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HOW TO BUILD AN ORSA ON A SHOESTRING,

AND WHY IT IS IMPORTANT

A WHITE PAPER

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WHITE PAPER
How to Build an ORSA on a Shoestring, and Why It Is Important

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INTRODUCTION:

Operations Research and Statistical Analysis (ORSA) has been an established profession for over 50 years. It is the discipline of applying advanced analytical methods and mathematical models to improve our knowledge of and design more useful, efficient systems. The modern field of Operations Research (OR) is generally acknowledged to have its roots in the events of World War II, where problems of probability were applied to war effort questions. To name just a few: optimal convoy size, enemy damage to returning bombers, and their optimum formation spacing to minimize mission losses. The Science of Management was already well established. Traditionally OR has attracted detailed and mathematically oriented individuals from a variety of business and technical fields. Many of OR's earliest practitioners and thinkers (e.g., Patrick Blackett, Cecil Gordon, C. H. Waddington, Owen Wansbrough-Jones, and George Dantzig) were either engineers or scientists.

Mathematically and technically oriented individuals are hard to come by. Traditionally, ORSA has been a rather rarefied and elite area of endeavor, both because of their mathematical ability as well as the cultural realities of the organizational hierarchy. With the exception of managerial and analyst positions, most employers have been lackadaisical in their efforts to ensure that their employees have sufficient statistical skills. Unless there is an immediate need, there is little forecasting of future needs for statistical skill-sets, nor very much thinking outside the circle on how an organization might profit from homegrown statistical talent, or how this might be achieved.

The professional workforce, however, is growing increasingly reliant on statistical skill-sets. The ability to understand how to generate statistically significant nominal, ordinal, and interval data, how to use various statistical methods to describe and test hypotheses against it, and how to analyze its results, will be the next "high demand" skill-set in tomorrow's professional workforce. The current trend in process control and process improvement will require it. Process efficiency without the ability to measure and subsequently analyze the results of target processes is not possible without a sophisticated knowledge of statistical methods.

Even the relatively recent interest in Statistical Process Control (SPC) and Six Sigma, has not seriously changed this dynamic. Statistics and statistical analysis continues to be viewed as an "elite" skill-set, outside the job role or job responsibilities of most workers. This bodes well neither for governmental nor private sector employers. The price of any commodity in short supply will only increase as demand increases.

The changing requirements of the workplace - i.e., the business need to implement and maintain an on-going process improvement effort within the enterprise - has changed our acceptable level for minimal skill-sets. We require functional workers, particularly <u>experienced</u> functional workers, to have a substantive knowledge of statistical methods and their analysis.

This divide between "non-statistical" functional workers and statistically savvy management and Operations Research and Statistical Analysis (ORSA) personnel continues to act as a constraint upon process improvement success. Precious time, effort and resources are already wasted in the seemingly endless cycles of ORSA-Functional meetings, where each tries to explain to the other their own world-view, without much success and with consider-

able gnashing of teeth. ORSA lack specific functional knowledge; Functional lacks the understanding of the requirements of statistical methodology. Neither has the capacity to communicate concepts critical to the other. Invariably, the result is a power-struggle in which teamwork and trust - if they existed at all - break down.

A common language is required: the language of statistical probability.

Unfortunately, the teaching of statistics is one of those subjects that have generally not been done very well in the past. All too often, statistical acumen does not transfer to insight about the teaching of statistical concepts or its methodology. As a recipient of some of this training, - from both academic and non-academic sources - as well as someone who is also mathematics "challenged", the author believes he may provide some insights.

Sloboda (2005, p. 2) has noted:

> "Facilitators of statistics courses often present the material in an abstract lecture format, followed by illustrations of the concepts of the lecture using prototypical examples and textbook exercises. Before the class session is over, the learners are assigned problems to complete to be submitted for the next class."

