Breaking paper clips provides marvelous therapy for any number of problems: boredom, frustration, anger, or whatever. So it comes as no surprise that students enjoy doing in-class tests of clip strength.

Years ago, before too many new tools crowded it out, Stat-Ease regularly presented this exercise in their DOE workshops. The experiment builds understanding of variation and how it can be handled with simple comparative designs. For teaching purposes it works best if each student breaks two brands of clips. This provides data for a paired t-test, blocking out variability due to the tester. Here is the procedure:

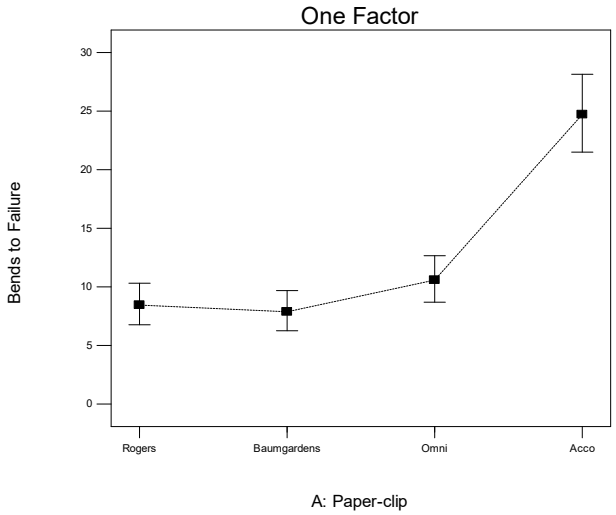
1. Randomly choose clip.
2. Gently pull it apart with the big loop on the right. The angle affects performance so be precise.
3. Move the smaller loop of the clip to the edge of the table (the big loop should now overhang).

4. Hold the small loop down firmly with your left thumb and forefinger. Then bend the big loop straight up and back. (This angle also affects performance, so be precise). Continue bending the big loop back and forth until it breaks. Record the count for each clip. (Each back and forth movement counts as 2 bends.)

In the process of developing this exercise, several brands were tested (results shown in parentheses):

⇒ Rogers #1 nickel (6, 8, 9, 12, 18, 3, 9, 13, 7, 4, 7, 9, 8, 11, 8)
⇒ Baumgardens #1 Golden (8, 3, 8, 10, 7, 8, 8, 10, 10, 4, 11, 8, 9, 6, 11)
⇒ Omni #1 Gem (4, 28, 12, 12, 27, 1, 13, 17, 8, 14, 1, 16, 10, 12, 6)
⇒ ACCO #1 (21, 27, 24, 25, 26, 25, 20, 28, 27)

Analysis from Design-Expert® software confirms what you can see from the raw data: The ACCO clips clearly outperform all the others. (If you have the software, you can verify this by entering data in a general factorial design and computing the ANOVA. Post-ANOVA pair-wise t testing is also a very useful feature.)



The first three brands (Rogers, Baumgardens and Omni) all incorporate a metal-plating that looks nice but reduces strength. (Non-skid clips also were considered, but the notches weaken them so much that they usually break on the first bend.)

After reviewing this data, Stat-Ease settled on the Rogers (nickel) and Baumgarden (gold) clips for its in-class experiment. (The Omni clips varied too much. The ACCO clips performed too well it takes too much work to break them.)

Several series of paired tests were conducted with 10 to 20 students each. The results consistently favored the Rogers clip by a slight margin over the Baumgardens. The difference was so small that it would have been obscured if each student had tested only one clip. But by having each person test both clips, an example of blocking, a clear difference often emerged.

Stat-Ease found the paper clips exercise to be a useful element in its DOE workshops. It nicely illustrated how statistical design and analysis of experiments can overcome variation. Plus the materials fit in a pocket!

Is all this data on lowly paper clips making you tense and irritable? That's easily remedied. Grab a clip and break it into little pieces. By the way, could you get a count on that?

Mark J. Anderson, Stat-Ease, Inc.

PS. Notice that I gave up on the Acco clips after breaking only 9 of them (versus 15 for all the others). Can I invoke a seven-year statute of limitations for slacking off like this? I hope so!

PPS. In a Winter 2002 article published by the *American Journal of Pharmaceutical Education* (V66) a University of New Mexico professor details how he used paper clips to run students through a mock clinical trial. The hypothesis was that breaking them provides stress relief. This exercise revealed many pitfalls to avoid in experiment design, such as not performing a power study beforehand to establish the required sample size. (See the next article for help with this.)