THE PROSPECT AWARD 1980

On-line Mixture Calculation System for Stainless Steel Production by BSC Stainless: The Least Through Cost Mix System (LTICM)

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A manufacturing industry with a raw materials bill of approximately £60 million per annum was faced with the problem of finding the best way of purchasing and using its raw materials to obtain operating and cost gains. This paper describes design and implementation of the system, which provides a 24 hour on-demand computer service that is run on a routine day-to-day basis as an integral part of the manufacturing process.

INTRODUCTION

This paper describes the development and implementation of the on-demand Least Through Cost Mix (LTICM) computer system installed by BSC Stainless, part of British Steel Corporation’s BSC Holdings, “to provide a more scientific and objective base for the buying and use of raw materials”. Stainless steel is an expensive product and is made from expensive raw materials whose prices vary in an irregular fashion. The annual BSC Stainless raw materials bill is about £100 million.

The decision to install the system was made in October 1974, following feasibility studies and the implementation of a pilot scheme at Panteg Works in South Wales. This work had demonstrated that theoretically savings of up to 10% could be made in raw material costs. It had also demonstrated that to achieve even a fraction of these savings it was necessary to provide daily routine access by steelmakers to complex and sophisticated computing facilities, with very high reliability and short response times.

Management requirements for the system, to be fully operational and tested at Panteg, ready for the commissioning of a large new stainless steelmaking facility at Tinsley Park, Sheffield, in Spring 1977, were to:

—calculate raw material mixes for casts on an individual and a daily basis
—evaluate raw materials on offer, giving guidance on optimum use, value to BSC, buying strategy, etc;
—control raw materials and record movements, usages, stock levels, values, etc;
—estimate raw material requirements for minimum cost steelmaking in the short, medium and long term;
—investigate and evaluate alternative practices in the use of materials and in the steelmaking process;
—allocate materials between steel qualities, works, process routes to minimise overall steelmaking costs;
—assist in setting operating standards.

These management requirements led to the following basic operational requirements:

—routine day to day use, fully integrated with operations and management.
—accessibility to the users over an 18-shift week, with the system always apparently accessible, with quick response, satisfactory turnaround and high reliability;
—easy to use by unskilled shop floor operators, technical and research personnel, operating management and purchasing staff with no computing background or interest;
—comprehensive and rigorous in calculation, considering all relevant factors;
—simple input;
—clearly presented and easily understood output for immediate use as a routine part of operations;
—minimum steelmaking production costs;
—reasonable running costs.

SYSTEM DESIGN

The theory of "the blending problem" was well known, and the purpose of the original feasibility studies had been to assess the applicability of Linear Programming to steelmaking mixture calculation. However, the feasibility studies, and the subsequent simple pilot weekly and daily calculation systems installed for Panteg to get operating experience, had demonstrated beyond doubt that to calculate mixtures acceptable to steelmakers it was necessary to go beyond the simple application of Linear Programming by specialists, and to include day-by-day operational and policy restrictions in the calculation, and to take account of the relationships between materials and process costs. It was clear that to obtain a simple system for the user it was necessary to have complex Mathematical Programming facilities with Integer Programming and process cost modelling included. It was also clear from the work at Panteg that the raw material information necessary for a mixture calculation included all the information necessary for a full raw material control system. It was decided that the whole system would be operated via Visual Display Units with associated printers. It was this very practical approach to system design by Operational Research, which had convinced BSC Stainless between 1971 and 1974 that such an approach to use of materials, would be viable and profitable.

There were practical problems in running even simple LPs within BSC. All the BSC computing facilities were data processing oriented, and work had to be fitted into schedules, precluding an on-line service quite apart from the question of the time taken to solve an LP on the machines available. It was therefore decided to develop the required Mathematical Programming model including integers and process cost modelling, develop benchmark jobs and approach potential suppliers of computing facilities. Such a model could easily become prohibitively expensive to run, with very long run times and the balance between detail, accuracy, cost, run time and user acceptability of results was critical. It was decided that the model must be as simple as possible while adequately representing all necessary variables. Extensive sensitivity testing was carried out to determine the degree of detail necessary in process representation. No satisfactory process model or process cost model existed, anywhere in the world, and extensive investigations were carried out to determine empirical cost relationships, using a research chemical model of the process and operational and experimental results on the Panteg plant.

Theoretically, mixture costs for a number of mixes are lower if all mixes are calculated together rather than sequentially. The benchmarks developed therefore represented calculation of a single mix (B1) a day's mixes (B2) and a week's mixes (B3). Table 1 shows the three benchmarks and actual representative single mix calculations in the implemented system.

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