it executes and animation can be updated by time interval, event time, or after every simulation event. Users can also view the event chain and query the current state of any resource, widget, attribute, or variable.

4 OTHER ANALYSIS FEATURES

As successive runs are executed during a given QUEST session, the system keeps track of all previously mentioned statistics for comparative analysis. Batch reports are automatically generated for analyzing trends. Buttons are provided for inquiring about statistical significance at a user-defined confidence level. Data sets can also be stored and retrieved for analysis at a later time. QUEST has an unlimited number of random number streams and users have the ability to change not only stream values but also seed values for any stream in the system.

QUEST also provides many interactive visual analysis tools. Status highlighting allows the user to see the state a resource is in based on its color. Users can save specifi views of the model and the viewing window can be split into up to four different views. Visually accurate conveyor

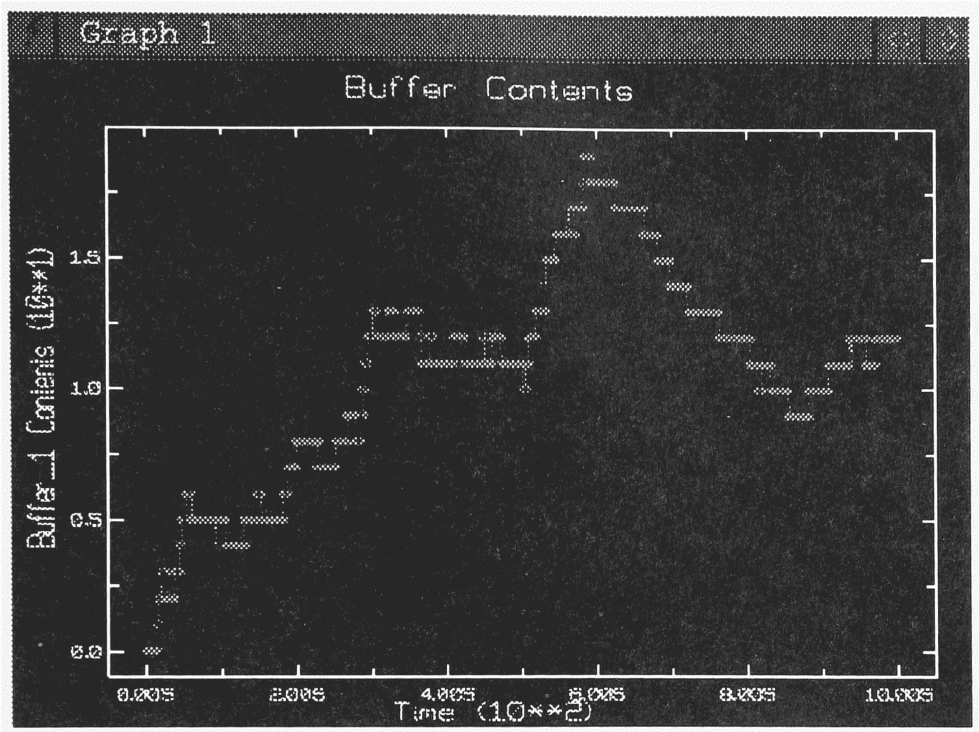

Figure 4: Output Graph

Figure 5: The Completed QUEST Model

accumulation and buffer stacking gives an exact look at the physical state of a facility at any point during a simulation. QUEST's unique incremental compilation allows for fast interactive validation of a system by forcing logical conditions to occur without recompiling or waiting for an entire program scenario to finish.

5 TUTORIAL

To demonstrate QUEST's capability, a model of a fictional office environment where papers are processed between the desks of three employees is created and simulated.

The first step is to import a CAD file of the office layout to add visual appearance of the model and give the ability to place desks in their proper location.

The second step involves creating the desks and workers. The first two work areas are represented by 3D geometry of an employee sitting at a desk, while the last work area is represented by an ergonomic model of a worker performing a task at his desk. The ergonomic model is created using Deneb/ERGO™, an option to IGRIP®, and then imported into the QUEST model.

Once the desks and workers are positioned in the 3D model, "in baskets" are created for each worker. Once a worker is done with a job/form, it moves directly to the "in basket" at the next desk.

Next, the two widget classes that represent the jobs that cross the desk of each worker are created by importing forms created in the QUEST CAD world.

The last entities that are required in the model are a source and a sink. The source defines the rate at which jobs arrive at the first desk as well as the ratio of different types of jobs that are performed. The sink serves as a termination point for all jobs that are completed at the last desk.

Once all entities/resources are created, they are connected to describe the job flow through the system. This visual connection mechanism allows complex part routing to be defined without programming.

Before running the model, cycle times are defined for each job at each desk as well as the arrival rate of jobs at the first desk. A normal distribution for the cycle times at each desk and an exponential distribution for the arrival of batches of jobs is used.

As additional cues, walls, a floor, and an analog clock are defined in the CAD world and imported into the workcell . Please see Figure 5 for the completed model.

6 SUMMARY

With QUEST, Deneb Robotics is eliminating the traditional gap between the icon-based simulators that promote ease-of-use and the language-based packages that perform well on larger, more complex systems. QUEST provides an open, flexible system that not only allows for the customization of terminology and interface appearance, but also gives the user access to a very low level of simulation detail. Users can create their own applications and modify the natural behavior of QUEST to fit the particular idiosyncrasies of their typical modelling tasks.

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AUTHOR BIOGRAPHY

JOSEPH C. HUGAN is the QUEST Product Manager at Deneb Robotics. He received his B.S. in Manufacturing Systems Engineering from GMI Engineering and Management Institute and his MBA from Wayne State University.