Executive White Paper

Reducing Energy costs for Plastic Manufacturers

The Role of Constraint Based Planning and Scheduling

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Executive Summary

Despite plastics production being more energy efficient than many other production processes, plastic manufacturers face higher energy bills than ever before. With a total industry fuel bill of €5,920M, even a small increase in energy prices can have a dramatic impact on company balance sheets. While fuel prices have moderated slightly since their peak in early 2006, energy prices remain at historic high levels and are likely to remain so for the foreseeable future. It is perhaps not surprising that an estimated 200 plastics manufacturers have gone out of business between 2005 and 2006 in the UK alone. Plastics associations, such as the AEA Energy & Environment (ETSU) and the British Plastics Federation (BPF), have concluded that "In order to survive, companies need to carefully investigate areas of cost savings. Companies with energy costs significantly in excess of industry averages will find survival increasingly difficult".

The news is not all bad, however, for the plastics industry. Studies indicate that there is considerable opportunity in most companies for energy reduction of at least 10-20%. A BPF/ETSU report on Energy Efficiency Best Practice concluded that approximately 50% of total energy consumption in plastics manufacturing is non-productive, confirming the considerable potential for reducing energy consumption and related costs. By embracing energy reduction initiatives, plastic manufacturers can therefore take some control over their own fate.

Various respected publications have identified measures that can be introduced by plastic manufacturers to reduce energy costs and so make plastic manufacturers more competitive:

- The first critical step is to recognise energy costs as a variable cost as opposed to a fixed overhead, and to undertake audits of manufacturing processes to identify where, when, why and how much energy is consumed by specific items on specific machines/moulds. This data can then be used to ensure that future planned production exploits optimal machine/mould routings to minimize production costs;
- A second opportunity for energy cost reduction is to minimise idle time on machines, which can otherwise account for 52-95.5% of the full moulding consumption. This can be achieved by Minimising mould changeovers, and better anticipating future long periods of idle time (to identify opportunity for turning off machines);
- Demand smoothing or "lopping", and staggered machine startups, can help remove peaks in demand and better average the load on manufacturing plants. This in turn enables manufacturers to take advantage of more attractive energy tariffs with lower Maximum Power Requirements (MPR), and Maximum Demand (MD);
- Improved shift patterns have the potential to reduce Load Factors (LF) on energy and so similarly reduce energy costs.

This report demonstrates how each of the above challenges is directly impacted by improved production planning and how constraint-based planning/scheduling systems, such as the Logility Voyager Manufacturing Planning™ system, are rapidly becoming a necessity for plastics manufacturers who must become more competitive to survive.

The Plastics Industry

Plastics are known as one of the most resource efficient and flexible materials available to society. Their low weight, strength and versatility make them applicable to a broad range of uses, ranging from packaging (e.g. crates, pallets, bottles, foil), household (e.g. microwave-proof containers), construction (e.g. insulation, pipes/guttering, PVC windows), furniture, transport (e.g. automotive interior/exterior parts), electrical goods (e.g. televisions, mobile phones), to medical and space travel. Due to its diverse usage, it is perhaps not surprising that each of us consumes in excess of 100Kg of plastic every year.

In terms of manufacturing plastic finished products, a range of different technologies are applied, including injection moulding, blow moulding, rota-moulding, thermoset processing, extrusion, thermoforming and vacuum forming. All of these technologies typically involve raw material polymer being shaped in a mould or die using a combination of heat, pressure and cooling. Figure 1 illustrates the relative usage of these processes within the UK[1]. The diagram clearly shows that the most prevalent technology is injection moulding. This is true of the Western World as a whole with an estimated 16,000 injection moulders within Western Europe (Source: AMI consulting), predominantly located in Italy (34%), Germany (21%), France (11%) and the UK (10%).

