PHILOSOPHIES AND PRINCIPLES OF CONTINUOUS IMPROVEMENT AND PROCESS MANAGEMENT

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The Perversity Principle (in Tribus, 1989):
"If you try to improve the performance of a system of people, machines, and procedures, by setting numerical goals for the improvement of individual parts of the system, the system will defeat you and you will pay a price where you least expected to."

The Need for Objectively-based Operational Systems in Pig Production:

Pig production continues to become increasingly business-oriented, yet has lagged far behind most other industries in terms of implementing process improvement and objective operations measurement systems. These other industries have applied such operational systems for decades – those based on the principles of continuous process improvement and statistical process control (SPC).

Pig production advisors throughout the world have long made good intentioned efforts in interpreting and acting on what they sincerely believe to be meaningful changes in performance from week-to-week and month-to-month – relying on experience for making beneficial recommendations. Yet, given the nature of production processes like those in pig operations, it will invariably be the case that credit is accepted for improvements and/or blame is assigned for decreased performance that simply did not exist. Learning and understanding the fundamental principles and techniques of continuous process improvement and SPC will enable production advisors to make the most effective use of their time spent on interpretation of production information.

The natural tendency for operations managers is to focus heavily on system outcomes, such as profits, revenues, and expenses with not enough attention paid to how they are obtained and improved. However, *"Instead of focusing on outcomes, such as expenses and profits, this better way [continuous process improvement] focuses on the processes and systems that generate the outcomes." (Wheeler and Poling, 1998).* Further, *"Using short-term earnings as the only rigorous measure of performance leads many companies to place too much emphasis on reducing costs and too little on investing in the assets [usually people] that generate growth." (Reichheld, 1996).*

No one can "report" or "graph" their way to better production. By the same token, neither can they "process behavior chart" their way to continuous production improvement. However, the critical difference between conventional reports and graphs and process behavior measurement

(SPC) methods is that SPC methods serve as the measurement foundation for use as part of an objective and systematic process improvement approach. Conventional production record systems – as we know them today – do not come close to serving that purpose.

Continual Improvement vs. Conventional Management:

Continuous measurement is not the same as continuous improvement. Without a corresponding and appropriate response, process measurement is, by itself, purely an academic exercise. It isn't until we act on what we learn from measurement that we extract any value whatsoever from what it tells us. ***This requires a coordinated system of measurement and action.***

Figure 1 illustrates in simplified fashion a continuous improvement system. There are **seven** basic processes which comprise such a system:

- Ongoing Measurement Process
- Measurement Interpretation Process
- Diagnostic Investigation Process
- Production Evaluation Process
- Target & Specification Evaluation Process
- Target & Specification Adjustment Process
- Intervention Formulation, Evaluation, & Implementation Process

There are numerous methods and steps embedded within each of these processes, each with their own requirements for logistics and resources (e.g., personnel, equipment, materials) to operate properly.

Figure 1 helps put process measurement into perspective. While important, process measurement (i.e., SPC or process behavior measurement methods) is only part of an overall system of continual improvement. While the system cannot function *at all* without process measurement methods enabling system feedback, the measurement process alone will not lead to process improvement without the other critical processes in the overall system.

In practice, the use of SPC as the measurement component of a continuous improvement system is, computationally, relatively simple and straightforward. However, its proper application is not trivial. As with any method used to facilitate the operations of a business, the measurement process mechanics must be correct, as well as what is measured, who records the measurement data, and when measurements are taken. Further, who acts on what is measured and how they act on it represents the rest of the story.

Figure 2 illustrates, in simplified fashion, a conventional management system. There are **six** basic processes which comprise this system:

- Conventional Measurement Process

- Measurement Interpretation Process
- Diagnostic Investigation Process
- Target & Specification Evaluation Process
- Target & Specification Adjustment Process
- Intervention Formulation & Implementation Process

On the surface, there are some similarities between the systems of continuous improvement (Figure 1) and conventional management (Figure 2). However, if we contrast Figures 1 and 2, it becomes evident that, while Figure 1 is consistent with objective measurement, Figure 2 is driven solely by management-derived subjectivity. While some may argue that it is management experience that drives the conventional system, it is still experience based largely on subjectivity, art, and sometimes a "brute force" management style. Such systems may improve, but such improvement will likely be inconsistent and volatile at best, and occur often due to factors largely unrelated to, even in spite of, their management influence.