Even assuming the completion of problem assignments, however, this does not necessarily correlate to the understanding of how to analyze the meaning of the results. Generally, problem assignments are uninspiring because they are not relevant to the student's experience or interests. The chances of any single individual or text being able to come up with a set of problems that would equally inspire all students is so low a probability that it approaches zero. Thus, with the exception of the exceptionally gifted teacher, or the exceptionally gifted student, statistics will remain a subject that must be endured, not mastered when taught in a cookie-cutter, institutional fashion.

A change is required in the dynamics, if we are to proceed forward.

1.0 A PROACTICE APPROACH TO STATISTICS TRAINING

As the author has pointed out in the past (Lefcowitz, 2006):

> "On the corporate level, certainly businesses recognize the need for specific skill-sets to meet organizational needs and future growth. Many companies train internally, and some even encourage skill-set training through educational grants or reimbursement. But only a few take a proactive approach."

A proactive approach is one that:

- Recognizes a skill-set that is either needed immediately, or one that is anticipated to be needed in the not-too-distant future;
- Identifies the constraints to fulfilling that need;
- Indentifies or develops "homegrown" resources; and
- Develops and initiates a plan of action that takes advantage of these resources - thus mitigating constraints - to achieve the desired skill-set attainment outcome.

A proactive approach can best be summed up by the unofficial mantra of the United States' Marine Corps: "Improvise, Adapt, Overcome".

Obviously, this is easier said than done. How then can we put this approach into operation?

Let us begin with the assumption that the need for a widely disseminated statistical knowledge and analysis skills are already perceived as being true. You are - after all - reading this White Paper. What, then, are some of the common constraints to statistical and analytical training? There seem to be four: lack of statistical acumen, lack of time, lack of personnel with mathematical and analytical skills, and lack of other resources and/or money. Let us take each, in turn, one at a time.

2.0 LACK OF STATISTICAL ACCUMEN

Someone - very likely a fairly large number of someones - in your organization has a firm understanding of statistical principles and methods. Whomever they are, whatever their job title, you need what they know.

Let us assume, however, for the sake of argument, that no one in your organization admits to having statistical and analytical skill-sets:

Then you are it, it is up to you.

So go out and get some statistical skills, yourself. Go out and take a brush-up college course. Go out and join the American Society for Quality, the American Statistical Association, or the numerous other associations that focus on statistics within your chosen profession. Get yourself certified in Six Sigma, first as a "Green Belt", and then as a "Black Belt". Better yet, become a Certified Operations Research and Statistical Analysts (C-ORSA ™) [1], first as a "C-ORSA-I", followed by "C-ORSA-II", and finally a "C-ORSA-III". Perhaps if you have the energy and the drive you may aspire to earn a certification as ORSA Trainer (C-ORSA-T). The point here is, you have to know what you are talking about, and you need to demonstrate that knowledge. One of the best ways of demonstrating acumen and commitment is through your own actions. That actions speak louder than words is proverb. The lengths that you have personally gone to, to learn all you can about the subject will speak volumes.

A wise, former sales manager of mine once inquired of me rhetorically: "Do you know what makes this country (the United States) great"? I was new to sales, and I had just stubbornly wasted considerable time and effort attempting to hit a "home run" sale, despite his wise counsel that I might be better served by not investing too greatly in one, single prospect. It came to pass that I had the unhappy duty of informing him that he had been right, all along. To say that I was disappointed and angry is an understatement. To his credit, my sales manager allowed me to ventilate my emotions for several minutes before he signaled a time-out. He impassively allowed me to spew forth my tirade, before he calmly leaned back in his chair and posed his question:

"Do you know what makes this country great?"

"No. What?"

"Everyone has the constitutional right to make bad business decisions… That's why they have bankruptcy courts."

My sales manager was right about my "home run" prospect; they did have the right to make bad business decisions, and if they made enough of them, they would be out-of-business soon enough. In either event, it was not my problem. Later on, in one of those delayed reaction moments, I realized that his message had been two-fold; I, too, had the right to make bad business decisions. I had wasted my time, and through my actions, I had lost an unknown amount of income in the process.

Once you have completed the task of rounding up and recruiting your company's in-house statistical talent, or becoming comfortable with statistical methodology yourself - in my own case, approximately a 3-year effort - you are now ready to persuade decision-makers to adopt your point-of-view.