Number of UK Plastic Processors defined by process

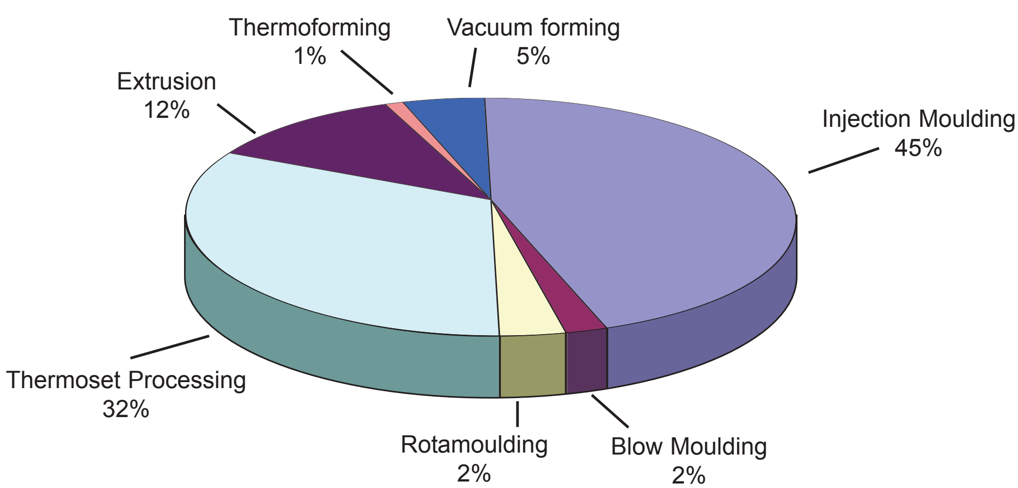

Figure 1: Number of UK Plastic Processors defined by process ***Source: BPF (2005)***

Despite the significant demand and growing popularity of plastics, a recent Plimsoll[2] report indicated that 38% of moulders are “loss making” with 33% “in danger”. Further evidence of the difficulties facing plastics manufacturers is provided in an article by AMI, published in the October 2006 edition of the leading plastics industry publication PRW; it states that the number of injection moulders in the UK decreased by 200 in the two years between their 2004 and 2006 reports on the size of the injection moulding industry.

There are three main reasons documented within the industry for this state of the plastics economy:

- Most significant is that oil prices have become more volatile over recent years, leading to significant increases in energy costs. In Autumn 2005, the BPF estimated that energy costs have increased on average by 58% for gas and 56% for electricity. A recent report by RECIPE partners[3] further confirmed that energy prices had doubled between January 2004 and October 2005. Although crude oil prices moderated somewhat in 2006, they remain at historically high levels and industry bodies anticipate that they are likely to stay high through the foreseeable future;
- The Middle East and East Asia have each become increasingly significant rivals to Europe[4]. Asia affords the opportunity of low-cost labour compared to Europe, while the Middle East has an inherent advantage in terms of low-cost energy and local raw material supplies. Although neither of these threats is new, their severity has increased over the past few years. This is especially true of the Middle East due to the increasing energy prices in Western Europe;
- More stringent environmental regulations are also increasing financial pressures on all industries, including plastics manufacturing. One example is the Climate Change Levy (CCL), a new British tax on industry energy consumption, introduced in the 1999 budget and in effect from April 2001. This rewards companies that agree to reduce energy consumption over successive years.

Although plastics production processes are more energy efficient than many other production processes, they nevertheless still consume an estimated 1.85 kWh/Kg[3] of energy at an average cost of 0.08 €/kWh across Western Europe. This equates to a total industry energy bill of €5,920M and so the recent energy cost increases and additional taxes have had a dramatic impact on company bottom lines.

The escalating energy costs only serve to worsen the effects of increased competition from the Middle/Far East. In their “Practical guide to energy in plastics processing”[5], AEA Energy & Environment (ETSU) and the British Plastics Federation (BPF) conclude that “In order to survive, companies need to carefully investigate areas of cost savings. Companies with energy costs significantly in excess of industry averages will find survival increasingly difficult”.

The potential benefit of introducing energy efficiency measures is considerable, as estimated by Tangram Technology in their report “Energy efficiency in plastics processing—Practical worksheets for industry—Energy worksheets 1-12”[6]. The energy bill for the average plastics company represents about 1 to 3% of turnover. Simple no-cost or low-cost energy reduction practices can reduce this by between 10%-20%, increasing profits by at least 2%.

Many other industries facing similar business challenges and improved profit opportunities have turned to enterprise resource planning (ERP) and supply chain management (SCM) technologies to make them more efficient. However, as a recent article by the independent Technology Evaluation Center (TEC)[7] shows, most generic industry solutions demonstrate a number of "fatal flaws" when applied to the plastics sector, fatal flaws being defined as ““*must have” capabilities, whose omission impede the user enterprise*'s *operation—even to the extent of complete failure*”. The TEC report concludes that there is a need to improve planning and scheduling systems for the plastics industry.

In summary, the need for improved planning and scheduling within plastics manufacturing has been recognised by independent analysts within both the plastics and IT industries. This document discusses how advanced constraint-based planning and scheduling systems can reflect some of the unique constraints and planning paradigms inherent to the plastics industry, and so help address many of the current challenges facing the plastics industry, specifically in the area of energy reduction.

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Energy Reduction Benefits of Improved Planning and Scheduling

In overview, Advanced Planning and Scheduling (APS) solutions can help plastic manufacturers reduce energy consumption in numerous ways, including:

- Representing energy consumption as a variable cost, thereby providing visibility of the impact of alternative production plans on energy costs;
- Optimising machine routing decisions;
- Reducing the frequency of mould changeovers and duration of machine idling;
- Demand smoothing;
- Providing improved energy monitoring and control, through improved visibility of future projected energy consumption/costs;
- Providing timely information for finance departments, including accurate cost projections and delivery dates for budget and cashflow planning and management;
- Improved what-if analysis.

