

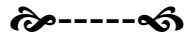
*“What is the use of a book,’ thought Alice,
‘without pictures or conversations?’*

*Lewis Carroll (Charles Lutwidge Dodgson)
Alice in Wonderland (1865)*



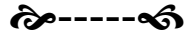
*I try to create sympathy for my characters,
then turn the monsters loose.*

Stephen King



*Characterization is an accident that flows out
of action and dialogue.*

Jack Woodford



*The best way to send information is to wrap it
up in a person.*

Robert Oppenheimer

The Players Appear

In which ...

*the gentle reader is introduced to the
main characters ...*

Perhaps “all the world” is a stage – but is it necessary for statistics and sampling to be *such* a drama? Angst, pain, suffering, confusion ... or did *you* have a different experience? There are, of course, people who actually like this kind of thing but they are a twisted and difficult bunch in general. You know this. Many of you have met them. Those who study statistics out of necessity can at least plead that they were forced into this perversion for a good reason. **There is, indeed, a good reason.** Few areas of mathematics apply so frequently and usefully to everyday life, let alone the expensive and sometimes important work that requires the measurement of things that naturally vary¹.

In this book, there are 3 major characters. They are augmented by a scattering of other actors when necessary, but these 3 do the heavy lifting. I didn't want to burden you with too large a cast, or ones with complicated names. Therefore, we have :

The Compassman (Lem)
The Nun (Vi)
 and
The Steakhouse Statistician (OH)

One of the astronomer Galileo's most famous books (*Dialogue on the Two Chief World Systems*, 1632) was written with a cast of 3 characters. One character served to ask honest questions, and was in a sincere search for understanding. Another (Simplico) put forward the politically correct dogma of the times and the church. His final character brought out the logic that Galileo wished to present to the readers of his book. I leave it to the gentle reader to assign the proper roles to our 3 characters.

¹ OK – addition and subtraction – I admit it. Unlike statistics, however, the *philosophy* of these is not important. Statistics is about logic rather than mathematics. This is why, at some point, it really helps to understand some of that logic - whereas you can just DO addition quite mechanically.

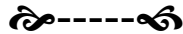


The Compassman

Known around the company as “The Kid”, this young man was only recently hired by the firm. He was being groomed to run the Forest Inventory department by a Vice-President who had an eye for talent. His acceptance of the job had some odd provisions. The Kid insisted that he be hired as a compassman to work on a typical field crew 3 days a week, with no special treatment. The rest of the time he would work with a mentor to learn the business. This was in spite of his being nearly finished with a Masters Degree in Forest Biometrics at a good university. He also requested that his education be kept quiet during this time. His previous experience in life convinced him that there was much to learn from people “on the ground”, and that future credibility, competence and respect would require spending some time there. He knew “what he didn’t know”.

The Kid’s final requirement was that a former associate be brought out of retirement for at least the same 12 months, as a resource for both the company and for himself. The Kid set up his office in the “bull pen” with the other timber cruisers working for the company.

He went by the nickname “Lem”, for reasons he never revealed to anyone. He had a name, but for the first year nobody outside the personnel department ever knew what it was.



The Nun

She had actually been studying to be a Catholic nun several years ago. She had a deep natural affinity for authority, discipline, and the infallibility of her causes (and of her “elders” in the chain of command). She had a love for authoritative books. She instinctively and rather shallowly accepted the official version of everything, no matter what the situation. She bore suffering well. *She was a natural*. She did, however, have a fatal flaw. She flunked the humility requirements. She just couldn’t do it, no matter how hard she tried. The Mother Superior finally threw her out of the convent for the good of everyone involved. It was the right decision.

Consequently, she cloistered herself in the math department at a nearby university. They had it all too – complex arguments, dogma, great books, and *certainty* above all else. *She was a natural*. Unfortunately, she did not have any instinct for abstract mathematics. She was just as smart as the other students, but she lacked the odd wiring that made a natural mathematician (although her lack of humility fit right in). So, she stepped onto the statistics track, which had better job prospects and paid better too. One could easily imagine the Nun standing before a mirror prior to her Masters Degree oral exam, repeating “Mirror, mirror on the wall ...”

She graduated with a Masters degree, overseen by the locally famous (but otherwise unknown) Professor Smiley of that department. Professor Smiley arranged for The Nun to be hired by a lackluster Vice-President who was not involved with forest inventory, and she was duly installed in a paneled office several floors above the undisciplined practicality of the field crews. She brought to the company her previous commitment toward righteousness and toward any form of written authority that was handed into her keeping. She *didn't* know “what she didn't know”.