What's the point? – Establishing goals & objectives for continuous improvement:

Continuous Improvement and SPC, quality assurance and process behavior – these terms just have a nice "ring" to them...like they are something that we ought to be doing in the pig and pork industries if we're really serious players. But besides their "sex appeal", what's the point of all this continuous improvement stuff?

Good pig and pork production businesses have business goals (if not, then they really shouldn't consider themselves good businesses). The existence of goals and objectives imply that thing are being measured which will indicate whether or not a goal or objective is being met. Nearly all business goals are, in some way, financially based, or at least financially linked. This is all well and good. However, it is far too easy to place excessive focus on explicitly financial goals, and neglect the proactive measurement of how these goals are achieved.

With the methods of Shewhart, and Deming, we have the opportunity to objectively and proactively measure those processes that are responsible for meeting business goals. ***This can only be a good thing!***

There are various methods for establishing operational and overall business goals. Describing these methods are beyond the scope of this paper. However, some very good resources include the principles which make up the *Theory of Constraints* (TOC) described by E. Goldratt (Goldratt, 1990; Goldratt and Cox, 1992). There are a number of other resources as well, but these TOC resources constitute some that are important for creating a good foundational perspective for all business goals and objectives, as well as for providing a perspective with which to facilitate measurement selection and decision making in the pursuit of continuous improvement.

SPC – The Measurement Cornerstone of Continuous Improvement:

Walter Shewhart of Bell Laboratories developed a number of business production analysis techniques, collectively called "Statistical Process Control" (SPC), designed to facilitate the objective evaluation of business operations and production processes *(Shewhart, 1939)*. Dr. W.E. Deming recognized the value of Shewhart's techniques, and spent the rest of his natural life applying them as the critical measurement component of a 14-step continuous quality improvement / total quality management business philosophy *(Neave, 1990)*.

The methods of statistical process control developed by W. A. Shewhart and the philosophy of continuous improvement developed by W. Edwards Deming have been around for 70-80 years. They have been used, and used very effectively by many industries all over the world. Yet, most of us in the pig and pork industries are, at best, unfamiliar with them, while very few others are just beginning to learn about them and explore their application in pig and pork production. Why?

There is no doubt whatsoever that SPC, as the measurement component of a continuous improvement system, has and will continue to work very well on the factory floor – there is an irrefutable mountain range of objective evidence that has been accumulating over the last 70 years *(Neave, 1990)*, and continues to build *(Wheeler and Chambers, 1992, Wheeler and Poling, 1998)*. But, to acknowledge the doubts of skeptics in the pork world, can SPC "make the grade" on the pig farm?...at the feed mill?...in the packing plant?...in the processing plant?

We have been functioning within an industry where many believe "black box" variation and unpredictability are normal and that there is little or nothing we can do about it besides what we are already doing and have been doing for years. The self-fulfilling prophesy, *"If you keep doing what you are doing, you'll keep getting what you've been getting"* comes to mind.

Clearly, not everything new and different leads to forward progress or improvement. By the same token, neither can maintaining the status quo lead to forward progress or improvement. However, to make measurable progress, regardless of what you do to attempt to achieve it, you must be in a position to measure it, and measure it objectively.

Production processes don't speak English, Spanish, or Chinese. They have a language all to themselves. Fortunately, this language is universal – it matters not whether the process produces pork, beef, poultry, fish, cheese, computers, or cars. Process behavior charts (i.e., SPC charts) have the profound feature of being able to translate this "process language" into whatever language we happen to speak. We can then communicate with the process through our response to signals as well as efforts to change the process itself. However, that which a production process responds to (i.e., "hears") is not any of us declaring our production targets or specifications. Instead, the process responds to our actions *(Polson, 1998)*.