The following sections discuss each of these main areas of benefit in more depth.

Energy Consumption: The Importance of Activity Based Costing When Planning

It has been said that you can't manage what you can't measure. The first step in addressing energy cost reduction is therefore to understand the what, where, how and why of energy consumption by representing and planning energy consumption as a variable cost rather than a fixed overhead cost. Recent European benchmarking surveys conducted by RECIPE partners[8] determined that plastics companies that allocated energy costs to specific machines/jobs and therefore treated energy as a variable cost showed significantly lower energy consumption than plants that do not, concluding that “It is clear that being able to allocate costs to a specific job is one of the best ways of controlling and reducing costs”.

Dr. Robin Kent explains in his 2005 paper relating to “energy efficiency in plastics processing”[9] that before energy costs can be reduced, it is fundamental to understand where, when, why and how much energy is used. He continues by explaining how useful energy key performance measurements (KPIs) can be derived and then used to monitor and reduce future consumption of energy. Of course, the word "future" naturally implies planning and so it becomes imperative if best practice advice is to be adopted, that any planning and scheduling system used within the plastics manufacturing environment includes activity based costing capabilities and appropriate cost outputs. The Logility Voyager Manufacturing Planning and Scheduling system is one of only a few constraint-based Advanced Planning Systems (APS) that includes the ability to associate fixed and variable costs with various aspects of production planning, including materials, usage of different machine/mould combinations, performing changeovers and idle time. It therefore enables companies to project the cost impact of alternative production plans (one plan using perhaps different routings with greater/smaller machine energy consumption values, another utilising different shift patterns, yet another introducing demand smoothing to reduce maximum energy consumption per day) and so fully supports the recommendations from RECIPE in its initiative on energy reduction and monitoring.

The ability to project the cost associated with a specific plan/schedule, while important, will not in itself reduce cost. However, if this capability is leveraged in conjunction with other capabilities of an Advanced Planning System, the system becomes a powerful and sophisticated tool to derive optimal plans that reduce energy, and simultaneously achieve the preferred trade-off between inventories and mould changeovers.

Optimising Machine Routing and Mould Allocation Decisions

In their 2006 report on Low Energy Plastics Processing[11], RECIPE derived a graph (shown in Figure 2) illustrating that approximately 60% of the energy cost for a typical moulding plant is associated with the injection moulding machines. The efficient operation of the machines therefore presents the greatest opportunity for energy savings for a plastics manufacturer.

Typical energy consumption associated with an injection moulding plant

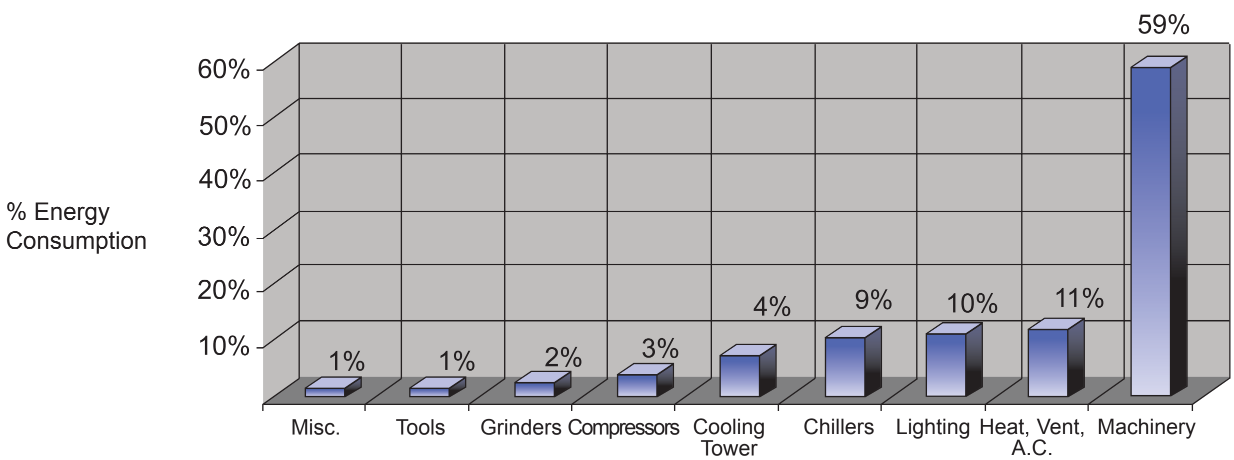

Figure 2: Typical energy consumption associated with an injection moulding plant[10]

The choice of machine and mould when manufacturing a specific material can greatly effect the machinery energy consumption and thus, manufacturing cost. RECIPE confirms[11] that site specific energy consumption (SEC) varies from 2.5 kW/Kg/hr for medium/large mould machines to 4.2 kW/Kg/hr for smaller machines. The document also reveals that electric injection moulding machines are typically more energy efficient than their hydraulic counterparts. Age, design, manufacturer and maintenance patterns can also of course impact the energy efficiency of a specific machine.

