





## New Features in V13 of Design-Expert

Here's a wrap up of DX13 features that Martin Bezener demonstrated in his webinar on "Cutting-Edge Tools" on February 17\*:

- **Modify Design Space Wizard** – expand, shrink, or shift the design space, and fill with additional runs
- **Import Data Set** – bring in existing data quickly and easily
- **Poisson Regression** – analyze count data (0, 1, 2, 3...) *<= This talk*
- **Multiple Analyses** – analyze your data in different ways and store the analyses for easy comparisons
- **Round Columns** – make your factor or mixture component settings feasible to perform
- **Other Features** – Edit Constraints, Box Plot, UI enhancements

\*Recording and slides posted at

[www.statease.com/webinars/cutting-edge-tools-unveiled-design-expert-version-13/](http://www.statease.com/webinars/cutting-edge-tools-unveiled-design-expert-version-13/)

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1. The case for counts as a metric for success or failure
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## The case for counts as a metric



- ✓ Far fewer runs needed versus pass/fail (binary)
- ✓ Very common form of measurement for experiments, for example:
  - ❖ Counts of solder defects per electronic circuit board (Montgomery, Ex 1.1, *Design and Analysis of Experiments*)
  - ❖ Number of pulls to start a weed whacker (*DOE Simplified*, Chapter 5)
  - ❖ Colony forming units for an antiseptic formulation (Design-Expert tutorial)
  - ❖ Pits in the bottom of pre-backed pies (Client)
  - ❖ 'Fish-eyes' on a film (Client)
  - ❖ Hits on a web page
  - ❖ Many more

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## Alternatives for modeling counts

*Why they need special handling and how to do so*

### Attributes:

- ❖ Discrete whole numbers with no upper bound (not continuous)
- ❖ Poisson distributed (not normal)\*

### Workarounds:

- ✓ Square root transformation (ordinary least squares regression)
- ✓ Poisson regression (generalized linear model--GLM)

*V13 of Design-Expert provides both options.*

\* Famously used by statistician Ladislaus Bortkiewicz to kept track of Prussian cavalry killed by their horses between 1875 and 1894 (*The Law of Small Numbers, 1898*). Gruesome!

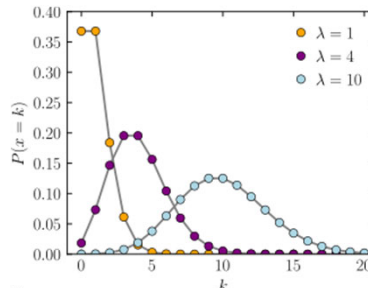
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## Further Consideration re Counts (and Poisson regression)

- ❑ A relatively rare event that occurs over a fixed area of opportunity.
- ❑ Need for special handling reduced as numbers go up (mean >20).
- ❑ Will not perform well with “too many zeroes”.
  - Aim for >20 counts per run when establishing your sample size
- ❑ The Poisson model restricts the mean and the variance to be the same. With large counts, unmeasured effects can increase the variability significantly beyond what is allowed. In such cases of “overdispersion”, the square-root transformation with standard regression may perform better than Poisson Regression.\*



\*(Introduction to Regression Modeling, Abraham & Ledholter, 12.4 Overdispersion)

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## Microwave Popcorn Experiment Measured by unpopped kernels (UPKs)

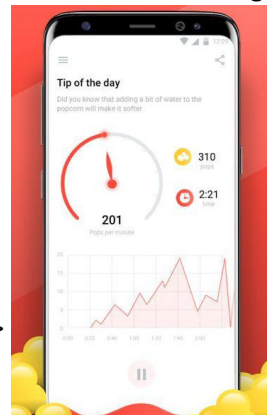
### Background:

Energized by Design-Expert’s new Poisson regression tool for modeling counts (and a new cellphone app!), I laid out a DOE aimed at reducing the number of unpopped kernels (UPK)—a far more precise measure than simply weighing them.

The experiment varied the factors

- A. Preheat with 1 cup water @ 1 minute,  
No vs Yes (a supposed “hack”)
  - B. Timing,  
GE default vs GE++ vs Popcorn Expert app =>
- in a replicated, 2x3 factorial (categorical) design.

*The results provided a huge breakthrough!*



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### An aside—learning by accident Importance of pre-experimental research and testing

While doing pre-experimental testing, I tried another hack—pouring the popcorn into a covered glass bowl. That failed completely—causing a very alarming “**SENSOR ERROR**”. It turns out that my GE Spacemaker uses humidity to for timing popcorn. The plastic cover prevented moisture from escaping. Oops! (Next time I try this it will be with a perforated lid.)

Upon researching the user manual for the first time since buying the unit 15 years ago (*engineers rarely read instructions*) and learning about the humidity angle for the first time, I discovered that pressing 9 twice after beginning the popcorn cook added 20 and then 10 more seconds (++) at the end. This was instrumental for achieving my breakthrough.

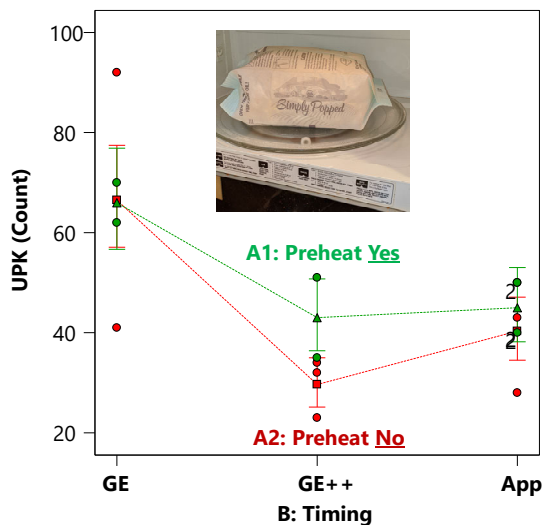
*Be careful if you experiment on microwave popcorn at your home or office! Safety first!*

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### The grand finale for my popcorn DOE Amazing! Awesome! Tasty!



*As you will now see demonstrated, Poisson regression revealed a breakthrough interaction that could not be seen otherwise.*



*Popcorn 2020  
Rebuild, show power 5/2 d/s  
Explain changes made*

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## Conclusions



- ❖ Counts serve well as a response measure—far better than binary results such as pass/fail.
- ❖ Expand the area of opportunity if coming out often at zero.
- ❖ Try several ways of modeling—no transformation, square root and Poisson regression\* and compare the fits.  
\*Note Design-Expert provides this special-model option only when it sees that all responses are positive integers. Watch out for typos!
- ❖ I remain a few kernels short of the perfect microwave popcorn: Great taste (no burning!) with zero UPK. But now that Design-Expert provides great tools for counts, I figure on more DOEs in future. 😊

*Give Design-Expert v13 a try!*

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## Stat-Ease Webinars

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statistics made easy®

*Make the most from every experiment!™*

*Even if only able to count!*

**Stay on for some chat if you like.**



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