Purposes of Process Measurement (SPC): The SPC process measurement methods developed by Shewhart (1939) and described by others *(Wheeler and Chambers, 1992; Wheeler, 1993; Wheeler, 1995; Wheeler and Poling, 1998)* which document process behavior have two primary purposes for pig production:

- **Purpose 1:** SPC is a means to detect real problems (indicated by "signals" on SPC charts) that represent unexpected (i.e., "special cause") variation in the process being measured, prompting a necessary response, and avoiding the unnecessary and wasteful responses we are often tempted to make by responding to "noise" or normal variation (often called "Type I" error). Likewise, SPC is a means to prevent the treating of special cause variation as normal variation (known as "Type II" error).

This first purpose is oriented towards identifying problems and enabling correction of the assignable causes "foreign" to the production process on an ongoing and "real-time" basis. The goal here is to achieve and maintain a predictable (i.e., stable) process.

It is appropriate to note that, even though a production process may be predictable, the process performance may still not be acceptable. Hence, the second major purpose for SPC…

- **Purpose 2:** SPC is a means for measuring and enabling objective review of process performance to:

  (a) Determine if process aim and variation are acceptable as compared to the performance of other "like" processes in "like" systems *(Meredith, 1983)*.

  (b) Determine if process performance *(voice-of-the-process)* is meeting the expectations of the customer and management *(voice-of-the-customer) (Wheeler, 1993)*.

  This is the only occasion where it is appropriate and meaningful to use targets and specifications for comparison to actual process performance. It is here that management must decide if the process is not meeting expectations due to poor performance or due to unrealistic targets and specifications (Figure 1). This is where performance "benchmarking" is useful *(Polson, Marsh and Dial, 1998)*.

"I can't use SPC because…" Excuses:

"Biological systems are too complex, variable, and slow to use SPC."

It has been said that W. Edwards Deming chose not to pursue application of continuous improvement methods and SPC in agriculture due to their complexity, choosing instead to work to apply these principles to the simpler more mechanistic manufacturing industries. We are certainly free to use the excuse that, *"Dr. Deming 'gave up' on SPC applications in agricultural systems, so we surely shouldn't try ourselves in pig production"* if we wish. The three most credible justifications to support this excuse are:

- Biologically-based production systems are far more complex than the simpler manufacturing processes, with the influence of countless physiological and infectious processes increasing to their complexity over that of manufacturing.
- Due, in part, to their complexity, biologically based systems are far too variable, as compared to most manufacturing processes.
- Biologically based systems have naturally long cycle times (measured in months for agricultural processes vs. minutes/hours/days in many manufacturing processes).

However, we should challenge the clarity of our thinking if we take so much comfort in this excuse that we dismiss the application of the methods of SPC measurement and continual process improvement.

Too complex? Too variable? Such a position suggests a reluctance to expend the effort to understand a complex system in such a way as to distill it into its simple critical functional elements. It further suggests a preference to continue treating the complex system as a "black box", requiring natural artistic talent to get the most out of the "unknowable".

Once again, it is appropriate to quote Oliver Wendell Holmes, *"I wouldn't give a fig for the simplicity on this side of complexity, but I would give my right arm for the simplicity on the far side of complexity."* Which side of the production system mountain do we want to be on? No one is suggesting that the understanding of a complex system is easy and effortless. Clearly, a lot of work must be done to acquire the type of understanding that gets us to the "simplicity on the far side of complex". But if we are content to continue to reside in the simplicity on the "near side of complex", then we must continue to accept the volatile temperament and unpredictable nature of the "black box".

Biological pig production systems may be somewhat complex, but they are not "rocket science". And a key weapon to help us systematically work our way through the complexity of a complex system are measurement methods like those of SPC coupled with the wisdom of other "management focusing" methods like those outlined in Goldratt's Constraint Theory *(Goldratt, 1990; Goldratt and Cox, 1992)*.

Too slow, with too long cycle times? This is the only biological system argument that has any potential for credibility. One of the fundamental purposes of SPC is the use of the charted data to detect problems and resolve their causes "real-time" to minimize any ongoing negative impact these causes have in an operating production process. Fulfilling this basic purpose is challenged by long cycle times.

However, while long cycle times are clearly a challenge in establishing useful "in process" applications of SPC methods for pig production operations, they are in no way a "show-stopper". Where production groups (cohorts) are started on a regular basis, there are ways to achieve "in process" and "real time" measurement even where the cycle times of a process are long – providing the process manager opportunities to intervene and resolve causes of problems detected in the process. This is true even where, as is the case in growing animal production, what is being measured is changing throughout the growth cycle.

