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AUTOSCHED™ AP BY AUTOSIMULATIONS

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ABSTRACT

AutoSched AP (ASAP) takes the best of AutoSched and combines it with the power, flexibility, and speed of a brand new C++ based simulation engine, hence the name AP, or Advanced Processing.

ASAP is a finite capacity planning and scheduling tool that helps you increase throughput, reduce in-process inventory, and increase equipment and personnel utilization. ASAP efficiently schedules all of the constraints in your factory, such as shift schedules, work setup rules, batching, preventative maintenance, machine efficiency, and operator skill classes.

ASAP's built-in task selection rules allow you to model how machines and personnel select tasks to increase factory performance. ASAP is able to model complex manufacturing processes, and then make model runs very quickly, facilitating its use for planning and scheduling of critical systems. Model output from ASAP includes extensive reports, Gantt charts, and utilization graphs.

In addition to scheduling, ASAP can be used as a planning tool for capacity analysis. Simulation technology makes it possible for you to quickly and easily consider what if questions such as, What new equipment do we need to buy for producing the new product? Simply add the new equipment to the model, rerun it, and review the results. Effects of capital acquisitions, process changes, and changing product mixes can be evaluated prior to

1 INTRODUCTION

As manufacturing companies look for ways to increase their competitiveness, many are turning to simulation modeling and scheduling to help them gain control of their facilities. There are many strategies that can lead to competitiveness, such as increasing production, meeting time commitments, utilizing resources and reducing lead time and inventory levels.

These are worthy goals; however, a factory is somewhat like a balloon, as illustrated in Figure 1. If you squeeze one section of the balloon, other sections bulge. It is easy to maximize a single goal in the factory at the expense of other goals. Goals must be coordinated so that overall factory performance is improved, not just one area's performance.

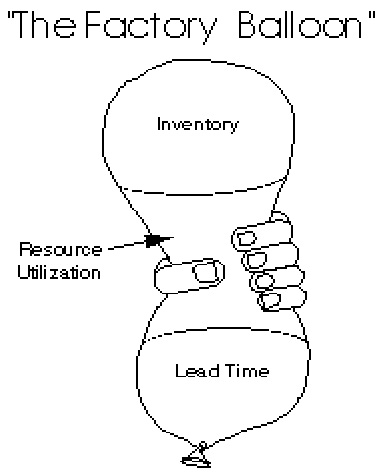

Figure 1: The Factory Balloon

The solution is to improve your factory's scheduling by prioritizing these goals and taking their dynamic interactions into account. Improving scheduling isn't easy. Most manufacturing facilities use manual methods for shop floor scheduling, which is difficult because:

- There are many combinations of schedules and resource constraints to consider. This is the single most difficult component of any scheduling problem.
- Manufacturing facilities are always changing. Unforeseen events may make previously developed schedules invalid.
- The scheduling process is time consuming. Normally, there isn't enough time to develop and test more than one schedule to see if a better one can improve performance.

Computer simulation allows you to quickly consider many alternative schedules, which makes it an excellent tool for establishing schedule performance measures. With computer simulation, you can see how scheduling alternatives affect factory performance before committing to any one approach.

2 WHY SIMULATION BASED SCHEDULING?

2.1 Analytical Models

Scheduling doesn't become a large concern until some fundamental planning decisions are made, such as: what products to manufacture, what manufacturing processes to use, what quantities of equipment and personnel to use, and how to lay out the facility.

Computer simulation has been used for over 20 years to help make these planning decisions. Simulation modeling is the creation of a logical model of a manufacturing system or facility on a computer. This is an 'analytical model' and is used for experimentation and as a tool for understanding the system.

Experimenting with a model, instead of the real system, has several benefits:

- Time can be accelerated, so long-term effects on the system can be understood
- Effects of capital acquisitions, process changes, and scheduling rule changes can be evaluated before committing to them.

Experimentation with the actual system is not always possible, and when it is, it can be costly and disruptive.

