KRONTIME INNOVATION FOR DIGITAL MANUFACTURING

WHITE PAPER

RESOURCE BALANCING

A BASIC INTRODUCTION

THIS WHITE PAPER TAKES A HIGH LEVEL LOOK AT RESOURCE BALANCING SOLUTIONS

WHAT IS RESOURCE BALANCING?

All manufacturing companies must operate within a set of constraints that govern the amount and types of resources it has available. On the production shop floor the problem is in being able to determine the optimum balance of assembly tasks among the available stations to achieve a defined output.

This is commonly known as the assembly line balancing problem (ALBP). The objective is to strive to reach the best compromise between available labour, facilities and resource requirements to meet a defined production volume level.

There are many types of constraints that relate to ALBP and include; line side constraints, task grouping, operator constraints, and a number of different approaches to solving them that take into account the type of line being balanced.

In order to perform line balancing several factors must be considered:

Common definitions for work include:

- operations-routines – a collection of tasks assigned to an operator or a workstation
- tasks – smallest amount of movable work; may be grouped or clustered, uses parts, tools, time …
- elements – lowest level of definable work; walk, turn, pick, place …

Line design is determined by the types of product being produced and includes:

- single – each product is the same
- mixed – products may change
- multi-model – where there is a combination of different types of products

Constraints are modelled as specific objectives, for example:

- number of fixed or floating operators
- operator delay minimisation
- reduction in the number of tasks assigned to one side of the line
- reduce resource conflicts

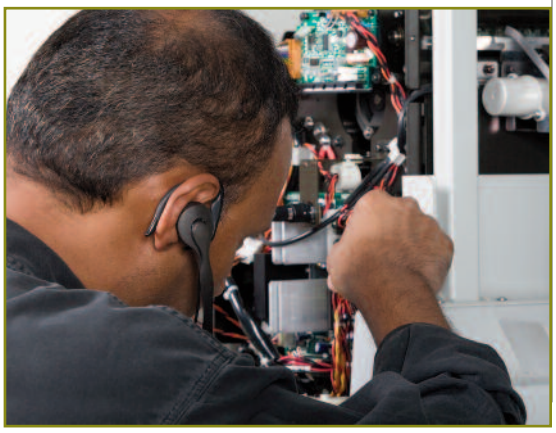
Different methods can be used to resolve these problems, which include:

- weighted average, workstation balanced against the weighted time for each station
- peak time, workstations balanced against real time

WHO USES IT?

Usage of resource balancing is extensive and covers a diverse set of industries that include:

- Machine tool manufacturers
- Component manufacturers
- Automotive manufacturers
- Special vehicle manufacturers
- Aerospace manufacturers
- Defence and weapons manufacturers
- Industrial machinery manufacturers
- Materials handling manufacturers
- Utility companies
- Building and construction companies
- Pharmaceutical companies
- Shipbuilders
- Service and maintenance organisations
- Consumer products
- Scientific equipment



HOW IS IT USED?

Today's resource balancing solutions rely on simplicity in meeting the key demands of today's competitive production environments. To start a precedence graph of the assembly process is defined which defines a number of key measures: task time, no. of stations, station time, maximum and minimum idle times. From this the efficiency of the line is calculated. Then the type of objective is determined either a base objective that is capacity related or multiple objectives where the constraints are modeled as an objective. This is followed by the definition of the line type problem – whether it's a batch of similar or mixed products. Using various solution procedures line balancing options can be investigated. A number of methods can be employed when considering process times such as the weighted average of stations or true station times known as the peak model. Implementation of a balanced line may also employ ergonomic constraints and work instructions. Utilization of lean charting can also be used to reduce non-value added work and identify bottlenecks to produce improved cycle times.

WHAT DO RESOURCE BALANCING SYSTEMS PROVIDE?

Precedence graph editor enables users to define the sequence of assembly. The range of process tasks that need to take place before another task can be defined. These are entered either using text or graphical input. Assignments of tasks to stations that are not feasible are eradicated by the ALBP algorithm using the precedence constraints.

Station display provides a graphical bar chart view of each station along with a tabular representation of the assigned activities. Typically this data can be taken into Excel for specific report generation and formatting needs.

Reporting module provides standard formatted displays of various utilization details such as; maximum, minimum and average resource allocation. Other reports types may include lean charting for value and non-value added percentage times.

