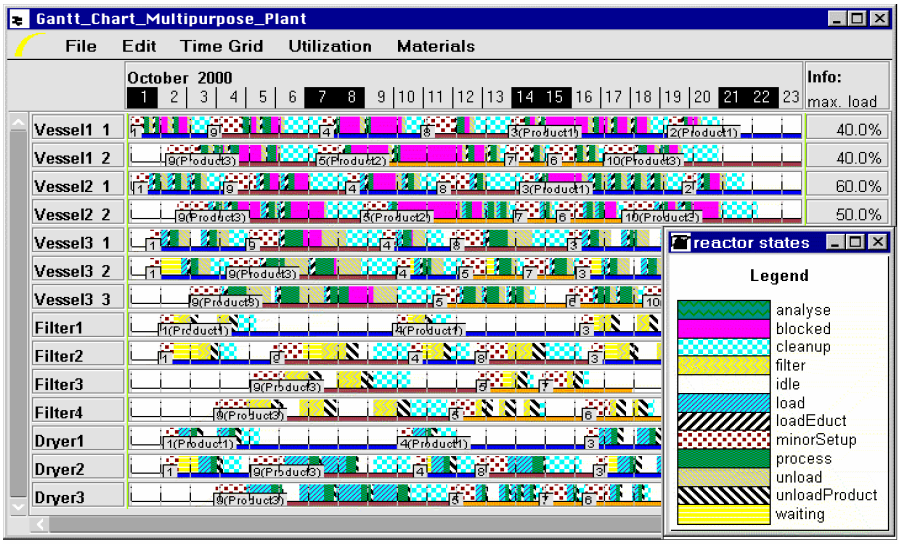
As few as necessary[1]

Finding out the equipment absolutely necessary in a multipurpose plant can turn to a very risky business.
Safety is provided by simulation tools which highlight device occupation and bottlenecks. In a fine chemical plant, BASF succeeded in this way in reducing the device park by a fifth.



An easy-to-learn Windows® user interface and the good support of the software producer make it possible to carry out modeling and simulation on one's own.

In multipurpose plants only a limited device park is available for the production of a multitude of related products. But what does "limited park" mean? As few devices as absolutely necessary, because the production costs can only in this way be optimal. This is particularly important in specific sectors of the fine chemical industry, where the product diversity is the rule and where the use of multipurpose plants constitutes a standard. The margins there have been drastically reduced due to the Asiatic competition.

To cope with this situation, BASF currently carries out a reorganization project to optimize the world-wide production of a specific portfolio of fine chemicals. In this context, the production capacity of a plant in Ludwigshafen has been analyzed. This multipurpose plant consists of 142 production devices in which about 500 different liquid and powdery chemicals are produced. The objective was to find the optimal number and configuration of devices for a specific assortment of 28 products with batch sizes from one to 20 tons.

Günther König, plant manager: "We stood under a strong time pressure. Within one year, the project should be completed, in fact by our own collaborators using their exact knowledge of the plant processes." At that time, the team had no experience of simulation tools yet. "Therefore", König goes on, "the time needed for modeling the processes could not be forecasted."

Hence, it was essential to the project to be able to easily represent the material flows in a clear model. The user-friendliness of the software to be used played an important role, since the development and the analysis of the model had to be carried out by a foreman of the batch plant. Nevertheless, a realistic representation of the production with its complexity and its special operations had to remain possible.

Taking all relevant factors into account, the plant decided to use the material flow simulation tool SIMBAX of AICOS Technologies. König: "Other software packages are very complex and can only be used by specialists. Because the time would not have been sufficient to introduce computer experts to the complex processes of our plant, we were

[1] This is an English summary of a paper published in the German magazine *Chemie Produktion* in November 1998.

looking for a system for which basic knowledge of computers was sufficient."

The project started in spring 1997 with an introductory training and a project-specific workshop. The model has been built according to the modularity provided by the software. Firstly, using a common factory plan, the equipment have been modeled: mainly reactors, spray dryers, grinders, mixers and intermediate storage places. Workers responsible for manual tasks have also been involved in the model as additional resources.

Then, for each product a corresponding production recipe has been modeled, the level of detail being fixed according to the needs. "The model development has only been refined until process operations were represented in such a way that their duration and the resulting throughput were in average correct", König explains. "Our objective was the reduction of the plant capital and of the related routine costs, taking the build-up of stock and the availability of the products into account."

The behavior of the intermediate storage places as a function of their size and of the number of product containers available was of great interest. Thanks to the extensive software functionality in the area of material transfers, both the bigbag filling operations and the recycling of product containers having been cleaned so as to be used for further batches could be represented precisely.

Further, the production processes have been analyzed for each final product, the bottlenecks determined and the resulting waiting and blocking times clearly identified. This enabled to design more efficient production processes, e.g., by using several drying, mixing and grinding devices in parallel.

The plant capacity has been evaluated by simulating production plans covering one year respectively one quarter, taking or not taking account of the customer ordering behavior. The resulting Gantt charts made it possible to analyze graphically the interaction between products sharing the drying, mixing and grinding capacity.

Thus, the plant can now avoid conflicts leading to capacity losses and determine the optimal configuration and combination of devices.

Efficiency – also in front of the screen

The material flow simulation software package SIMBAX enables to quickly determine and to systematically eliminate the bottlenecks of a production plant. The software has been developed from the very beginning to fulfill the needs of the process industries. The advantages:

- easy use thanks to the utilization of the technical language of chemical engineers and plant managers in the interface;
- very short learning phase thanks to the graphics and the fully object-oriented architecture;
- reality-like representation of the production environment in form of equipment, recipes and production plan;
- effortless and realistic modeling of complex processes with alternative, parallel and semicontinuous operations, buffer tanks, filling and storage processes as well as clean-up and set-up operations;
- detailed representation of additional resources like workers and utilities via calendar specifications including shift models, weekends and breakdowns;
- simplified data input over an Excel interface;
- clear results: dynamic animation in the layout and in the Gantt chart during the simulation, useful statistics for the easy comparison of scenarios (among others utilization charts, reactor and storage contents curves, resource and material consumption curves).

Last but not least, the optimization was extended to the synthesis. The results showed that, depending on the product, either the synthesis or the finish stage constituted the bottleneck. The foreman directly worked out on his PC recipe-specific rules for the synchronization of both stages. Should for instance the synthesis be the bottleneck, then storing the products before the finish stage was necessary in order to avoid standstills in the area of the spray dryers. A well-founded dimensioning of the corresponding intermediate storage became in this way possible.

Before concluding the study, the model developed was used to estimate the sensitivity to dryer breakdowns of the conclusions drawn. Using the simulation, several types of disturbances (staff shortage, non-planned repairs, late delivery of raw materials) could be compared very easily.

In this first self-directed material flow simulation of the production plant, the good support provided by the software producer was of great importance. “Worth mentioning are the successful training and the online help over the hotline.”, König means. “The user learnt step by step – in an analogous way to the refinements of the model. The Windows interface facilitated the use of the software.” The processes of the fine chemical plant could be analyzed with no effort. “Furthermore, the producer developed and implemented some new functions tailored to our needs.”

König wants to tackle further projects of the same plant in a similar way, using the same software tool. The consequences were already considerable for the first project. König: ”Devices with a total cost amounting to 20% of the plant capital and that were reserved for this special product group can now be used for further purposes. After all, these are devices worth more than four million German marks.”