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(Partial List)

Scheduling the Automated Laboratory

INTRODUCTION

“...the system will model the robotic and automated sample preparation and analysis equipment used throughout the research process, together with the availability of trained staff and ancillary equipment, enabling the laboratory to maximise the efficiency of its high throughput experimentation operation.”

This was the mission statement agreed with management at the start of a project to apply finite capacity scheduling technology to the operation of a complex and highly automated laboratory which provides a centralised research capability to a global and diverse speciality chemicals manufacturer. The functions of the system are to identify bottlenecks under a wide variety of experimental conditions, to improve the utilisation of highly expensive capital equipment and trained staff, and to maximise the throughput of experiments. This leads to reduced time to market for innovative products and improved reaction to quality perturbations.

THE ANALYSIS PROJECT

The project has four principal phases;

- Define the scheduling requirements for the laboratory
- Build a proof of concept computer model to confirm the suitability of finite capacity scheduling techniques to the problem
- Build a prototype scheduling system
- Develop the prototype system for fully integrated operation

1. Define the scheduling requirements for the laboratory

This initial phase identifies operations which are required by the wide range of experiments undertaken by the high throughput experimentation laboratory, together with the various robots and instruments which are available for that experimentation.

2. Build a proof of concept model

In order to rapidly confirm the suitability of finite capacity scheduling technology to the laboratory operation, a simplified model of the process was constructed. This included the principal equipment modules and some typical experiment designs, together with the basic mechanisms for robotic transfer of samples between machines and storage locations. The concept was proved by this method and the scope of implementation of the system defined and agreed.

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3. Build a prototype scheduling system

Following proof of concept, a model was built which contains all the equipment, storage facilities and other resources required for operation of the high throughput experimentation facility. Degrees of freedom available for the schedule, such as the possible choices of sample processing stations, were incorporated. Secondary constraints such as the availability of limited sample plate storage locations were also identified and modelled. The operations required for a representative range of possible experiment designs were entered, together with processing times, operation to operation constraints and technician skill availability. The model was run with a range of due-date specific experiments and reporting functions such as bottleneck identification, equipment utilisation and timeliness.

4. Develop the prototype system for fully integrated operation

Examination of the prototype model and its operation enabled identification of gaps in the model, such as missing technician skills and some robot operation times. These were incorporated as were links to other systems to enable import of both experiment design and demand data. All remaining data was identified and incorporated, such as a complete set of possible experiment designs, shift calendars for people and machines and so on.

The system was also configured to enable rescheduling – in which some aspects, such as work already in progress, are fixed.

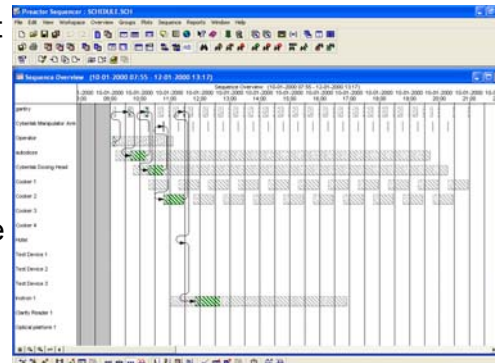
Finally a complete suite of reports were provided, enabling the company to compare various scheduling scenarios to identify the most appropriate, taking into account utilisation of equipment and technicians.

BENEFITS

The laboratory scheduling system enables a highly complex process to be managed effectively. Realistic experiment completion times can be calculated, and the impact on these of changes in demand or resource availability can be identified rapidly. Opportunities for inserting additional experiments can be identified. Synchronisation of the robotic systems which run overnight, with the technicians who work only during the day, was a key issue which has led to substantially improved efficiency.

THE PREACTOR FINITE CAPACITY SCHEDULING SYSTEM

The Preactor finite capacity scheduling system, from Preactor International, was selected for this application. This is a highly flexible product, with more than 3,000 licences being installed in over 800 companies around the world. With a low cost of ownership and flexible configuration facilities, it offers a rapid return on investment. Preactor is a family of scheduling solutions, providing a range of functionality appropriate to many types of scheduling problem; it can be used by companies ranging from the smallest to the largest. For this application, Preactor 300 was selected because it enables multiple finite constraints such as operator availability and storage space.



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