If you are the boss of your organization, you have one less thing to worry about. If you are not the boss, then your first job is to convince your superiors of the merits of having an in-house ORSA. Your group of statistically savvy individuals - or yourself alone - must explain why a general familiarity with statistical methods and analysis throughout your organization is necessary to that end. When all is said and done, your efforts at persuasion will have either one of three outcomes. Two of those outcomes equate to a rebuff: either your initial proposal will be received with stony silence, or it will be rejected outright. In either case, do not pass Go, do not collect two-hundred

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dollars; start looking for somewhere else to work where there is greater receptivity to your ideas. You will not be happy where you are, and your efforts to improve your organization under its current leadership will be a waste of your own precious time.

If, however, the outcome of your initial presentation to superiors has a happier outcome, then you must be prepared to handle and overcome the inevitable objections that are sure to follow.

3.0 LACK OF TIME

Everyone perceives themselves as having too much to do, and not enough time to do it. We all suffer from the psychology of time contraction under stress. Paradoxically, we all also waste time; that is, we all fail to manage time wisely. Generally, however, if something is important enough we find the time to do it, regardless.

The argument of lack of time is almost always an excuse for someone who is really not interested in doing whatever it is they are being asked to do. It is time-tested put-off designed to change the issue from your request to their lack of time. Do not fall for it; there is always time to do something that all concerned agree is truly important.

Not many years ago, I was assigned a group of interns for a major federally mandated project for a large municipal government. The group was assigned to function as junior business analysts, under my day-to-day supervision. None had any business analyst experience, and few had any familiarity with business analyst tools or concepts. I got this plumb assignment because the kick-off tasks for the business process re-engineering piece of the project had been pushed back 30 days. In other words, I was the first available warm body.

The expectations for this group were low, and the entire intern effort was expected to last about 90-days. There was no training plan; there was no training budget. It was a task destined to fail if nothing was done to mitigate the circumstances. Fortunately, I already had a bag-of-tricks in my project manager's bag that I had used successfully in the past: subordinate-led staff meetings, and subordinate-led training.

Without going into great detail, the technique is based upon my own belief in the innate mentoring responsibility that the supervisor has to their subordinates. A supervisor's primary task - I believe - is to be a mentor, to mentor all their subordinates, not just the chosen few.

I generally try to have my weekly team meetings last no more than 45 minutes to an hour, depending on the size of the team and the requirements of the agenda, with 20 - 30 minutes reserved for team training. One of the first things I do when I have a new team that is composed largely of inexperienced individuals is to delegate responsibility of running team meetings away from myself to the entire team, under my supervision. After all, I know how to plan a meeting agenda; I know how to run a meeting; they do not. Why should individuals be put in the situation of learning these skills by-way-of trial-by-fire, after they have the weight of supervisory responsibility placed upon their shoulders?

At the initial team meeting, I also talk to the team about my performance expectations, as well as my skill-set expectations. I already know what my skill-set criteria are, and I may already have a good idea who has what skill-sets. However, I need to be sure, and I need to make it a group problem to be solved, not my problem, alone, to solve. This conforms to my management principle of placing everyone in the same foxhole, more formally known as a superordinate goal.

Based upon the skill-set needs, as well as the native talent and interest that reside within the team, a training agenda is put together by the entire team, to be implemented by the entire team for the entire team. Individuals are assigned specific training tasks, and instructed to develop a presentation outline for a 20 -30-minute presentation to the entire team, as a part of the weekly team meeting agenda. Each presentation is reviewed and approved by the supervisor, one week prior to the presentation. I always make it a point to lead the first training session because conflict resolution and conflict theory is almost never a subject that anyone other than me is knowledgeable. A stacked deck, but it gives me the opportunity to lead by example.

Once responsibility for the group training is established, the question of who has responsibility for running each of the team meetings in the schedule is established. Again, the agenda is reviewed and discussed with the supervisor, just prior to the meeting to assure that all necessary issues have been included. The rule is either the one who does the training ran the meeting the week before, or the week after. It is left up to the group to decide which they prefer. I like this method because it quickly shows who is willing to step-up to the plate, and who is reluctant. The reluctant team members need to be watched more carefully, and given more support.