Her real name was “Vernonia” - apparently for a town in Oregon where her mother had grown up. That sounded good as “Sister Vernonia” but in her secular life she chose to be called “Vi”. It also sounded a bit like the Greek letters used in statistics, which she enjoyed. She adopted the title “Statistical Officer”² for herself, and began to send “discussion papers” around the company to straighten out procedural heresy and misguided beliefs. She was also writing several statistical articles that she planned to publish. She was in the *very* early stages of that life-long journey from cocksure ignorance to thoughtful uncertainty.

She had actually attained her original goal (although she was perhaps the only one who did not realize it). She was, indeed, *a novice*³.

² There never seems to be a “Statistical Lance-Corporal” in the world. They are all *officers* – and typically get exactly the respect they deserve from the troops. Lem posted the title “technical expert, third class - probationary” over his own desk.

³ Let me assure the few Catholic readers of this book that I mean no disrespect to their religion. The thing is ... the Catholics just *have it all*. Divine guidance, sin (original sin, no less), devils advocates (now dismissed), doctrine, dogma, scholarship, saints, holy scripture, infallibility, it just goes on and on – not to mention the inquisition and the scrap with Galileo (oh – that brings to mind heresy, persecution and redemption). If there is a natural religion for most statisticians, it *has* to be the Catholic model. I must admit that my knowledge of religion is not scholarly, so perhaps I have missed something here. At any rate, it seemed natural for Vi to be Catholic, so I decided she might as well be *very* Catholic.



The Steakhouse Statistician

He was called “OH”⁴, and like The Kid he had another name but it didn’t really matter. He might be the nearest thing to our hero in the story.

Little was known in the company about his past, but he seemed to have one. Apparently he had an advanced degree in Biometrics (perhaps a Ph.D., but there was nothing hanging on his walls, so one could never be sure). It was, however, clearly not from a math department. Apparently he had worked in the woods enough to know his way around a bit, and appeared to actually enjoy the somewhat unruly and Lutheran kind of company provided by timber cruisers and other working folk.

The rumor was that he had once been pensioned off from a larger forestry company because of some kind of hassle with a “senior person”⁵. Small items in his office hinted that perhaps he had traveled in Tibet. Recently, he had been running a steakhouse nestled into a sunny California vineyard⁶ and had been living reasonably well from the proceeds of his small private forest. Nobody knew why he had accepted this job.

Although he made some practical suggestions to the working classes and seemed busy enough, nobody knew exactly what he did. He set up his cubical in the middle of the timber cruisers area, and seemed content with the same lack of space and non-privacy that they enjoyed. Later, some would say that this was just a ploy to overhear interesting issues whenever they popped up, and perhaps to let the cruisers eavesdrop on his thoughts whenever OH wanted to introduce changes to their field procedures.

⁴ “OH” was pronounced as though it was a pair of initials (O.H.) but he preferred to write it without these periods (“full stops” to you Canadians, eh). Out of respect for his wishes, I have done the same.

⁵ Readers of an earlier and more technical book might recognize OH. In “chapter last” of that book OH had a very “Sherlockian” encounter with Professor Smiley and subsequently vanished. Like Holmes, he had apparently reappeared after a decent interval. It is possible there might be two people with the same name, but hard to believe there would be two with the same philosophy.

⁶ It pains me, this part of OH’s past. I would so much rather that he drank fine German white wines. Perhaps every character is better off having a minor fault.

Introduction

In which ... the gentle reader gets the scoop on what the author intends ...

I work as a consulting Forest Biometrician - a geek for hire, as it were. I think that a reader has a right to know about the author they are dealing with, so here is the short story.

- I have done quite a bit of forest inventory and legal work involving serious sums of money, and some academic work as well.
- My current business is strictly practical, although certainly not simple.
- My sympathy lies with the victims of statistics, not the victimizers.
- I think well of the working folks in the business, and it is my opinion that they are underrated - as sources of good questions, good answers and good judgment.
- For about 30 years, I have been trying to master the techniques of statistics and the wise use of those ideas.
- **This book is aimed toward those who must deal with the practical issues of statistics and who have had the usual courses so rich in detail and so short on insight and depth.**
- Mathematics will be kept to a minimum.

A friend suggested to me 35 years ago that there were “plenty of interesting train wrecks” to observe in any profession, and that it did little good for me to keep stepping between the trains. “You need to recognize when it is hopeless, Kim. Back off, and try to observe something about the process”, he suggested. “Why did it happen? How much did it cost? What was the fatal flaw? Was it worth saving anyway?”. His advice has done more for me in life than mastering yet another calculus technique. I wish I had met him sooner.

