Advanced process visualisation

Suzanne Gill reports on an interesting graphical technology which can reduce variability in process operation, with the added benefit of also reducing operating costs.

Geometric Process Control (GPC) is a patented technology based upon the geometry of n-dimensional spaces, where n is greater than 3. It brings together production control, process control and alarm management. GPC is a graphical method for visual analysis and process modelling which makes it understandable by everyone working in a process plant including those with little mathematical education.

The starting point for GPC is the historical performance data that already exists in the process historian databases that are found in almost every plant. GPC allows for visualisation of hundreds of variables, simultaneously, instead of the three or four that are possible with traditional methods such as Cartesian coordinates.

For simplicity, there are two main GPC products: CVE which is the exploratory product and CPM/CRSV which are control tools. Through a combination of these applications, plant engineers are able to visually find, see and model the operating envelope of an entire process.

GPC provides a simple and non-mathematical method to create real-time models of the operating envelope of a process, including a real-time operator display. The multivariable graph is used to find examples of previously successful operating points and the resulting cloud of points is 'shrink-wrapped' to create the operating envelope. The mathematics behind this are the same for every process, whether batch or continuous, so the software can be provided once, for the use of all users, without their needing any deeper understanding of mathematics.

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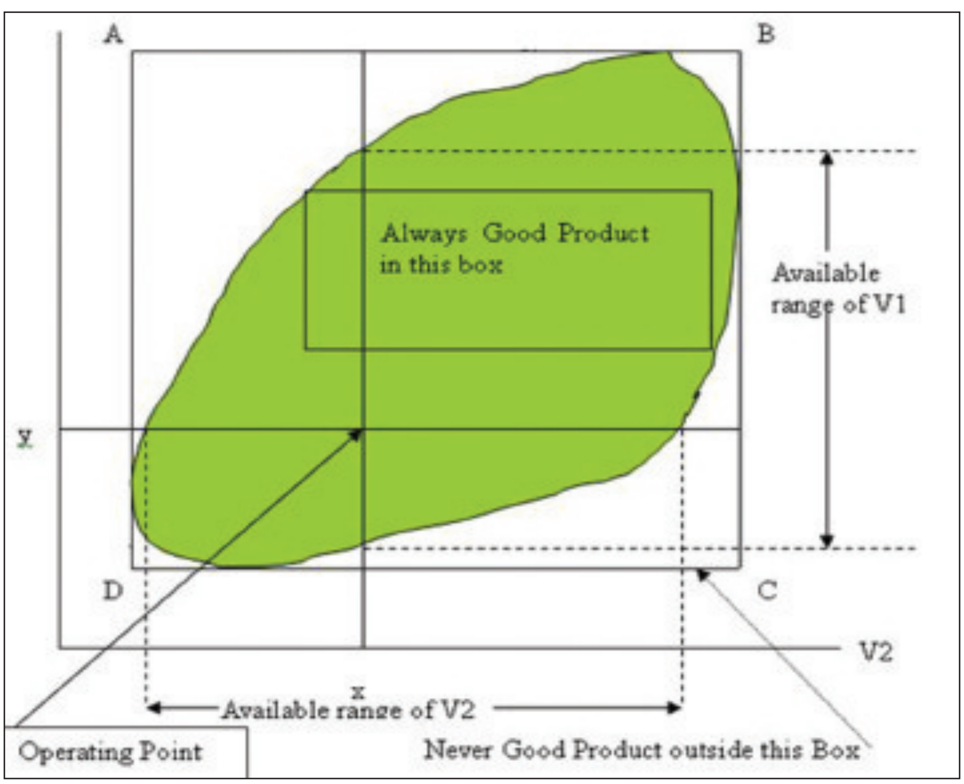
GPC models can incorporate hundreds of variables simultaneously and give the operator a simple 'you are here' display, which shows the current process position within the Operating Envelope as well as its distance from its boundary. Should the process stray out of the envelope, alarms and alerts are generated and corrective advice is provided as movements of the manipulable process variables. This advice can be used in open-loop applications by the operator or in closed-loop applications can be sent directly to the set point of the lower-level process control scheme. Further, optimisation for secondary process objectives, such as minimising energy usage, is achieved by expressing the objectives in terms of variables in the model that are to be maximised or minimised and then seeking sub-spaces



GPC models can give the operator a simple display, showing the current process position within the Operating Envelope as well as its distance from its boundary with the Envelope where the secondary objective is also achieved.

