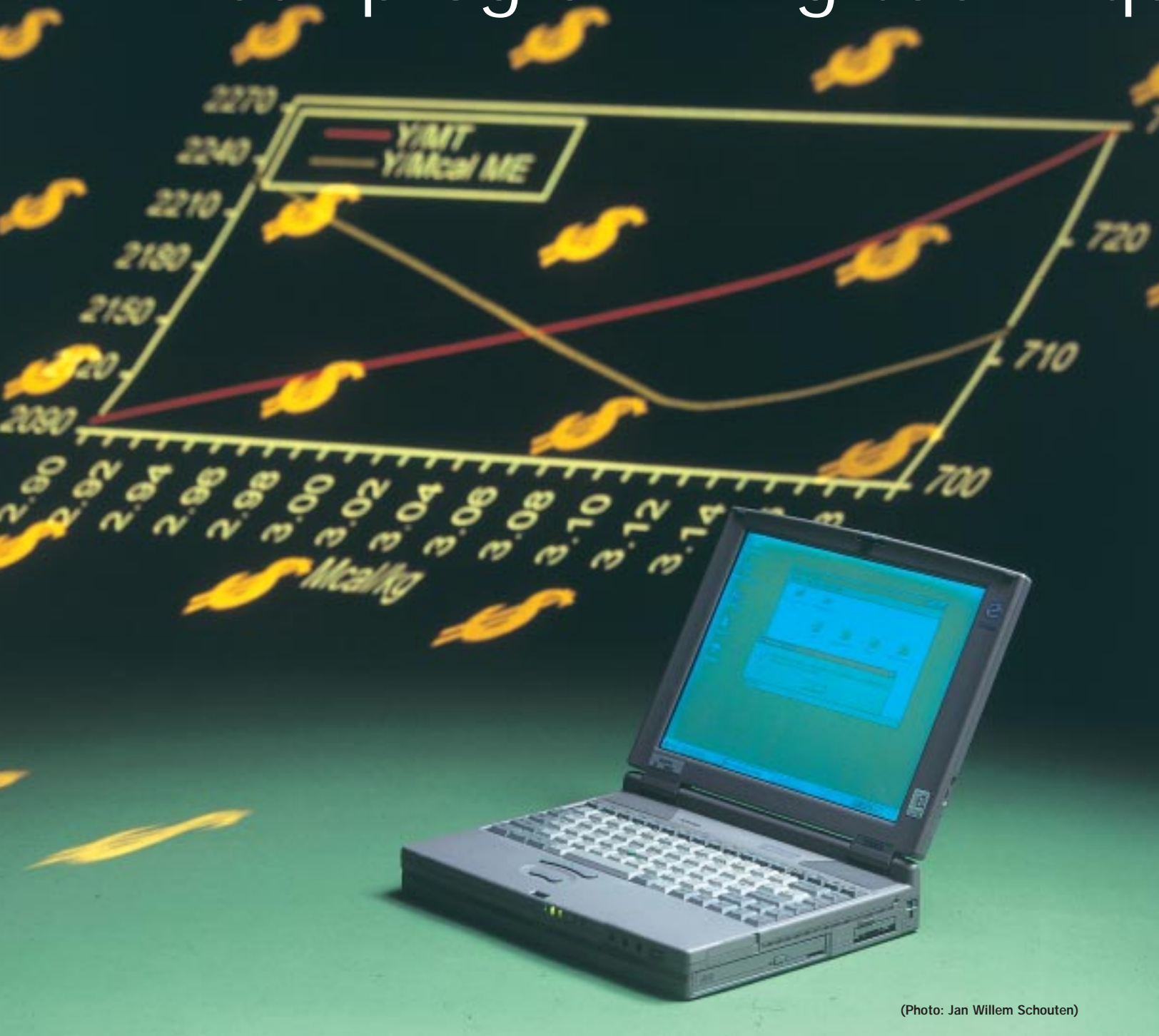


Nutrition

Linear programming technique



Software employing the linear programming technique has been used in feed manufacturing for over 30 years. It has offered the benefits of containing recipe cost whilst meeting the technical requirements of the products. As technical knowledge, market conditions and legislative requirements change the demands on a formulation system have moved beyond purely designing least cost recipes.