In this book I will be talking about ideas that I think are useful. Such ideas are a bit too dry unless you have a vehicle to carry them along – that’s why there are the story lines and characters in this book. History also suggests to me that a story format is more memorable and provides better focus than other approaches. **The chapters can be read in random order**, but it would be good to begin with the previous two chapters to get the characters sorted out. From there the choice is open, although there are slight advantages to staying with the sequence – but skip the chapters that do not interest you.

I have always admired the book “*Up the Organization*”, which used short topics, each self-contained and in memo format. I cannot write as well as Robert Townsend, so these examples eat up more space. I am sorry about that. I wish I could do better.

I intend to give opinions. If that bothers you, why not bug out now and save us both some grief? Is giving opinions less than professional or scientific? – no, it is not. What would give anyone such a silly idea? Please don’t make the mistake of thinking that because this writing is informal that it is less than *deadly* serious.

Many books involving statistics are meant as reference books. They are not inclined to be educational, only correct and error free. That’s why you cannot read them⁷. It’s not your fault. Even professionals have a very hard time prying the ideas out of them. It’s like trying to learn literature from a dictionary. Very few of these books will offer advice. That’s too dangerous – and too hard. **One of the problems with statistics is that it hides its philosophy behind a difficult wall of mathematics and detail.** My own opinion is that if you do not get around that wall in some way you will not be able to apply statistics effectively (or to protect yourself).

I give equal space to the business of developing a useful career. I think it is just as important as the technical issues of sampling and computation. The business is littered with people who wasted the only career they had because they did not understand this.

There are many advantages in writing a book for a field that does not actually contain a commercial market. Since there is little financial incentive, and because the book tours and groupies are non-existent, you might as well suit yourself and do something you consider interesting or potentially useful. **There is certainly no reward for doing this kind of writing**, especially for non-academics like myself. I once wrote a more

⁷ An exception in statistics writing would have to be “A Lady Tasting Tea” by David Salzborg, which treats big ideas with wonderful writing and deep understanding. I wish he was everybody’s major professor.

technical book for practical inventory people, so this one can be a wee bit lighter – not to be confused with “less serious”.

Now I dearly love academia, and might well have been there myself. I still teach courses, and love it, but usually I teach working people. Students taking statistics in a university are generally ill-served by their courses, except for a divine few teachers who can never be thanked enough. I had two such teachers ⁸, and consider myself more than blessed.

As a friend once said to me : “It takes 20 years to learn what is basic” let alone to master it. **In this field, as in sports, the basics count – a lot.** Unlike sports, there are places in this profession where you can continue to play for a lifetime (quite happily) without ever being dumped for consistently losing. Certainly the field of statistics and consulting in which I work has been more enriched by practical people than by academics. Interesting techniques are often published. Good mathematics, too. Little judgment and insight - unfortunately. Useful industrial psychology is not encouraged in most journals ⁹.

Those of us who clean up after some of these ideas and individuals find the work interesting, but our clients have spent a *lot* of money to amuse us this way. Consultants who make a living at this work do not usually maximize their net worth by giving away their best ideas, or revealing the way they actually solve problems. That does not mean that they are not out there doing it. They are just less visible, and very quiet. Over a glass of wine, they will share a great deal.

Another valued friend once said “**this profession is a system – inside other systems. Never forget that**”. He was dead right. Social systems, legal systems, tax systems, cultural systems, political systems – and they all have to be considered. There is little point in optimizing only one of these systems, especially if it throws the other ones too far out of adjustment. There is little hope of ignoring the other systems you are imbedded within. **Learn to observe and understand them.**

The problems I see in my work are seldom mathematical. How would a young graduate become aware of the practical issues or applications? By painful personal experience, for the most part, and some of that pain could be avoided if they were so inclined. **As in the military, there is something to be learned by being under fire with a tangible and personal loss at stake.**

⁸ Dr. Dan Brunk and Dr. Eric Särndal.

⁹ Except a rare few - like the Woolsey “fifth column” articles in the journal *Interfaces*. His old articles, very sadly, are not freely available on the Internet.

Perhaps these young people will be wise enough, deserving enough, or just lucky enough to meet somebody like “OH” and the other archetypes who inhabit these chapters.

When you have a clear and well defined problem involving only the need for an answer, then a trip to the statistics department is sometimes warranted. I have seldom seen that kind of problem. Certainly it occurs no more often than one time in 100. What is needed to solve the other 99 situations ?

