

Focusing on FUSION

By Anny Dentener

D.o.E. FUSION Pro by S-Matrix, version 7.3.20

Website: www.smatrix.com

Function: *Design and Analysis of Experiments; Historic Data Mining; Method of Steepest Ascent; Multiple-Response Optimisation.*

Cost: US\$495

Rating: ★★☆☆ (out of 5 stars)

Need a carbonated drink bottling line optimised to avoid wasting product while maintaining high filling speed? Want to speed up a new analytical method and work out if you can justify switching to it? Require maximum strength out of your packaging material? Looking for the best texture when mixing different food materials? These cases are described in the extensive D.o.E. FUSION Pro tutorial. As the cheapest of the tailor made Design of Experiment packages reviewed to date, I was curious if it would represent value for money.

When starting a new design in FUSION Pro you enter all variables (name, units, type and limits) on one sheet before proceeding to design generation. This logical step suits the way I work, in contrast to selecting a design first as in Design Expert (Review FTNZ September 2002 *) and then entering the variables. As a non-statistician I generally have no idea initially what statistical design is necessary, and appreciate assistance from the program. Entering all design variable information on one page is also more convenient than the many steps required by ECHIP (Review in FTNZ February 2003 *).

Design variables (see Figure 1) can be continuous (e.g. concentration), discrete numeric (e.g. speed 1, 2 or 3 on a mixer), categorical (brand A, B, C) and/or mixture variables (need to add up to a certain %). Availability here of the combination of mixture and process variables (called crossed designs) is good for food industry work, but often lacking in general statistics

packages. Mixture variables do not need to add up to 100% but can be any amount specified. For instance, if you sorted out half your product formulation but needed to refine the other half, it works out the exact numbers for the rest. It is also possible to choose a so called “split-plot” design, where you keep those variables that are hard to change (e.g. a main plant setting or treatment) the same in the one lot.



Figure 1: “Create a Design” opening sheet

To generate a design, you use the “Design Navigator Wizard” when you do not know the design to use and require assistance, similar to the guided mode of Camo Guideline (Review in FTNZ May 2002 *). For those statistically inclined, use the “Design Menu Wizard”. In each case it asks to confirm whether you are at the screening stage, finding out the significant few, or at the optimisation stage. The relatively large size of optimisation experiments is the reason that screening experiments are employed first. Further steps all have “default” buttons and the software explains choices in “plain” English. There is an extensive Help file when you still get stuck but this is in parts more “statistic speak”.

If you have historical data that you want to analyse and discover patterns in, skip the design steps and go straight to “Data

Entry/Mining". Data are entered easily from any spreadsheet and are then juggled with the help of the very handy "Matrix Master Wizard" in which you designate design and response variable columns before analysis.

"Data Analysis" requires you to do the Analysis separate for each response. This can be Automated (i.e. for non-statisticians) or User-Defined. The first report is called a "Plain Talk Report" where I would expect a summary of which of the design variables are most crucial for that response. Instead, it states if the statistical analysis worked well or not, and requires you to use a pull-down menu to find all facets of the analysis. Unfortunately when Automated did not come up with good results it told me to go into User-Defined and adjust it which does defy the automated option concept. The next pull-down report is the Pareto chart (Figure 2) where effects are sorted into order of importance, followed by more statistical results in separate reports.

Missing are reports of all statistics combined for one result, as well as a complete overview of all results (e.g. the star charts in ECHIP). Fusion Pro does not correctly analyse binomial (yes/no) responses and treats them as continuous. Use is advised against by the e-mail support line.

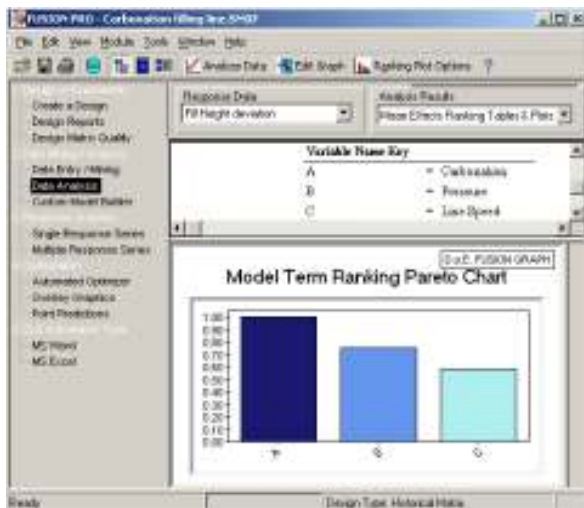


Figure 2: Pareto chart for effects of carbonation %, pressure and speed on filling height deviation in bottling