"Using SPC will just create more piles of useless reports and charts."
There is a temptation for those of us who have a genetic predisposition to an obsession with data is to apply a new or different way to present data and apply it to all the same countless measures that we "Dataholics" have presented at other times in other more antiquated ways. The "report everything" paradigm is one of the big quagmires that current production information management systems continue to be stuck in.

For the "recovering dataholic", the first step in any good "12-Step" program is to first admit that you have a problem. If there were such an organization as "Dataholics Anonymous", it would a sure bet that most of the rest of the steps in their "12-Step" program would be advocating the methods of continuous process improvement and statistical process control. There is no better way – properly applied – for "curing" the data junkie from an obsession with low-value measures, data, and information.

The "what" of System Measurement: If we earnestly commit to learning and properly applying the collective methods of continual improvement (process measurement, diagnostics, and intervention), as well as some other related operations management methods (e.g., Goldratt's Constraint Theory), we will learn how to more effectively manage with far fewer measures, not more. We may also find that some, if not most, of the measures we track today will not make the final cut, and that many of the measures we end up using are not those we are using routinely today.

Production system quality and performance measures could be divided into six basic categories:

- Operational measures (i.e., input and output volumes)
- Physical performance efficiency measures
- Financial performance measures
- Quality and conformance measures
- Standard operating procedure (SOP) compliance measures
- Standard of care measures

Examples of ***operational measures*** would be the number of herd genetic replacement animals entering, or the number of animals produced per unit of time. These types of measures are becoming more commonly tracked due to the recognition of their importance in measuring system output as well as for managing the flow of "work-in-process" (WIP). In conjunction with selected performance efficiency measures, output measures are the foundation upon which most bonus and incentive programs are based within pig production operations.

Physical performance efficiency measures are, by far, the most commonly used type of measure; and might include pigs weaned per breeding female per year, farrowing interval, average daily gain, percent mortality, and feed:gain ratio. It is within this category that we in the pig industry have consistently overused and abused measurement, to the point of mimicking the stereotypical sports statistician – who has yet to meet a set of numbers that couldn't be turned into a host of useless statistics.

Financial performance measures commonly used in pig production are net profit, revenue, and cost per pound; percent return on equity or assets; and debt:equity ratio. One only has to page through financial and managerial accounting references to understand that there are countless others. Given the importance of financial outcomes to any business, it is very easy for a system's management to become addicted to financial measures, even to the point of irrational and counterproductive behavior *(Goldratt and Cox, 1992)*.

Quality and conformance measures for work-in-process and final product are not commonly used in pig production. However, this lack of attention constitutes an increasingly serious oversight, particularly given the increasing demand for higher levels of quality and safety even within the commodity-oriented pig industries supplying food to the consuming public. Examples of quality and conformance measures could be percent of market animals (vs. pre-market or cull animals), or percent of animals exceeding a backfat/carcass specification.

SOP compliance measures are also a much-ignored measurement category. It is all to common a practice in the various pig industries to assume that outlined procedures are being fully and consistently complied with. It is here where we may find sources of variability in the processes which comprise pig production systems that contribute to more performance fluctuations than we could have realized. Examples of measures designed to assist system management and personnel with tracking procedural compliance fall into such areas as **health** (e.g., population response to immunization), **nutrition** (e.g., percent crude protein and/or energy content of prepared diets), **management** (e.g., number of inseminations per estrus), **environment** (e.g., high-low temperatures or temperature curves), and **genetics** (e.g., percent halothane gene positive).

Standard of care measures are those which should indicate the ability of animals to produce up to their sustainable potential within a pig production system. There may be a temptation to call this the "welfare" category; yet its focus is not just on the physical well-being of the animal, but also on the animal's readiness to produce at a level which it is genetically capable of. Examples of standard of care measures could be body condition scores, and backfat (of breeding animals).

In addition to these categories, we can also get some direction on measure selection when we consider why we are measuring at all. There are two basic potential applications of process measurement (SPC) methods in pig and pork production systems: [1] local "in-process" measurement, and [2] global operations measurement.