Once the concept and reality of the Operating Envelope is established the proper role of Operating Limits and Alarm Limits become clear as 'probes' used to detect and/or indicate the surface of the envelope. Traditionally, it has not been possible to visualise an image of an n-dimensional envelope.

Alarm limits

Operator alarm limits are the first line of defence for a process and should give the operator sufficient time to understand and correct a problem before it becomes dangerous. The values at which the alarm limits are set determines this but setting the limits 'too tight' produces too many alarms for the operator to be able to assimilate and use in the time available. 'Too widespread' and alarms will not alert you until your process is on the brink of danger. There has never been a scientifically-based method for finding values for alarm limits, hence most are very poor and many are routinely ignored by operators as 'false alarms'. GPC can

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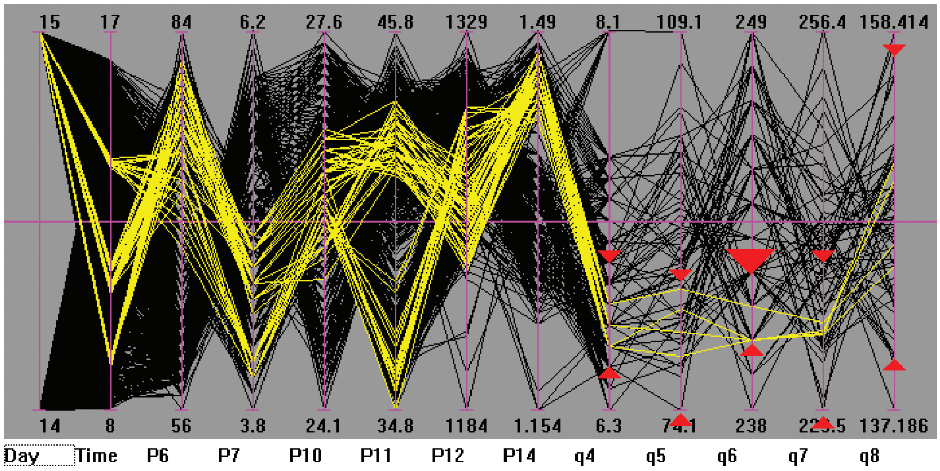
offer a simple visual method to find much better values for alarm limits complete with predictions of the standing alarm counts and annunciation rates, resulting in the elimination of opinion and guesswork that characterises today's prolonged and time-consuming alarm rationalisation reviews.

Working behind the scenes

GPC works behind the scenes by transforming the many orthogonal axes of n-dimensional space into a 2-dimensional form. The unique



GPC creates real-time models of the operating envelope of a process, including a real-time operator display

combination of parallel coordinate transformation and n-dimensional geometry makes it possible to see a multi-variable graph containing several hundred variables (such as temperatures, pressures, flows and product qualities) and thousands of different observations in a single picture.

The key issue preventing the comprehension of such a large collection of data was visualisation. With this in mind, a new form of graph was created, with axes drawn vertically and parallel to each other, allowing many axes, and a related set of variable values, to be represented by a polygonal line connecting the values of each variable plotted on its own axis.

The graph becomes infinitely more useful when many points (or hours of operation) are overlaid upon one another forming patterns and delineating modes of operation. The ranges which fall outside of ideal product specifications provide information on how to reduce the range on these variables and, once manipulated, can help by eliminating undesirable production. The software can be taken a step further and the existing 'box' or settings which were previously used to control product specifications can be mapped against the new process variables which have been found. The immediate yield increase can be calculated and the benefit of this lies in the proof that (in most cases) GPC software has already paid for itself. Using the software for daily improvements or additional projects then becomes an added bonus.

GPC technology is easily retrofittable. It works with process and quality data already captured in the plant historian, or even in manual spreadsheets of data. This means that any plant, regardless of how advanced the systems in place are, should be able to make use of this technology. The only requirements are a Windows based operating system 2000 or above. A Windows based network is required for network installations, as opposed to individual licenses.

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Chemical and pharmaceutical benefits

GPC also has major benefits in speciality chemical and pharmaceutical industries, where batch processing dominates. In the past, batch processes have been difficult to analyse and control because there are so many variables changing at once and so many radically different sets of activities taking place in sequence.

GPC allows gives users the ability to analyse multi-stage processes, linking end-of-batch product qualities - for many batches simultaneously - back to what was happening in an individual phase during the first stage of a batch. The operating envelope may also be mapped to model each phase of a batch given a selection of good batches.

GPC tools can then be used either off-line, setting better targets for each phase of the process, or online, giving the operator real-time operating advice for use in either open-loop or closed-loop control.