Another industry paper by the ETSU/BPF[12] explains that there are similar variations in energy consumption depending upon the choice of moulds. The document explains that injection moulding is at its most efficient with well designed lightweight moulds, where the energy consumption is typically in the range 1.3-1.6 kW/Kg. This contrasts with an average energy consumption of between 3 and 4kW/Kg for heavy duty moulds.

Given the evidence that energy consumption depends mostly upon injection moulding machine consumption, which in turn depends both on machine size, machine type (hydraulic vs electric) and the choice of mould, it is irrefutable that the total energy consumption and cost related to a specific plastic company is significantly and directly correlated with the skill with which specific machines/moulds are chosen for particular jobs. Given that 90-95% of the total energy consumed by the manufacturing process relates to machine operation itself[13], the magnitude of the energy saving in optimising the use of machines/moulds for specific items is considerable.

It may seem obvious that all plastic companies need to do is to simply improve their allocation of machines and moulds to specific jobs to immediately benefit the environment and the bottom line. So, why haven't all plastic companies already adopted these improvements? The problem is that plastic manufacturing environments are very complex and considerably flexible in nature. A large plastics manufacturer could have 50-100 injection moulding machines at one site alone. They may have several hundred moulds, with perhaps multiple copies of the more popular moulds, and usually any one mould can be fitted to multiple machines. The portfolio of items that can be made may run into thousands. The combinatorics of the problem are therefore enormous. There may also be practical considerations on the shop floor such as trying to achieve long production runs (to avoid unnecessary and costly changeovers) that may sometimes prevent the least cost machine/mould combination from being used. Considering all of the possible routing options and related cost implications, while simultaneously creating a weekly master production plan for 6-12 months and respecting the myriad of constraints, becomes impossible using conventional tools such as spreadsheets.

Constraint-based systems such as Logility Voyager Manufacturing Planning are uniquely able to simultaneously consider all of the possible routing options, both in terms of machines and moulds, deriving a feasible plan in minimal time. Despite providing considerable automation, planners may still influence the characteristics of the plan derived by Voyager Manufacturing Planning, indicating preferred routings for specific items perhaps based on the age, type and general energy efficiency of each machine when producing specific materials. Since Voyager Manufacturing Planning also includes a costing capability with variable costs defined per item/route, the cost/energy related to any derived plan is immediately transparent to the user. Therefore, the planner is able to let the system manage the constraints and complex capacity/demand calculations while they apply their considerable planning knowledge more effectively, focusing on a comparison of different planning strategies and conducting what-if analysis to arrive at the most acceptable trade-off in terms of plant throughput, energy consumption, customer service and machine efficiency.

Reducing Mould Changeovers and Machine Idling

In its worksheets recommending best practices in energy efficiency in the plastics industry, Tangram Technology identifies several situations within the plastics manufacturing environment that can lead to wasted energy. One such scenario is where machines become idle for long periods of time. Tangram explain how injection moulding machines can use between 52% and 97.5% of the full moulding power consumption simply when idle and so should not be regarded as "free" economically. As a result, idle periods of between 20 to 45 minutes may make it more economical to switch off machines and restart when required.

One of the main causes of machines becoming idle is when performing a mould switch, (often referred to as a mould changeover), from one machine to another. The plastics manufacturing environment is somewhat unique in that a specific mould or tool can typically be used on more than one moulding machine, and the range of products that can be made on a given machine depends on the range of moulds that can be fitted. If it becomes necessary to switch a mould from one machine to another, then not one but two moulding machines may become idle for the duration of the changeover. A further undesirable consequence of changeovers and restarting machines is increased wastage of costly material. For this reason, Tangram recommends that tool changes be planned into production schedules and that any such changeovers are optimized from a planning perspective. It is difficult to adhere to this advice when using basic planning tools such as spreadsheets.

The financial implications of reducing changeovers can be considerable; every time a machine stops, it is estimated that approximately 10Kg of material can be wasted. If we then consider the number of machine/mould combinations that may be planned in a typical month, and therefore the number of changeovers potentially required, the size of the benefit in optimizing changeovers becomes abundantly clear.

There are several repercussions from the above observations:

- It is important to be able to associate different costs with different states of a machine when planning: idling (which can account for more than 50% of operating energy costs), changeover and producing;
- It is advantageous to be able to identify when in the future machines may be idle for long periods of time, to identify opportunities for energy reduction through stopping/starting machines;
- It is advantageous, where practical, to minimise idle time by planning long production runs;
- It is desirable to minimise mould changeovers during planning/scheduling, to reduce wasted energy and costly material.