Many simulation models can be classified as 'throw-away' models. Throw-away models are analytical models that are put on the shelf after they have been used for making specific planning decisions. They are used for design and analysis of the facility, not for the operation and control.

2.2 Operational Models

Simulation-based scheduling takes the analytical model and expands its accuracy, degree of detail, and usefulness. Models used for scheduling and control are called 'operational models.' The accuracy of the operational model is verified by comparing the model's predictions of factory performance with actual factory performance. Evaluating and adjusting parameters, such as time standards for setup and processing and local operating rules calibrate the model. In this way, you can be confident that the simulation model processes accurate results.

Much of the data required to create and run an operational model normally exists in databases for Material Requirements Planning (MRP), Shop Floor Control Systems (SFC) and Manufacturing Execution Systems (MES). Data integration is an important difference between pure simulation models and scheduling models. Operational models must be initialized to the current state of the shop floor. Also, operational models generally use stochastic data to a lesser extent than analytical models.

AutoSimulations provides the product AutoMod to meet the needs of analytical modeling. To meet the needs of operation modeling, AutoSimulations has developed AutoSched AP.

3 AUTOSCHED AP

AutoSched AP is a tool that has grown out of a the premier simulation product in the world today, AutoMod. This simulation tool provides the basic framework necessary to manage today's factory. ASAP is used for Short Interval Scheduling, Rule Analysis, Capacity Analysis and Planning.

Short Interval Scheduling is running the model with the current status of the factory (WIP) to create dispatch lists for equipment or operators for the next schedule period.

Rule Analysis is testing existing policies and creating new dispatch rules to analyze their effect. Using a combination of rules and family work list ranking, you set the criteria to determine which lot to work on next at any given station.

Capacity Analysis is the process of determining, in detail, how many machines, personnel, and generic resources (reticles, cutting tools, etc.) are required to meet a specified product demand.

Planning is using the model to decide when to start lots through the factory. Planning usually looks at a time horizon beyond (even well beyond) the current scheduling period.

4 MODELING WITH AUTOSCHED AP

Modeling a factory on the computer requires translating real-world terms into model terms. Figure 2 shows examples of how real-world entities are modeled in ASAP.

4.1 Calendars

Calendars are used to model shifts, holidays, machine failures, etc. ASAP uses five types of calendars:

- Shifts – unlimited number of breaks and meetings. 8-hour, 12-hour, or other repeating intervals are possible.
- Down – Mean Time Between Failure by calendar time or by the number of lots or pieces processed. The first down occurrence can be specified as either a random event or a specific date/time.
- PM – Mean time to PM by calendar time or by the number of lots or pieces processed. The first PM

occurrence can be specified as either a random event or a specific date/time.

- Exception – Time resources are not on shift as defined by a start and end time. Used to model holidays and engineering time.

- Reserved – Periods when resources are reserved for running specific products.

- Any number of calendars of all types can be attached to a resource.

Real World	ASAP Model
tools, testers, assembly equipment, machines, tables, work stations	stations
production and maintenance personnel	operators
reticles, kanban, handlers, probe cards, jigs, cutting tools, router bits, masks, stamping dies	generic resources
manufactured piece, wafer types, devices, sub-part, purchased part	parts
processes, recipes, manufacturing instructions, production card	routes
shifts, PM, MTBF/MTTR, holidays, engineering time	calendars

Figure 2: ASAP Entities

4.2 Random Distributions

ASAP includes random distributions for all time-based events, such as processing, loading, setup, etc. There are eight distributions supported including constant, normal, exponential, weibull, uniform, lognormal, triangular and gamma. Other distributions (Binomial, Cauchy, Discrete uniform, exponential power, …) are available through a standard extension.

4.3 ASAP Extensions

Extensions are additional features to the base ASAP product. Extensions can model:

- Resource or route attributes
- new equipment behavior
- user-defined statistical distributions
- rule filters
- ranking functions
- batch ok and batch criteria functions
- action list actions

Extensions are dynamic linked libraries that add functionality to the main ASAP program. Extensions are easily added to models.