Graphs for each single response are available in "trellis" format, where design variables A and B (x- and y-axes) display results for three different levels of design variables C and D. It pays to first check which two variables are most important for the results. Where more than four design variables affect the results, the off-screen setting of other variables is awkward, even more so for crossed designs where mixture variables are graphed separately from process variables. Graphs can be 3D Response Surface or 2D Contour. Each graph can be enlarged and adjusted with many graphic options. The Reset button is good to return back to the original. It is not possible to enlarge just a few of the graphs at the same time for easy visual comparison. Graphs copy across well but only 2 design variable axes are shown with no mention on it of the settings of the other design variables, which then need to be entered manually.

The Multiple Response Graph plots a maximum of nine response graphs in rows. When I deleted the least important ones from 14 responses the program did not let me add other ones and I was not able to get the deleted ones back either. A fault in the program that should be remedied in the next upgrade.

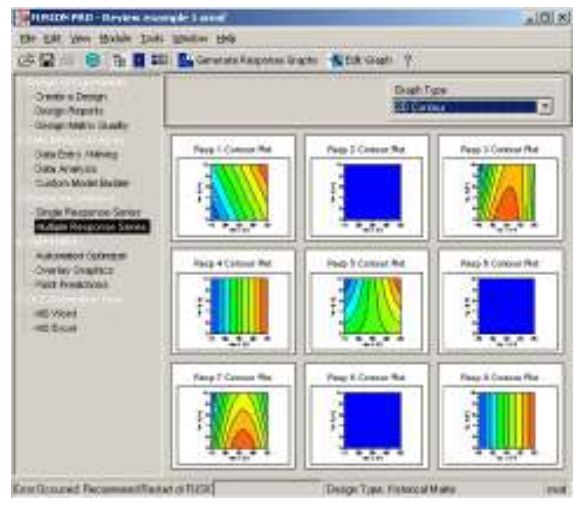


Figure 3: Example of a "Multiple Response Series" with 2D contour graphs

Optimisation for conflicting objectives can be done in two ways. The “Automated Optimizer” works with equations. You can select which design variables to include and set selected response variables on maximum, minimum or a target range. The importance of each factor can be defined from 1.0 down in 0.1 steps. With target ranges, upper and lower limits can be defined with associated weighting, and confidence ranges can be set. The program then starts the equations and comes up with the most desirable fit, and the predictions for the responses for those settings. Results obtained here are similar to those obtained by the other programs I have tested.

Overlay Graphics provide a visual optimisation and show the combination of factors where objectives are met. While the program provides an “extrapolation – this may give false results” warning here when trying to adjust the Axis to points outside the initial design, no such warning is given when outside points are entered under “Point Predictions”.

Once you have analysed your results, especially in screening trials, you may find you did not find that best point yet, and that further work is required. FUSION Pro offers a unique “Method of Steepest Ascent” in which it has a “next experiment” strategy for every design it creates. It can also do this from historical data. It steps up with 2-50 steps (default is 10) from the best point discovered, keeping the changes of all design variables in line with the best settings in the original design. For my example the step size was half that of the original range which is quite sensible. Once you reach a maximum, you carry out further screening and/or optimisation trials around that point. The programme also offers options to “augment” screening designs to optimisation. When the existing data set does not contain the required information FUSION Pro can generate Repair experiment designs that define what additional data must be collected.

There are many statistician-focussed features in the program that I have not explored. The program indicates that it includes full and fractional factorial designs, Star, Box-Behnken, Central Composite and Robust mixture-process designs. It also has classic Plackett-Burmann screening designs but advises against its use as there are better alternatives.

The website boasts over 100 names of users in the corporate and university sector as well as indications of validations by a well known statistician and a major pharmaceutical company. I obtained one reference from a long term user who supply ingredients for pharmaceuticals. They are glowing about the software, both in terms of user friendliness and company support. They use it for product and process developments, both to find acceptable working ranges and optimums. Information is also used to help clients optimise their processes. Staff find it very easy to work with, use it in the majority of projects and think it represents good value for money.

The software is reasonably stable under Windows XP but crashed at odd times and frequently indicated “Error occurred. Recommend restart Fusion”. Overall I am impressed with the features of this user friendly software, especially the non-statistician automated route, the historic data analysis and the Method of Steepest Ascent option. The support service by e-mail is good. However reporting, graphics options and stability can be improved.

In comparison with other packages reviewed to date* it rates well and at only US\$495 with minor upgrades free, major upgrades US\$95 and no annual fees FUSION Pro should definitely be on your shortlist.

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