Automatic balancing features to allow users to select and define priorities over a range of constraint

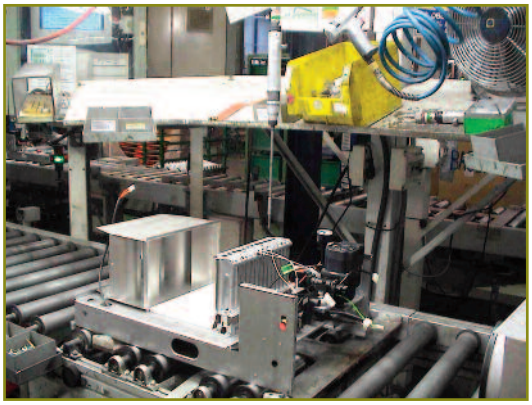
areas. This in effect enables comparisons to be carried out in a "what-if" style. In this way an unlimited number of tasks and stations can be analyzed and reported on. Typically data can be imported from spreadsheet sources and exported to numerous other applications.

Ergonomic risk assessments may also be available for customers who wish to determine how to reduce operator stress and injuries.

Export capabilities that allow data to be taken into other industry standard analysis and reporting tools such as Oracle Discover, Crystal reports and Microsoft Office Excel all of which provide advanced features for further analysis and the production of highly tailored reports. These may also be published to the Web.

Many types of factors can be defined, such as:

- Calculation of number of staff required to balance a line to achieve optimised production
- Multiple zone balancing when working on large pieces with multiple on-part work locations
- Left and right side line balancing where there are two work locations within a single station
- Single and mixed model batch production with selectable product configurations
- Optional task definitions where optional components are involved
- Fine tuning of an automatically balanced line using manual input
- Definition of value and non-value added work for lean analysis
- Estimation of workforce resources needed to overcome problems when station cannot be added
- Use of industry time standards such as MODAPTS allowing fast time estimation



FEATURES

- Easy to use graphical user interface
- Selection and setting of process precedence
- Worker allocations to station zones
- Left and right sides line balancing
- Batched single model and mixed model production
- Specification of mixed percentages for optional tasks
- Fine tuning by manually entering balancing inputs
- Definition of value and none-value added work
- Man power estimation for stations
- Use of standard process times (MODAPTS)
- Identification of constraints
- Reporting and data export options

WHAT ARE THE BENEFITS OF RESOURCE SYSTEMS?

- Reduced bottlenecks
- Improved workflow
- Quick identification of constraints
- Reduced work overload
- Fast estimation of manpower needs
- Rapid solution identification

WHAT ARE THE CURRENT TRENDS IN THE INDUSTRY?

Today manufactures are looking to leverage their investment in information technologies to lower costs, reduce cycle times, increase quality and improve the efficiency of their operations. A common approach is to adopt integrated solutions or to select products that are interoperable. In the first part of this paper we focused on resource balancing and showed how it is used and the benefits that result.
However this addresses only one problem area where manufacturing companies are looking to improve efficiencies. Manufactures are also looking to manage complex assemblies that can be comprised of hundreds or thousands of parts. Industrial engineers want a complete environment that integrates design and development activities with shop floor manufacturing facilities. An environment that can respond quickly and with accuracy to changing demands, new designs, complex product configurations, different shop floor layouts, machine types and resource availability.

Next generation systems provide fully integrated frameworks with process planning handling task times, operational constraints, lines locations, resource availability and ergonomic factors amongst many other factors. Line balancing provides the analysis of constraints with the capability to understand how to optimise resource utilisation.

CAD integration is not only used to communicate part geometry but is also being employed in visualising the interaction of resources on the production line. Advances in this area will provide simulation capability to visualise resource constraints and line balancing scenarios. Also of key importance in the implementation of a balanced line configuration is the communication of work instructions that detail how work is to be carried out and the need for process document management to control versions of associated text, video, pictures and hyperlinked information.

TRENDS

Advances in resource balancing approaches are benefiting from tight integration with other solutions that include:

- Process planning
- Ergonomics
- Work instructions
- Process document management
- Manufacturing costing

In addition CAD tools are providing resource balancing solutions with the capability to visualise in 2D and 3D the configurations of lines based on optimised “what-if” scenarios.
This is providing benefits in being able to understand the physical implications of a given balanced line configuration. Issues such as clashes, interference and ergonomic constraints can be detected and isolated.
Future developments are also being studied by academic institutions to develop more sophisticated optimisation methods and algorithms.

WHO ARE INS?

INS VALLÈS is dedicated to delivering its visions of providing effective answers to the complex problems of managing and improving production times, processes and manufacturing work methods. Our first priority is to deliver high quality software applications to our clients to help them optimise resources and achieve maximum benefits.
Our Krontime application suite has a long and proven track record of delivering significant business benefits to our clients across the world. We continue to invest in the latest technologies to ensure our products offer the most competitive solutions to industry - enabling our customers to improve their manufacturing operations.
Krontime is used by our clients in many different sectors that include: automobile supply chain, motorcycle manufacture, manufacturing automation, electronics, textile, household electrical products, construction and many more. We provide international coverage for our customers in Spain, Portugal, Poland, Czech Republic, Austria, Brazil ...

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