4.4 ASAP Action Lists

Action lists provide users with control over how data is accessed and how model resources behave. Action lists are composed of actions that access data and cause time delays (i.e. setup, process, down etc.) in the model. There are two types of action lists: process and preempt action lists.

Process action lists are associated with:

route steps	claimed resources
PM tasks	calendars

Preempt action lists are attached to actions with time delays. For example, a preempt action list defines what happens when a resource goes down during processing. Preempt actions determine whether the equipment releases the lot for repair or holds the lot until the equipment is operational again.

4.5 ASAP Dispatch Rules

ASAP provides standard dispatch rules for *all* resources, including stations, operators, and generic resources. This means that the same flexible and intelligent rule engine used to dispatch stations is used for operator selection and generic resources such as jigs, router bits, kanban and handlers. ASAP rules determine: how lots are ranked when entering the queue (family work list), how lots are selected (i.e. FIFO, same setup, hot lot, etc.), how lots are grouped for batching

5 AUTOSCHED AP INTERFACE

The data required for AutoSched AP™ to model and schedule can be entered and managed using two interfaces: an Excel™ worksheets for each data type (stations, routes, orders, parts, etc.) or using an AutoSimulations proprietary interface called DB Client™ which allows management of the model and schedule data in many of the available relational database management system. Either environment gives you the ability to enter and manage your model and scheduling data. The demonstration will show the data using the Excel interface.

6 CREATING THE MODEL

An ASAP model requires three categories of data: factory resources, products, and demand. Some or all of this information may exist in a database such as an MES, MRP, or shop floor control system. If it does exist, it can be imported into ASAP.

6.1 Stations

Each station is defined in this file. Stations are grouped into families. A family shares a common input queue. Each station has its own task selection rule and family work list rank.

6.2 Operators

Each operator is defined, along with its certifications and task selection rules.

6.3 Generic Resources

This file defines each of the factory's generic resources (tools, fixtures, etc).

6.4 Calendars

Each resource (stations, operators, tools) can have its own work schedule. This work schedule can be composed of an unlimited number of calendars. Once calendars are defined, they can be attached to resources in an attachment file. There are five calendar types: shift, down, preventative maintenance (PM), reserved, and holiday/exception.

6.5 Calendar Attachments

A resource can have any number of calendars attached to it. For example, an operator might have a shift calendar, a holiday calendar, and a vacation calendar attached to it, respectively. Calendar attachments allow a flexible, easy-to-maintain work schedule.

6.6 Parts

This file lists all of the part types that you manufacture, as well as which routes they use.

6.7 Routes

The route describes the process steps of different products. Each product type has its own route that defines setups, processing times, batch sizes, etc.

6.8 Order and WIP Status

The order file describes all orders scheduled during the simulation period and their current status. This information consists of both a current "snapshot" of the shop floor and a list of the orders yet to be released.

7 MODEL OUTPUT

There are two types of output from the simulation/scheduling run: graphical and statistical. Graphical output includes:

- Load vs. Capacity graphs
- Gantt charts – for each resource and each lot

Statistical output includes:

- Schedule file – schedules for each resource and order
- Standard reports – over 15 types of reports that collect the statistics you need
- Continuous Reports

8 SUMMARY

Today, manufacturers are looking for ways to be more responsive to customer needs. Improve the time to market, and maximize resource utilization. AutoSched AP is an invaluable tool in pursuit of these goals.

With flexibility, power, and speed, AutoSched AP is quickly becoming the simulation based scheduling tool of choice in many of the world's most competitive industries.

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AUTHOR BIOGRAPHY

TYLER PHILLIPS, Western Regional Account Manager, joined AutoSimulations, Inc. in 1994. Over the past 4 years, Mr. Phillips has trained hundreds of users at all levels in most of AutoSimulations' products, including *AutoMod*, *AutoSched*, and *ASAP*. He also spends several days every year lecturing on Customer Service. His main interest is in providing excellence in training and customer support for all AutoSimulations' customers. Mr. Phillips holds a BA from Brigham Young University.