However, the initial introduction of the subject matter presented at the team meeting is not the end of the process. The team is expected to start using the new knowledge in the performance of their duties, with the team-member presenter designated as the tier-1 subject matter expert. Since the team training is focused on skill-sets needed by the group as a whole, there is almost always a way to make sure that everyone gets the chance to hone their skills and become comfortable with the new knowledge. It also insures that everyone has the opportunity to take-on a leadership role within the group, on something.

Using this approach, the training up of my intern group was accomplished in about an 8-week period, with priority given to the top mission-critical skills. What began as the standard summer internship ended up being extended – because of the acquired skill sets and abilities of the entire group - to a yearlong project. Of the 11 interns in my team, four were offered permanent jobs by the customer upon their graduation, and one was retained as an independent contractor.

Obviously, I had some considerable advantages; interns are almost always eager to please. However, I have used this method with more experienced teams as well. The point is there is always time if you make time.

4.0 LACK OF PERSONNEL WITH MATHEMATICAL AND ANALYTICAL SKILLS

As someone identified by the educational system as a high school failure, I reject the general notion that statistical skill and analytical ability are only for individuals who did well in mathematics in school. I am not claiming an absence of a relationship between an understanding of mathematics operations and concepts to the understanding of statistics; obviously, the relationship exists. Nor am I claiming that everyone has equal native analytical abilities. We know that both attributes tend to be distributed normally.

I do question, however, the ability of our educational system to spark sufficient student interest and motivation necessary to overcome cognitive challenges. This is not entirely the fault of our educational system; our childhood and young adulthood is spent competing with and comparing ourselves to our peers. Often the outcome of this painful process colors what we believe we can and cannot do. Only as adults do most of us learn the futility of comparing ourselves to others. What may be unimportant or seem unattainable to a child or young adult, may become sufficiently important to an adult to motivate concerted effort and single-mindedness of purpose.

More to the point, the age of computers have given all of us an advantage not previously enjoyed by those who have preceded us: we have the ability to calculate, quickly and accurately, complex mathematical and statistical functions. We need not laboriously write out complex statistical calculations by hand, they and graphical representations of data distribution can be automatically calculated and displayed with a single m**o**use-click. In turn, this makes the art of analysis much more attainable. Confidence Level / Confidence Intervals, R-Square, Hypothesis Testing, Critical Values, and Tests of Significance are straightforward when coupled with graphical representations of data dispersal.

While only a few may have the temperament and mathematical ability to be true statisticians, most of us can attain enough statistical insight to function as first and second-tier statistical analysts within the context of our own professional and functional duties.

5.0 LACK OF OTHER RESOURCES AND/OR MONEY

Jeffrey S. Simonoff, a Professor of Statistics at New York University's Leonard N. Stern School of Business has self-published a short piece (Simonoff, 2006) in which he makes the argument that Excel (2002) is unsuitable for statistical analysis, because it is not a "statistical package". In his article, he gives an example how basic algorithmic instabilities of this version of Excel's regression function LINEST() produced incorrect answers. He then proceeds to discuss the problems Excel (all versions) generally has in properly dealing with missing data.
The solution Simonoff suggests is to perform statistical analyses using the appropriate tool - a "good" statistical package. He cites Minitab ("often costing $100 or less"), a powerful free package, R (www.r-project.org for information), or more generally the multitude of Excel third-party add-on packages that do not use the Excel algorithmic engine and who have carefully checked their own code own for potential problems.

One must remember to whom Siminoff is primarily addressing himself: his students. It is true; students are able to purchase Minitab for under $100. They are the only group that can. At the time of this writing, the best non-student single user price I have seen for the current version (Minitab 15) is just under $1000; a government single user price could expect approximately 20 percent less. Annual multi-user packages decrease the unit cost of Minitab considerably, but it is still a sizeable chuck of change to dole out for all but the largest organizations. The pricing realities of a "good" statistical package make widespread purchase impractical for use on an extended workforce basis. This acts as a constraint upon the organization's ability to train and implement any process improvement plans they may have.