By Ian Mealey, business development manager, Format International, UK

Format evolves into multitask tool

Whilst formulation software's main purpose is the least cost optimisation of recipes, developments in this area, applicable to the feed and food industries have been relatively infrequent. Format International were the first formulation software provider to extend the application of linear programming from single products to multiple products with overall constraints on raw material availability, and to multiple products in multiple plants and periods in the Multi-Mix® and Global-Mix® products in 1974 and 1978 respectively. Similarly they were the first provider to include probability constraints using stochastic techniques in the QC-Mix™ module in 1991.

All of these advances were driven by the need for feed producers to address real issues affecting costs. One of the most recent advances in recipe optimisation is Format International's Integra-Mix® module. This is the first commercially available software package to optimise, at least cost, products, which contain sub-component recipes where these sub-components may be shared between finished products in multi-level hierarchies.

Future developments are required to allow feed and food manufacturers to cope with increasingly complex constraints including the need to control relationships between ingredients in the recipe or taking into account the nutritional value of the mixture where it can be proven to be different to the simple sum of its parts. For these types of questions the focus will be on developing practical and usable techniques to optimise recipes with non-linear constraints.

Formulation management

Increasingly, the emphasis of development has been to create tools and facilities to assist formulators in the management of the formulation process. This is particularly valuable where resources are limited; quality and accuracy must be maintained at all costs even in this situation.

Software providers have recognised this and have worked over many years with clients to provide suitable facilities within software. For example, the NC™ system includes the "Central" database hierarchy. This allows centrally maintained raw material and product specification data to be dynamically distributed across multiple databases and through multi-level hierarchies, whilst respecting local differences. For companies managing formulations for multiple production sites, this can offer increased efficiency, accuracy and control of data, which is a fundamental

input to the formulation process. Similarly, any formulation system must provide a wide range of easy-to-use functionality that allows efficient, accurate data maintenance.

However, due to the increasing pressures on formulation departments, we developed new techniques that help with processes that are part of the formulation function, but do not relate directly to least cost optimisation.

During the last five years several products have been developed in response to the changing needs of the industry, such as Smart Label™, which generates legal declarations for products based on the contents of the recipe and offers the user the ability to define their own rules and settings so that the local legislative requirements for the declaration of nutritional, ingredient and additive contents can be included and the inclusion of warnings and texts. Or Bio-Security™, which was developed to formalise and automate the manual process for checking and approval of recipes before they are passed to production. Tracer™ was developed to allow the storage of historical formulation data. Tracer stores a snapshot of the formulation database; ingredients, specifications and recipes, as it stands at the time a new set of recipes is produced, with each element being given a unique version number for identification.

Access and flexibility

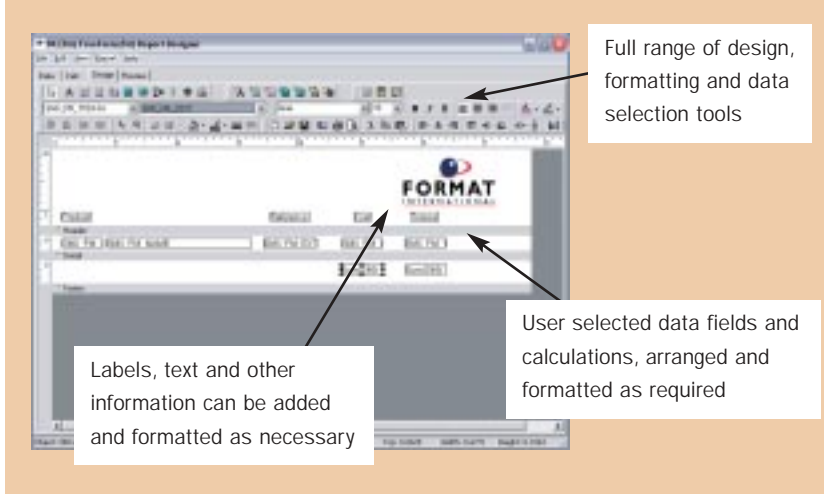
Another trend that is noticeable in formulation systems is the need for greater accessibility and flexibility. As well as having to respond to new challenges, users of formulation software are more and more familiar with a range of software products and what they are now capable of. They expect their formulation systems to integrate easily with other systems ranging from the company ERP system to office software such as spreadsheets.