Local "in-process" measurement: The objectives of local "in-process" measurement target enabling system "front-line" personnel to…

- rapidly identify *("real time")* signals *(evidence of the existence of one or more special causes of variation in the process being measured)* which indicate a lack of predictability in the process being measured, and
- give them some direction with identifying and correcting the assignable cause(s) so that performance problems can be prevented or corrected for the *same* group of animals being measured and/or prevented for all *subsequent* groups.

Clearly, the need for the detection of signals to be as close as possible to the event(s) that cause them stems from the desire to rapidly identify and resolve the relevant cause(s) and, thus, minimize their negative impact on performance. Obviously, the further away you get from the actual signal-causing event(s) before the signals are detected, the more production there is that can potentially be affected by the cause(s), and the greater is the possibility that the signal-causing events will not be recalled by farm personnel (particularly where "notable" event records are not kept).

Global operations measurement: While very useful, the greatest value of SPC measurement methods may not be in its local in-process "real time" application. Instead, the greatest value may be in SPC methods enabling an objective measurement of system operations and the impact of proactive production process changes.

The objectives of global operations measurement target enabling system management personnel to…

- monitor the ongoing performance (inherent process variability, and aim) of all or portions of a production system (input consumption, output production and quality, and process efficiency), and
- assess the performance impact (physical and financial performance) of planned process changes over time in all or portions of the production system.

The value of efficiency and output measures for local in-process measurement is marginal, at best. In stark contrast, these measures are of tremendous value for global operations measurement. So what has changed? The objectives for global operations management are very different than those for local in-process measurement.

With global measurement, we no longer need to emphasize early signal detection. Process signals are not what we're primarily concerned with here. Rather, the emphasis is now on evaluating the process itself, comparing process performance (variability and aim) prior to, during, and subsequent to planned process changes. We are no longer focusing on process predictability and *special cause* variation. Instead, our focus is redirected to evaluating the ability of planned process changes to reduce *inherent* (i.e., normal or random) process variation and improve the aim (relative to target) of the process.

Some research has been conducted to determine which measures of breeding herd efficiency are most influential on overall pig production efficiency and financial performance (Polson, PhD Thesis, 1996). Some work has been done by Dial and co-workers in the mid-1990's evaluating the relative importance of breeding herd operational and efficiency measures on breeding herd output. Also, various researchers have, to a very basic extent, evaluated the relative importance of growing pig efficiency and operational measures on production output and profitability. However, considerably more work needs to be done in this area to better identify the essential measures for routine charting of data in pig and pork production, and avoid the all to common "cancerous" proliferation of measures that are charted simply because the data is collected and stored.

The Scope of CQI and SPC Applications: SPC is not new – it has been around and used by many industries for over 70 years *(Shewhart, 1939, Wheeler and Chambers, 1992).* Neither is SPC brand new to the pig industry. Yet, its usefulness has just recently been receiving the wider recognition it deserves.

The time is now to discard the current arbitrary methods of measurement and introduce ourselves to the measurement methods of continuous improvement, i.e., SPC, recognize their value for enhancing management of pig production operations, and start learning how to effectively apply them to our pig production processes.

There are today a handful of production systems in North America who have been making efforts to use SPC as part of a continuous process improvement initiative in their production systems. Others have (incorrectly) focused on the use of SPC as a technique, without such process measurement methods being positioned as part of a continuous improvement system. Those using SPC as just another way to represent data as a graph are either setting themselves up for disappointment, or are doomed to greatly under-utilize the potential synergy available when used as a component of continuous improvement. However, those using SPC as part of a continuous improvement system are setting themselves up to be vastly more effective managers of their business operations and co-workers.

Barriers to implementing continuous improvement:

The computations and techniques used for creating Shewhart's charts are relatively simple and straightforward. There are also quite a number of computer software programs available that use the correct calculation methods for charting. Clearly, the barriers for applying process measurement and improvement methods in pig and pork production are not technological. So where does resistance to implementing and operating continuous improvement come from?