What I take Simonoff to be saying to his students is, "Be aware that you may get misleading answers when you use Excel, particularly any version of Excel prior to the 2003 version. So far so good, but like Henry II's plaint about Thomas Beckett, one should not jump to conclusions and actually go out and rid the King of the troublesome priest.

A major DoD agency took the Simonoff article to heart to justify their position to allow only statistical analysis to be performed on Minitab. Let us be clear, the security restrictions on any government computer are severe and strictly enforced. Unauthorized software is not allowed to be loaded without first going through a careful vetting process, and then only by individuals who have administrator privileges. Most large companies follow similar practices. It is unlikely that Siminoff's suggestion to use a free package or some third-party add-on package is a realistic solution outside the walls of academia. In this particular case, the DoD agency never even considered these alternatives; it was Minitab, or nothing.

I am aware of no statistical computation properly performed using Excel that would have changed the ultimate business decision outcome had it been calculated, instead, on Minitab. The statistical criteria for accepting or rejecting the hypothesis take place before the statistical calculation actually occurs, and the analysis of the data is a direct outcome of the criticality criteria that have been pre-established for rejection or acceptance.

Is that, however, really the issue, here? Is it really about Microsoft Excel versus Minitab, or Minitab versus some other package? Is it about which is better, really?

Whether you like Microsoft products or not, for the foreseeable future they are a reality, enjoying a worldwide market share on-the-order-of 90 percent. Is Minitab more powerful than Excel? Yes. Is it more accurate and reliable than Excel? Sometimes. Does that imply that organizations should not attempt statistical analysis without Minitab? To my mind, this makes as much sense as a man marooned on a desert island that refuses to build a shelter due to the lack of "appropriate" tools. If you lack a hammer and nails, figure out what you do have and start using that, instead.

Virtually everyone in the business world has Microsoft Office on his or her computer at work; the vast majority of businesses and governmental agencies do not have to buy any extra software to get started on establishing an in-house ORSA.

You use what you have available at the time, and worry about doing better later.

6.0 WHY A "SHOE-STRING" APPROACH TO ORSA IS IMPORTANT

ORSA - and for that matter, business process improvement - is a team activity. It is the capability of the team, not its individual members, that has the greatest impact. ORSA requires both functional subject matter experts (SMEs) who are familiar with the operational process being studied, as well as statistical SMEs who are familiar with the requirements of statistical methods and advanced model building. Neither is more important than the other; each should be given the weight of authority within their respective areas of expertise. An ORSA may be able to describe the statistical signature of a specific group of data, and perhaps in general terms interpret its significance, but only a functional SME can understand its nuances, and perhaps ascribe causality to correlation and non-correlation.

To do this successfully, however, both ORSA SMEs and functional SMEs must speak the same language. In the past, this was the case. OR originated as a discipline among mathematically oriented, scientifically trained individuals, to analyze primarily engineering phenomenon. Today, that is no longer the case; OR has moved to the entire range of business and logistical endeavors. The professional elite distinctions of the past are no longer applicable in a world where change is constant and hard-to-find skill sets are difficult to fulfill using traditional approaches to human resources.

To continue the man marooned on a desert island analogy used above: let us suppose that instead of one, there are two castaways. Let us further suppose that neither speaks the same language, and each has a very different idea of what a "proper" house should be. Would they not need to figure out some way to communicate so that they could work more efficiently as a team, as well resolve potential conflicts?

In the case of business process improvement, that language is the dialect of statistical probability. Presuming the existence of a seed of statistical know-how, virtually every large and medium sized organization has the raw materials available to them, already, to start an in-house ORSA; they have the people; they have a perfectly acceptable first-tier statistical software package that is already bought and paid for. The real question is: will they have the political will and managerial savvy to implement.

Again, as a sales manager of mine once said, "Everyone has the constitutional right to make bad business decisions…"

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