Direct access to data in formulation systems enables more efficient communication of information. With convenient facilities, the user of the software is able to configure, control and maintain their own integration without being dependent on the software provider.

Reporting of formulation data is another area where the user of formulation software increasingly requires more flexibility and control. Users expect to be able to present their reports in a more professional way, according to their own requirements and in a variety of formats. Accordingly, we have recently developed a new reporting tool; NC™ FreeForm™.

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Figure 1 – Example of a report being designed in NC FreeForm



This utility allows users to create their own report designs, and produce reports as printouts, on-screen or saved to common file formats such as PDF and XLS. A wide range of facilities allow reports to include graphs, bar-codes, images and calculations in addition to the NC database fields. The illustration in *Figure 1* shows a new report being designed in NC FreeForm.

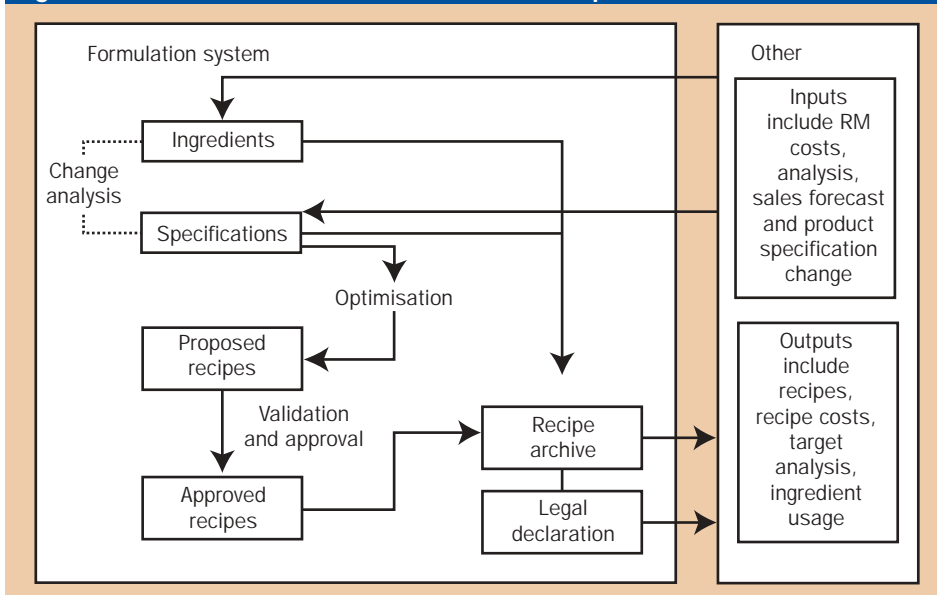
Utilities such as integration and reporting toolkits significantly enhance the value that can be realised from the software and enable companies to meet their own needs, without the necessity to wait for new releases of the software.

The formulation process

All of the developments in formulation software are designed to allow the user to produce least cost recipes within the constraints, whether nutritional or more external pressures, in the most effective manner. The tool should support the user in whatever formulation process they wish to implement. A typical formulation process can be outlined as follows:

1. *Data inputs* – The collation and input of data required by the system, including raw material analysis and costs, product specification limits and product sales forecasts.
2. *Change requirement analysis* – A check may be implemented to assess the need for re-optimisation.
3. *Optimisation* – The creation of new recipes using the latest inputs and constraints.
4. *Validation* – Checking the new recipes for conformance and accuracy.
5. *Approval* – Once recipes have been validated, with any problems corrected, the recipes can be formally approved for manufacture and move on the next stage of the process.
6. *Data output* – Including reporting, the generation of legal declarations and transfer of relevant information to other systems, e.g. the recipe to the production system.