A non-exhaustive list of sources for resistance are:

- The gravitational pull of "tradition" *("...we've always done it that way before, and I don't 'do' change very well...")*
- Fear of the new and unknown
- Fear of anything that looks, smells, or tastes "statistical"
- Fear of personal accountability
- Fear of objectivity & rigidity (loss of the ability to practice "art")
- Fear of "big brother" watching over
- Fear of disagreement

Four excellent resources (there are certainly many others) which delve into the foundational basis for these and other sources of resistance to change and teamwork, as well as the philosophies and corresponding methods which have been developed to facilitate change and teamwork are Pfeffer (1994), Kotter (1996), Reichheld (1996) and Scholtes (1998).

Implementing continuous improvement:

The burden of effective implementation primarily lies on the shoulders of those who advocate the changes. What are some factors under the control of the implementers that, when not done properly, impair effective implementation of continuous improvement efforts?

- Training & education
  - Goals & objectives
  - Roles & responsibilities of those involved in...
    - Production operations
    - Analysis & interpretation
    - Decision making and formulating action
    - Intervention implementation
  - Methods
  - Tools
- Automation

- Capturing data
- Moving and storing data
- Analyzing data
    - Problem detection
    - Identification of cause(s)
- Learning from the information
- Presentation of knowledge

- Relevance
    - To those in the barns
    - To those in the offices
    - To management and leadership

- Simplicity
    - …of the measurement process
    - …of process evaluation and diagnosis
    - …of target/specification selection ("benchmarking")
    - …of intervention selection and evaluation (PDSA)

- Clarity

Addressing these issues is fundamental to the effective implementation of process measurement and improvement efforts within a pork production system. Without effectively addressing these issues, efforts with implementation and continued operation risks, at best, ineffective application of the methods , and, at worst, failure.

<u>Familiarity vs. Execution:</u>

It is all too common a belief that, if we are <u>familiar</u> with a method, like those of continuous improvement, we can apply it effectively. Regardless of the method, experiencing any legitimate benefit espoused by its proponents distills down to proper execution, not familiarity. It really is that simple. Proper execution is a matter of only two things: [1] commitment, and [2] competence. Once a business makes the sincere commitment, developing a sufficient level of competence is achieved through a concerted effort into a cycle of education and experience. There are useful tools that can help us apply continuous improvement methods, but it is dangerous to think that even great tools will replace the need for our necessary intellectual effort.

<u>There are many excuses that have been used, and will continue to be used, to justify not exploring the application of Shewhart's methods and Deming's philosophy to pig and pork production. Some are genuine, all require an effective response for any hope for implementing process measurement and improvement.</u>

<u>The old adage, "you don't know until you try", applies. We can make all kinds of excuses and rationalizations not to try something new or different. We'll never</u>

run out of the "Yeah, buts". After all, paradigm shifts can be very painful, and often are.

One of the biggest roadblocks to effective application of continuous process improvement is a comfort with the status quo. It is natural to resist change, with this resistance even more entrenched where we're comfortable with the way things appear to be going. Only when we're sufficiently uncomfortable with our current state, or sufficiently curious about some unfamiliar innovation, will methods like those of continuous process improvement and SPC be considered and adopted.

This issue has been eloquently addressed by Wheeler (1995), in a product of his own education and experience:

"Statistical tools do not exist in a vacuum. They have to be used and used properly in order to be effective. The way a [business] is organized, and the attitudes of its managers, will determine if and how the knowledge created through process behavior charts (SPC) is used. Since most [businesses] are full of internal barriers to cooperation and communication, there is little hope that these tools will be used as effectively as they have been in Japan, unless the [business] culture is changed from top to bottom."

With the necessary commitment from their management, the effective application of process measurement and improvement methods holds tremendous promise for taking production systems within the evolving pig industry to a new and sustainable level of performance. Implemented as a coordinated system of continuous improvement, these methods will become essential components for operating the integrating and coordinating livestock businesses which will exist in pork production's future.

Today, we can speculate only on the magnitude of the tangible value which effectively applied continuous improvement methods will bring to agriculture. It will be all too easy for many in the pig industry to hold on to the familiarity and comfort of the status quo, providing various excuses as reasons not to begin adopting these methods. Yet, like so many innovations that eventually become accepted as standard practice, we'll likely be asking ourselves, *"Why didn't we do this sooner?!"*.

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