May I suggest : judgment, insight, a deep understanding of what statistics and sampling are really all about, and an understanding of how projects go wrong. These do not come from taking more statistics courses. The scholarly variance contortionists we have trained at the PhD level often lack some of these vital skills.

I, for one, have never had enough of any of those virtues, but I keep trying. I work at acquiring these insights because I have *no choice*. If I could imagine away the real limitations or collapse the mathematics by a well placed assumption, then I would do it. I am as lazy as the next man.

There are some wonderful exceptions in academia. I have made it a point to meet most of the major individuals in North American Forest Biometrics, and to a lesser extent, the world as a whole¹⁰. There are only a very few in any profession who make central and lasting contributions. This is not to say that there are not plenty of chinks in the walls for the rest of us to usefully fill, but very few of us lay any serious foundations for the profession. Most of us are essentially worker bees who adapt ideas (or fail to, as the case may be). It's honest work, and often interesting.

The few who inhabit the uppermost levels in the profession are uniformly practical, insightful, curious, generous and delightful individuals. At the top levels there is simply no pretence or puffery. You see this even in the early stages of their careers¹¹. This extends, to a large degree, to the second level of talent. The third and fourth levels of the field can lose these characteristics rather quickly, however. Try reading the articles in Forest Science and see if you do not get the same impression. The policies of scientific journals, of course, make this impression even worse.

Many thanks to those who helped me minimize the errors I was inclined to make in this book. Any remaining mistakes are mine, and I do not mind having them pointed out if you are so inclined. For the foreseeable

¹⁰ Well, perhaps I have missed one of *your* favorites - but let's keep moving.

¹¹ You might find impatience, and some arrogance – but that mellows with age.

future, you can always reach me through my website¹². If you are a self-proclaimed member of the Grammar Police, please don't bother me. If you have a deep and abiding sensitivity to politically correct phraseology, please don't bother me. I suggest this for your own good.

I want to thank a number of people who have given me ideas, provided proof-reading and improved the content : **Kristen Berube, Chris Cieszewski, Eleanor McWilliams , Mike Fall, Jeff Kerley, Dave Marshall, Don Reimer, Jim Wilson, Jason Zayatz, and so many British Columbia timber cruisers.**

Unspecific thanks are also due to the *many* examples of bad decisions, bad behavior, bad management and sheer absurdity that are readily available in any profession. There is a good reason why timber cruisers must be patient, non-violent people; and there is a reason they can often be seen with a "1,000-chain stare" as they listen to people whose authority far exceeds their competence. You can't make up stuff like this.

My thanks to you all, advisors and examples alike.



A book dealing with statistics has a tedious subject to handle, and needs all the help it can get. If possible, read it with a good glass of wine at hand.

Kim Iles,
(Husband of the ever-patient Carolyn)
Nanaimo, British Columbia, Canada
May 28, 2009

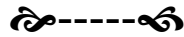
OK – on with the parade ...

¹² You can easily find my website by entering "Kim Iles" in any search engine.

The larger the sample size (n) the more confident you can be that your sample mean is a good representation of the population mean.

In other words, the "n" justifies the means

Author unknown



All mankind is divided into three classes: those who are immovable, those who are movable; and those who move.

Benjamin Franklin

A Sample Size is chosen

In which ... The arbitrary nature of the process is examined, and a few myths are addressed.

*The Nun gets a hearing,
and Dr Smiley sees an opening.*

Vi believed strongly that sample sizes should be calculated using one of the complicated equations that she learned from Dr. Smiley. Why had she spent all that time in statistics class if it was not really important? It was unthinkable. Although she had ignored OH's heretical procedures for the first few weeks of her employment, she decided that it was time to take a stand. Some recent inventory work had been done, and OH had set an arbitrary sample size of 150. Vi sent a memo around the company demanding that this decision should be reviewed. Betsy, the department secretary "mistakenly" left a draft of the memo where OH happened to notice it. OH was intended to be the last one to see the memo. Vi had made a mistake in doing that.

OH's Vice-President was confident that OH could handle the situation. He arranged to preside over the meeting on this topic, and said that Vi would have his full attention. In fact, the VP brought along a bunch of experienced senior managers – none of whom had an advanced degree. Vi thought that gave her an advantage, because *no doubt* they would be impressed with her Masters Degree. She also brought along Dr. Smiley. It was two against one, she reasoned. She had made the classic error of mistaking manpower for firepower. She and Smiley had reviewed sample size theory for a full day before the meeting, and they felt well prepared.

