

Experimental design software ECHIP

By Anny Dentener

Software package: ECHIP 6.4.1

(with comments on vs 7beta, planned release January 2003)

Function: DOE, Experimental Design and Analysis.

Website: www.echip.com

Rating: ★★★★★ (4 out of five stars)

Ever wondered why your pizza development project never turned out as good a pizza as those you buy from Pizza Hut? This may be because Pizza Hut uses Design of Experiment (DOE) software to develop new equipment and food, and you are not. So why not keep using your classical “One-Variable-at-a-time” approach? Comparing results when changing one factor at the time can be both statistically meaningless (especially where differences are small in comparison to variability), can totally ignore interactions (more rule than exception!), and will never allow you to fully understand your product and process. With the need to deliver top results on short time lines, use of DOE can be crucial to get maximum result from minimum effort. More importantly, it tends to be the only way to discover that best compromise between conflicting objectives.

ECHIP has been around since 1983 and claims to be the world-leading experimental design software for engineers and scientists, offering a state-of-the-art DOE package in a form that can be used robustly by non-statisticians. It is fairly well known in New Zealand through past exposure in Massey University FTRC courses. The software has acquired the common Windows “look” and is available in a Macintosh version. Costs are US\$1,495 for a single license with an annual license renewal/upgrade fee (US\$150) required to keep design and analysis functioning. Special licenses are available for university staff (US\$500 plus US\$150 p.a.) and students (US\$75 plus US\$75 p.a.). Courses are run regularly in the US and Europe. So does ECHIP deliver an easy to use package for non-statistician food industry

users, and does it cover the essentials outlined in my DOE overview article (FTNZ, July 2001; and at www.foodinc.co.nz/SoftwareRevs.html)?

On start-up you are greeted with a thought or smile-provoking quote. The design cycle starts at the top and goes around clockwise

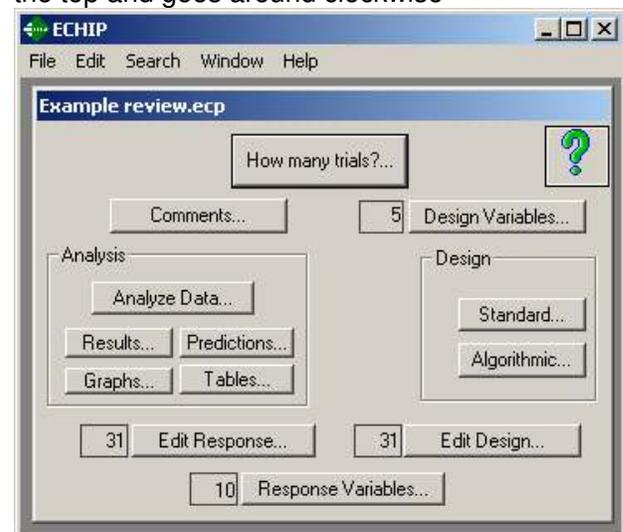


Figure 1: Interface showing design cycle

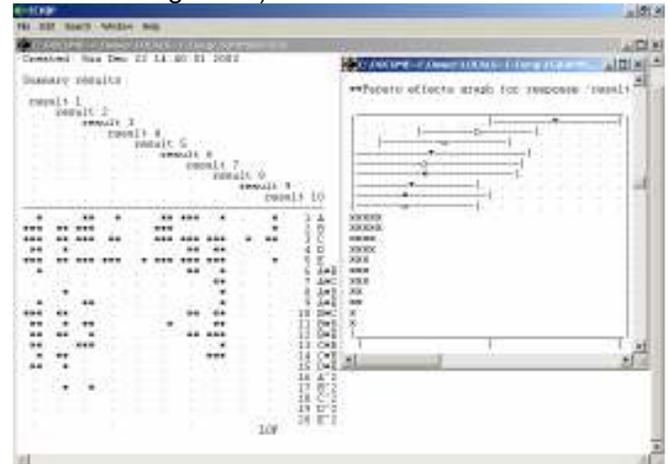
The “How many trials” dialog gives an indication about the number of trials required to find significant effects. For new developments where variability is unknown, I suggest you take big daring steps in your experiments. Advanced options for experienced statisticians are available here (indicated by a green door icon), and again in the design and analysis stages, but after a peek I quickly retreated. Start the design stage by entering input variables, choosing between continuous (e.g. for pizza: temperatures, times), mixture (dough ingredients adding up to 100%),

categorical (additive A or B) and/or block (runs grouped together e.g. oven lots) variables, and specifying their high/low limits and/or levels. This ability to combine mixture variables with other variables (additives, processing) is crucial for food developers. Entering of variables is very step-by-step and would benefit from a single entry sheet. An advantage is having the inputs sorted before deciding on a design.

Within “Design” you can choose “standard” ECHIP designs, claimed to be selected for greatest effectiveness, or choose special “algorithmic/D-optimal” designs for mixture designs and other tricky situations. Decide here whether you are still at the screening stage (finding the few significant factors), or if you want to know all interactions using a response surface model (RSM). In a screening design sorting out e.g. 10 variables only requires 18 unique tests (plus 5 replicates - default setting - and 1 centre point). Trials can and should be randomised to avoid bias, and constraints can be set when certain areas or combinations need to be avoided, e.g. don’t burn the pizza. ECHIP even allows you to use the screening results in a RSM design with an “augmentation step” by selectively adding trials. Fine in theory but in my experience initially chosen ranges for screening trials often need adjusting. Factorial and Tachugi designs are available but only recommended for statisticians. I tried factorial designs once with the help of the manual but found it hard to follow. Design settings can be overruled in “Edit Design”, which suits both historic designs and those occasions where you don’t quite achieve the exact set points. The “Help” files have some “how to” and several background statistic discussions. I found the manuals more useful.