How can an APS system help address these concerns? The Logility Voyager Manufacturing Planning system allows a broad and flexible range of factors and their costs to be represented in the model, distinguishing between multiple fixed/variable production costs, changeover costs and idle costs. It therefore enables the impact of all of these factors to be considered when developing alternate planning scenarios, to determine the overall "best" plan considering all pertinent factors.

A second benefit in this area is that Voyager Manufacturing Planning is a constraint-based system and so it is able to represent all typical constraints associated with the plastics manufacturing environment. This includes mould changeovers. As a result, any derived plan is feasible and provides more accurate long term visibility of projected times when specific machines may be idle. Management are therefore better informed in terms of introducing machinery shutdowns at appropriate times and so minimising related energy costs.

Finally, due to its heritage in the plastics industry, the Logility solution incorporates sophisticated algorithms capable of minimising mould changeovers and achieving the desired tradeoff in terms of long production runs, mould changeovers, and inventory. Planners are able to evaluate any plan in terms of not only cost but also number of changeovers, inventory levels, energy usage, customer service, and machine utilisation.

Demand Smoothing

As explained in Tangrams' energy worksheets[13], there are three primary parameters that define energy tariffs and that can significantly impact companies, if violated:

- **Maximum Power Requirement (MPR):**
  This is the maximum current a site may draw at the supply voltage;
- **Maximum Demand (MD):**
  This is the current drawn at the supply voltage, averaged over half an hour;
- **Load Factor (LF):**
  This is a measure of the hours per day that the user draws from the supply;

Violating the MPR can result in financial penalties. Increasing the LF, or the MD, similarly results in increased energy costs.

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Given the above energy key performance indicators (KPI's), it is advantageous to try to smooth energy requirements (thereby reducing MD and reducing the risk of exceeding MPR) and to efficiently manage the duration of energy consumption per day (thereby reducing LF). The difficulty, however, is that demand is rarely smooth. Production, and therefore energy, requirements is therefore also likely to peak and trough in a reactive manufacturing environment that is trying to provide high levels of customer service with low inventory.

The key is to change from a reactive to a proactive planning environment. As recommended by ETSU/BPF[12], maximum demand costs can be reduced by smoothing demand (or demand “lopping”) and scheduling machine operations such that individual maximum demands do not coincide, thereby avoiding spikes in total factory demand. Achieving demand smoothing requires long term visibility and advanced pre-building capabilities based on the theory of constraints. This is where a system such as Voyager Manufacturing Planning can deliver real benefits. The system affords full visibility of long term demand, as well as the ability to automatically respect numerous time-phased constraints impacting the manufacturing environment, and so is able to simulate the impact of demand volatility on the shop floor when targeting different MPR/MD/LF constraints.

For example, if there is a financial advantage in reducing MPR, the planner can set the target MPR as a constraint and the planning system will automatically stagger machine to start-ups where necessary respect the designated MPR, warning if staying under the limit creates other exceptions and delineating the impact of the policy on production, total energy cost, and MD. Similarly, the planner can simulate the impact of alternative shift patterns on production and therefore the projected LF value. The MD and LF factors may also be defined as KPI's within Voyager Manufacturing Planning and compared between different plans as well as becoming a published KPI on the web for senior management to track production/ energy performance. By conducting what-if energy simulations in this way, plastic companies may assess the feasibility of switching to alternative energy tariffs, thereby identifying opportunities for significant financial benefits.

Improved Visibility and Control

In a 2005 paper, Dr. Robin Kent explains that it is fundamental to understand where, when, why and how much energy is used in the manufacturing environment. However, this is only valuable if a company can apply this knowledge proactively in the planning of future production. Examples may include:

- Biasing the manufacture of specific products, where possible, to optimal (energy efficient) machine/ mould combinations;
- Minimising changeovers and so reducing material/energy wastage;
- Smoothing demand, or "peak demand lopping" to reduce energy tariff penalties;
- Changing shift patterns to minimise energy tariff penalties;

Of course, there may typically be no one optimal trade-off between the above factors, especially when trying to balance the other company objectives such as high customer service and low inventories. This is where the planners' judgment becomes invaluable. However, the planners judgement is arguably only as good as the information and systems put before them. Their judgement may also be impeded by the amount of available time that they have to compare alternative plans. Often, all available time is spent performing mathematical calculations in spreadsheets to derive just one plan, while handling troubleshooting on the shop floor. Reducing the time required to plan is another area where Voyager Manufacturing Planning can provide significant advantages, with clients claiming time reductions of 75%-90%.