Smiley saw this as a chance for him to grab some consulting work. Although OH had been difficult to deal with on previous occasions, Smiley had been doing extra reading on this subject, and was loaded for bear.

OH, however, was more like a teddy bear – or so it seemed.

“We appreciate your coming, Dr. Smiley”, he said. “We are all prepared to reconsider the arbitrary sample size that I had suggested, and I wonder if the two of you can just lead us through the scientific issues here”, he said – all sweetness and light. Lem knew that this meant he was *really* angry at this put-up job, and at The Nun for organizing it.

Vi, as the good apprentice, started out. “Before Dr. Smiley gets into the complicated optimum forms of sample size estimation”, she said, “I would like to review the most basic logic for the managers present”. They all nodded their appreciation. Truth was, they were just there for the show. You could have sold tickets for this one.

“As you know, the most trivial and simple equation is :”

$$\frac{\text{Standard Deviation}}{\sqrt{n}} = \text{Standard Error}$$

“Now as we move up in complexity ...”

“*Excuse me*, Vi, I have a question here”, said OH. “I take it that you don’t just want to choose ‘n’, the sample size. Is that right? You really want to solve this equation based on the two other variables”.

The Nun thought that was just about the *stupidest* thing she had ever been asked. Of course you calculated sample size. It was in all the books. “Well certainly we want to calculate ‘n’”, she said. “I think it’s apparent that you can’t just *invent* a number in these matters”. *I think I stated that with appropriate academic firmness*, she thought. She was pleased.

“Well, **I** can do that”, replied OH. “We are all adults here. As sampling specialists we have judgment, we know what would be credible, and we have done this sort of thing before¹³. **I** have no problem choosing a number – it’s 150 by the way – I just wanted to make sure you felt compelled to calculate it. If it’s not right to simply choose ‘n’ then we have 3 coefficients and 3 unknowns in the equation. I suppose that you can just whittle that down with a little theory. Please continue, Vi”.

¹³ It was apparent to all in the room that The Nun and Smiley were not really included in the term “we” here – well, perhaps not obvious to those two.

At this point, Dr. Smiley smelled blood in the water. Perhaps he could score points early with this simpler material that the managers would understand, and he could build on that success later.

“*Excuse me, Vi*”, Smiley interrupted. “I think I can bring some theory to bear upon this situation. As all of you probably know, I teach statistics at the University, and this topic is one I deal with all the time. Now ...”

“*Excuse me*”, said OH. “Perhaps we could just cut to the chase. We know that you need to establish both of these unknowns. Can you tell me, Dr. Smiley, what the Standard Deviation is in this formula?”. OH seemed to give Smiley the perfect opening, and he grabbed for it.

“Well, let’s suppose that it is ...”

“*Woops* – you misunderstand me, Dr. Smiley, I was asking what the Standard Deviation IS in this instance. What is it for this population?”. Smiley froze for a moment. Nobody had ever asked him such a question. He was used to defining it. You just pulled a number out of the air and ... used it. The answer for an actual population? He was immobilized.

“Well, the point is ...”

“*The point is*, Dr Smiley, that *you don’t know* the Standard Deviation, do you?”, interrupted OH. OH allowed an awkward pause during which it was obvious that this was the truth. “*Troubling*”, said OH, “so I suppose that still leaves us with 3 coefficients and 3 unknowns. Hard to solve that sort of thing, as I am sure your mathematics training tells you. Just to help you out, let’s suppose that after *quite* a bit of work we have an estimate - not the right answer, mind you – but an estimate of $SD = 60$. That only leaves us with 2 unknowns. We seem so close now. Please continue.”

Smiley was not quite sure what had just happened, but it appeared that he had been embarrassed, and had no idea what the answer was for this actual sampling problem. That never happened during his lectures. Not a man to let that kind of thing stop him, he forged ahead. All he needed was one simple coefficient and he was home free. *Perhaps*, he thought for a brief moment, *I should have found out what this sampling project was all about.*

“That seems about right”, he said (after trying to look thoughtful for a few seconds), “Now all we have to determine is the Standard Error that is needed. Let’s suppose ...”

“*Woops*, pardon me again, Dr. *I don’t know* the amount ‘needed’, and *neither do you*. At this point, I have given you an answer for one of the 2 coefficients. You, however, now need one of your very own. Where are you going to get this Standard Error?”. At this point, Smiley started to lose

his confidence a bit. In class, he had simply picked a number out of the air. In the textbook, the “required” precision was always stated in the exercises. He had never actually thought about this. That didn’t stop him.