Once a “Design” is completed, “Run Sheets” can be generated with room for comments and results, an excellent feature when having to weigh lots of different raw material combinations and when doing the experiments. Things you intend to measure are entered in the box “Response Variables” and results can be pasted into the “Edit Response” spreadsheet. “Analysis” follows, using the design chosen earlier, or a simpler model. The program deals well with “yes/no” answers but help of the manual for correct set-up may be required. Some “Missing data” can be accommodated, and this is indicated

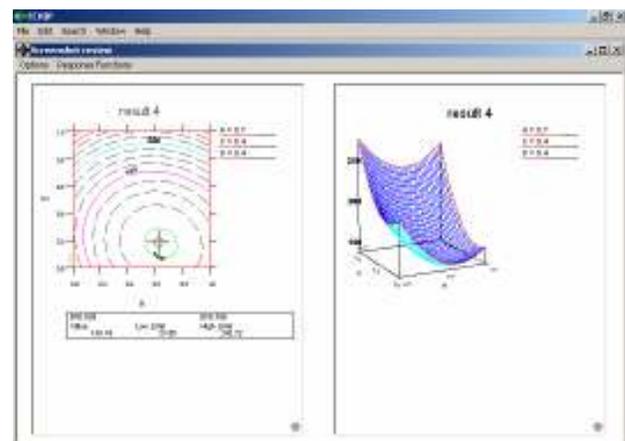
in the graphs. Once analysed I first check the “Summary” and “Pareto effects graphs” (effects sorted to magnitude)



Example of Summary Results, and a Pareto effects graph (★=5%, ★★=1% and ★★★=0.1% significance levels). Note Lack of Fit (LOF) indicating that the model cannot make the data fit.

In the same “Results” area useful statistical results appear, such as ANOVA tables. This area is not as clear as in Design Expert and offers no suggestions for “Transformations” (e.g. log of result) if/when required. Many of these results have now also become available in graphical form in ECHIP 7 beta.

The real fun starts with the 2D and 3D “Contours” (called “Graphs” in vs 7) plots



Example of 2D contour and a 3D plot.

which bring the information to life. Select two input variables for the X and Y axis and all other

factors are first set on their mid-points but can be changed to suit. Numbered coloured contour levels are spaced approximately one SD apart. Predictions outside the design area can be made but be cautious with that extrapolation. "Optimize" allows for searching for the "Maximum", "Minimum" or a "Seek Target" value for each result with the option to set "Constraints" on the inputs. I use this optimising feature a lot. Clicking anywhere in a plot gives the prediction for the result (with 95% confidence limits) and this point can be recorded for comparison in the prediction spreadsheet. The 3D option is good to visualise the effects. The plot can be manipulated 3-dimensionally but a return to "Default" setting would be welcome. Both graphs copy across well for reporting into Word or PowerPoint, but the 2D graph is of a better quality and generally more useful than the 3D.

Optimising more than one result for conflicting objectives is possible under "Contours" using the "Combined Responses" function, a confusing name. Responses can be in/excluded, set to "Maximum", "Minimum" or to a nominated "Goal", "Low" and/or "High" limits can be set and all weighted in importance from 0-1. The software converts this to a mathematical equation and the best solution can be found as another response under "Contours". Bit of a circuitous exercise that could be simplified, especially since you again need to activate the search for the best solution with the right hand click menu. Optimisation has been one of the most important features for me. I enter the optimum in the "Predictions" sheet which will then indicate all the results (with/without confidence limits), and I then decide whether I can live with the compromise or if rebalancing of the objectives is needed. ECHIP also features "Robust Tolerances", used to design sturdy processes, i.e. best result with least variability. I have never used this feature so cannot comment on it. In the new ECHIP version optimisation including "pass-fail" inputs performed fine, whereas this tended to crash in 6.4.1. Version 7 has two different optimising modes,

including a new one allowing "categorical" (e.g. additive brand) variables.

I obtained the consent from Pizza Hut, McDonalds Corporation and McCormick & Co to mention that they use ECHIP. One company was not willing to detail their use of the programme. Another has used the programme for 20 years and was really happy both with its performance as well as with ECHIP service. They in particular use the mixture design option a lot and highly recommend it. The answers of a 3rd company did not arrive in time. My experience with the company's response time to my queries is variable, taking from overnight or a few days, to weeks.

In 1998 I tested the 30-day demo for a clients' project and found the results so good that I promptly bought ECHIP and have used it ever since. Use tends to focus on more difficult, involved projects. Overall I am very pleased with ECHIP, however after reviewing other packages I can now also see some of its weak points. It is definitely user-friendly for non-statistician users with its step-by-step process, and default settings to guide you through. The 6.4.1 version was stable under Windows98 and XP, except for optimisations including pass/fail answers. One useful feature for me has been the option to place a Play/Demo version on a client's computer, covering only the results of their experiments. They can access the results and demos, run predictions and different optimisations, but cannot set up new designs or analyses. If you are looking for a DOE package I suggest you seriously consider ECHIP and download the software for a 30 day trial.

Anny Dentener is an independent Food Technology Consultant and a founding member of the FoodInc Consulting Group (www.foodinc.co.nz/). Contact: anny.dentener@xtra.co.nz