Figure 2 – Schematic outline of the formulation process



The formulation system should provide a range of suitable transactions to help with this process. In addition to the standard functionality that would allow a user to input and maintain data, optimise and output and report data, the following tools can all be involved in the formulation process:

- Interface utilities and file imports and exports, can automate the data input and output.
- Format systems include a script functionality, which the user can set up themselves to perform calculations as required for any

stage of the process.

- Bio-Security can play a vital role in the validation stage of the process, ensuring that only valid recipes can be approved.
- Approved recipes can be stored in a specific area, during which process (along with other data involved in the formulations) a unique version number is placed against the recipe to help with identification.
- Legal declarations can be generated using labelling software. Labels may be output directly or transferred to other systems using the interface utilities described earlier.
- Format provides a comprehensive macro facility, which can be set up by the user to automate any set of transactions within the system.

An outline formulation process is shown in *Figure 2*.

Different types of formulation process

The above description focuses on the routine formulation process to derive a new set of recipes that is typically performed on a monthly basis in many organisations. However, there are other, equally important, valid demands on the formulation function, the main one being for forward evaluation and planning.

This area can often be neglected but is extremely valuable for those companies that use their formulation software strategically; bringing additional value and offering further cost savings and efficiencies. The use of the system for this purpose requires similar data inputs and methods as those used in the routine formulation process, so many of the tools described there can be used for this purpose as well.

Typically, though, different outputs are required – the types of report produced and the information that may need to be transferred to other systems will focus on ingredient usage, rather than the actual recipe. Also the validation and approval exercise may not need to be so rigorous as that required during the routine process where the recipes are destined for manufacture.

The main challenge for a forward evaluation formulation procedure is to turn decisions, which were based on information obtained during the evaluation, into a plan, which forms parts of the constraints on the routine formulation procedure. For example, if I run an optimisation exercise in July, looking at the December period, a variety of decisions may be made based on that work. When December arrives, the recipes that will be used in that period (and which will be derived during a routine formulation exercise)

Conclusion

Formulation software should give the user enough facilities to enable the accurate maintenance of data, without demanding disproportionate time and effort. With this level of functionality, the formulation role is freed to devote more time to tasks such as forward evaluation and planning. Time devoted in these areas is rewarded with cost savings and increased profitability and quality – the reason for which formulation software is employed in the first place.

Future developments should be conscious of the needs of the user. Time, manpower, legislative and competitive constraints will become ever more demanding and the software must respond. Focusing on usability and flexibility so that users can be in control in order to answer their own needs.

must take those decisions into account. If a constraint on a raw material's usage is ignored, I may end up costing the company more money, even though on the face of it money may be saved in that period and location. Having said that, it is not only perfectly legitimate; it is desirable to challenge any decision since new information may now be available. However, the routine process must at least be aware of the constraints. In this way, the evaluation concept can be applied even in the short term.

Continuous variability

Another significant challenge for the effective implementation of a plan is the inherent variability in the materials and markets with which we work. As stated above, new information may be available at a later date, which affects the validity of a decision, which may have been made sometime ago and without this information. Variability may be found in raw material prices, availability and quality and in product sales forecasts or even specification constraints.

Formulation software must provide suitable functionality to allow the user to assess risk and in this way, hopefully make a better decision. Format developed its Parametric approach based on this need. Parametrics allows the investigation of step-wise changes in factors involved in the optimisation. For example, running a Multi-Mix Parametric exercise on the cost of a raw material will show how sensitive the material is to movements in price, and the effect on the rest of the materials' usage. An invaluable tool when assessing how much of a material to buy. ●