“I believe that the standard texts are quite clear about this OH, we simply ask the decision maker what he needs, and then ...”

“*Woops*. Pardon me again Dr. Smiley, but we are surrounded by decision makers here. In fact, these are exactly the people in the company who would make this decision. You could simply ask them”. OH sat back and waited for Smiley to bleed out.

“Very well”, he said. Choosing a manager at random he said “You over there ... could you give me a number please?”. “What kind of number?” was the reply. “Well, the required precision, of course”, said Smiley. “I have no idea”, was the response. “Well, we have to have one”, said the good Doctor – in the tone one might use with a graduate student.

The manager was not impressed. “Look, Bubba, this sounds like expensive stuff and I am *not about* to grab a number out of thin air. You asked what I ‘needed’ and *I don’t know*. I know of no such requirement. There is no company policy, no legislation, and if it existed it would be arbitrary and not based on any known ‘need’ – it would be as arbitrary as choosing the sample size directly. *I just don’t know*. What are the units for this ‘need’ anyway – dollars, Board Feet, field weeks - what?”. “Well”, Smiley replied, “I don’t think that matters”. This caused a brief silence in the room, reflecting how profoundly detached from reality his response was.

... *Woops* ...

Smiley now realized his mistake. These people were not students. He was actually expected to answer questions himself, and they were not going to give him a free ride. As always, he thought the best thing to do was to charge ahead. He tried again. “Well let’s assume that you needed ...”

“*Whoa*, Dr. Smiley, *Whoa*”, said OH. “We are still seeking ‘need’ here. It was, after all, your protégé here who insisted that numbers should *not just be made up*. Now I have never personally known anyone who knew what they ‘needed’ for a Standard Error, but maybe you can find one. The first thing we should do is ask if there is anyone in the room who knows. Hands up anyone who knows ... anyone ... anyone?”. No hands went up.

“So, Dr. Smiley, we are still stuck with 3 coefficients and either 2 or 3 unknowns (since you might not even accept my invented number for Standard Deviation). I have a suggestion”. OH nodded at the equation on the board.

$$\frac{60?}{\sqrt{?}} = ?$$

OH reached into his coat pocket, and fanned out ten serially marked \$100 bills on the table in front of him¹⁴. “Dr. Smiley, I propose to give you this \$1,000, *plus* your daily fee, *plus* a note of apology to be posted on the Internet if you can just solve this *simple* equation before we move on to the ‘more advanced’ methods. If you cannot, all I want is a note of apology from you and Vi here to be posted on my website. The only restriction is that you cannot just ‘invent’ a number as you *rightly* identified that I did – and which led to this expenditure of time and effort. The alternative is that you all walk away and agree that this problem needs no more discussion.”

“Deal - or No Deal ? ... Dr. Smiley ?”

The room went silent. Smiley realized that the game was up. Everyone else had realized that several minutes earlier.

The meeting was at an end. The VP tried to wrap it up politely.



Lem was curious why OH was so annoyed by this encounter, and when the VP took them both to a fancy lunch he had a chance to ask. “This kind of thing usually does not rile you, OH. What was the problem here?”. “Simple, Lem, this young twit and her jumped-up mentor tried to attack our credibility. In inventory, credibility is *by far* our most important asset. They also went about the issue in an unacceptable way. If Vi had come to talk to me I would have explained this to her, and she might just have understood, but she decided to stage this scene”.

OH put down his fork. “She puts me right off my fresh fried lobster. She is what we call a *regular academic clown*¹⁵. The university is too good an institution and too good an influence in the world to be represented by folks who do not understand the rudiments of their craft and have no manners. It’s a double loss. Let’s pray that she does not go straight back and teach. I think that Deming put it well when he said ‘a hack of a statistician should be learning, not teaching’ ”¹⁶

¹⁴ This was not the first time OH had done this to Smiley. Lem had previously heard OH’s story involving World War II, a Swiss bank, and the \$100 bills.

¹⁵ Apparently, OH was a fan of the movie “MASH”.

¹⁶ Deming “Out of the Crisis”, 1986, 24th printing, page 468

“Did they have any case at all here?”, asked Lem. “Nope”, OH replied. “Choosing either a Standard Error or a sample size directly are both arbitrary. The real issue was whether you can live with the Sampling Error you would get with 150 observations. If you were foolish enough you could calculate the Sampling Error that would *require* a sample size of 150, then pretend you wanted that SE all along, put it back into the equation and find (surprise) a ‘requirement’ of 150 observations as a result. Simple fraud”.