Constraint-based planning systems provide a means by which the countless variables can all be considered simultaneously. Long term demand visibility and future inventory goals are merged with complex machine/mould constraints, and sophisticated algorithms used to quickly identify candidate feasible plans. The ability to represent costs and compare plans from a broad range of perspectives (customer service, changeover frequency, cost, energy, production throughput) enables the planner to then quickly and consistently identify the optimal trade-off between customer, energy and production conflicts. In the case of Voyager Manufacturing Planning, this information is not only available to the planner but also optionally available through the Web to senior management, allowing KPI's to be synchronised across the entire enterprise. Management strategies and production operational objectives can be aligned easily. Logility Voyager Manufacturing Planning thus allows energy monitoring and control objectives to be embraced as an integral part of the planning process, making it a proactive rather than reactive effort.

Key Performance Indicators illustrate the tradeoff between plant utilisation, production cost, changeover frequency and inventory value

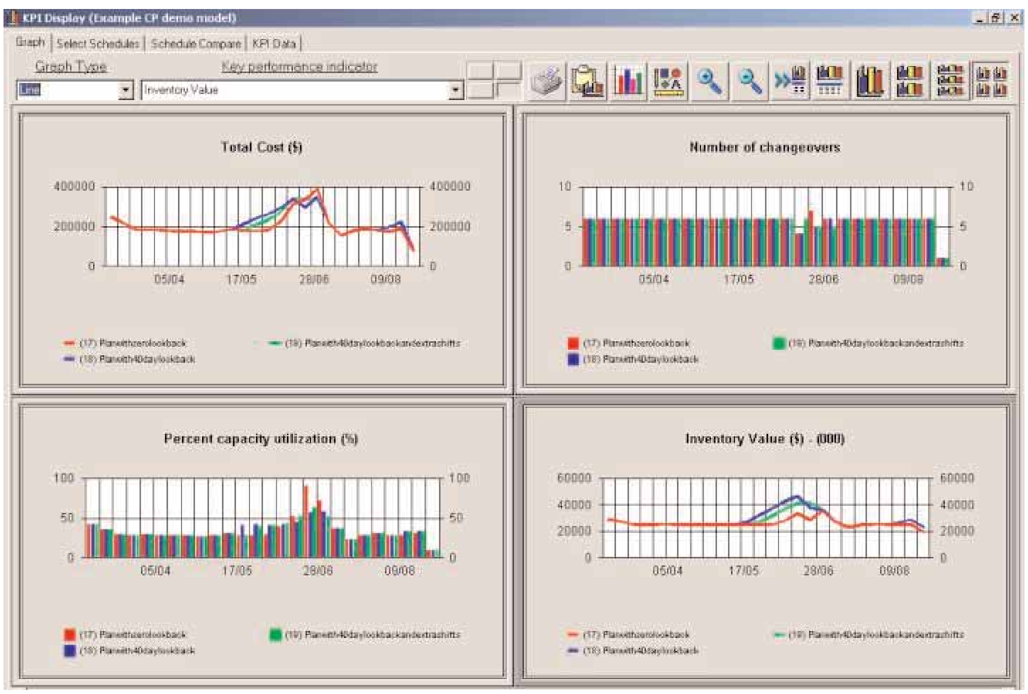

Figure 3: Key Performance Indicators illustrate the tradeoff between plant utilisation, production cost, changeover frequency and inventory value

Accurate Production Budgets

Another area where APS systems such as Logility Voyager Manufacturing Planning can be invaluable is in budgeting. Voyager Manufacturing Planning supports costing of materials, production costs by item/machine/mould, inventory costs, and changeover costs, so projected costs by item/machine/mould are readily available. Projected costs for future production can be the point of comparison for alternative production plans and scenarios. Production and finance can easily coordinate their concerns and agree on the best plan from both perspectives. Finance has accurate projections of future production and inventory costs to help plan cash flow.

Another unique strength of Voyager Manufacturing Planning relative to budgeting is that the same constraint-models used operationally for planning purposes may be used off-line. This allows them to be used easily to conduct what-if analyses, to simulate for example the impact of investment in new machines on production throughput, costs, and customer service levels, thereby helping justify capital expenditure (CAPEX) proposals and ensuring efficient use of funds.

Powerful What-If Analysis

Plastic companies often need to conduct what-if simulations for a variety of reasons but typically struggle to identify appropriate solutions to undertake such activities other than spreadsheets that can be time-consuming to maintain and which afford limited representation of reality. APS systems such as Voyager Manufacturing Planning provide a powerful alternative. Example what-if simulations include assessing the impact on energy/throughput/customer service/inventory of:

- Changing to a new energy tariff (with different MPR, MD and/or LF constraints);
- Changing manufacturing strategy in terms of the number of mould changeovers permitted per week;
- Increasing/decreasing the number of moulds/machines available;
- Changing to a new type of moulding machine with different energy consumption ratings or product flexibility;

Voyager Manufacturing Planning facilitates such strategic analysis. Alternative plans may be created simply by changing the constraints/costs in the model. Standard features of the system then allow the alternative plans to be compared side by side in terms of production throughput, customer service, inventory levels, cost, and changeover frequency, enabling management to identify the optimal decision moving forward.

