Linda Quinn
Statistical Consultant
lmq2@po.cwru.edu

"Little lady, I have been packing boxes since before you were born. I don't care if you do have a fancy college degree and a whole lot of computer papers, it won't help you pack a box any better!" Here I am holding a handful of computer simulations and a list of heuristics for box packing and no one at this warehouse, especially this man who is older than my father, wants me to be there - let alone believe that what I did with a computer and some statistics will make the simple job of packing a box more efficient and optimal. How the heck did I get here?

I left grade school wanting to be a Ph.D. mathematician. I don't think I had a clue what either meant, but that's what I wanted. During math classes in high school, my teachers encouraged me to read about other math topics – topology, probability and statistics, engineering, and computers. In college, I majored in math taking all my electives in math type classes if possible – accounting, econometrics, statistics, finance, and computer science.

Straight on to graduate school where I could complete a double MS within two years, have my tuition paid, and receive a stipend. The possibility of an MS in applied statistics and a spare MS in computer science without going into debt - what a deal! Well, that sealed my fate. I fell in love with statistics and the power they had. Between the course work, teaching introductory business statistics, and working within the Statistical Consulting Center, I saw a lot of possible application areas for statistics. Math with applications that can get you a real job!

So that leaves me with my first "client." Wow, they didn't tell me about this in graduate school. If he had been doing this job for thirty years and I hadn't even set foot in this plant, how could I possibly be sure that my analyses for order filling would work? Sure, I had lots of statistics to back me up, but were they right? I started learning right then that the language and terminology of the client were important to understand engineers, physicians, econometricians, chemists, or warehouse managers. This skill has allowed me to learn about welfare reform, spinal anatomy, greeting card ratings, legal issues around determining oil royalties in Alaska, and how to pack a box. Good written and oral communication skills were important - to discuss and write results for all sorts of audiences from this manager on the factory floor to the company CEO or board of directors or to an expert advisory panel of the FDA. Visual arts are also important because a good graph is worth more than a thousand numbers, especially since some clients can interpret pictures better than reams of computer paper.

Since then, my tour of duty has included a wide breadth of applications: market research on greeting cards, legal work to value crude oil from Alaska, quality systems for manufacturing, R&D development of new products, clinical trials, poverty forecasting, health service research, and urban policy studies. And that was before I decided to try being a consultant. I really consulted in all my positions, as an internal resource and typically as the sole statistician in the company. For the last seven years, I've been doing it as a one-person statistical consulting company with many of my clients being former employers.

I love that statistics is very multi-disciplinary. It involves problem solving in a group environment and it involves many skills and talents. I love the ability to be a mathematician, computer scientist, teacher, quiz master, sleuth, and devil’s advocate all rolled into one. As it turns out almost all of my heuristics were right on target for packing boxes and they did help to make the process work optimally.

QED, quod erat demonstandum, which was to be proved - the classic end to a mathematics proof and sometimes the end to a statistical analysis, proving and disproving research questions, and an appropriate name for a statistical consulting company of one. I haven't forgotten about that Ph.D. yet - tune in later. Now, how exactly do you optimally pack statistics into a box?

Order Processing

Why aren't we selling more? The sales managers complained that the stores were leaving the shelves empty and that we were losing sales. The department store managers were complaining that their orders weren't getting filled fast enough. They can't sell what we won't give them. How do we get to the bottom of the problem?

Ask questions. How does an order get processed? First, the store manager fills out an order form and mails it to the company. The company processes the order and gets the order ready to ship. Then a trucking company delivers the boxed product orders to the store. Where is the problem? The company is sure it isn't them and the store managers are sure it isn't them - after all, we can control both of those processes.

It must be the US Mail System. Everyone always complains about the mail system. They never get anything anywhere on time. But how do we check if this is the problem or not? Collect data! For a three-month period, we asked store managers to write on specially colored envelopes the date and time the order was mailed. When it arrived in the mailroom at the company, it was date and time stamped. Sometimes, there was even a postmark that had a date as well. Now we had what region of the U.S. the order came from, what date it was mailed, and what date it arrived at the company. We can estimate the average mail time for different regions of the country and see if that is the problem. It wasn't!

So it must be the transit time to get the filled orders back to the customer. Maybe we should switch trucking firms! How can we tell? Ah! We can do the same thing - collect data and estimate the average transit times for different regions of the country and see if that's the problem. It wasn't!

So it must be us. How can we tell how long order processing takes? Collect data! As soon as an order was received, it was dated. When the filled order was placed on a truck it was dated. We can now estimate the average order filling time to see if this is the problem. It was!

(Use boxplots of data to draw comparisons.)

Body Fat

At the local hospital there is a health and wellness center that has a program designed to reduce weight and promote exercise. As an indication of how healthy a person was, the clinic uses body fat measurements. There are several ways to take a body fat measurement - measure skinfolds with pinchy calipers; use bioelectrical impedance that runs a small electrical current through your body; use a water tank to determine your underwater weight after you exhale all the air from your lungs; or use a water tank to determine your underwater weight after you take a maximum breath of air.

None of these are perfect because none of them directly measure body fat. There is only one sure-fire way to accurately measure body fat - cut you up, separate the fat from the lean muscle mass, and weigh it out. Not appealing options for a weight loss clinic that needs live paying clients.

Scientists feel the gold standard - the best and most accurate method - is the use of underwater weighing in maximal expiration (UWME). That is, sit on a swing in a water tank, blow out all the air in your lungs, dunk your head under water, and hold still while the technician gets an accurate read on the scale. Repeat two more times. Average. For most people, the idea of exhaling and then going under water is against their basic survival instincts. The center uses this method to get accurate data for its research studies and to counsel patients on their individual programs.

However, patients don't sit still for this, literally and figuratively. The center then may use the same procedure but let them take a big gulp of air before going under water, underwater weighing in maximum inspiration (UWMI). This makes some patients feel better, but not everyone. Lastly, and the easiest and cheapest method, is to have body fat estimated by measuring skinfolds using calipers (SKF).

So the center uses three methods - calipers and the two water tank methods to estimate body fat. How can we determine how different the results could be depending on the method used? Are they interchangeable? Are they close enough? Why torture clients needlessly?

The center decided to collect measurements of body fat using all three methods for over 500 patient volunteers. Now what? Let's use a scatterplot to look at the relationship between UWME and UWMI. If it was ideal and they both gave the exact same measurement of body fat, what would the plot look like?

(Build into regression and look for the y=x relationship)