“In practice, the first thing the manager will ask us is ‘what seems like a reasonable goal for the precision?’ – probably in percentage form, or perhaps he would ask ‘what is the industry standard for precision?’. If Smiley did pick his ‘requirement’ out of the air and solve for a sample size, someone would immediately observe that considering the cost, the time limit, the manpower available or the psychology of the situation, some other sample size would be better. At this point they would adjust the ‘required’ SE together until the sample size was comfortable. I have seldom seen it done any another way”.

“The thing that intrigues me here” OH continued, as he sat back in his chair, “is that instinctively I believe this young lady has something worth developing. It’s hard to explain, but I think she has just been criminally misled in the past, and she is worth more than is apparent so far”.

“Do you think this is over now?”, Lem asked “One can only hope”, said OH. “But I doubt it. Wait until she finds out that the plan is to do a systematic sample rather than a random one. That should *really* set them off. Rookies of that degree are mesmerized by random samples”.

Another tangle like this? *Not likely after this embarrassment,* thought Lem – *she would have to be absolutely bonkers.*

Absolutely Bonkers

In which ...

*The Nun discovers that randomness is
not all it's cracked up to be,
and that the answer might
actually matter - sometimes more than
the statistics,
but that both can be accommodated.*

It was inevitable, perhaps. The subject of systematic samples erupted from the paneled office of the official Statistical Officer. Vi sent a memo around the company, and suggested that such sampling procedures were not acceptable, based on scientific principles¹⁷.

This time, The Nun didn't nip at the heels of OH. She attacked a project by Lem, who had suggested systematic sampling to a group of ecologists, and she brought up the fact that "any valid hypothesis test" would require a random sample - therefore "this unfortunate advice" should not be repeated in the future. In addition, she strongly implied that systematic samples were biased. Lem was grumpy. Another meeting was called. Dr. Smiley stayed home. This time it was just the main players. If she was to be outmaneuvered again, Vi did not want it done in front of the managers. OH had been right. She was able to learn - but not experienced enough to arrange the meeting when OH was out of the building.

¹⁷ The details were missing from her memo. Presumably this was because the huddled masses would not understand them anyway. She thought it sufficient that divine guidance was provided, and that the answer was revealed.

Vi arrived with her stack of statistics books. The opposition was empty-handed. So far, everything was going well for her.

“I can understand”, she said, in as gracious a tone as she could muster, “that the *practitioners*¹⁸ prefer to do systematic sampling. The advantages in cost, time and difficulty are obvious. I even understand that it is so much easier to spot a missing data point on a map. My concern, however, is about the sampling error calculations that are critical to analyzing the data”. “I see”, said Lem, “and I feel your pain”. She ignored this, and continued.

“My first point, she said, “is that there is a problem with the bias in systematic samples. As you can see from some of the pages I have marked in these texts, this can be a problem and I think we want to avoid it”.

“Don’t be daft”, said Lem. “Systematic samples, just like many other samples that are done correctly, are certainly not biased. All that is required is that the items have the same long-run probability of selection”. The Nun bristled a bit when it was suggested that her near-biblical text references were inappropriate or even incorrect.

OH did her the courtesy of quickly scanning the pages. “I am familiar with the material you are referring to here, Vi”, said OH. “They are all examples where something vaguely ‘systematic’ was done, but done *incorrectly* so that the probabilities of selecting observations were not equal. There is absolutely no doubt that when the probabilities are equal (as in Lem’s study) the estimate is unbiased. You have not read these pages carefully enough. If you doubt this, I can give you the phone numbers of the authors and you can ask them directly”. This astonished Vi. Were these people still alive? Who would have thought of just asking them?

OH continued. “Samples in which some parts of the process are random while other parts are not random have the same problem. The selection probabilities can be unequal, so the *overall* selection probabilities are not correct – and therefore the samples are biased. It happens all the time. It’s not a problem with ‘randomness’. The discussion here today should assume correct procedures.”

I sense thin ice, Vi thought. *Best to keep moving*. “My second point moves into the serious statistical realm”, she announced¹⁹. “With systematic samples we cannot compute valid Standard Errors. That

¹⁸ By this she meant “the little people” who merely went out into the cold and dangerous hinterland to bring back the raw data for her to bless.

¹⁹ Imagine this conceit - as if data was created only to allow complicated and “serious” statistical manipulation, rather than mere averages. Dr. Smiley had done Vi no favors at school, and she had lost sight of the importance of averages.

eliminates any valid scientific hypothesis tests. She pronounced the term “scientific” with reverence.