Comparison of alternative plans

KPI Display (Example CP demo model)

Graph | Select Schedules | Schedule Compare | KPI Data

Grid Lines

Type	Start Date	End Date	Unit of Measure	Planwithzerolookback	Planwith40daylookback	Planwith40daylookbackandextrashifts
Value of inventory in stock-out	3/8/2004	9/5/2004	dollars	$317,128.78	$59,899.97	$205,097.63
Quantity of Stock-out	3/8/2004	9/5/2004	quantity	0.00	0.00	0.00
Inventory Carrying Cost	3/8/2004	9/5/2004	dollars	$2,564,041.64	$2,824,680.97	$2,750,543.15
Safety Stock Carrying Cost	3/8/2004	9/5/2004	cost	$.00	$.00	$.00
Variable Cost	3/8/2004	9/5/2004	dollars	$2,655,033.03	$2,648,463.03	$2,639,463.02
Fixed Cost	3/8/2004	9/5/2004	dollars	$28,377.08	$27,150.00	$26,770.83
Usage Cost	3/8/2004	9/5/2004	dollars	$.00	$.00	$.00
Inventory Value	3/8/2004	9/5/2004	dollars	$26,063,718.38	$28,675,638.62	$27,933,391.86
Safety Stock Value	3/8/2004	9/5/2004	value	$.00	$.00	$.00
Average Cost	3/8/2004	9/5/2004	cost	$.00	$.00	$.00
Total Cost	3/8/2004	9/5/2004	dollars	$5,265,151.75	$5,517,294.00	$5,435,377.00
Minimum Inventory Quantity	3/8/2004	9/5/2004	quantity	42,804,001.83	43,016,177.03	42,939,131.91
Maximum Inventory Quantity	3/8/2004	9/5/2004	quantity	76,450,198.36	77,684,060.20	77,350,991.61
Average Inventory Quantity	3/8/2004	9/5/2004	quantity	59,657,689.14	60,375,977.31	60,329,706.20
Minimum Constraint Quantity	3/8/2004	9/5/2004	quantity	29,833,440.00	29,833,440.00	29,833,440.00
Percent of orders completed on-time	3/8/2004	9/5/2004	percent			
Percent of orders completed late	3/8/2004	9/5/2004	percent			
Percent of orders completed NOT late	3/8/2004	9/5/2004	percent			
Percent of orders completed early	3/8/2004	9/5/2004	percent			
Percent of orders not filled	3/8/2004	9/5/2004	percent			
Percent of orders partial filled	3/8/2004	9/5/2004	percent			
Number of orders completed on-time	3/8/2004	9/5/2004	quantity	0.00	0.00	0.00
Number of orders completed late	3/8/2004	9/5/2004	quantity	0.00	0.00	0.00
Number of orders completed NOT late	3/8/2004	9/5/2004	quantity	0.00	0.00	0.00
Number of orders completed early	3/8/2004	9/5/2004	quantity	0.00	0.00	0.00
Number of orders not filled	3/8/2004	9/5/2004	quantity	0.00	0.00	0.00
Number of orders partial filled	3/8/2004	9/5/2004	quantity	0.00	0.00	0.00
Total Order Span	3/8/2004	9/5/2004	quantity	0.00	0.00	0.00
Average Order Span	3/8/2004	9/5/2004	quantity	0.00	0.00	0.00
Total Production Time	3/8/2004	9/5/2004	hours	3,067.00	3,087.00	3,110.00
Total Available Time	3/8/2004	9/5/2004	hours	9,216.00	9,216.00	9,312.00
NonWork Time	3/8/2004	9/5/2004	hours	0.00	0.00	0.00
Unused Time	3/8/2004	9/5/2004	hours	0.00	0.00	0.00
Total Time	3/8/2004	9/5/2004	hours	0.00	0.00	0.00
Total Required Time	3/8/2004	9/5/2004	hours	2,581,096.83	2,613,774.92	2,613,774.92
Number of Unit outages	3/8/2004	9/5/2004	quantity	0.00	0.00	0.00

Figure 4: Comparison of alternative plans

Voyager Manufacturing Planning may also be used at a more tactical level. It is important to convince staff of the benefits of proposed changes to engage them in the process of energy reduction. Voyager Manufacturing Planning provides such a vehicle. Planners can simulate the impact of alternative proposed procedures (e.g. changeover reductions, longer/shorter runs) on production throughput, customer service and energy consumption, thereby gaining greater support for proposed energy reduction initiatives.