“Look, sister”, said Lem. “Nobody cares about hypothesis testing. The ecologists are trying to find the average here, and nobody even contemplates computing other statistics. Didn’t you read the study plan?”. She had not, of course, and she could not imagine stopping the analysis at the point of only having a simple average.

“What’s more” said Lem, “the managers *don’t want* to see statistics. They all had a miserable time in statistics class at business school and are looking for a dog to kick. If you start spouting that stuff they will start kicking at *you*. They want the answer, and they want someone to say something like ‘... *and the data is adequate to make decisions with. The details are in this stack of material and it could be put up on the projection screen if you want to spend the time*’. The chairman will not want that. You have done them the courtesy of doing the detailed analysis while sparing them the tedious bits. They want to depend upon your personal credibility to know that they can use the numbers in examining the bigger picture.”

Not want to see the statistics ?, thought The Nun. *How could anyone feel that way ? Best to keep moving ...*but OH interrupted again.

“You might want to read those sections again”, said OH. “What they say is that a *single* systematic sample does not offer any estimate of the Standard Error, just as (usually) a single observation of any kind would not. You could perfectly well do a hypothesis test using an assumed Standard Error. You don’t require the data Standard Error to do a hypothesis test.”

Darn, she thought, *perhaps I should have read all the way through this project material before I shot off the memo*. She vaguely remembered that you could do a hypothesis test with an assumed Standard Deviation (and thereby an assumed Standard Error). It was never done in school, of course. She remembered that a Binomial average implied a Standard Error at the same time, but could not quite see how this applied. Was that estimate for random or systematic samples ?²⁰ *Best to keep moving*

“Well in this case we only have a set of measurements from one grid”, she announced, “and therefore we have a problem. Technically the answer is a ‘cluster’ which provides only one observation. I admit that if we had several independent grids on that area we could get a valid sampling error, but that is not the case here”.

²⁰ It was for random samples – systematic samples typically have better precision. Although exceptions can be constructed, they never seem to occur on the ground.

OH agreed. “It’s true that a solitary systematic sample will not provide a valid Sampling Error statistic (that nobody wants) to do hypothesis testing (that nobody wants), but the point is that we are virtually certain to get a *better average* (which everybody does want). A decision will be made based upon that average (regardless of the Standard Error), and we want the best estimate possible. If we had cared about the other options, we would have used several grids. At worst, we would compute a Sampling Error estimate that is virtually certain to be too large (and therefore conservative) by using the standard equation for random sampling.

Lem defended his approach. “We took the precaution of doing a simple simulation, and once the bugs were worked out of the computer code we were able to estimate that when we geographically spread out the samples they were 8 times more efficient than when we used a random sample. It would have been 15 times better if we had pre-sorted the data based on rough estimates of the measured characteristics²¹ but we used a simple grid because the psychology was so much better”. *Psychology*, thought The Nun, *what’s that got to do with it?* The point is that everything that we know about the process indicates that we will get a much better answer with this process, and it is clearly unbiased”.

“Well, perhaps I was hasty”, Vi admitted. “I can see your point. I would like to reread some of this material, and maybe this process is OK. Perhaps I should have asked you directly”.

“Too late, I am afraid”, suggested OH. “Your Vice-President has already had lunch with the CEO, and the ecologists have been told ‘from on high’ to take random samples. They are now faced with 8 times the cost per unit of precision that they want to obtain. No doubt they will remember you in their wills.”

“This meeting is over”, announced OH.

He and Lem then went off to one of their weekday lunches, where they often discussed how things happened in the company.

²¹ As they say – “your results may vary”. Check it out.



“That girl does show promise”, said OH, who was actually quite upbeat during lunch. “Did you see how quickly she picked up the fact that you could use several grids and get a valid Standard Error?. It was poor preparation going in, but a pretty fair recovery on the spot.”

“She’s an unctuous twit”, replied The Kid. He was thinking of the botched project design. At this late stage it couldn’t be fixed without embarrassing upper management - and that was not about to happen for the amount of money wasted. He could only hope to make sure that the ecologists were well aware that it was not his own error. Still, it reflected badly on everybody who did statistical work.

“No”, suggested OH. “She’s not hopeless, just hapless. She’s been raised badly (in the professional sense). We all need a little adjustment early in the career when we are young and stupid”.

He stared pointedly at Lem for a moment. *Yes, Lem thought, I do remember being there not so long ago. Message received.*

“I don’t think she will be sending many unseen memos of the same sort. She needs some calibration and she has a way to go yet, but there is always the hope of redemption”.