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Conclusions:

Plastics companies in Western Europe are coming under increasing pressure from their competitors in the Middle East and Asia. To meet this commercial challenge, while accommodating energy cost increases and ever more stringent environmental regulations, it is imperative that companies take advantage of every opportunity to reduce energy costs. The ETSU and BPF have themselves already identified that companies with energy costs significantly in excess of industry averages will find survival increasingly difficult.

The first step is to make energy costs visible when planning - as direct costs for production, idle time, and changeover time. This insight into the costs impacting the manufacturing environment can and must then be leveraged to develop the most effective tradeoffs between energy costs, production schedules, customer service, changeover frequency and inventory objectives. Companies must regularly compare different strategies such as using least cost machines/mould routings, minimising mould changeovers and machine idling, and smoothing demand to accommodate advantageous energy tariffs. Recognising the complexities and flexibility inherent to a large plastic manufacturing site, these objectives only become practical with the aid of an advanced constraint-based planning/scheduling system. Conventional planning techniques are too time-consuming and limited in terms of the variables that they can consider.

As well as being capable of representing the unique constraints associated with the plastics industry, it is imperative that any APS system chosen by a plastic manufacturer be able to support the planning paradigms unique to the industry. It is also critical that the system accommodate evolving best practices, including the ability to represent energy as a variable cost which is applied differently for production and for idle/changeover time. Only then can a plastics manufacturer be confident that derived plans are feasible and executable, while providing sufficiently accurate visibility of the impact of the plan on energy costs, as well as production, inventories and customer service.

Logility Voyager Manufacturing Planning is a proven solution for the plastics industry. Its richness in representation enables plastic constraints to be fully described and modeled. Sophisticated algorithms, developed in conjunction with plastics manufacturers, accommodate the needs of the industry in terms of achieving an acceptable trade-off between mould changeovers, production times, inventory levels and customer service. Variable costs are also supported by item/machine/mould, together with changeover costs, material costs and idle costs. A broad range of key performance indicators (KPI's) are available to view over the internet, affording the opportunity to synchronise corporate objectives with operational planning.

About Logility

With more than 1,100 customers worldwide, Logility is a leading provider of collaborative, best-of-breed supply chain planning solutions that help small, medium, large & Fortune 1000 companies realize substantial bottom-line results in minimal time. Logility Voyager Solutions is a complete integrated supply chain management solution that features performance monitoring capabilities in a single Internet-based framework and provides supply chain visibility; demand, inventory and replenishment planning; supply and global sourcing optimization; manufacturing planning and scheduling; transportation planning and management; and warehouse management.

Logility Voyager Solutions enable plastic companies to become performance-driven enterprises, achieving competitive advantage through realizing dramatic improvements in revenue, cycle time, forecast accuracy, inventory optimization, production throughput, cost reduction & improved customer satisfaction.

As the only supply chain planning software solution provider who is also a member of the British Plastics Federation (BPF), Logility are committed to applying their extensive supply chain planning domain knowledge to understanding and resolving the unique supply chain challenges facing the plastics industry.

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Related information

- More information can be found on Voyager Manufacturing Planning™ from Logility at: www.logility.com

- More information relating to the RECIPE project (Reduced Energy Consumption in Plastics Engineering), including some of the published articles referenced in this document, can be found on the website www.eurecipe.com

- Other best practice guidance specific to energy reduction in the plastics industry, including ways of achieving better energy prices from energy suppliers, may be found by contacting the British Plastics Federation (www.bpf.com)

Footnotes

1 Figures are from the UK but are representative of western manufacturing

2 Plimsoll is a leading industry analysts firm operating primarily in the UK, France and Japan

3 Reduced Energy Consumption in Plastics Engineering (RECIPE) "Low Energy Plastics Processing -European Best Practice Guide", RECIPE partners (October 2006)

4 "Keeping competitive in commodity plastics - Strategies for survival in Europe" - a report from the Economist Intelligence Unit (2006)

5 "Good Practice Guide 292 - Energy in Plastics processing - a practical guide", ETSU/BPF (1999)

6 "Energy efficiency in Plastics Processing - Practical worksheets for industry", Tangram Technology (2005)

7 "The Tricky Enterprise Applications Needs of Plastics Producers", Technology Evaluation Center (September 2006)

8 "Reduced Energy Consumption in Plastics Engineering (RECIPE) - 2005 European Benchmarking Survey of Energy Consumption and Adoption of Best Practice", RECIPE partners, (2005)

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13 "Energy efficiency in Plastics Processing - Practical worksheets for industry (Energy Worksheets 1-12)", Tangram Technology (2005)